



Strengthening Mathematics and Science

Education in Africa

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Strengthening Mathematics and Science Education in Africa

SMASE-AFRICA



COMSTEDA 20 GHANA CONFERENCE HELD IN 2024

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PREFACE

Welcome to the Fifth Edition of the Journal for Science, Technology, Engineering and Mathematics Education in Africa (JSTEMEA)

The first blended (physical & virtual) Conference for Mathematics, Science and Technology Education in Africa [COMSTEDA20] was held on 22nd -25th, November 2024 in Accra, Ghana. The theme of the conference was, *“Teacher Professional Development in Africa: Knowledge, Skills, Values & Attitudes in STEM Learning Environments”*. Teacher professional development in Science, Technology, Engineering and Mathematics (STEM) education is a critical area of discussion owing to its importance in equipping learners with 21st century skills. Research in this area widens the scope of understanding context of STEM education and deepens knowledge and skills that respond to the needs of African continent.

The international forum focused on Teacher Professional Development in Africa towards developing knowledge, skills, and values in STEM learning and teaching engagements; School culture and learning in STEM towards creating supportive learning environments; STEM curriculum development, implementation and assessment; and ICT integration in STEM education.

A total of forty-four papers were presented during the conference. The 5th edition of the journal will continue to further trigger research in STEM education from early learning to tertiary levels of education. The edition contains fourteen (14) research papers that were presented during the forum. We thank the leadership of Uganda Institute of Information and Technology for hosting the conference in partnership with SMASE-Africa. Gratitude to the conference organizing committees with membership drawn from various stakeholders including country focal point persons for teamwork during planning and implementation of the conference.

Gratitude to all the SMASE-Africa partners for support in terms of material and human resources that immensely contributed to a rich event. To SMASE Africa delegates, participants, and paper presenters, we are grateful that you chose to be part of this great milestone and for valuable inputs during the virtual conference.

We hope that COMSTEDA 20 was a wonderful learning experience and look forward to seeing more research papers in COMSTEDA 20 in Ghana.

COMSTEDA 20 Organizing Committee

ABOUT SMASE-AFRICA AND COMSTEDA FORUMS

SMASE-Africa Association: was established in the year 2001 during a regional conference with an aim of strengthening mathematics and science education in African countries. The Association grew in membership to include representatives from ministries of education, STEM-based organizations or stakeholders with interest in STEM education in African countries. The members share innovative ideas and practices that are relevant to respective countries through conferences, technical workshops and exchange visits. The regional secretariat located in Kenya is hosted in one of the premises of CEMASTE. SMASE-Africa is also an affiliate member of two clusters of the African Union's Continental Strategy for Africa namely; teacher development and STEM education.

Vision: *"A leading organization in promoting quality STEM education in Africa"*

Mission: *"To promote quality STEM education through research, capacity development, advancing policies, good governance, collaboration and linkages in Africa."*

COMSTEDA International Forums: SMASE-Africa designed an international forum known as the Conference on Mathematics, Science and Technology Education in Africa (COMSTEDA). It is a continental platform for sharing innovative ideas, best practice and interrogating issues relating to Science, Technology, Engineering & Mathematics (STEM) education. The annual conference hosted by member countries or STEM-based organizations aim at building synergy in strengthening capability of youth in STEM subjects for 21st century living. COMSTEDA forums bring together; policy makers, researchers, teachers, educators, NGOs working in education, public and private sector. In 2001 to 2013, the regional conference was known as SMASEWECSA which was later changed to COMSTEDA in 2014. COMSTEDA 14 was held in Nairobi, Kenya (2016); COMSTEDA 15 Livingstone-Zambia (2017); COMSTEDA 16 Maun-Botswana (2018) and COMSTEDA 17 Nairobi, Kenya (2019), virtual COMSTEDA 18 hosted by Mozambique (2021), blended COMSTEDA 19 hosted by Uganda (2022), and blended COMSTEDA 20 hosted by Ghana (2023).

The objectives of COMSTEDA 20 were:

1. To bring together educators, governments, academic and private sector institutions to interrogate issues, share ideas on best and promising practices and challenges relating to the teaching and learning Mathematics, Science and Technology Education in Africa
2. To improve quality of education in Africa through sharing impact and research findings on classroom practices to inform policy and practice
3. To present case studies and research findings in Mathematics, Science and Technology Education in Africa
4. To promote and highlight the role of STEM education in the development of Education in Africa

EDITORIAL

Article 1

Presented by *Ebenezer Bonyah, Shashidhar Belbase, Seth Amoako Atta*. The paper titled: 'An investigation of the connection of Bloom's taxonomy to the core mathematics curriculum for Senior High Schools in Ghana'. This paper attempted to preview the connection of Bloom's taxonomy to Ghana's Senior High School mathematics curriculum. Mathematics is a vital tool for economic growth and national development as a STEM subject. Bloom's taxonomy, which presents a hierarchical model, helps educators teach school mathematics to enable students to acquire basic Knowledge known as Low order thinking (LOT) skills and develop higher-order thinking (HOT) skills. The analysis of the mathematics syllabus concerning Bloom's taxonomy revealed that the syllabus concentrates more on the three fundamental skills in Bloom's hierarchy in teaching and assessment. Remember 18.1%, Understand 33.3% and Apply 29.8% totaling 81.2%, leaving only 18.8% for the top three HOT skills. The study recommends that Ghana adopt a curriculum model that focuses on teaching transversal skills that can churn out informed citizens rather than putting students under the shackles of tests.

Article 2

Mapping STEM with competency-based education and assessment with STEM in a business-focused institution presented by *Nirmal Kumar Betchoo*. The paper aimed to assess how Science, Technology, Engineering and Mathematics (STEM) could be mapped within competency-based education and assessment in a business-focused institution such as SDIM which is a campus of Université des Mascareignes, Mauritius. Most higher education institutions advocate an outcome-based learning which focuses on what academics expect from students. The competency-based education approach differs in that it expects students to master essential techniques and skills which would directly benefit them. The challenge for universities is firstly to find out how they could better impart STEM education in the system as these are vital elements that must be integrated to achieve a holistic and effective pedagogy. At the same time, there is a need to identify competences within STEM education. The paper analysed the possibility of mapping STEM with competency-based education and assessments. Feedback was obtained from a panel of expert opinion within the university. The relevance of competency-based education was appraised while it was important to identify courses that

might blend STEM with competences. Though the task was challenging, the prospect for creating new programmes based on competences and STEM education remain valid at SDIM.

Article 3

The paper titled 'Teachers' Confidence of Teaching Mathematics and Science: Impact of Continuous Professional Development among 14 Districts in Rwanda' was presented by *Aimable Sibomana, Josiane Mukagihana, Joseph Ndiritu*. This study aimed at exploring teachers' confidence of teaching Mathematics and science as result of Continuous Professional Development (CPD) by the African Institute for Mathematical Science (AIMS Rwanda) through its Teacher Training Program (AIMS-TTP). It employed an ex post facto research design targeting 351 secondary school teachers. The findings revealed a positive and significant relationship ($p < .05$) between AIMS-TTP interventions and teachers' confidence to teach Mathematics and science. Besides, linear regression model indicated that the dependent variable Teachers' Confidence to teach Mathematics and science was regressed on predicting variables of improved capacity to plan, adapting teaching to the level of learners, ICT integrated in teaching and learning; learning from peers; addressing cross-cutting issues; use CBC to develop competences; and the use of the application of bloom's taxonomy. The independent variables significantly predict teachers' confidence of teaching mathematics and science, $F(7,326) = 183.843$, $p < .001$, which indicates that the factors under study have a significant impact on teachers' confidence of teaching mathematics and science. Our research suggests that policy makers should consider developing and endorsing training on innovative teaching and learning methods to boost teachers' confidence when it comes to instruction Mathematics and science at basic levels.

Article 4

Presented by *Aimable Sibomana, Josiane Mukagihana, Joseph Ndiritu*. The paper titled: 'Teachers' understanding of gender-responsive pedagogy and its application in the teaching process: Case after Teacher Training Program interventions in Rwanda'. The presented study explored mathematics and science teachers' understanding and application level of gender-responsive pedagogy after attending teachers' training programs interventions. A survey design was used and the study was conducted in 14 districts of Rwanda where the teacher training program implemented its activities. Purposive and random sampling was used to select 351 teachers who answered a web survey questionnaire of 0.71 Cronbach alpha reliability. Data were analyzed descriptively using Microsoft Excel 2016 while the hypothesis was statistically tested by STATA v.18. The findings revealed that after attending training, both male and female teachers hold a high undertaking and application of gender-responsive pedagogy at

percentages beyond 80% with an agreement mean estimation of ($M = 80.25$). There was no statistically significant difference ($\chi^2 (12) = 13.2500$ $Pr = 0.351$, $P > 0.05$) in understanding and application of gender-responsive pedagogy between males and females, between teachers in rural and urban schools Pearson ($\chi^2 (42) = 54.0000$ $Pr = 0.101$, $P > 0.05$), between teachers in boarding and day schools Pearson ($\chi^2 (20) = 19.0000$ $Pr = 0.522$, $P > 0.05$), and neither between teachers with 0-5 years and 6-10 years of teaching experience Pearson ($\chi^2 (36) = 40.5000$ $Pr = 0.278$, $P > 0.05$), 0-5 years and >10 years of teaching experience Pearson ($\chi^2 (30) = 29.2500$ $Pr = 0.504$, $P > 0.05$) nor between teachers of 6-10 year and >10 years of teaching experience Pearson ($\chi^2 (30) = 32.2500$ $Pr = 0.356$, $P > 0.05$). This implies that teachers increased equally their understanding and application of gender-responsive pedagogy. We recommend expanding similar training to teachers in other districts than those who received interventions.

Article 5

The paper titled, 'Perceived adequacy of entrepreneurship course content and entrepreneurship intention among library and information science postgraduates in southwestern, Nigeria '

was presented by *Adebayo Muritala Adegboye*. The paper investigated the menace of graduate unemployment pervades every nook and cranny of the African sub-region of the world and is more rampant in Nigeria due to its population. The Nigerian university system churns out a huge number of graduates on yearly basis to be confronted with the reality of unemployment. The situation is inimical to the environment and results in the idleness of youth who are, and should be useful in their productive years. Entrepreneurship has been proven to have a positive impact on students' economic prowess after graduation and various studies have indicated its ability to take people out of poverty. This study, therefore, modelled the entrepreneurship intention of Library and Information Science (LIS) postgraduates on the perceived adequacy of the course content of entrepreneurship courses taught while in school on the students' self-employment intention, type of entrepreneurship practiced and purpose of engaging in entrepreneurship. The research design is a survey of the correlational method. The sample size of 154 students, non-randomly (accidental sampling) drawn from the total population of all postgraduate students of library and information science schools in the southwestern part of Nigeria, was used for data capturing. The data-gathering instrument was a validated questionnaire ($r = 0.86$). Data were analysed through correlations and regressions following the

structural equation modelling procedure based on a 0.05 level of significance. Perceived adequacy of the course content of the entrepreneurship courses offered did not correlate with constructs of entrepreneurship intention (self-employment intention, $P = 0.051$), (type of entrepreneurship, $P = 0.113$) and (purpose of engaging in entrepreneurship, $P = 0.083$). However, perceived adequacy of the course content of the entrepreneurship courses offered ($r = 0.173$; $P = 0.031$; $p < 0.05$) correlates weakly with the entrepreneurial intention of LIS graduates (that is, self-employment intention, type of entrepreneurship, and purpose of engaging in entrepreneurship) when taken together. It was concluded that there is no association between the LIS entrepreneurship courses offered and the intention to engage in entrepreneurship by the LIS graduates. It was recommended that the curriculum of LIS entrepreneurship courses should be reviewed generally by all stakeholders including LIS lecturers, entrepreneurs, policymakers, and others to inculcate the new trends and practical activities that will engage the students in having practical experiences.

Article 6

'A Case Study of the Challenges and Successes in the Implementation of Blended Learning in Eswatini Schools as Perceived by Teachers' by *Philile Lindiwe Tenele Nxumalo* noted that the covid-19 pandemic served as a harsh wake-up call for Eswatini; at the time, the country's education system, particularly its schools, suffered greatly from a lack of a sound strategy to support online and distance learning. After discovering the value of this pedagogy, certain schools in Eswatini have made an effort to incorporate blended learning. Blended Learning implementation is one of the short-term objectives of the Eswatini education policy document, "2018 ICT Strategic Framework." This study employed a case study in Eswatini schools that have already adopted blended learning. The three phases of blended learning were divided into three categories for schools: (1) exploration; (2) early phase of blended learning; and (3) mature phase of blended learning. The purpose of the case study was to identify and elaborate on challenges and benefits of the implementation of blended learning in Eswatini Schools as perceived by teachers. It also sought to ascertain whether teachers in Eswatini schools are familiar with the 2018 ICT strategic framework that is found within the education sector policy. According to the research, phase 1 of blended learning, which is the exploration phase, was being used by all three of the selected schools. The study also revealed that there is a breakdown in communication between school administrators and instructors. All the teachers noted a number of benefits and difficulties with using blended learning.

Article 7

The paper titled 'TVET Innovations for Livelihood Improvement in the Informal Settlement: A Case Study of Eldoret Town', was presented by *Evans Ondati, John Kikwai, Loice Yator*. Our Study The study aimed at assessing the best agricultural innovations that would at least improve the livelihood of the informal settlers in Eldoret town, Uasin Gishu county. A survey was conducted in the two slums and appropriate innovations were developed. A modern chicken coop was developed to address poultry challenges highlighted by the slum dwellers

Article 8

The paper entitled, 'Should Universities in Africa Ban the Use of ChatGPT in teaching and learning?' was presented by *Faisal Iddris*. This study examined the integration of Artificial Intelligence (AI) technologies, such as ChatGPT, into higher education has sparked a contentious debate. This paper explores the question of whether universities should ban the use of ChatGPT in teaching and learning contexts. The discussion delves into various facets of this issue, including the potential benefits and drawbacks of ChatGPT, ethical considerations, and its impact on academic integrity. Drawing upon a comprehensive review of the existing literature and empirical studies, this paper provides insights into the multifaceted nature of the debate. While some argue that ChatGPT offers valuable educational support and fosters inclusivity, others express concerns about its potential for misuse and its impact on critical thinking skills. Ultimately, this paper seeks to contribute to a nuanced understanding of the role of ChatGPT in higher education and offers recommendations for universities to make informed decisions about its usage. It underscores the importance of striking a balance between leveraging AI for educational enhancement and addressing the associated challenges to ensure the integrity and effectiveness of the learning environment.

Article 9

The paper entitled, 'Assessing mathematics teachers' integration levels of Information and Communication Technology: a case of Ongwa circuit, Ohangwena region, Namibia' was presented by *Ferdina P. Albinus, Frans N. Haimbodi*. The paper focused on the integration of Information and Communication Technology (ICT) into the Namibian basic education curriculum is a pivotal aspect of the educational landscape, with the Ministry of Education, Arts, and Culture [MoEAC] highlighting its significance (MoEAC, 2016). ICT has the potential to transform education, not only reshaping the roles of teachers and students but also enhancing the quality of mathematics instruction (Zakaria & Khalid, 2016). This integration offers educators

the tools to improve lesson planning, teaching methodologies, and pedagogical knowledge, making it a critical consideration for the Namibian education system. In line with the developmental goals outlined in National Development Plans 2 and 3 (NDP 2 and 3) and Vision 2030, the Government of the Republic of Namibia (GRN) has introduced various ICT initiatives. These include programs like Tech/Na, NETSS, X-net secretariat, the ICT Literacy Foundation Curriculum for Literacy, ICT for Education (ICTED), and the Millennium Challenge Account (MCA). The MCA initiative, in particular, aimed to improve infrastructure in ten schools in Ohangwena and provided training to educators on utilizing ICT facilities (MCA-Namibia, 2014). Despite these provisions, the extent of ICT integration in mathematics education in MCA-affiliated schools remained uncertain. This study thus sought to assess the level of ICT integration among secondary mathematics educators in MCA-supported schools within the Ongha Circuit of the Ohangwena Region. The evaluation employed the SAMR model and aimed to assess the actual implementation levels, address any obstacles hindering the assimilation of ICT into mathematics classroom instruction, and propose strategies to overcome the challenges associated with integrating ICT into the educational framework of MCA-supported schools in the Ohangwena Region.

Article 10

'Influence of Coaching Teaching Style on Biology Examinations in Public Secondary Schools in Molo Sub-County, Kenya' was presented by *Julius K. Koskei, Ezekiel N. Omwenga, Enock Obuba*. The study investigated the influence of coaching teaching style on achievement of Biology in Kenya Certificate of Secondary Education (KCSE). in public secondary schools in Molo Sub-County. Objective was to examine the influence of coaching teaching style on achievement in biology assessment test (BAT); Anchored on constructivist theory by Lev Vygotsky, randomized pre-test, post-test with control quasi-experimental design was adopted. 191 students were purposively sampled from a population of 2800 from two students from four schools which were randomly assigned experimental group or control group with students in their intact classes. BATs and questionnaires were used to collect data from students and interview guides from teachers. Instruments validity was assessed through expert judgment and reliability through split-half method. The calculated r was 0.865 for the theory BAT and 0.823 for the practical BAT. The experimental group were taught using Coaching Teaching Style while the control group were taught using the conventional methods. The two groups of students undertook another BATs to establish the knowledge gained after undergoing a six-week lesson.

SPSS version 25.0 was used in data analysis. Descriptive statistics and independent sample t-test results revealed that students taught using coaching method had a statistically significant higher mean score in both theory and practical BATs than counterparts taught using conventional method. The study concluded that coaching improves students' achievement in examinations. It recommended that teacher training institutions should integrate coaching teaching style and hire more biology teachers to reduce class size.

Article 11

'Utilization of Virtual Physics Labs in Tertiary Education in the COVID-19 Era: Opportunities and Challenges'. The Paper was presented by *Omosa Elijah Mochama, Ezekiel Nyambega Omwenga*. This study noted how the world grapples with the novel coronavirus the COVID-19 pandemic. Virtual laboratories (V-labs) have been touted as an alternative to the real laboratory. The study investigated the opportunities and challenges of utilization of virtual Physics laboratory by trainees in the Craft Certificate in Science Laboratory Technology (CCSLT) in tertiary Physics in Kenya. The model of the study was founded on David Kolb' experiential learning. The study targeted all CCSLT trainees in Kenya and their trainers. The sample consisted of fifty-three (N=53) Second Year Physics trainees and four trainers from The Kisii National Polytechnic, Kenya. A survey research design was applied in the study. A questionnaire for trainees and an interview schedule for trainers were used to collect data. The instruments were validated by experts before use. A Spearman's Correlation Coefficient of reliability was calculated as $r = 0.79$ for the trainees' questionnaire and $r = 0.75$ for the trainers' interview schedule respectively. The collected data was analyzed using the Statistical Package for Social Sciences, SPSS-23.0 and results presented in tables and discussed thematically. It was established that virtual labs make trainees to enjoying learning physics, understand content better and as a result boost academic achievement. Virtual labs do not favour a trainee of any gender. Virtual labs allow the user to get experiences that are not attainable in the actual world; Allow for experiments to be done without any fear of depletion and also v-labs are a 'non-tiring teacher' and good for revision. V-lab help trainees retain content better but had no effect on retention of content based on gender. The challenges v-labs pose include; financial constraints, low internet bandwidth, lack of technical skills on e-learning by both the trainers and trainees and lack of interest and commitment among the trainers to use v-labs. The study recommended that trainees be given an opportunity to engage in hands-on Physics as it enhances learning by the trainees and innovative ways to be applied to mitigate challenges due to v-labs. The results of this study will

be beneficial to future researchers and educators who are interested in using v-labs in physics and related subjects at tertiary level of education.

Article 12

Muzenda A.C, Takavarasha S, Mugijima S, Masheka M, presented a paper based on a study on 'Use of e-learning management systems: A student perspective'. This study aims to understand how students perceive the usage of learning management systems. A descriptive survey design was used. A sample of 50 students was randomly selected from the Information Systems department. For data triangulation, 10 lecturers were purposively selected for the study. For data collection semi-structured questionnaire, focus group discussions, and online survey were engaged. Descriptive statistics were used to analyze quantitative data while qualitative data was manually analyzed according to emerging themes. Research findings show that implementation of LMS is at times punctuated with challenges such as poor Internet connectivity, exorbitant data, lack of knowledge and skills as well as insufficient student orientation. Furthermore, students showed that they were satisfied with the implementation of LMS and acknowledged through improved pass rate. The study recommended that training and workshops as well as investing more in appropriate mobile devices are an integral component in improving LMS implementation.

Article 13

The paper on Online Learning Modes and Learners' Safety Concerns in Zimbabwe's Marginalized Schools was presented by *Samuel (SM) Mugijima, Allan (ACM) Muzenda, Jeremiah (JM) Musariwa, Chikuvadze P*. The study explored Technological advancement has compelled transformation of classroom communication methods and modified instruction strategies. Online learning has made teaching and learning interactive and collaborative instead of the traditional teacher- talking and students listening approach. It is against this background that descriptive survey design was engaged to gain an in-depth insight on the effectiveness of implementing online learning activities in one peri-urban community. Sample was drawn from one peri-urban community population and 60 residents were selected using stratified random sampling procedure. The sample comprised 5 community I.T experts who were purposively selected. For data triangulation, 20 parents/guardians were randomly selected for the study as well as 20 teachers in the community under study and 15 secondary school students were selected into the study. For data collection semi-structured interviews and focus group discussions and online survey were engaged. Descriptive statistics were used to analyse quantitative data while qualitative data was manually analyzed according to emerging themes.

Mobile Learning theory and TAM formed the lens through which this study was observed. The analysed data revealed that online implementation was an important component in this information age in Zimbabwe as it facilitates ubiquitous learning environment. Research findings also show that to large extent stakeholders were not aware of online learning policies that govern learning activities. Furthermore, online activities showed some aspect of negative unhu/ubuntu in the community under study. Findings also revealed that integration of online learning face challenges such as lack of appropriate technological gadgets, exorbitant data and inappropriate technological knowledge and skills. Parent-teacher engagements during online learning activities were among strategies cited to reduce challenges. Therefore, the study recommended that training and workshops as well as designing systems that monitor learners online in learning institutions are an integral component in communities. The study suggests that further studies, which includes urban and rural location be carried so as to come up with an all-encompassing insight pertaining to best practices that enhance safety of learners online in Zimbabwe.

Article 14

The paper 'Assessment of students learning difficulties and misconceptions in electricity among senior secondary school physics students (male & female) in Ondo State' presented by *Edidiong Enyeneokpon Ukoh, Adeniyi Michael Adeduyigbe*. The study observed that efforts are being made by physics teachers and science education researchers to improve students' achievement but less attention is being given to misconceptions which most times impair students' conceptual understanding. This study therefore seeks to assess students' learning difficulties and misconceptions in electricity among senior secondary school physics students' in Ondo state. This study adopted descriptive survey research design. Purposive sampling technique was used to select six (6) secondary schools of the schools in Ondo West local government area of Ondo state involving 50 randomly selected students from each of the schools making a total of 300 senior secondary school two (SSSII) students. The research instrument used was a Simple Electric Circuit Diagnostic Test (SECDT) which was administered to test what they have been taught in the past. The data collected were analyzed using descriptive statistics of frequency count and percentage, and inferential statistics (t-test) was used to test the hypotheses. The results revealed that students find areas related to workable connection, magnitude of currents, and brightness of bulb difficult to understand and comprehend. Also, the study showed that there is significant difference in the male and female

students' difficulty in electricity, and that students from private schools had higher difficulty than their counterparts in public schools. It is therefore recommended that; teacher should always identify the misconceptions in topics they want to teach so that learning hurdles will be removed and students will be able to learn with ease.

Article 15

The presentation by *Sikutegemea Kikomelo, Laurent Lulu, Evelina Wilson* titled 'Analysis of Academic Performance Trends in Mathematics: A Study of Tanzania's Certificate of Secondary Education Examination for Eight-Years (2015-2022)'. This study examined Mathematics playing a pivotal role in shaping students' future prospects, particularly in fields reliant on strong quantitative skills like engineering, computer science and accountancy. This study aimed to: determine the Mathematics trend enrolment in Certificate of Secondary Education Examination (CSEE) from 2015 to 2022, analyse performance trends in Mathematics during this period, examine mathematics failure rate trends, and project future pass rates in Mathematics for the next eight years, from 2023 to 2030. An ex-post facto research design was used whereby all students sat for CSEE for the specified years (2015 -2022) constituted a sample size. The analysis done using Statistical Package for Social Sciences (SPSS) revealed a consistent rise in student enrollment. The pass rate was low as it never exceeded 21% throughout this period, while failure rates consistently exceeded 78%. Furthermore, the study predicted that pass rates will continue to be low from 2023 to 2030. The study recommends provision of teacher training in pedagogical practices and assessment, review of mathematics curriculum, improving learning environments, and hiring mathematics teachers in schools.

Article 16

Rashid J. Haji, Rose J. Shiyo, Nipael E. Mrutu, conducted a study on 'Exploring Effective ICT Integration Strategies in Education: A Case of Two Public Primary Schools in Mombasa, Kenya'. This paper explored the experiences of educators as they incorporate ICT into teaching and learning. The study was conducted in Mombasa City, Kenya, and utilized qualitative research methods, including in-depth interviews, focus group discussions, and classroom observations, in a case study design involving two urban primary schools. The research meticulously documented the experiences of 16 participants. The findings of the study highlight several advantages of using ICT in teaching and learning, including easy access to information, interactive and personalized learning opportunities, as well as collaboration. However, the data also revealed significant challenges faced by educators, such as unstable electricity, inadequate

ICT gadgets, internet fluctuation, and Lack of skills to integrate ICT into teaching. Educators consistently stressed the importance of continuous support and professional development to enhance their ICT integration skills. Furthermore, the research emphasized several promising recommendations, including the Installation of alternative sources of electricity, sourcing for additional ICT devices, Supervising learners while using ICT gadgets, conducting professional development initiatives tailored to the creation of a collaborative community of practice (COP), which have the potential to effectively address these challenges. To fully leverage the potential of ICT for enriching the learning experience, equipping students with essential digital skills, and preparing them for a digital-centric world, educational institutions, and policymakers must prioritize investments in technological infrastructure, and foster a culture of innovation and collaboration among educators.

Article 17

'A reflection on the implementation of STEM approach in Mozambique' presented by *Emília Maria José Guiraguira, Damasco Rocha Mateus Chalenga*. This study discovered that in actual society, characterized by systematic changes caused by the evolution of science and technology, the improvement of more challenging pedagogical practices based on contextualized and interdisciplinary approaches becomes fundamental to awaken curiosity and stimulate students' creativity in the teaching and learning process, science, and mathematics. This study aims to reflect on the implementation of the STEM (science, technology, engineering, and mathematics) approach in the Science and Mathematics classroom in Mozambique. The adopted methodology was characterized by a qualitative approach supported by a bibliographical review of the subject in study. From this reflection, the challenges in implementing this approach stand out: the lack of adequate teaching resources for curricular integration, the low participation of women and the limited capacity of the teacher to introduce teaching innovations and significant changes in curricular revisions, anchored to the development of transversal skills, considered fundamental for any citizen to face the challenges of the 21st century.

Article 18

The Paper titled 'Empowering the Next Generation through Innovative STEM Education' presented by *Rosemary B. Onyancha*. This study examined the examines cutting-edge teaching techniques with a focus on career promotion, mentorship, gender, inclusiveness, equity, and technology integration in order to address important concerns in STEM education. Even with

advancements in educational access, persistent gaps continue, especially in STEM sectors where female representation is lower, requiring focused interventions. With 270 respondents (teachers, students, and administrators) from secondary and tertiary institutions, the study used a mixed-methods strategy that combines questionnaires, interviews, and in-class observations to provide thorough insights. The theoretical framework; fusing feminist pedagogy and social constructivism acknowledges the value of collaborative learning environments and empowers underrepresented groups. Notably, data from Nakuru schools underscore the difficulties experienced by female teachers and learners, highlighting the necessity of inclusive practices. Significant findings show that there is a professional development gap that affects the quality of education. The advancement of educators is impeded by inadequate mentorship and career development, particularly for women in STEM fields. Furthermore, technology integration shows promise as a driver for inclusive and interesting teaching. The study's conclusion emphasizes the critical need for focused initiatives to reduce gender inequalities and improve inclusivity in STEM education in Nakuru. Strong professional development activities, increased mentorship programs, and the use of technology into teaching techniques are all advocated for in the recommendations. These steps are intended to create a climate that promotes fairness in education, gives every student support, and moves Nakuru's teachers closer to being world-class STEM educators.

Article 19

Design and Implementation of Science and Technology Curriculum presented by *Loyce Alinafe Chisale*. This study investigated Malawi Institute of Education responsible to design and develop the primary school curriculum and support its implementation. Science and Technology which is currently in use was designed and developed between 2001 and rolled out in 2007. Malawi adopted Outcomes Based Education which focused on learner-centered pedagogy and continuous assessment for improving learner achievement. The reformed curriculum was supposed to be reviewed in 2015 at the end of the eight-year primary cycle to respond to the needs of the Malawian society. However, the curriculum has not been reviewed since. Hence the need for a review of the primary school curriculum. This study forms part of the needs assessment of the curriculum review process to establish areas to be maintained, identify areas to be removed in the curriculum, find out areas new content to be added, establish challenges faced when teaching the subject, explore assessment strategies to be maintained and determine challenges faced when assessing learners in Science and

Technology. The study took the qualitative approach and data was collected from teachers and data was collected using a teacher questionnaire from 20 teachers from 10 schools in two educational districts, Blantyre Urban and Thyolo. The findings of this survey will contribute to the conceptualization of a new primary school curriculum in Science and Technology. The main findings of the study include: maintaining all topics with practicality, and real-world applicability, removing topics that are sensitive, redundant, and with no resources, adding new topics with an aspect of practical skills, current issues, technological literacy, and a strong academic foundation, lack of resources, large class hinder the assessment of the subject.

Article 20

Albert Chituka, Chipo Namakau Sakala, Benson Banda conducted a study on 'Transforming Teaching and Learning: The Role of Item Analysis Feedback in Instructional Leadership in a Rural School of Central Province. This paper investigated the transformative potential of instructional leadership in conjunction with item analysis feedback in a rural school located in the Central Province. The study explores how these components influence teaching and learning processes, with a focus on their impact on teacher planning, remedial work, and tailor-made professional development programs. In a dynamic educational landscape, the central question addressed is the extent to which instructional leadership, coupled with item analysis feedback, can catalyze positive change in a rural school setting. The research employs a comprehensive methodology that includes data collection through interviews, surveys, and observations. The findings reveal that item analysis feedback has empowered teachers to: 1. Strategize their teaching methods 2. Deliver tailored remedial work for learners and 3. Actively participate in tailor-made professional development programs. The implications of this study extend beyond the rural school of Central Province, shedding light on the critical role of instructional leadership and feedback mechanisms in improving teaching and learning. This research contributes to the larger discourse on effective education in resource-limited settings, offering insights into how to optimize available resources for the betterment of learner outcomes. Ultimately, this study contributes to the importance of continued research in educational practices and leadership strategies for sustainable development in rural education.

Article 21

'Enhancing Motivation of Secondary School Students in Physics Using Gamified Strategy in Ondo Metropolis, Nigeria' presented by *Komolafe Olaide Gbemisola, Adetunmbi L. Akinyemi and Ayotola Aremu*. The paper investigated the impact of gamification on the motivation of

secondary school physics students. An intact class of Senior Secondary Students Two (SS II) participated, wherein gamified elements like storytelling, points, and levels were combined with clear instructional objectives to enhance the understanding of complex physics concepts. A total of 165 senior secondary school II Physics students from four schools were divided into groups: storytelling, points, and levels (84) and a control group (81). Three physics topics—force, motion, and friction—were gamified. The study adopted a pretest-posttest control group quasi-experimental design and tested two null hypotheses at a 0.05 significance level using Analysis of Covariance. The results revealed a significant main effect of treatment on students' motivation to learn physics ($F(2, 165) = 14.44$; $p < 0.05$, partial $\eta^2 = 0.12$), with a substantial effect size of 12.3%. This means that 12.3% of the 64.0% variation in students' motivation towards Physics can be attributed to the significant impact of the treatment. Students reported that gamified instruction was enjoyable, exciting, highly motivating, and provided a positive learning experience. The study also revealed there was no significant effect of gender on students' motivation. In conclusion, the study recommends the incorporation of gamified elements into physics instruction in educational curricula, as they effectively boost student motivation, encourage sustained learning, and foster desired learning behaviours.

Article 1

An investigation of the connection of Bloom's taxonomy to the core mathematics curriculum for Senior High Schools in Ghana

Ebenezer Bonyah, Shashidhar Belbase, Seth Amoako Atta

Abstract

This paper attempts to preview the connection of Bloom's taxonomy to Ghana's Senior High School mathematics curriculum. Mathematics is a vital tool for economic growth and national development as a STEM subject. Bloom's taxonomy, which presents a hierarchical model, helps educators teach school mathematics to enable students to acquire basic Knowledge known as Low order thinking (LOT) skills and develop higher-order thinking (HOT) skills. The analysis of the mathematics syllabus concerning Bloom's taxonomy revealed that the syllabus concentrates more on the three fundamental skills in Bloom's hierarchy in teaching and assessment. Remember 18.1%, Understand 33.3% and Apply 29.8% totaling 81.2%, leaving only 18.8% for the top three HOT skills. The study recommends that Ghana adopt a curriculum model that focuses on teaching transversal skills that can churn out informed citizens rather than putting students under the shackles of tests.

Key Words: STEM, Curriculum, Syllabus, Revolutionized, Modernization, Globalization, Higher Order Thinking Skills

Introduction

Mathematics is rated as one of the most important subjects within the (Mereku, 2000) foundation subjects that constitute the core curriculum for the basic (primary and secondary) education in countries across the world(Martin et al., 2020; Mereku, 2010). As a science, technology, engineering, and mathematics (STEM) subject, it occupies a privileged position in the school curriculum because the ability to cope with more of it

improves one's chances of social advancement (Mereku, 2000) and contributes meaningfully to the economic development of a nation. According to Mereku (1992), as cited in (Mereku, 2000), mathematics attained this enviable status when it was made to replace classical languages like Latin or Greek (Mereku, 2000), which were previously used as the screening devices for admission into institutions of higher learning and certain professions.

Today, mathematics is seen as a tool for national development (Abramovich et al., 2019) since it has been the source of many technological advancements and innovations across the globe. The demand for the application of the knowledge of mathematics never ceases to end because mathematics has varied applications. As a result, the need to revolutionize the content and focus of school mathematics to reflect changing views about the subject and what is valued globally (Mereku, 2004, 2019). This calls for the design and implementation of a critical mathematics curriculum that allows students to take responsibility for their learning (Darder et al., 2003; Giroux, 2020). This kind of instruction enhances student creativity and critical thinking skills and develops specific societal values that make the individual an informed citizen (Bada, 2015; Bruner, 1962; Gruenewald, 2003; Wink, 2005). Mathematics should be craftily rolled out to develop students, tolerance (respect for other people's views), leadership skills, good communication skills, loyalty, collaboration, and problem-solving skills (Ernest, 2018).

Until recently, the cane was an excellent negative motivational technique in teaching mathematics in Ghana. Mereku (2010) revealed that the cane was used excessively to make pupils know the tables of numbers and those of measurements and solve practical problems in measuring, commerce, and so on. The teachers forced pupils to use repetitive and rote learning techniques to learn mathematics. However, as observed by Gyang (1979, as cited in Abroampa et al., 2020), this method made many students develop a hatred for mathematics. School mathematics was characterized by punishment, force, and fear, which forced some students to end their schooling prematurely, the paper noted (Abudu & Mensah, 2016; Mereku, 2019).

It was the 1987 Educational Reform that brought the Modern Mathematics, which was developed with a renewed mindset to make the teaching and learning of mathematics meaningful and less computational (Mereku, 2004). However, (Mereku, 2000) asserts that the pupils' achievement in mathematics never improved, notwithstanding the

introduction of new content and modern teaching skills. The 1980 Reform, even though it was greeted with much hope, turned out to be a fiasco because learning and teaching activities that could encourage the use of the new teaching skills and strategies were not included in the curriculum (Mereku, 2010; Santos-Trigo, 2020). It was not surprising that Mereku (2004) reported that Ghanaian students who took part in the international standardized test known as the Trends in International Mathematics and Science Study (TIMSS) 2003 could only answer questions that demanded computational skills and, for that matter, could not perform well. Ghana's continuous abysmal performance in the TIMSS made them pull out after the second unsuccessful attempt in 2007.

Analysis of trends in the Senior High students in Ghana's West Africa Senior School Certificate Examination (WASSCE) performance by Owusu and Amedahe (2018) revealed that poor teaching methods had contributed to student failure. Teaching mathematics at the Senior High School only encourages memorization of facts and computational algorithms. Nothing seems to trigger the switch to innovative teaching approaches like problem-solving and inquiry-based learning. This is mainly because the goal of teaching is for students to pass the final examination.

In 1956, one psychologist, Benjamin Bloom, developed a three-domain hierarchy of learning that aims at developing the totality (the Head, the Hand, and the Heart) of the individual (Furst, 1981). The focus of the taxonomy is to enrich students with higher-order thinking skills that will make them battle-ready to face the challenges posed by modernization, globalization, natural disasters, and socio-cultural dynamics (Aziz & Kharis, 2021; Stinson et al., 2012; Tanujaya et al., 2021). The taxonomy is helpful in education because it helps educators develop critical thinking skills and higher-order cognitive abilities in students (Thompson, 2008; Zhang et al., 2020). It also offers a framework for the organization and classification of classroom objectives based on the level of students. Bloom's taxonomy has been widely harmonized in mathematics curricula across the globe because of its focus on developing higher-order thinking (HOT) skills (Mullis & Martin, 2017; Principles, 2000; Ramírez, 2006). Skills needed in this 21st century to boost industrialization and workforce skills for national security, economic growth, and development.

Statement of the Problem

There have been a lot of curricula reforms in Ghana to position the teaching and learning of school mathematics in its proper perspective and per the international best practices and demands of international assessments (Adu-Gyamfi & Otami, 2020; Akyeampong, 2017; Mereku, 2000). Even though much has been done, as a developing nation, the country has not attained much in terms of school mathematics (Byrne & Prendergast, 2020). One would wonder whether the secondary school graduates being churned out have the repertoire of experience and knowledge illustrated in the mathematics curriculum (Dogbey & Dogbey, 2018). As it stands now, the mathematics syllabus stands on Bloom's taxonomy in terms of teaching and assessment. As indicated in the profile dimension (MOE, 2010). Meanwhile, no such studies have been done to find out the percentage of the various levels of Bloom's taxonomy incorporated in the curriculum in the areas of the specific objects, content, and assessment. Therefore, this study seeks to show how Bloom's taxonomy has been incorporated into the mathematics curriculum in terms of percentages.

Purpose, Objectives, and Research Questions

The study aims to thoroughly investigate how Bloom's taxonomy has been linked to the Ghana mathematics syllabus to promote higher-order thinking among students. The objectives of the study basically were: To find the link between Bloom's taxonomy and the Ghana mathematics curriculum for senior high schools and to investigate the capacity of the Ghana mathematics curriculum to produce students who are critical thinkers. Ghana has not been able to participate in the TIMSS for a long time since their last two unsuccessful attempts in 2003 and 2007, respectively. Meanwhile, there have been a lot of reforms in secondary school mathematics education that are supposed to produce students who can compete internationally. Notwithstanding, the student's performance in the final examination conducted by the West Africa Examination Council has not been too good (Abreh et al., 2018; Amankwah, 2020; Bosson-Amedenu, 2018). There is always the question of whether the curriculum is fit for producing graduates who can face real-life challenges in this technological era. Among the specific research questions are:

1. Is there any link between Bloom's taxonomy and the Ghana mathematics curriculum for senior high schools?

2. Does the current Ghana mathematics curriculum have the capacity to produce students who are critical thinkers?

Mathematics Curriculum in Ghana before Independence

Ghana's mathematics curriculum at the elementary school level before independence from British rule in 1957 was arithmetic (Mereku, 2010). The traditional school arithmetic taught primarily involved mechanical number facts and tables of measurements. The few foreign books used at the time focused mainly on arithmetic, as their names suggest; Simon and Milliken's *Arithmetic* and the *Larcombe's Arithmetic* series with accompanying speed test in mental arithmetic at the Basic Schools. At the Senior secondary school and teacher training school levels, mathematics was in three main branches: arithmetic, algebra, and geometry. They were taught largely using British grammar school textbooks such as *'School Arithmetic'* and *'School Algebra'* by Channon and Smith (1938, 1948); and *'School Geometry'* by Durell (1939) as cited in (Mereku, 2000).

Around the 1960s, global mathematics education took a dramatic turn for several reasons. Russia's post-war experience and other discoveries were the main catalysts for a paradigm shift in content and pedagogy in the school mathematics curriculum in the United States and other countries, including Ghana (Principles, 2000). A lot of new methods and techniques for solving old and new problems were developed, and new concepts were created (Mereku, 2010). These developments led to a careful formulation of ideas and a greater precision of mathematical language. Sets, and to a lesser extent, functions, emerged as unifying concepts (Van der Blij et al., 1981).

Mathematics Curriculum in Ghana after Independence

The birth of the Africa Mathematics Program (AMP) was a result of a conference of ministers of education in Africa to revitalize and restructure the inherited colonial curriculum to suit the African soil, as documented by UNESCO (1961) cited in Mereku, (2010). The AMP managed to blend experience from Africa, Britain, and America to produce mathematics books for smoother African mathematics education, especially in English-speaking countries. The Entebbe Math Series was the first mathematics series produced by the AMP and was later updated and named Joint School Project (JSP) for secondary schools (Abdul Gafoor & Kurukkan, 2015; Mereku, 2000; Wilson, 1982).

In Ghana, the JSP was criticized for being foreign, so a few local publishers were tasked to produce local mathematics books that suited Ghanaian culture and practice (Doku,

2003; G. A. A. Williams, 1976). The project received funding from local and international organizations like; the Nuffield Foundation, Centre for Educational Development Overseas and Overseas Development Administration in London, Mathematical Association of Ghana (MAG), University of Ghana, and the Ghana Ministry of Education (Mereku, 2010). Some of the books produced were the New Mathematics for Primary Schools (NMPS), Modern Mathematics for Elementary Schools, Book 1 to Book 8, and West African School Mathematics, usually referred to as AWAM; for Middle Forms 3 and 4 (Gibson and Mar dell, 1965) as cited in (Mereku, 2010)

The AMP was later developed into West African Regional Mathematics Programmes (WARMP) for the three participating countries in West Africa, namely, Ghana, Liberia, and Sierra Leone (Kamara, 2018; A. Williams, 1978). The Ghana Mathematics Series (GMS) textbooks and Teacher's Handbooks, which were used in the country for three decades, were products of the WARMP (Mereku, 2010) hinted.

The Bloom's Taxonomy

Bloom's taxonomy is a hierarchical model system used to categorize learning objectives into graduated levels of complexity (Krathwohl, 2002). The taxonomy is categorized into various degrees of difficulty, from basic recalling of facts to a higher level of producing new and original knowledge. As an educational psychologist and a chair of the committee of educators at the University of Chicago in the mid-1950s, Benjamin Bloom, in collaboration with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl, was working to devise a system that classified levels of cognitive functioning (Furst, 1981; Ruhl, 2020). He provided a sense of structure for the various mental processes we experience (Armstrong, 2010). After a series of studies focused on student achievement, the team identified factors inside and outside the school environment that affect how children acquire knowledge (Cox & Wildemann, 1970; Krathwohl, 2002; Tabari & Tabari, 2015). It came up that relying upon one universal curriculum was not helping many students because of individual differences in learning due to varied cognition levels (Tanujaya et al., 2021). One such factor was the lack of variation in the teaching. In other words, teachers were not meeting each student's needs. In the attempt to address this issue, the team postulated that if teachers could provide individualized educational plans, students would learn significantly better. This hypothesis formed the basis and motivation for Bloom's taxonomy.

The taxonomy was initially published in 1956 but was modified each year for 16 years before it was finally revised in 2001 (Krathwohl, 2002). It consists of three learning domains: cognitive, affective, and psychomotor. The cognitive produces outcomes that focus on knowledge and abilities requiring memories, thinking, and reasoning (Abeysekera & Dawson, 2015). Cognitive knowledge is classified into *Factual Knowledge*, *Conceptual Knowledge*, *Procedural Knowledge*, and *Metacognitive Knowledge* (Artelt & Schneider, 2015; Haberkorn et al., 2014). The practical focus is on learners' feelings, interests, attitudes, dispositions, and emotional states. The psychomotor also deals with developing motor skills and perceptual processes (Furst, 1981; Njura et al., 2021). The hierarchy designed for cognitive learning from low-order thinking abilities to higher-order thinking abilities is; Remember, Understand, Evaluate, Analyze, Apply and Create (Krathwohl, 2002).

Remember involves the study of facts, figures, and basic concepts. The action verbs are used to depict remember, list, recite, outline, define, name, match, quote, recall, identify, label, recognize, and others. Putting these action verbs in objectives indicates that students must be able to recall basic information delivered during lessons (Krathwohl, 2002).

Understand concerns with understanding the facts gathered during the knowledge stage in a productive manner. In this category, learners are expected to describe, explain, paraphrase, restate, give original examples of, summarize, contrast, interpret, and discuss (Thompson, 2008).

Evaluating is about making judgments or defending opinions. To show evidence of reaching this stage, learners are expected to choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, and evaluate (Furst, 1981).

Analyze is the stage where learners can conclude and establish a relationship between concepts taught. For example, they will be able to; design, formulate, build, invent, create, compose, generate, derive, modify, and develop, among other things (Pujawan et al., 2022; Ruhl, 2020).

Apply concern with the use of the knowledge acquired to solve real-life problems. *In applying the concepts, students are expected to;* calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, and present (Thompson, 2008).

Create is the last and final stage in the hierarchy, which involves producing new results by planning, designing, developing, and the actual application. Action words associated with this stage are; design, build, build, invent, create, compose, generate, derive, modify, and develop (Ruhl, 2021).

Affective domain

This domain focuses on how we handle all things related to emotions, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes (Wei et al., 2021). From lowest to highest, with examples included, the five levels are:

Receiving is about essential awareness. Listening and remembering the names of your classmates when you meet them on the first day of school. Responding is active participation and reacting to stimuli, focusing on responding, such as participating in a class discussion. Valuing is also concerned with the amount of premium put on a particular object or piece of information based on previous experience (Gafoor & Kurukkan, 2015). Organizing deals with categorizing concepts or objects into priorities and creating a unique value system. The emphasis is always on making comparisons and relating previously identified values. Characterizing is about building abstract knowledge based on the knowledge that has been acquired previously.

The Psychomotor Domain

The third and final domain of Bloom's Taxonomy is the psychomotor domain. The psychomotor model focuses on physical movement, coordination, and anything related to motor skills (Njura et al., 2021). Mastery of these specific skills is marked by speed, precision, and distance. These psychomotor skills range from simple tasks like washing a car to more complex tasks like operating an intricate piece of technological equipment.(Muhayimana et al., 2022; Njura et al., 2021) The psychomotor model does not come without modifications, as with the cognitive domain. This model was first published by Robert Armstrong and colleagues in 1970 and included five levels: imitation, manipulation, precision, articulation, and naturalization (Zhang et al., 2020).

Connection Between Bloom's Taxonomy and Mathematics

Several theories share the view of Bloom's taxonomy; however, this study discusses only two theories that connect the taxonomy. The first one is Polya's problem-solving approach. The whole Bloom's taxonomy is submerged in problem-solving. According to

its originator George Polya, problem-solving has no single definition because it is directly linked to real-life situations (Santos-Trigo, 2020). Real-life situations also come in many forms in many forms and the approach to finding the solution to contextual problems also differs. The real-life conditions are faced with many challenges that need innovative approaches to solve, and it is through HOT skills that individuals are challenged to find solutions to real-life issues (Aziz & Kharis, 2021). What the problem-solving approach in learning mathematics seeks to do is to imbibe in the students the ability to reason, think, reason, and communicate mathematically so that they become independent in life and resolute in handling any challenges that arise or may occur in daily life activities (Bhuttah et al., 2019; MOE, 2010; Mullis & Martin, 2017). Studies have shown that the focus of school mathematics has been on for decades in several countries. Primarily Realistic Mathematics Education (RME) was borne out of problem-solving (Aksu & Colak, 2021; Arsaythamby & Zubainur, 2014) and has become a household name in mathematics education. Most of the best-performing countries in the TIMSS assessment project have reviewed their mathematics curriculum to absorb the RME (Mullis et al., 2012)

The constructivist theory of learning also links with Bloom's taxonomy since the very aim of the theory is to enhance students' creation of knowledge based on their previous experience (Adom et al., 2016). The zone of proximal development (ZPD), for instance, asserts that students have basic knowledge and need to reach a certain level of higher thinking order (Lasmawan & Budiarta, 2020). Students can reach this stage through assistance from other capable individuals or through their efforts through the process of the conceptual change model, i.e., Accommodation and assimilation processes (Belbase et al., 2022; Gómez, 2016). The constructivist theory for education implies that students must be challenged to take responsibility for their learning (Atta & Brantuo, 2021). Therefore, the teachers are to act as coaches, curators, or facilitators to facilitate students' independent learning (Minarni & Napitupulu, 2020). It is expected that when the student is actively involved in constructing knowledge, it enhances their chance of utilizing it to solve contextual problems (Atta & Brantuo, 2021).

The concern of Bloom's taxonomy is to help learners acquire knowledge and use the knowledge to solve real problems and create a new situation that will make life better (Bermejo et al., 2021). This can be accomplished if the learners apply innovative strategies through collaborative and independent creative thinking to solve real-life

problems (Adu et al., 2017). Mathematics is a STEM subject, and as a language on its own, it should be taught focusing on not just the acquisition of knowledge but the application of knowledge in creating new knowledge (Diego-Mantecón et al., 2022).

The current mathematics syllabus of Ghana has been built around Bloom's Taxonomy. It fosters the acquisition of lower-order Thinking (LOT) skills such as knowledge and understanding (KA) and Higher Order Thinking (HOT) skills termed Application of Knowledge (AK) which encompasses; "apply," "Evaluate," and Apply and Create (MOE, 2010). The specific objectives are stated using action words regarding Bloom's taxonomy. The syllabus has provided a benchmark of knowledge and understanding of 30% and Application of Knowledge of 70% for assessment. This is to guide teachers to plan and deliver appropriate instruction, design valid tasks and assessments, and ensure that such instruction and assessment align with the outlined objectives. The table below shows the scope or content of the core mathematics syllabus. The syllabus consists of thirty topics grouped under seven main learning domains.

Table 1.0: The Scope of Content for the Core Mathematics Syllabus

SCOPE	TOPICS
Numbers and Numeration	Sets and Operations on set
	Modular arithmetic
	Number Bases Variation
	Relations and Functions
	Real number system
	Surds
	Indices and logarithms
Plane Geometry	Number Bases
	Plane Geometry
	Plane geometry II (Circle theorems)
Mensuration	Constructions
	Mensuration I
	Mensuration II
Algebra	Algebraic expressions
	Simultaneous linear equation
	Logical reasoning

	Quadratic functions
	Linear equations and inequalities
	Sequences and Series
	Ratio and Rates
	Variation
	Percentages I
	Percentages II
Statistics and Probability	Statistics I
	Statistics II
Trigonometry	Trigonometry I
	Trigonometry II
	Bearing and Vectors in a plane
Vectors and Transformation in a Plane	Rigid motion I,
	Rigid motion II and Enlargement

Source: (MOE, 2010)

Methodology

The study was a non-experimental survey that focused mainly on the teaching Syllabus for core mathematics for Ghanaian senior High Schools, From One to Form Three. The average age range of students in this category is Sixteen years to Eighteen years. The Curriculum Research and Development Division designed the core mathematics syllabus under the Ministry of Education, Ghana, in 2010 (MOE, CRDD, 2010). Since the introduction of the Free Senior High School (FSHS) policy, the senior High school has become the termination point for Ghanaian students who wish to exit formal education to enter into their chosen careers, and a foundation for those who want to further their education (MOE, 2010) Therefore, choosing this grade level for the study based on the incorporation of Bloom's taxonomy was the best decision. All the action verbs used in the syllabus have been listed and grouped according to Bloom's hierarchy and analyzed based on the frequency at every hierarchy level.

Table 1.1 shows 171 action verbs used in the syllabus regarding objectives, content, and assessment. A total of 52 verbs are used in the objectives section across the hierarchy, with understand having the highest, followed by remember, Apply and Create in that order. The verbs are almost fairly distributed, except that "Create," Evaluate and

Analyze are almost missing for assessment. It, therefore, gives credence to the fact that the assessment tools are made to evaluate only the LOT skills leaving the HOT skills.

Table 1.1 Summary of Action Verbs Used in the Mathematics Curriculum

Bloom's Taxonomy	Objective		Content		Teaching and Learning Outcome		Assessment		Total
Remember	Write	Identify	Draw		read	Sort	Write	Record	
	Read	Recognize	Recognize		write	Map	Read		
	State	Perform	Identify		List	Copy	State		
	Define	Practice			State	Study	List		
	Recall	Select			Draw		Define		
	Draw				Practice		Draw		
	11		3		10		7		31
Understand	Interpret	Factorize	Add	Equate	Interpret	Factorize	Explain	Find	
	Subtract	Find	Subtract		Explain	Find	Interpret	Convert	
	Add	Rationalize	Multiply		add	Rationalize	Approximate	Distinguish	
	Multiply	Share	Approximate		subtract	Share	Subtract	Describe	
	Divide	Construct	Convert		multiply	Perform	Multiply		
	Approximate	Translate	Differentiate		Approximate	Convert	Estimate		
	Convert	Distinguish	Describe		Estimate	Translate	Add		
	Express	Classify	Rationalize		Express	Distinguish	Express		
	Describe		Reverse		Describe		Factorize		
	17		10		17		13		57
Apply	Simplify	Depreciate	Simplify	Operate	Simplify	Compute	round off	Relate	

	Investigate Determine Compute Apply Calculate Represent Solve	Use Relate Present	Round off Solve Calculate Depreciate Apply Represent Relate	Construct Change Present	Solve Calculate Depreciate Derive Determine Construct Use	Discover Investigate Relate Guide Plot Illustrate Represent	Solve Simplify Calculate Use Determine Construct Apply	Translate Illustrate	
	12		12		16		11		51

Table 1.1 Continued

Bloom's Taxonomy	Objective		Content		Teaching and Learning Outcome		Assessment		Total
Analyze	Analyze	order	Examine	order	Order		Order		
	Compare		Check	Compare	Compare		Compare		
	3		4		2		2		11
Evaluate	Verify	Increase	Decrease	Reflect	Measure		Verify		
		Decrease	Increase		Verify				
	3		3		2		1		9
Create	Respond	Develop	Correspond		Revise	Form			
	Create	Undertake	Exchange		Deduce				
	Organize	Form			Develop				

	6	2	4	0	12
Total	52	34	51	34	171

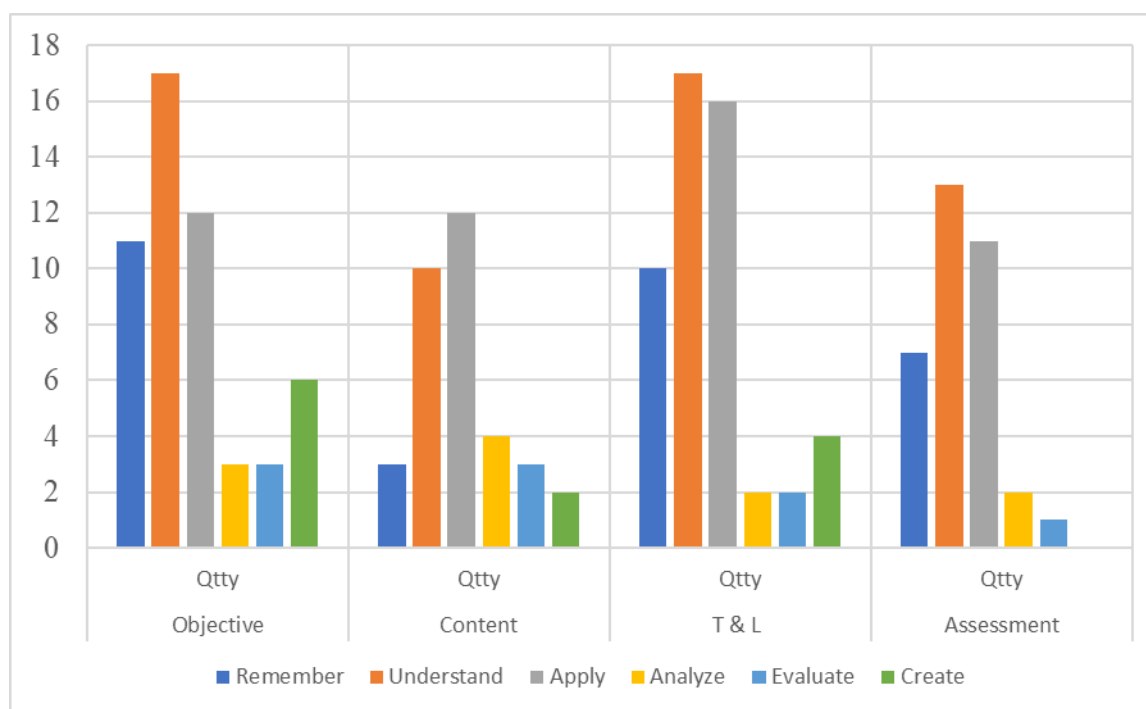
Results

Table 1.2 displays the summary of the action verbs used in the syllabus regarding the hierarchy. Remember and Understand, which constitutes the LOT skills, covers 51.4% against 48.6% for HOT skills in objective, content, and assessment. The syllabus concentrates more on the three skills in terms of assessment. Remember 18.1%, Understand 33.3% and Apply 29.8% totaling 81.2%, leaving only 18.8% for the top three HOT skills. It is worthy to note that "create" is even missing when it comes to assessment.

Table 1.2 Statistical Analysis

Bloom's Taxonomy	Objective		Content		T & L		Assessment		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Remember	11	6.4%	3	1.8%	10	5.8%	7	4.1%	31	18.1%
Understand	17	9.9%	10	5.8%	17	9.9%	13	7.6%	57	33.3%
Apply	12	7.0%	12	7.0%	16	9.4%	11	6.4%	51	29.8%
Analyze	3	1.8%	4	2.3%	2	1.2%	2	1.2%	11	6.4%
Evaluate	3	1.8%	3	1.8%	2	1.2%	1	0.6%	9	5.3%
Create	6	3.5%	2	1.2%	4	2.3%	0	0.0%	12	7.0%
Total	52	30.4%	34	19.9%	51	29.8%	34	19.9%	171	100.0%

Chart 1.0: A chart showing the summary of action verbs used in the syllabus in relation to the Bloom's taxonomy



As observed in Table 1.2, Chart 1.0 is pICTorial evidence to buttress the discussion. The bar representing “Understand” overshadows all the skills in all the categories, except under content that “Apply” tops all. It is worthy to note that, as indicate early on, the three LOT skills stand tall in all categories. The top three HOT skills are not fairly represented except under Objective that “Create” is quite visible.

Discussions

The senior high school curriculum encourages memorization and recall of facts. Even though the profile dimension assigns 30% for Remember and Understand, the study has revealed that 51.4 % are rather devoted. For the rest of the percentage, Apply alone constitutes 29.9%. This Apply component in the curriculum is still at a low level and, at best, can be applied in solving some contextual mathematics problems in the classroom but not in real life. It, therefore, confirms the work of Mereku, which indicated that the Ghanaian students who took part in the TIMSS in both 2003 and 2007 could only answer the question that required recall of facts. The TIMSS is a standard test that tests students’ ability to apply their knowledge in solving contextual problems (Mereku, 2010). It is no wonder that Ghana, as a middle-income state, still depends on other nations for almost everything since we cannot manufacture or process our products due to a lack of technical know-how and the absence of industries. Even though the mathematics syllabus for senior high school has been designed to help students develop the required

mathematical competencies needed to solve real-life problems, it fails to assess students on practical skills like innovativeness, creativity, and problem-solving-oriented tasks needed in real-life activities.

Effective mathematics teaching uses tasks to motivate student learning and help students build new mathematical knowledge through problem-solving (Brahier et al., 2014). In order for students can engage in high-level thinking, the curriculum must be challenging. It should be able to engage both the teacher and the students in activities that promote reasoning and problem-solving. These tasks will encourage reasoning and access to mathematics through multiple entry points, including using different representations and tools and solving problems through varied solution strategies (Brahier et al., 2014).

The mode of assessment at the senior high school, especially the final examination by the West Africa Examination Council (WAEC), has come under several attacks as researchers believe that it only encourages rote learning and its resultant examination malpractices (Abreh et al., 2018; Ashiagbor, 2019). As part of the requirements to enter higher education, students need to pass the core mathematics, which creates many avenues for examination malpractices. Paulo Freire's critical pedagogy alludes to the fact that assessing curriculum based on paper and pen tests is not the best and does oppress the students and limit their thinking (Darder et al., 2003; Giroux, 2020). Paulo observed that the more oppressed, the poorer one becomes and that the mathematics curriculum should train the students in social justice and tolerance to develop informed citizens. A similar study by Olawale, Mncube & Harber (2021) also indicated that educators and school administrators must make it a duty to cultivate critical teaching and learning experiences that can connect the standardized school curriculum to the reality of learners' everyday lives.

The standards for school mathematics across the globe have been changing to conform to the demands of this technological era (Principles, 2000). NCTM recently revised the principles 2000 to Principles to action to offer students more opportunities to learn through problem-solving and problem-based strategies (Baker et al., 2018; Mann, 2014). Apart from being a scientific subject, mathematics is viewed as a tool for social justice and economic emancipation. The TIMSS countries, for the past 20 years, have adopted a lot of modern pedagogies and process skills like inquiry-based learning into their

curriculum to ensure that their students have what it takes to be generational thinkers and problem solvers.

Conclusion

The NCTM's principles to actions focus on developing students' mathematical thinking skills through problem-solving to equip learners to be innovative, critical thinkers and problem solvers. In order for Ghana to be able to move from a knowledge-based economy to a production-based economy, there is the need for a mathematics curriculum that will produce generational thinkers rather than churning out individuals who can only remember. Therefore, the mathematics curriculum should focus more on HOT skills in teaching and assessment.

Recommendation

The results of the study demonstrate that the focus of the syllabus is on the first three bottom skills in the hierarchy (remember, understand and apply). These basic skills practically deal with the mental faculty (developing the Head). To balance the equation, the syllabus must be able to target the Heart (affective) and the Hand (psychomotor). These can only be achieved if attention is fixed on the HOT skills. If students are given the opportunity to discuss, explore, and come out with their own findings, observation, and conclusions and put them into action, it also influences their thinking and reactions. The syllabus must therefore be activity-oriented through problem-based and problem-solving strategies.

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Article 2

Mapping STEM with competency-based education and assessment with STEM in a business-focused institution

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Abstract

The aim of this paper is to assess how Science, Technology, Engineering and Mathematics (STEM) could be mapped within competency-based education and assessment in a business-focused institution such as SDIM which is a campus of Université des Mascareignes, Mauritius. Most higher education institutions advocate an outcome-based learning which focuses on what academics expect from students. The competency-based education approach differs in that it expects students to master essential techniques and skills which would directly benefit them. The challenge for universities is firstly to find out how they could better impart STEM education in the system as these are vital elements that must be integrated to achieve a holistic and effective pedagogy. At the same time, there is a need to identify competences within STEM education. The paper analysed the possibility of mapping STEM with competency-based education and assessments. Feedback was obtained from a panel of expert opinion within the university. The relevance of competency-based education was appraised while it was important to identify courses that might blend STEM with competences. Though the task was challenging, the prospect for creating new programmes based on competences and STEM education remain valid at SDIM.

Keywords: STEM, competency-based education, competency-based assessments, higher education, business courses

Introduction

From a general perspective, STEM education needs to be included throughout the educational system although this might be more felt at the primary and secondary level.

In higher institutions like polytechnics or universities, STEM is existent as a result of the nature of the programmes offered. However, this might not be totally applicable to institutions that provide education in liberal arts or business. This might be applicable to Swami Dayanand Institute of Management (SDIM) which is one of the three campuses of the Université des Mascareignes, Mauritius (UdM).

The purpose of this paper is not only to see how STEM could be implemented in business studies as courses are mainly theory based supported by Mathematics. The element of engineering is nascent as well as technology.

The other issue might be to see how STEM could be effectively mapped with the education proposed at SDIM. The current system is outcome-based as it relies on developing learning outcomes first and running the courses. It is not practical to identify STEM approaches in this context.

If a competency-based education (CBE) was proposed, this might probably encourage the development of competences like skills and techniques that could be purposely applied to courses. If this eventuality exists, then there might also be competency-based assessments. It can be here purported that STEM concepts might be correctly mapped with the practical needs of students.

Brief literature on STEM and selected educational pedagogy

Over the past decade, STEM education for students has received better attention, with calls both for greater emphasis on these areas and for improving the quality of curricula and teaching. education (Wahono & Chang, 2019). Integrated STEM education is an effort to link science, technology, engineering, and mathematics in a classroom based on networks between subjects 'real-world problems. Integrated STEM approaches can transform traditional education into innovative and inclusive education for social equality and sustainable development (Nguyen et al., 2020). According to Wahab et al. (2021), the integrated STEM approach has the potential to expand the content of STEM education. Fully integrated STEM with project-based learning can increase teaching effectiveness (Jamali et al., 2017).

Regarding common outcome-based education, Spady (1994) states that learning outcomes are the hard work of what has been learned. Outcome-based education (OBE) is in the outcome that can be called success (Yusoff et al., 2014). They arise from lessons, tests, homework, projects, etc. Teachers must also adapt to the roles required to achieve the expected student outcome (Zhang & Fan, 2020). OBE is widely

recognised in the conventional and routine centre teaching strategy centred on the teacher towards the learner. Outcome-based instruction (OBE) or cantered instruction of students achieves the instructional goal in terms of person, skill group, guidelines, benchmarks and stipulated goals for achievement (Thirumorthy, 2021).

Competency-based learning is an educational approach that underlines the acquisition of practical skills and abilities necessary for success in real-life contexts (Alt and Raichel 2018). Learners become active when they participate in inquiry practices (European Commission 2018). Consequently, teachers are required to situate students in authentic and relevant tasks (Care and Kim 2018), provide varied representations of course content, enhance dialogue (Sherbino et al., 2021) and substantiate the needs and needs of each learner. interests (European Commission 2018). To increase student productivity in the workplace, researchers have discussed how higher education institutions can improve students' soft skill sets by placing them in constructivist learning environments (Nghia 2019). Building on student-centred approaches to teaching and learning, competency-based learning focuses primarily on enhancing students' skills and sense of agency (Hess et al. 2020).

With respect to competency-based assessments, competency-based academic programmes aim to place students in a wide range of contexts that resemble "real-world" situations and allow them to develop self-directed approaches. -reflection and reflection toward self-assessment (Kitagawa, 2004; Cano and Ion, 2012). This shift in learning and teaching approaches requires greater emphasis on facilitating student learning (Tillema & Smith, 2009) and assessing student skills. Lasse (2020) states that to be useful, competency models should only contain tasks and skills essential for success in the role, and not all the activities they perform in their job arising from an analysis traditional work tasks).

The STEM context under study

The purpose of this paper is to identify curriculum development and assessment within the STEM approach. Although this concept is currently accepted and applied to higher education, this might not be entirely applicable to a business-centred curriculum. The Université des Mascareignes (UdM) has three broad specialisms that it offers to students namely business, engineering and computer technology. Based on the actual situation, there is every evidence that STEM approach broadly applies to the university curricula. The current paper focuses on the business area which addresses the objectives of the

Swami Dayanand Campus (SDIM) based in the northern part of Mauritius. This institution was opened in 1995 and has been since then offering courses in marketing, Human Resource Management, Accounting, Banking and Finance including an important component of computer education in all the programmes offered.

Although it might look quite evident from the outset that the STEM approach is applicable in the SDIM case, it is still complex to fully ascertain its effective implementation. For instance, a large number of courses might be theory based with some component of practical activities. In a business context, it would be then easier to locate concepts like management theory and practices, case studies, language development through communication courses including a little percentage of Mathematics. The argument might be the lack of science-based courses and a total absence of engineering programmes. There might be some application of technology and Mathematics due to the fact that students might need to learn to work with computers and undertaking calculations as part of the quantitative aspect of some courses. Biener et al (2012) posits that a “one size fits all” framework is not needed for all STEM education projects, but each individual STEM education research project should have a defined conceptualisation of STEM education and faculty from across the nation should be aware of these different conceptions.

Current OBE curriculum at SDIM

The existing curriculum at SDIM relies upon outcome based learning or education (OBE). Courses are developed in such a way that students need to focus on what they should learn and how they could apply such learning. Since the courses are module-based, students need to develop clear knowledge of concepts and techniques that they need to apply to their learning. Once the courses are completed, students might keep up some of the material learnt and apply them to further learning stages.

The OBE approach is applied nationally since curriculum design and planning are subject to a continuous evaluation from the Higher Education Commission, the governing authority concerning higher education in Mauritius. Lecturers, per se, need to work out all their courses by developing learning outcomes and seeing that most or all of them are covered during the time available for teaching.

Arguments arising from the existing OBE

The current OBE has been successfully applied over the years at the SDIM business studies oriented institution. It has also enabled SDIM to devise advanced level

programmes like Masters in Sustainable Business Management or a Master's in Business Administration (MBA) based on prerequisites developed from former learning outcomes from undergraduate courses. It is seen as a stepping stone to developing advanced learning outcomes for upcoming courses.

In the existing case, it is worth mentioning that the STEM approach might not be feasible. The reason is that STEM needs to be integrated as competency-based not outcome-based. Since business courses are essentially theory-based, the aspect of Science, Technology, Engineering are not clearly assessed through outcome-based approach. There is little evidence of such application since they are not examinable.

If STEM approach were considered as an alternative to effective learning in higher education, it would be important to view the relevance of adopting a competency-based education approach. So far, it is felt like this applies to the technical or scientific area and has little or nothing to do with business education or even worse in the case of liberal arts. Orozsi (2020) suggests that an all-inclusive approach to education is needed while traditional education, competency-based, problem-solving, and the capabilities approach all have their place in education, depending on the materials and the audience.

The competency-based approach needs to be henceforth viewed as a new possibility of designing and developing curricula. It does not mean that outcome-based learning should be replaced by competencies but, rather, it should be appreciated that STEM approach would be more aligned with the latter. Williams (2011) suggests there is a need to further investigate STEM education research to determine how different methods impact the classroom, not just a focus on workplace trends and "top-down," promotion of STEM initiatives.

Research Methodology

The research framework was based upon selected curricula that are offered at SDIM. The focus is on business courses offered by the SDIM campus that focus on business management particularly Marketing, Human Resource Management, Accounting, Banking and Finance with a recently-created faculty, Digital Humanities.

The research questions address subject areas covered namely business courses offered by SDIM. A selected number of courses namely Marketing Planning and Analysis, Human Resource Analysis and Decision, Corporate Accounting, etc. are briefly analysed.

These are potential subjects that integrate STEM within the university and might also be courses that might showcase competency-based learning.

The feedback is based on an analysis of Module Information Sheets (MIS), assessments and examination papers. The main source of feedback came from questions developed on the research topic with a panel of expert opinion comprising seven academics from all the three disciplines who gave their opinion as per question addressed.

Research Questions

Five key questions were developed from the existing situation at SDIM. The questions are listed below:

Are there courses at SDIM that incorporate STEM education?

Is there a possibility of developing courses on competency-based education?

What are the benefits of competency-based education at SDIM?

What might be some drawbacks of competency-based education at SDIM?

How could selected business courses integrate effective assessment-based education and assessments?

Findings

The first question addressed the existence of courses that incorporate STEM at SDIM. Since there is a majority of theoretical-based courses, STEM might not be initially assessed. However, it is seen that there is component that include Mathematics and Science through the use of computer technology. A brief list is indicated in table 1 below.

Course	Module	Element of STEM incorporated	STEM specific knowledge
Marketing	Research Methods	Quantitative Techniques	Mathematics
	Marketing Planning and Analysis	Market Analysis Techniques	Information Technology (ICT)
Human Resource Management	Human Resource Analysis and Decision Dissertation	Quantitative labour market analysis Mixed method technique	Mathematics, ICT Statistics with Scientific techniques

Accounting	Most Accounting modules Computer-based Accounting Methods	Analysis and preparation of accounting data Automated computation of data	Mathematics ICT
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Table 1: Courses at SDIM campus incorporating STEM

It is noted that the engineering element is not depicted in business courses while the aspect of technology covers Information Technology based courses. Apart from that, most of the courses are based on the acquisition of knowledge through theory and practice.

The possibility of developing courses on competency-based education

Competency-based courses rely on specific competences that are needed in a programme. In STEM, competences must be linked with the four key elements namely Science, technology, Engineering and Mathematics.

As from 2023, new courses such as Corporate Social Responsibility, Workplace Ethics, Sustainability as well as independent management courses have been set up. In the latter case, such courses have adopted backward design which in itself seeks to develop learning outcomes and competences first and then align them to the needs of learners.

Table 2 provides an outlook of the possibility of including competency-based education in selected areas of management.

Course	Competency-based education	Element of STEM to be addressed
Marketing	Market Analysis and Planning Marketing based videos for presentation Effective communication and persuasion	Science and Engineering linked with data formulation and modelling Technology and engineering linked with software and editing tools like Lumi Use of technological tools to communicate online with customers
	Preparation of HR reports	

Human Resource Management	Development of Human Resource Information System Conceptual framework for HR research	Use of ICT and basic programming to develop HRIS Adopting scientific aspects of management learning and theory to practice
Accounting	Preparation of computer-generated Accounting data Auditing of corporate accounts	ICT skills linked with programming, need to learn basic IT engineering and programming Basic scientific and mathematical knowledge to be developed for corporate auditing

Table 2: An outlook of the possibility of including competency-based education

From the information provided in Table 2, there are opportunities that favour the possibility of including competency-based education in most of the main courses offered by the UDM at SDIM Campus.

There is a need to shift from the current outcome-focused learning to competency-based learning if STEM approach is to be incorporated with higher education at the undergraduate level. Otherwise, courses will focus essentially on outcomes but these might not contribute to the implementation of STEM education. Here again, efforts to identify Engineering as a concept to be included remains difficult.

In general, it is from new course development that competences might be better analysed. Such competences must be aligned with what the university expects from students at the end of a programme. Far from relying on the outcomes developed, a STEM approach enables academics and subject specialists to identify where the key STEM components might be identified. It might be again stated that the new courses or modules might include the backward design technique to facilitate academics finding out where such competences could be properly aligned. So far, this activity is not evident from outcomes-based education.

Benefits of Competency-based education at SDIM

The next research question addressed the benefit of competency-based education at the UDM and particularly at SDIM. For this specific purpose, lecturers involved in course design and development were grouped as a panel of expert opinion to state the

benefits that they could expect from the new model purported in this analysis. The responses are compiled with reference to key arguments raised once CBE was explained to the respondents.

Flexibility of CBE

'CBE is flexible from what I learn. Students can monitor their own learning through practical project and assignments that are linked with the competency that they want to achieve. They will also develop STEM competencies.' (ICT Lecturer)

Learning proprietorship

'For me, students know what competences are being expected from them. They will feel like having control or simply owning what they are learning.' (Management Lecturer)

'What is interesting in the CBE perspective is that students will progress in their programme and not get themselves bound to outcome or syllabus-based requirements.' (Accounting Lecturer)

Job-related experience

'CBE is likely to foster real-life experience to the students. By the way SDIM courses are already positioned as work-related and I see that this is a golden opportunity to bring learning to real life situation; a proper blending of theory and practice.' (Communications Lecturer)

Quality-driven programme

'If STEM approach is integrated with CBE, there will have to be quality standards to be abided by learners. I assume CBE to be a key driving force for quality standards in our institution. Besides, there should be an insight with regards to quality.' (Marketing Lecturer)

Purpose-driven

'The CBE approach looks to have a clear intention. There is the possibility of fairness and equity. With a STEM integrated approach, there will be a culture of learning. Students might also develop leadership abilities.' (ICT Lecturer)

In a nutshell, Haddouchane et al (2020) suggest that CBE is characterised by the versatility of the teaching methods on the one hand and, on the other hand, by a wide array of activities that replace the traditional lecture-based courses, such as case studies and scenario-based teaching. Orozsi's contribution (2020) could also address some benefits of CBE namely: a method to decrease failure in completion, the flexibility of the programme with a student's schedule and teaching with less overhead and excess profit.

Weaknesses of Competency-based education at SDIM

The next question addressed any shortcoming or weakness that the panel of expert opinion might have on CBE at SDIM. (Accounting Lecturer)

Assessment of skills and competences

'In CBE, it is important to identify and quantify skills and competences. These are much needed in STEM-focused approach. We must also think of situations of how learners might accommodate new learning skills and techniques especially when The learning approach is not suited for learning where the skills and competencies are such things cannot be easily accommodated.' (Management Lecturer)

Social learning

'I would ask whether CBE encourages social learning or not. It must be stated that social learning has its benefits. When students can learn independently, social learning opportunities must be also taken into consideration.' (ICT Lecturer)

Different student needs

'My argument with regards to STEM based learning embedded in CBE is that students have different abilities. This is a common issue everywhere and we need to see whether all students can quite fairly embark on such an ambitious project.' (Accounting Lecturer)

A useful consideration might come from Sánchez, and Ruiz (2008) suggesting that CBE requires a much more constant and systematic dedication to learning, plus a greater commitment on the part of the student to plan and manage his/her time appropriately.

Integrating effective assessment-based education and assessments

According to Lasse (2020) a competency assessment is the assessment of someone's capabilities against the requirements of the job undertaken. Those requirements are defined in a competency model. To be valuable, competency models need to contain only tasks and skills that are critical to success in the role, not all the activities undertaken.

Assessment is done on those identified tasks and skills for which a grade is selected based on how well they perform that task, which defines their level of proficiency. In other words, a competency assessment measures a learner's behaviour to achieving a task or skill.

Table 3 below provides a model how STEM components identified in three different disciplines could match behaviours with skills that learners would develop. This might align CBE with competency-based assessment aligned with STEM.

Competency based Education Area under assessment	STEM component available within the module or subject area	Competency-based assessment	
		<i>Behaviour</i>	<i>Task and skill assessed</i>
Human Resource Management	Research Methods: Quantitative (Mathematics) Computer-generated responses	Ability to understand Mathematics or Statistics principle Ability to process data in a computer	Manipulating figures to be used in dealing with a real life problem Generating data from information input to a computer
Marketing	Marketing planning and analysis Customer demographics	Arranging data in a meaningful way Creating customer databased with regards to geography, lifestyle, etc.	Understanding sales forecasting during seasonal variations Computer analysis of data created on spreadsheet and cross analysis of such data.
Accounting	IT Accounting packages	Using scientifically prepared data and programs in	Developing general knowledge of IT, IT control knowledge,

	Corporate governance Accounting	in creating Accounting data arising from research findings	IT control and mathematical competences
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Table 3: Mapping STEM components identified in three different disciplines

Discussion

From the findings, it is seen that there exist courses that incorporate STEM education at SDIM Campus of UdM. Certainly, in a business-related environment, it is difficult to find out courses that focus on the four key elements that are purported for business programmes. There are courses within each discipline that incorporate components of mathematics and Technology, mostly based on ICT concepts. By the way, all courses have modules training students to be versed in technology. The scientific part might focus on scholarly work and theories developed as a science. Engineering is mostly available in IT courses and engineering programmes offered by the Rose Hill campus of UdM.

The eventuality of developing courses using competency-based assessments exist. In a near past, collaboration of the UdM with Commonwealth of Learning (COL) has enabled the institution to review some programmes in each field and to address competency-based education. Such competences are skills specific and job-relevant and do not overemphasise academic education. This might require a shift from outcome-based learning to competency-based education. To achieve this is not possible here but there is the eventuality of converting some practical courses to competency-based education. Competency-based education is beneficial and a prospective area seen from the feedback of the panel of expert opinion. The members stated course ownership, job-related experience, purpose-driven and flexibility as key drivers of such a learning strategy. Sánchez and Ruiz (2008) comment that CBE provides greater enrichment of learning methodologies, closer monitoring and tutoring of students individual. It consists in developing the necessary generic or transversal--instrumental, interpersonal and systemic--competences and the specific competences pertaining to each

profession. The aim is to endow students with scientific and technical knowledge, and enable them to apply such knowledge in diverse complex contexts (Sánchez and Ruiz, M, 2008).

Drawbacks of competency-based education were also addressed namely the difficulty of encouraging social learning, the challenging task of assessing skills and competencies of students prior to enrolling in a programme. Additionally, the individual needs of every student might not be the same making it difficult to ascertain whether they can succeed in the competency-based system. Blackburn (2020) advocates that the learning approach is not suited for learning where the skills and competencies are difficult to identify and quantify. It is also not seen as suitable for situations where new skills and new knowledge need to be rapidly accommodated.

The key challenge was to integrate STEM education within competency-based education. To this end, a mapping of selected subjects in the three main fields: Marketing, HRM and Accounting were undertaken. There was evidence of identifying STEM approaches within the courses where most competencies would better address Mathematics and Information Technology and, to a lesser extent, Science which could be more focused on scholarly work and scientific principles and foundations that underpin basic learning in each of the areas identified. Sánchez et al (2018) purport that today's university and employers agree on the importance of training graduates in professional competencies which refers to competencies that graduate students will need to acquire for their profession known as "technical competencies.

Conclusion

This paper demonstrated the complexity of integrating STEM education in a university or higher learning context especially when courses are provided in business studies or social sciences area. This applies to SDIM campus, part of the UdM, where business courses are mostly taught. It is generally perceived that outcome-based learning promotes too much academic learning and remains a little far from the practical demands of the job market. The fact that some academics of SDIM have recently been trained in competency-based education makes it a compelling case to introduce and develop such learning in the campus. The question was to address STEM education within the framework of competency-based education and assessment.

Although it is correct to say that the blend of STEM within competency-based education is bound to produce more adaptable learning for students, the mapping of certain

courses that cover STEM must be identified. This enables finding out how STEM principles are identified within courses and how both competency-based education and assessment will be henceforth implemented. The possibilities have been discussed in this research including the benefits that mostly overarch the drawbacks. In an SDIM context, the possibility exists if elements of Science, Technology and Mathematics might be incorporated into selected courses. Achieving CBE and effective assessment will certainly offer a new learning perspective to prospective students of the university.

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Article 3

Teachers' Confidence of Teaching Mathematics and Science: Impact of Continuous Professional Development among 14 Districts in Rwanda

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Abstract

When teachers are confident in their ability to teach math and Science, it can inspire students to have confidence in their own abilities. Students are more likely to engage with and enjoy these subjects when they see their teacher's enthusiasm and belief in the material. This study aiming at exploring teachers' confidence of teaching Mathematics and science as result of Continuous Professional Development (CPD) by the African Institute for Mathematical Science (AIMS Rwanda) through its Teacher Training Program (AIMS-TTP). It employed an ex post facto research design targeting 351 secondary school teachers. The findings revealed a positive and significant relationship ($p < .05$) between AIMS-TTP interventions and teachers' confidence to teach Mathematics and science. Besides, linear regression model indicated that the dependent variable Teachers' Confidence to teach Mathematics and science was regressed on predICTing variables of improved capacity to plan, adapting teaching to the level of learners, ICT integrated in teaching and learning; learning from peers; addressing cross-cutting issues; use CBC to develop competences; and the use of the application of bloom's taxonomy. The independent variables significantly predICT teachers' confidence of teaching mathematics and science, $F(7,326) = 183.843$, $p < .001$, which indicates that the factors under study have a significant impact on teachers' confidence of teaching mathematics and science. Our research suggests that policy makers should consider developing and endorsing training on innovative teaching and learning methods to boost teachers' confidence when it comes to instruction Mathematics and science at basic levels.

Key words: Teacher Training Program, Mathematics Education, Science Education, Continuous Professional Development, Innovative Teaching Methods

Introduction

Education is a pre-requisite for the development of a country. It is a well-established fact that it is mainly through education that people can be made to develop an in-depth awareness, favorable attitudes, values, participate in effective decision-making and develop capabilities, which help to contribute the societal welfare. The teacher is the backbone of the education system and is the architect of society (Srinivasacharlu, 2019). The progress of a country depends upon the quality of its teachers and education system, closely related to this Rwanda has shifted from Knowledge Based Curriculum (KBC) to Competence-Based Curriculum (CBC). The decision to make this shift was driven from several factors, including the recognition that traditional knowledge-based education was not adequately preparing students for the demands of the modern workforce and global economy (REB, 2015). Teachers continued to teach as they were taught employing lecture teaching methods (Sibomana et al., 2021); thus a need to train them on innovative teaching methods to cope with the 21st century learning models.

To complete the Government efforts, the African Institute for Mathematical science through its Teacher Training Program (AIMS-TTP) in partnership with MasterCard Foundation trained Mathematics and science teachers within a period of 5 years from 2018 to 2022.

AIMS-Teacher Training Program Theory of Change in Rwanda

Effective teaching and learning of Mathematics and science is the foundation for building human capacity for an innovative knowledge-based economy. Nevertheless, traditional methods that do not promote literacy and positive attitude toward science and mathematics currently dominate the teaching of mathematics and science. Teachers continue to over-rely on teacher-centered approaches and inadequately integrate ICT in teaching and learning (Nizeyimana & Nkiliye, 2015).

Several challenges preclude the use of innovative teaching methods; these include inadequate teaching resources such as laboratories, chemicals, apparatus, and physical infrastructure, limited pedagogical skills to implement advanced teaching methods that engage both girls and boys, among others. Consequently, students loose interest in studying Mathematics and science and emerge from learning institutions with gaps in competencies and skills necessary to address individual as well as societal needs for economic development (Qutoshi & Poudel, 2014; REB, 2017).

AIMS believes the quality of secondary schools' Mathematics and science teachers will improve when teachers are provided with the right tools and resources to deliver the subjects in a way that engages girls and boys in a conducive environment. Consequently, this will lead to improved performance of girls and boys in Mathematics and science thus increasing the number of students pursuing STEM courses at the advanced level of secondary schools. Addressing these issues requires training of pre-service and in-service teachers on innovative gender responsive pedagogic skills, training on relevant subject matter content, English language proficiency, and in techno-pedagogical skills. There is also a need to provide adequate teaching materials, resources and infrastructure to support students' learning, outreach to facilitate the appreciation of the role of Mathematics and science in development of the country as well as policy dialogue for a conducive environment of teaching and learning.

Furthermore, AIMS-TTP assumes that this theory will hold if a number of assumptions hold, including mainstreaming of gender equality and inclusion to close the gender gap in the number of girls and boys pursuing STEM at advanced level of secondary school levels.

Moreover, women present a historic and worrying gap in Math, science and technology related disciplines, generally known as STEM (García-holgado & García-peñalvo, 2015; Uwineza et al., 2018). Thus, a holistic approach requires to support policy makers worldwide in bridging the gender gap in STEM, in which basic education has a crucial role.

The African Institute for Mathematical Science Rwanda through its Teacher Training Program (AIMS-TTP) is making a significant impact on the quality of education for secondary school teachers by providing a range of training workshops, including trainings on the competence-based curriculum, techno-pedagogical skills, and hands-on activities, use of improvisation, gender responsive pedagogy and assessment. Thus, the main goal of this study is to examine the impact of AIMS-TTP on teachers' confidence of teaching mathematics and science with the following hypotheses:

H_0 : There is a significant impact of pedagogy training on teachers' confidence of teaching mathematics and science

H_0 : There is a significant impact of ICT integration (training on ICT) on teachers' confidence of teaching mathematics and science

H₀: There is a significant impact of CBC training on teachers' confidence of teaching mathematics and science

H₀: There is a significant impact of assessment training on teachers' confidence of teaching mathematics and science

Methodology

The study employed an ex-post facto. Participants were all Mathematics and science secondary teachers from 14 districts under AIMS-TTP interventions and 351 were purposively sampled. The study applied a survey research design to collect data with the Pearson correlation coefficient of 0.71. Data were analyzed using regression analysis.

Findings and Discussions

Table 1: Multiple Regression Results

Model	R	R Square	Adjusted square	R Std. Estimate	Error of the
1.	.850 ^a	.733	.721		.539
Model	Sum of squares	Df	Mean squares	of F	P-value
Regression	281.245	7	40.178	183.843	.000 ^b
Residual	71.246	326	.219		
Total	352.491	333			

The study seeks to investigate the effect of each of the following (capacity of planning, adapting teaching to the level of learners, ICT integration in teaching and learning, learning from peers, addressing each cross-cutting issue while teaching, use CBC to develop learners' confidence, use bloom's taxonomy in assessing) on teachers' confidence to teach mathematics and science.

PredICTors were grouped in four themes namely *training on pedagogy* (including the capacity of planning, adapting the teaching to the level of learners and learning from peers); *training on ICT*; *training on CBC* (including training on addressing cross-cutting issues and training on developing competences); *training on assessment*.

The dependent variable teachers' confidence to teach Mathematics and science was regressed on predICTing variables of improved capacity to plan, adapting teaching to the level of learners, ICT integrated in teaching and learning; learning from peers; addressing cross-cutting issues; use CBC to develop competences; and the use of

bloom's taxonomy. As indicated by table 1, the independent variables significantly predict teachers' confidence of teaching mathematics and science, $F(7,326) = 183.843$, $p < .001$, which indicates that the factors under study have a significant impact on teachers' confidence of teaching mathematics and science. Moreover, the $R^2 = .723$ depicts that the model explains 72.3% of variance on teachers' confidence to teach mathematics and science.

Table 2: Predictor of Teachers' Confidence to Learn Mathematics and Science

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	.068	.119		.569	.570
Improved capacity to plan (Scheming, lesson planning)	.081	.052	.082	1.551	.122
Adapt teaching to the level of learners	.156	.054	.153	2.899	.004
ICT integrated in the teaching and learning process	.015	.038	.015	.396	.693
Learning from peers developed the teaching capacity	.138	.057	.138	2.411	.016
Addressing CCI among learners in my class	.100	.056	.098	1.791	.074
Use CBC to develop competencies among learners	.166	.063	.165	2.654	.008
Use of Bloom's taxonomy while assessing	.331	.049	.325	6.729	.000

a. Dependent Variable: Confidence to teach mathematics and science

Additionally, assessing coefficients in order to ascertain the influence of each of the factors on the criteria variable (teachers' confidence to teach mathematics and science) leads to rejecting 3 hypotheses and maintaining 4 among the seven tested as indicated by table 2.

For example, H_{o6} : Evaluating whether the training on CBC (use CBC to develop competences among learners) significantly and positively affects teachers' confidence to teach mathematics and science. The results revealed that the mentioned training has a significant and positive impact as ($B=.166$, $t=2.654$, $p=.008$), hence the hypothesis is supported. However, H_{o7} : Evaluating whether the training on planning (lesson planning, scheming) significantly and positively affects teachers' confidence of teaching mathematics and science. The statistical results show that the impact is not statistically significant as ($B=.081$, $t=.1551$, $p=.122$). This implies that, the significant impact that is observable in reality; statistically is not noticeable.

The results corroborate the findings of Nkundabakura et al., (2023) that continuous professional developments allow teachers to learn new skills and techniques and improve their teaching abilities. Furthermore, teachers are motivated once they receive regular training which help them to fill the gap and facilitate them to interact with colleagues in the same domain (Ahmed et al., 2021). According to Umugiraneza et al., (2016), teachers who have access to internet instructional resources have higher levels of confidence in teaching Mathematics.

Moreover, our study validates the findings of Srinivasacharlu, (2019) that in order to effectively prepare teachers for the demands of the 21st century, it is imperative that teacher educators maintain a consistently high level of expertise in the field. This is only attainable through their commitment to ongoing professional development (CPD), which encompasses a wide range of activities, both formal and informal. These activities are designed to enhance the intellectual capabilities of teachers (cognitive domain), boost their self-assurance, attitudes, values, and interest (affective domain), and further develop their skills and competencies (psychomotor). Such comprehensive development is essential for cultivating well-rounded individuals capable of fulfilling their roles within the teaching profession in alignment with the evolving requirements of both prospective teachers and the society as a whole.

Conclusion and recommendations

The study aiming at examining the impact of the African Institute for Mathematical Science, Teacher Training Program (AIMS-TTP) on teachers' confidence of teaching mathematics and science among 14 districts of Rwanda, revealed noteworthy improvements in teachers' confidence regarding their competence in teaching Mathematics and science. This improvement was attributed to the training in pedagogy, ICT integration in teaching and learning, implementation of the Competence-Based Curriculum and the training of assessment method and techniques.

Mathematics and science teachers should use innovative teaching methods; strengthen the culture of peer learning to implement the Competence-Based Curriculum and incorporate technology into teaching and learning to engage learners actively.

Education stakeholders should support ongoing professional development for teachers, encourage participation in workshops that equip them to learn best ways to deal with learners' diversity.

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Conflicts of interest

The authors confirm that they have no potential conflicts of interest to disclose.

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Article 4

Teachers' understanding of gender-responsive pedagogy and its
application in the teaching process: Case after Teacher Training Program
interventions in Rwanda

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Abstract

The presented study explored mathematics and science teachers' understanding and application level of gender-responsive pedagogy after attending teachers' training programs interventions. A survey design was used and the study was conducted in 14 districts of Rwanda where the teacher training program implemented its activities. Purposive and random sampling was used to select 351 teachers who answered a web survey questionnaire of 0.71 Cronbach alpha reliability. Data were analyzed descriptively using Microsoft Excel 2016 while the hypothesis was statistically tested by STATA v.18. The findings revealed that after attending training, both male and female teachers hold a high undertaking and application of gender-responsive pedagogy at percentages

beyond 80% with an agreement mean estimation of ($M = 80.25$). There was no statistically significant difference ($\chi^2 (12) = 13.2500$ $Pr = 0.351$, $P > 0.05$) in understanding and application of gender-responsive pedagogy between males and females, between teachers in rural and urban schools Pearson ($\chi^2 (42) = 54.0000$ $Pr = 0.101$, $P > 0.05$).), between teachers in boarding and day schools Pearson ($\chi^2 (20) = 19.0000$ $Pr = 0.522$, $P > 0.05$), and neither between teachers with 0-5 years and 6-10 years of teaching experience Pearson ($\chi^2 (36) = 40.5000$ $Pr = 0.278$, $P > 0.05$), 0-5 years and >10 years of teaching experience Pearson ($\chi^2 (30) = 29.2500$ $Pr = 0.504$, $P > 0.05$) nor between teachers of 6-10 year and >10 years of teaching experience Pearson ($\chi^2 (30) = 32.2500$ $Pr = 0.356$, $P > 0.05$). This implies that teachers increased equally their understanding and application of gender-responsive pedagogy. We recommend expanding similar training to teachers in other districts than those who received interventions.

Keywords: Gender-responsive pedagogy, Understanding, application, teaching process, teacher training program.

1. Introduction

Women's participation in mathematics and science education is a major concern in many regions of the world. Adoption of gender-inclusiveness and sensitive teaching techniques in early teacher education and in-service teacher training is crucial to teacher development by alleviating gender disparity (Abrha et al., 2023). The gender disparity in education begins in the early years of education with the ignorance of gender-responsive instructions. Girls are frequently channeled into "lower status" subjects and discouraged from speaking in circumstances where boys consume a disproportionate amount of teachers' energy. Also, Education materials frequently reinforce low expectations of women and girls, thus a scarcity of female students in disciplines like math and science (Chapin & Warne, 2020)

Gender equality in math and science education can be achieved by incorporating gender mechanisms into the pedagogical delivery of mathematics and science instruction. Even though advancement is being made toward gender parity, gender inequality persists in the education of boys and girls mainly in developing countries (Adeyemi & Akhigbe, 2020). This was also supported by Timothy, (2022) who noticed that there is no gender equality in Nigeria. Besides Abraha et al., (2021) noted that in Ethiopia, teaching and learning activities of science have been challenged by gender

inequality. In developing countries Gender-blind teaching approaches foster gender inequities in the classroom, giving rise to the concept of a teaching and learning environment where male students are allowed to dominate debates and classroom space (Chapin & Warne, 2020).

One of the strategies to alleviate gender disparities in mathematics and science education is the adoption of Gender Responsive Pedagogy (GRP) which ensures that boys and girls are equally treated and involved in classroom activities (Dorji, 2020). Gender-responsive pedagogy refers to teaching and learning practices that focus on the different learning needs of male and female students. It doesn't merely focus on addressing women's and girls' needs but also is about being conscious of the intersection between gender and learners' needs in general, to rectify the imbalances in society (Chapin & Warne, 2020). Gender-responsive pedagogy bring in gender-sensitive teaching that focuses on what is taught, how it is delivered, and how what is taught is retained in the context of both male and female learners (Thege et al., 2020).

To integrate and treat equally both boys and female learners in class activities, mathematics, and science teachers should be knowledgeable of gender-responsive pedagogy and be skilled in its application in the teaching process (Mhewa et al., 2020). Teachers should be aware of how to plan for both boys and females by creating a class environment with instructional methods and materials that support equal learning (Lee, 2021). However, the literature shows that still teachers have a limited understanding of gender-responsive pedagogy (Mhewa et al., 2020). For instance, it is reported that science teachers are ineffective to incorporate gender context in lesson planning, preparation, and in use of teaching materials, besides, they lack gender-responsive sexual maturation management skills (Abraha et al., 2021)

Similarly, years ago, gender inequality was reported in the Rwandan context of education where males and females were used to not being taken equally while learning and this used to lead to boys outperforming girls. Poor understanding of the gender equality concept including gender sensitivity, and resistance to behavior change in both parents and teachers was the most to foster gender disparity in the Rwandan education system (Nader, 2016). To alleviate gender disparity in education, Rwanda has settled different gender policies including the "Girls' Education Policy 2008" aiming to eliminate gender disparities and inequality in education and training as well as in

management structures (Haysom. et al, 2021). To achieve this policy goal, Rwanda has reformed its curriculum and shifted from a knowledge-based curriculum that had no particular consideration of gender equality in mathematics and science teaching to a competence-based curriculum that integrates gender in lesson planning, and in the teaching and learning process as a crosscutting issue (Rwanda Educational Board, 2015). Implementation of a competence-based curriculum in 2016 required teachers to be not only knowledgeable on math and science content, and hands-on activities for teaching but also gender-responsive pedagogy, gender-sensitive method, and inclusive to equally focus on the specific need of both males and females in classroom activities. To implement inclusiveness, gender-responsive learning environments, teachers must be well skilled in approaches preventing gender bias and gender-based discrimination in their classrooms, and also they needed to be supported in utilizing a variety of approaches and strategies that positively and effectively engage all students in lessons (Uworwabayeho et al., 2017). These skills were supposed to be transferred to in-service teachers through training for continuous professional development (UNICEF Rwanda, 2017).

With these imperative needs, Rwanda planned and trained all teachers over the country, however, it could not achieve easily and directly for all teachers alone. Due to this Rwandan education board worked (REB) closer with different Non-Governmental Organizations (NGOs), supporting education to train teachers. With this regard African Institute for Mathematical Science through its teacher training program (AIMS-TTP) and with support from the master card foundation and in partnership REB trained all mathematics and science teachers in 14 districts of Rwanda.

The AIMS-TTP was a five-year project which started its implementation activities in 2018. Its framework was specifically designed with the purpose to implement girls' education policy promoting girls' participation in mathematics and science subjects through developing the capacity of Math and science teachers to understand and applying gender-responsive pedagogy to ensure that their teaching process can cater to the learning needs of both boys and girls. It is in this regard that the present study aims to explore, trained mathematics and science teacher's understanding and application of gender-responsive pedagogy after attending AIMS-TTP training interventions. The study was grounded on the following objectives and hypotheses:

Objectives:

1. To examine teachers' understanding and application of gender-responsive pedagogy after attending AIMS-teacher training program interventions in 14 districts of Rwanda.
2. To test whether there is a statistically significant difference between males' and females' understanding and application of gender-responsive pedagogy after TTP interventions
3. To test whether there is a significant difference in understanding and application of gender-responsive pedagogy between teachers teaching in rural and urban schools, between teachers from Boarding and day schools, and between teachers with different years of teaching experience after AIMS-TTP interventions

Hypothesis:

Objectives two and three resulted in the following null hypothesis:

H01: There is no statistical significance difference between males' and females' understanding and application of gender-responsive pedagogy after AIMS-TTP interventions

H02: There is no statistically significant difference in the understanding and application of gender-responsive pedagogy between teachers teaching in rural and urban schools after AIMS-TTP interventions

H03: There is no statistically significant difference in understanding and application of gender-responsive pedagogy between teachers from boarding and day schools after AIMS-TTP interventions

H04: There is no statistically significant difference in understanding and application of gender-responsive pedagogy between teachers with different years of teaching experience.

2. Methodology

2.1. Research design

The study employed a web-based survey design (Creswell, 2015). Survey research is a common design in education and it is useful to describe the population's attitudes, beliefs, habits, and opinions or characteristics. Due to dynamic technology, researchers may now use web-based tools and services to get survey data from their large population. Technology has made conducting online surveys easier than ever before (Fraenkel et al., 2012). The web survey was opted by this study, to ease the collection of data from a more dispersed population of mathematics and science teachers from 14 selected districts of Rwanda.

2.2 Participants and sampling techniques.

Eight thousand (8000) mathematics and science teachers teaching in ordinally level (O-level) and advanced level (A-level) or in both levels of secondary schools in 14 selected districts of Rwanda where AIMS-TTP implemented its activities were targeted in this study. Purposive sampling allowed their selection focusing on those teaching in all categories of public school which are day and boarding (nine years of basic education, twelve years of basic education, and excellent schools) that received training and facilities AIMS-TTP. Random sampling was adopted to ensure a positive probability of each trained teacher being selected and participating among a population of more than 8thousands trained teachers. Based on (Krejcie & Morgan, 2018) sample size determination table, 367 number is the exact sample size of eight thousand population, however among them 358 reached the end of the survey.

2.3 Tata collection tool

Data were collected using a survey questionnaire after AIMS teacher training program interventions. The questionnaire is made of eight items on gender-responsive pedagogy content See appendix 1. It was developed by researchers and validated for content validity by experts in gender-responsive pedagogy at the University of Rwanda College of Education. Its reliability testing by statistical software for data science (STATA v.18) proved a Cronbach's alpha reliability of 0.71.

2.4. Data collection procedure

To collect the data, the survey questionnaire was webbed using Microsoft Team, and an online link was generated. The link was distributed to teachers' WhatsApp groups after the introduction and warranty of confidentiality by staff in African Institute for Mathematics Science, Teacher Training Program (AIMS-TTP). During the introduction, teachers have been explained the purpose of the survey and were all explained that

everyone is allowed or has a chance to respond to the survey. The explanation of the survey structure was added and they were all provided internet bundles to be able to open and reply. The link was active for one week, and regularly teachers were reminded about the survey and the expiration of the link. After one week, the responses were downloaded in Excel format, the participant count was 358 a number near the sample size estimate of eight thousand population (Krejcie & Morgan, 2018).

Among 351 mathematics and science teachers, 112 were female while 234 were male teachers. Basing their school's location, 287 teach in rural while 64 teach in urban schools. Considering their teaching experience 119 hold 0 to 5 years of teaching experience while 93 have 6 to 10 years and 139 have above 10 years of teaching experience.

2.5 Data analysis

Data summary and visualization through graphs were done by Microsoft Excel 2016 while descriptive and inferential statistics were computed by the Statistical software for data science version 18.0 (STATA vs 18.0). After being downloaded in Microsoft Excel format, data were cleaned by replacing scales with corresponding numbers as strongly disagree by "1", disagree by "2", undecided by "3", agree by "4" and strongly agree by "5". During cleaning, the participants registered by name and without responding to any statements were removed, and 351 participants reached the analysis stage. To visualize the data, "COUNT IF" function was used to count the number of responses per each statement through five scales. Thus, to each statement, the frequency and percentages of those who strongly disagreed, disagreed, undecided, agreed, and strongly agreed were computed. This also was done for comparing the understanding and application of gender-responsive pedagogy among teachers condensing their gender, school location, school category, and teaching experiences. Different paragraphs were plotted and displayed teachers' agreement and disagreement levels on their understanding of gender-responsive pedagogy after AIMS-TTP interventions. The chi-square test by STATA vs 18.0 was computed to test for the hypothesis. The test fitted to the data of this study which were individual counts and categorical in scales.

3.Results and Discussion

Figure 1 shows levels of mathematics and science teachers' understanding of gender-responsive pedagogy and its application in mathematics and science competence-

based curriculum. Its illustrates an understanding and application level beyond 80% for all 8 statements except for statement two 67.1% [I address gender stereotypes] and statement six 77.5% [I use gender neutral (verbal and non-verbal) language in my class].

83.5 % of teachers agreed that “they are now confident in designing learning activities that engage girls and boys in mathematics and science lessons” The agreement to this statement tells that teachers ‘current understanding and application of gender-responsive pedagogy is different to their understanding and application level before attending the AIMS-TTP training interventions. They are confidently able to plan classroom activities that equally give both boys’ and females’ chance of participation. This will lead to equal performance thus developing a country society where both males and females are equally competent at the job market.

The findings contrast with what was found in Ethiopia where teachers were found to be unable to create gender- responsive lesson plans and teaching materials (Abrha et al., 2023). This ineffective of teachers to apply gender responsive pedagogy explain the lack of its understanding in the country and strengthens the importance of AIMS-TTP training on gender-responsive pedagogy and its use in Rwanda. However, the study line with Ananga, (2021) notice that after attending Ghana’s initial teacher training program, teachers increased their understanding and the use of gender-responsive pedagogy in teaching of English Language, Mathematics, and Science. This implies that training improves teachers' understanding and skills to use pedagogy that focuses on the specific need of both boys and females in classroom activities. Therefore, gender-responsive pedagogy training should be extended to all teachers in another district of Rwanda that did not yet receive AIMS-TTP interventions.

82.7 % of teachers understand inclusiveness and can make math and science lessons more inclusive see statement three, Figure 1. When the educational system adjusts to meet the requirements of all students, inclusive education occurs. education of girls and boys focusing on their specific needs is one of the central strategies to ensure that there is an inclusive basic education for all (Uworwabayeho et al., 2017). The fact that 82.7% of teachers understand and apply inclusiveness in their class education tells that during AIMS-TTP training, teachers acquired the relationship between gender-responsive teaching and inclusive education. In addition, the findings tell that teachers strongly emphasize trying to meet the diverse learning needs of all students without removing

anyone from the classroom. This shows that AIMS-TTP training contributed to teachers' understanding of gender promotion through an inclusive classroom which implies that after attending training, teachers in their professional teaching in 14 districts of Rwanda are aware of and able of creating gender-inclusive learning environments. The findings agree with (Gurung & Rajbanshi, 2020) who also noticed that teacher training programs are essential for transforming teachers' gender-biased perspectives through promoting their understanding of gender-inclusiveness. Besides, the findings line with a systematic review that noticed that through increasing teachers' training, they become gender inclusiveness teachers by focusing on girls and boys students' specific needs in an inclusive classroom (Guerrero & Guerrero Puerta, 2023).

The fact that 83.3 % understand and apply gender equity in their classroom activities tells that teachers are highly able to apply gender approaches in teaching. Similarly, they confirmed at 83.2% that they integrate the gender approach in all aspects of teaching, and learning processes like lesson planning, classroom management and performance evaluation, and learning activities that equally interest and engage both girls and boys in mathematics and sciences, see Statement 4 and 5 Figure 1.

The implication is that teachers implement a competency-based curriculum (CBC) by planning the learning activities in consideration of boys' and females' specific needs to promote equal learning achievement. Besides, it implies that trained teachers in 14 districts of Rwanda gained high knowledge of equality and equity teaching thus promoting equity in learning by focusing on each learner's particular need to achieve the same level of learning and achievement. The findings line with Bhattarai, (2021) who noted that teachers apply gender-responsive pedagogy through greater equality in the classroom. In contrast, the findings dislike Timothy, (2022) who noticed that teachers understanding and application of gender-responsive pedagogy is very low and that teachers need more training to promote a positive mindset on gender equity in teaching activities. This proves that Rwandan teachers who attended AIMS-TTP training interventions increased their understanding of gender-responsive pedagogy. In other words, AIMS-TTP training increased their understanding and application skills of gender-responsive pedagogy.

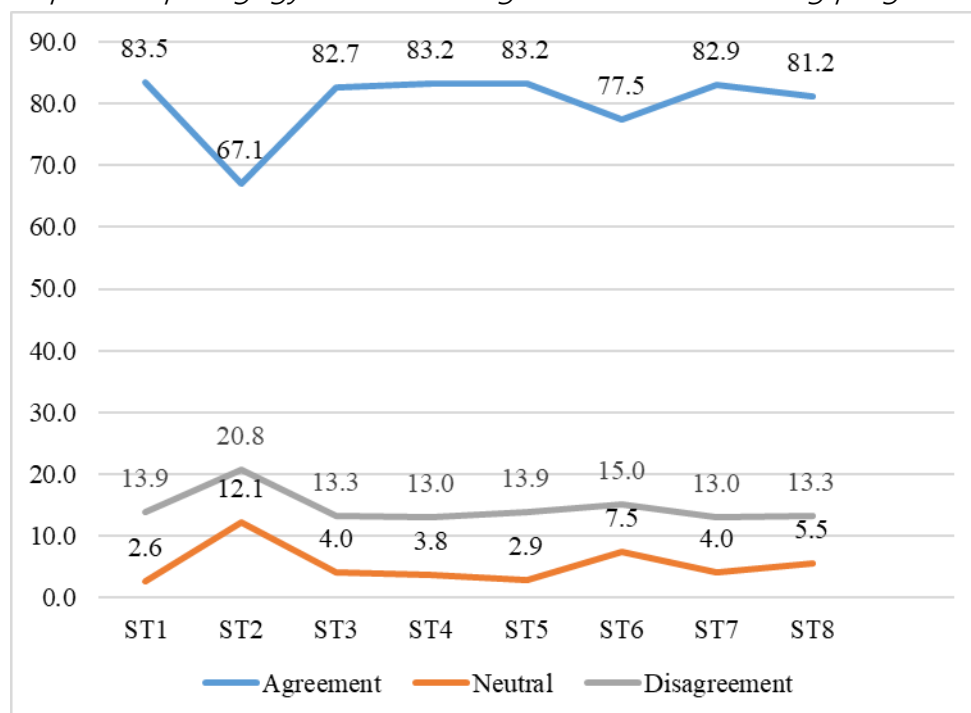
82.9% of trained teachers attested that in their teaching practice, they acknowledge the equal ability of boys and girls in achieving mathematics and science proficiency,

additionally, 81.2% conformed that they adapt teaching to meet the needs of each learner as learners are different but can achieve the learning outcomes see statement 7&8 Figure 1. The reason to have this high application of gender-responsive pedagogy in teaching results from the AIMS-TTP trainings which were planned with various purposes including helping teachers to be able to value equally the learning ability of both female and male students and to facilitate both female and male students' abilities to learn and progress equally and reach their full potential.

The finding attested the full achievement of AIMS-TTP objectives of increasing teachers' understanding and application of gender responded pedagogy and line with the testimony in an educational report by (the United States Agency for International Development (USAID), 2018 p.4) that among the key skills demonstrated by teachers who promote a gender-responsive classroom environment include "Valuing equally the learning ability of both female and male students, facilitating both female and male students' abilities to learn and progress equally to develop their potential to the fullest"

Figure 1

Mathematics and science teachers' understanding and application of gender-responsive pedagogy after attending AIMS-teacher training program interventions.



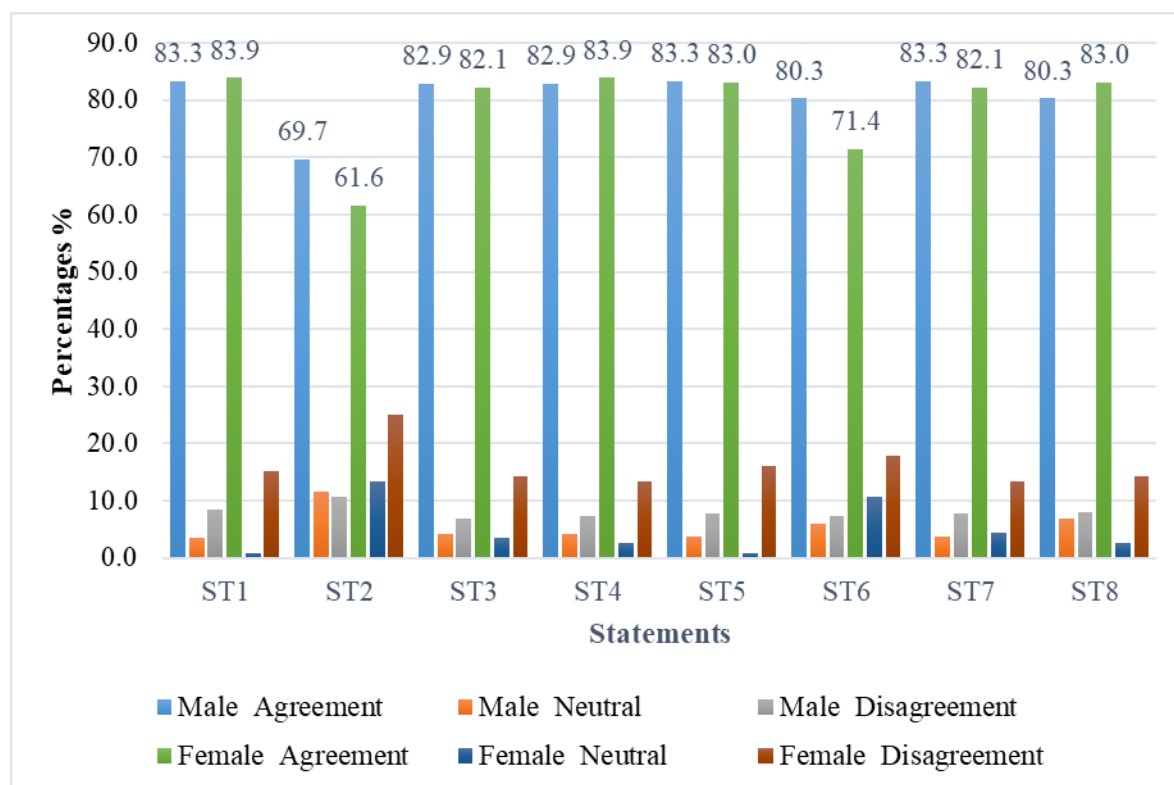
The mean estimation (M= 80.25) of teacher's confirmation of their understanding of gender-responsive pedagogy is higher than the mean of their disagreement (M=14.32),

which proves that Teachers achieved a high understanding of gender-responsive pedagogy and high application in the teaching and learning process of mathematics and science.

Figure 2 Compares male and female teachers understanding of gender-responsive-pedagogy. It is clear that, the agreement and disagreement level to confirm their understanding of gender-responsive- pedagogy and its application in the teaching process is different throughout the eight statements. However, both females' agreement level is above 80% except to statement two and six where their agreement is less than 80% see Figure 2.

Figure 2

Comparison of male and female understanding and application of gender-responsive pedagogy after attending AIMS TTP intervention



The mean estimation of both male and female confirmation to their understanding level of gender-responsive pedagogy is slightly different with male agreement mean of (M=80.72) and (M=79.26) for females. However, the difference has no statistically significant difference Pearson ($\chi^2 (12) = 13.2500$ Pr = 0.351, $P > 0.05$). This tells that no statistically significant difference between male and female agreement on their

understanding and application of gender-responsive pedagogy. Besides their disagreement on the statement did not make any statistically significant difference Pearson ($\chi^2 (36) = 42.0000$ Pr = 0.227, $P > 0.05$). The findings imply that both males and females hold an equal understanding and application of gender-responsive pedagogy. This confirms that they both equally increased their understanding and application of gender-responsive pedagogy after attending the African Institute for mathematical science Teacher Training Program (AIMS-TTP)'s interventions. Therefore, the null hypothesis stating that there is no statistical significance difference between males' and females' understanding and application of gender-responsive pedagogy after AIMS-TTP interventions was accepted.

The male and female teachers' equal understanding and application of gender-responsive pedagogy after AIMS-TTP interventions result from the gender equality approach that was applied during training. They were trained also to apply gender-responsive in teaching taking into consideration the specific need of every teacher. Female teachers were facilitated to attend as their counterpart boys by focusing on the specific facilities they need. For instance, female mothers with newborns from 4 months to two years were supported to attend with their babies at the training center. They received additional support both in terms of living facilities and transport means to girls' baby cares. Pregnant women were cared more to feel a training center as a home environment.

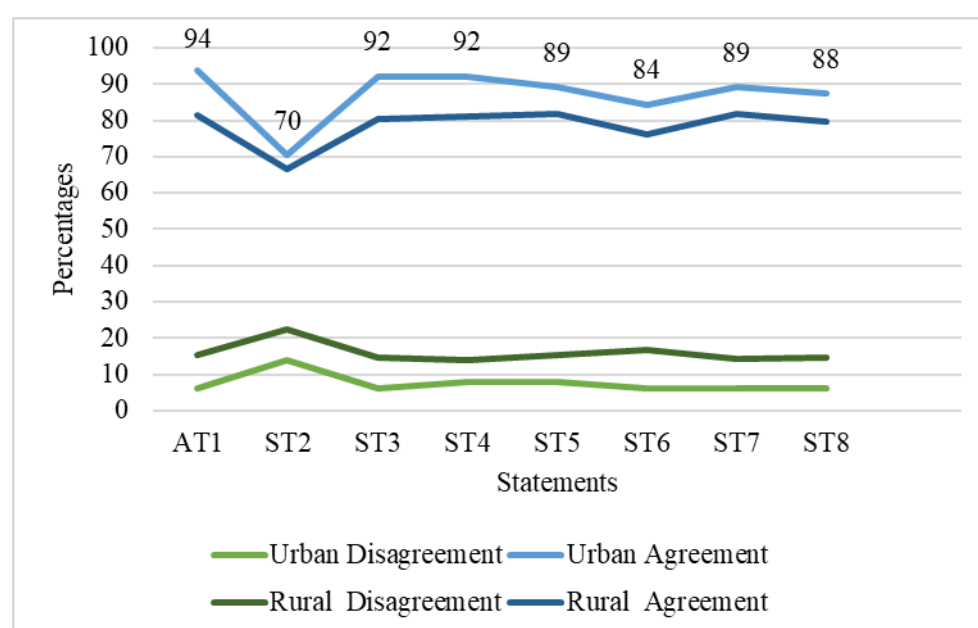
During training equal participation was emphasized and trainings were free of gender bias thus this led to an equal increase in gender-responsive pedagogy understanding and application. Similarly, Abrha et al., (2023) affirmed that training increased equally male and female application of gender-responsive pedagogy. Besides, Chapin et al., (2020) reported that once equally trained, both male and female teachers address gender bias in their teaching environment. Therefore, training on gender-responsive pedagogy and its use should be encouraged as it contributes to learning achievement, hence promoting the sustainable development of a country.

The study checked the teachers' understanding and application level of gender-responsive based on their school location. Figure 3 shows that teachers from urban

schools confirmed their understanding and application level at high % than those teaching in rural schools, however, both showed their understanding level beyond 80% except to statement 2 where teachers from urban schools agreed at 70% and 67% of the agreement to those from rural schools. Besides, later agreed at 76% on statement six. See figure 3

Figure 3

Urban and Rural mathematics and science teachers' understanding and application of gender-responsive pedagogy after AIMS-TTP interventions



Besides, there is a difference in the mean agreement on understanding and application of gender-responsive pedagogy. For instance, urban teachers' mean agreement is ($M=87.5$) while the agreement means for teachers teaching in rural schools is ($M=78.6$). However, the difference is not statistically significant (Pearson $\chi^2(42) = 54.0000$ Pr = 0.101, $P>0.05$). This shows that after AIMS-TTP interventions, teachers from urban and rural schools hold the same understanding and application of gender-responsive pedagogy. Therefore, null hypothesis two stating that "There is no statistically significant difference in the understanding of gender-responsive pedagogy between teachers teaching in rural and urban schools after AIMS-TTP interventions" was accepted

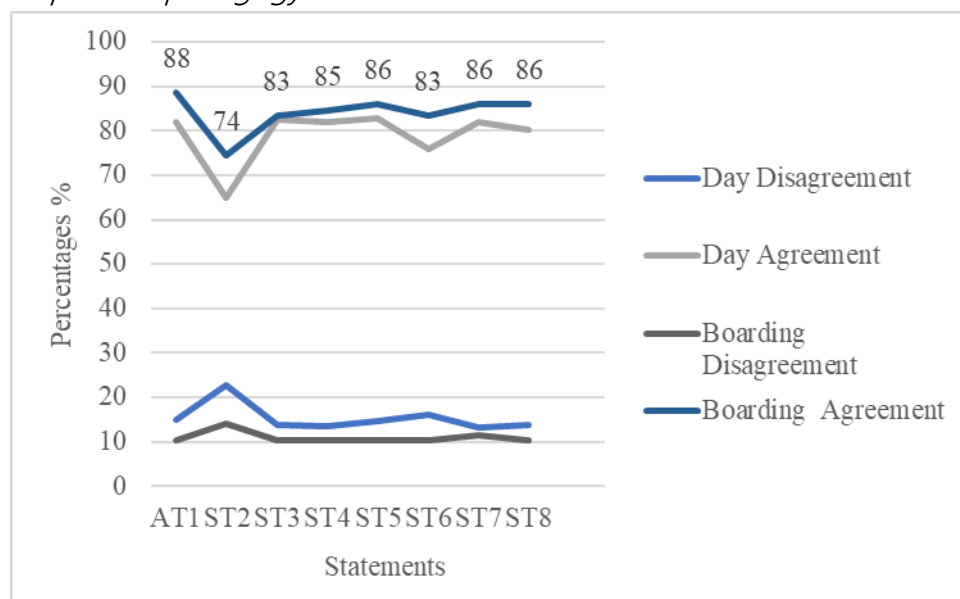
The equal understanding and application of gender-responsive pedagogy between teachers in rural and urban schools result in the fact that AIMS-TTP training was equally

given to all math and sciences teachers from both rural and urban schools. No separation of them instead they were all trained together, were given the same pedagogical content, and all training facilitations were equally provided. In addition to being gender-responsive, trainings were also inclusive. This tells that in all schools' beings located in rural or urban areas in all 14 districts of Rwanda where AIMS-TTP implementation was done, trained mathematics and science teachers apply gender-responsive pedagogy. This implies the contribution of AIMS-TTP to girls' education policy implementation in Rwanda (Rwanda Ministry of Education, 2008) and to the competence-based curriculum implementation that integrates gender education as a cross-cutting issue (Rwanda Educational Board, 2015).

Figure 4 shows the understanding and application of gender-responsive pedagogy of teachers teaching in boarding and day schools. Based on percentages of agreement, teachers in boarding schools have a high understanding and application of gender-responsive pedagogy than teachers in day schools. Boarding school teachers' agreement on the statements is above 80% except to statement two where they agreed at 74%. Similarly, day school's math and science teachers agreed at 80% on statement six and at 65% on statement two, and 76% agreement on statement six. See Figure 4.

Figure 4

Boarding and day school mathematics and science teachers' understanding of gender-responsive pedagogy.



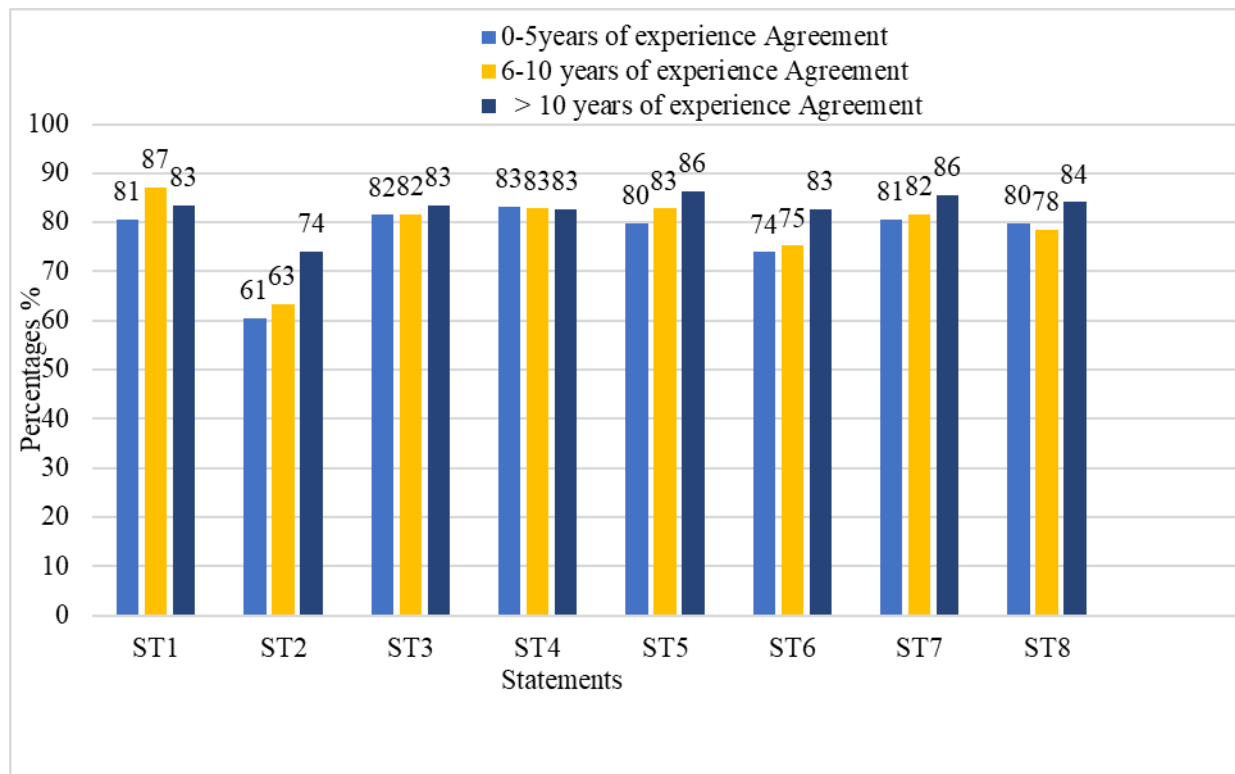
The difference in understanding and application of gender-responsive pedagogy was also realized between their agreement means where boarding schools mean is (M=83.9) and day school agreement means is (M= 79.16). AIMS-TTP has trained all mathematics and science teachers from public schools in 14 districts of Rwanda. Teachers from boarding and day schools (Twelve years and nine years basic schools) participation was different in the number being high number of teachers from day schools as these schools also are more than boarding. Therefore, the slight difference in their agreement percentages and mean resulted from this fact of difference in participation number.

Statistically, the boarding and day school teachers understanding and application of gender-responsive pedagogy is not significantly different (Pearson χ^2 (20) = 19.0000 Pr = 0.522, $P > 0.05$). Therefore, hypothesis three that "There is no statistically significant difference in understanding and application of gender-responsive pedagogy between teachers from boarding and day schools after AIMS-TTP interventions" was accepted. This implies that Gender responsive pedagogy is being applied equally math and science class activities in boarding and day schools in 14 districts of Rwanda.

Figure 5 Visualize mathematics and science teachers' agreements on their understanding and application of gender-responsive pedagogy based on their teaching experience. Teachers in all categories of experience 0-5 years, 6-10 years, and above 10 years of teaching experience confirmed their understanding and application at 80 % and above on all statements except for statement two where they all agreed at % less than 80% see statement 2 in Figure 5. On statement six only teachers with above 10 years of teaching experience agreed at above 80%.

Figure 5

Gender-responsive pedagogy understanding and application level of mathematics and science teachers with different teaching experience



Besides, there is a difference in the mean agreement of teachers based on their teaching experience categories as expressed by the following findings

Table1

Mean agreement of teachers with different teaching experience.

<i>Years of teaching experience</i>	<i>Mean</i>	<i>Std. err.</i>	<i>[95% conf. interval]</i>	
0-5-year agreement	77.4043	2.303249	72.09299	82.7156
6-10 agreement	79.68937	2.312067	74.35773	85.021
>10 years agreement	82.81375	1.171411	80.11247	85.51503
0-5 disagreement	17.08683	1.129168	14.48297	19.6907
6-10years disagreement	14.21744	1.289548	11.24374	17.19115
>10year disagreement	11.91047	.5509212	10.64005	13.1809

However, inferential statistics proved that there's no statistically significant difference in understanding and application of gender-responsive pedagogy neither between teachers with 0-5 years and 6-10 years of teaching experience (Pearson χ^2 (36) = 40.5000 Pr = 0.278, $P > 0.05$), 0-5 years and >10 years of teaching experience (Pearson

$\chi^2 (30) = 29.2500$ $Pr = 0.504$, $P > 0.05$) nor between teachers of 6-10 year and >10 years of teaching experience (Pearson $\chi^2 (30) = 32.2500$ $Pr = 0.356$, $P > 0.05$). This means that regardless of their teaching experience, teachers have an increased understanding and application of gender-responsive pedagogy. In addition, this tells that teaching experience has no influence on teachers' understanding and application of gender responsive- pedagogy.

This equal understanding roots from AIMS-TTP training ways used where both less experienced and highly experienced teachers were treated equally in the training thus equally gained and increasing their skill on gender-responsive pedagogy. The findings agree with (Abrha et al., 2023; Ananga, 2021) who noticed that teachers' teaching experiences do not affect teachers' understanding and implementation of gender-responsive pedagogy. The implication is that all mathematics and science teachers in all 14 districts of Rwanda where AIMS-TTP touched apply gender-responsive pedagogy regardless of their teaching experiences.

In general teachers in all of their aspects of teaching categories, responded at a less than 80 % to statement two [I address gender stereotypes] see Figure 1 to 5. Gender stereotypes are preconceived notions about what men and women ought to look like and be capable of doing. It involves assigning people certain qualities, traits, and roles based on their gender, For instance, males can't change diapers, women are lousy drivers, men are stronger, women are better carers, and females should be docile and permitted to cry, but boys are expected to be brave and not cry, females are better suited for nursing while boys are suited for Mathematics etc. (Francois & Case, 2021; Uworwabayeho et al., 2017).

The fact that teachers showed a moderate level of addressing gender stereotypes in teaching mathematics and science does not mean that training skipped this gender concept rather it means the persistence of a social-cultural mindset in teachers who resist change. This shows that in classroom activities some teachers still assign roles differently to boys and females. And the roots cause may rely on different factors that among others include instructional materials like textbooks, web images, and charts, which may still portray male and female roles differently. The same existence of gender stereotypes was also recently realized in Rwandan upper primary education (Nizeyimana et al., 2022). Besides, Eni, (2021) noticed the existence of gender

stereotypes and recommended majors to fight against it starting from media. Similarly affirmed the persistence of gender stereotypes in Nigerian education.

The findings alarm the education policymakers, implementors, and evaluators to focus on this matter by taking majors to limit and alleviate gender stereotypes in schools. Besides, the findings show the necessity of continuance and regular teacher training on gender-responsive pedagogy. therefore AIMS-teachers training programs in Rwanda should be extended to reinforce pedagogical training including gender-responsive pedagogy.

4. Conclusion and Recommendation

The study investigated mathematics and science teachers understanding and application level of gender-responsive pedagogy after attending African Institutes for Mathematical Science Teacher Training Program (AIMS-TTP) interventions. It was conducted in 14 districts of Rwanda where the AIMS-TTP implemented its activities. A web-survey design and survey questionnaire were used to collect data from mathematics and science teachers teaching in public schools, both in boarding and day schools. The study findings showed that after teachers' training program interventions, trained mathematics and science teachers understand and apply gender-responsive pedagogy at a percentage level beyond 80% with an average mean agreement of $M = 80.25$. The high understanding and application level were expressed by both male and female teachers and there was no statistically significant difference in understanding and application of gender-responsive pedagogy in the teaching and learning process.

The findings on the comparison of teachers understanding and application of gender-responsive pedagogy based on different aspects of teacher categories proved no statistically significance difference. For instance, inferential statistics by chi-square test attested no statistically significant difference between teachers teaching in rural and urban schools, between teachers teaching in boarding and day schools, and between teachers with different years of teaching experience. The findings implication is that AIMS-TTP trainings added to teacher's knowledge and application skills of gender-responsive pedagogy as the findings affirmed that after attending teacher training program interventions, all trained teachers in 14 districts of Rwanda hold a high understanding and application of gender-responsive pedagogy. In addition to a high understanding of gender-responsive pedagogy also, become gender-sensitive teaching implementers, therefore an overall recommendation is regular training on gender-

responsive pedagogy and gender sensitivity to teachers and extension of training to teachers in other districts who have not received AIMS-teachers training programs interventions.

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Article 5

Perceived adequacy of entrepreneurship course content and
entrepreneurship intention among library and information science
postgraduates in southwestern, Nigeria

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Abstract

The menace of graduate unemployment pervades every nook and cranny of the African sub-region of the world and is more rampant in Nigeria due to its population. The Nigerian university system churns out a huge number of graduates on yearly basis to be confronted with the reality of unemployment. The situation is inimical to the environment and results in the idleness of youth who are, and should be useful in their productive years. Entrepreneurship has been proven to have a positive impact on students' economic prowess after graduation and various studies have indicated its ability to take people out of poverty. This study, therefore, modelled the entrepreneurship intention of Library and Information Science (LIS) postgraduates on the perceived adequacy of the course content of entrepreneurship courses taught while in school on the students' self-employment intention, type of entrepreneurship practised and purpose of engaging in entrepreneurship. The research design is a survey of the correlational method. The sample size of 154 students, non-randomly (accidental sampling) drawn from the total population of all postgraduate students of library and information science schools in the southwestern part of Nigeria, was used for data capturing. The data-gathering instrument was a validated questionnaire ($r = 0.86$). Data were analysed through correlations and regressions following the structural equation

modelling procedure based on a 0.05 level of significance. Perceived adequacy of the course content of the entrepreneurship courses offered did not correlate with constructs of entrepreneurship intention (self-employment intention, $P = 0.051$), (type of entrepreneurship, $P = 0.113$) and (purpose of engaging in entrepreneurship, $P = 0.083$). However, perceived adequacy of the course content of the entrepreneurship courses offered ($r = 0.173$; $P = 0.031$; $p < 0.05$) correlates weakly with the entrepreneurial intention of LIS graduates (that is, self-employment intention, type of entrepreneurship, and purpose of engaging in entrepreneurship) when taken together. It was concluded that there is no association between the LIS entrepreneurship courses offered and the intention to engage in entrepreneurship by the LIS graduates. It was recommended that the curriculum of LIS entrepreneurship courses should be reviewed generally by all stakeholders including LIS lecturers, entrepreneurs, policymakers, and others to inculcate the new trends and practical activities that will engage the students in having practical experiences.

Introduction

Entrepreneurship, as a Library and Information Science (LIS) course was introduced into the LIS curriculum in Nigeria shortly after the National University Commission (NUC) made it mandatory for all universities in Nigeria to offer a general university course, tagged GST 311 which is to be jointly taught by lecturers with knowledge background in areas such as business administration, economics, management and allied courses so as to re-orientate Nigerian students on a future career path (Ekoja and Odu, 2016). The fallout from that is the introduction of infopreneurship by LIS schools based on the resolution reached by LIS educators at the National Association of Library and Information Science Educators (NALISE) conferences of 2011, 2012, 2013 and 2014 (Ekoja and Odu, 2016, Nwosu, 2019 and Chukwuji and Umeji, 2019). Therefore, LIS schools such as the Universities of Ibadan, Ilorin, Nigeria, Abuja, Abubakar Tafawa Balewa University, Ahmadu Bello University, and Babcock University pioneered infopreneurship-related courses. For instance, Ahmadu Bello University, Zaria decentralized its infopreneurship courses into LIBS 414: Publishing and Advertising, LIS 323: Financial Management, in Libraries and Information Centres, LIBS 321: Marketing of Libraries and Information Centres; and LIS 220: Business Information Systems and Services to properly position the students to take up entrepreneurship after graduation.

Other universities such as the University of Ibadan offer the course as a unit. In the Department of Library, Archival and Information Studies where the author is domiciled, the course is tagged LIS 412 (Entrepreneurship in Library, Archival and Information Science) taken at 400 level with the following synopsis: entrepreneurship-theory and practice; staffroom/marketing the new venture; determining capital requirements, writing business plans, business options, openings and possibilities for entrepreneurship, employment creation; requirements for establishing and managing enterprises, business plan project; introduction to small business start-up; and identifying business opportunities.

The ultimate aim of the infopreneurship as put together by NALISE is to expose LIS graduates to taking up information-related entrepreneurship opportunities such as abstracting, indexing, publishing, database development and management, collection management, knowledge management, organization of knowledge, current awareness services, staff recruitment and development, the conduct of researches, bibliographic and metadata searching, journals and book business, materials conservation and preservation, generation of ideas, etc. (Ekoja and Odu, 2016). However, the fact relating to the viability of the content of infopreneur courses being taught in Nigerian LIS schools as perceived by the students is yet to be determined, this is coupled with whether the aim of introducing the course has also resulted in predICTing entrepreneurial intention among LIS students.

Statement of the Problem

The career opportunity for library and information science graduates reached its peak in the late 80s and early 90s when library science is only domiciled in first-generation universities. During this era, only the University of Ibadan, Ahmadu Bello University and the University of Nigeria were the only universities offering the course. This afford library and information science graduates the best opportunity to be gainfully employed immediately after graduation. This trend equally avails the practitioners of a blistery civil service career either in higher institutions or government parastatals. Based on the presumed job opportunities enjoyed by the profession due to a manageable number of students enrolling for the course and coupled with its low publicity as against the elite courses, library and information science students have over the years hold a myopic view regarding future career path which has been narrowed to working in the library or information centres only. Therefore, graduates of library and

information science have consistently limited their career opportunities to securing salaried appointments or employment.

The late 90s and the millennium ushered in a surge in the number of universities offering library and information science. This was partly due to the number of admission seekers to the programme pushed by the assumption of securing jobs quickly and the upsurge in private universities which opened new opportunities for the employability of librarians. Thence, more institutions offer to float the course in order to cater for the societal demands for librarians. This led to a sharp increase in the number of universities offering the course from three in the early 90s to twenty-seven in the year 2020.

The resultant and immediate effect of this is the growth in the number of library and information science graduates and the saturation of the librarianship profession's labour market with a large number of unemployed LIS graduates. To combat this challenge, LIS schools began the inclusion of entrepreneurship in the courses offered by students so as to widen their scope regarding their future career path and as such, the coinage of catchy words like infopreneurship, libpreneurship, etcetera.

Observation has shown that the students are still not engaging in entrepreneurship activities as expected. Evidence from the literature shows a slow pace in the level at which libraries and information science take up entrepreneurship (Anyanwu, Obichere and Ossai-Onah (2013), Nnadozie, et al. (2013), Chukwuji and Umeji, 2019) based on factors such as lack of entrepreneurial skills and the needed ICT skills. The studies were merely a systematic review of the literature and are not based on empirical evidence. This researcher, therefore, seeks to empirically predict the LIS graduates' entrepreneurial intention from the angle of LIS entrepreneurship course content adequacy.

Hypotheses

The following hypotheses were tested.

1. There is no relationship between entrepreneurship courses offered and the entrepreneurship intention of LIS graduates.
2. There is no relationship between entrepreneurship courses offered and the type of entrepreneurship LIS graduates engages in.
3. There is no relationship between entrepreneurship courses offered and the purpose of engaging in entrepreneurship by LIS graduates.

4. There is no relationship between entrepreneurship courses offered and the joint constructs of entrepreneurship intention of LIS graduates.

Literature Review

No known study has been conducted regarding the relationship between the adequacy of the content of LIS entrepreneurship courses and entrepreneurial intention. However, there exists literature regarding the entrepreneurship curriculum in general. A study by Aluede, Idogho, and Imonikhe (2012) about entrepreneurship curricula in Nigeria through a qualitative analysis reported that the curricula are defective. In the same vein, Onoh (2013), affirmed that the curriculum or course content of entrepreneurship courses taught in schools plays little or no role in the entrepreneurial intention and skills of people as entrepreneurial education is learnt through trial and error and experience. In 2014, Olorundare and Kayode (2014) observed challenges facing the entrepreneurship curriculum in Nigeria including the inadequacy in funding the curriculum, inadequate curriculum implementation relating to a lack of quality trainers, or total lack of expertise. Thus, the curriculum of entrepreneurship courses generally has not actually met the objectives with which they were introduced.

Oguerri and Edem (2017) were of the opinion that the LIS entrepreneurship curriculum is just a mere fulfilment of righteousness in most LIS schools as there is a widespread perception of students by LIS students that they do not need employability skills since they can get jobs upon graduation. In 2020, a study by Odumosu, Binuyo, Adefulu and Asikhia (2020) empirically proved that social innovation influences graduate entrepreneurship. The study was aimed at juxtaposing education innovation, entrepreneurship education, digital and agricultural innovation, and Nigerian graduates' entrepreneurial intention. Using the Batch C 2019 Youth Corps Members across the six geopolitical zones in Nigeria, and through the analysis of multiple linear regression, results showed that there is a collective significant effect of social innovation dimensions on graduate entrepreneurship ($F(4, 510) = 35.081, p < 0.000, R^2 = 0.210$). Nonetheless, educational innovation and digital innovation have a positive and significant effect on graduate entrepreneurship while entrepreneurship education and agricultural innovation have a positive but insignificant effect on graduate entrepreneurship in Nigeria. Abioye (2020) equally reported that the non-practicality of entrepreneurship education was responsible for its low impact on graduate students' entrepreneurial intention.

Theoretical Framework

Proposed model

Independent Variables

Dependent Variable

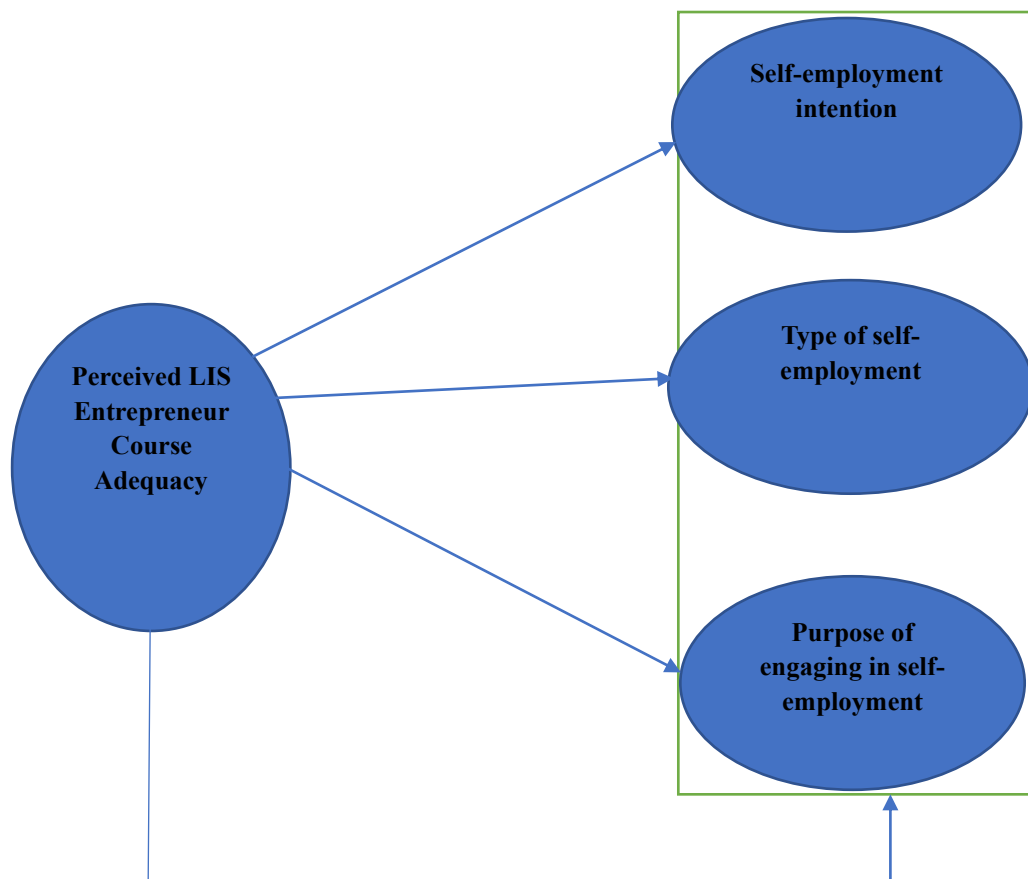


Figure 1: Proposed conceptual model

Methodology

This study is a survey of correlational type. Due to the nature of this study, and its expected large population, the survey is found most appropriate as stated by Babbie (2013). The population of the study comprised 411 postgraduate students across the four selected universities (University of Ibadan – 200, Tai Solarin University of Education – 85, Adeleke University – 49, and Lead City University – 77). The accidental sampling technique (a type of non-random sampling) was used since the data-gathering instrument was distributed online. A total of 154 respondents filled out and submitted the data instrument, therefore, the sample size of the study was 154, representing 34 per cent of the population. The author was of the opinion that survey design is the most appropriate for collecting large samples. Therefore, the main source for data gathering is quantitative using a validated questionnaire with a Cronbach Alpha coefficient of 0.86 (See Appendix I). The reliability of the instrument was carried out using thirty (30) copies of the questionnaire distributed to the graduate students of the Department of Data and Information Science, Faculty of Multidisciplinary Studies, University of Ibadan, Nigeria. Twenty-nine copies were returned and used for the analysis of the reliability of the instrument. The overall reliability coefficient of the instrument using Cronbach's Alpha method generated a total of $r = 0.86$ for the 50-item instrument. The $\bar{x} = 154.345$, $\sigma^2 = 173.448$, $\sigma = 13.17$ showing the scale statistics and the factor loading.

Table 1: Total Item Statistics

Notation	Dimension/Item	Reliability	Factor loading of items on the dimension to which they belong	Corrected item-to-total correlation
SEI	Entrepreneurship Intention Scale	0.685		
SEI Q1	Intention to start a business after completing studies		.629	.560
SEI Q2	I believe I have the ability to grow my own business		.305	.713
SEI Q3	I am willing to take some business risk		.456	.640
SEI Q4	I always observe what are the business opportunities available		.457	.631
SEI Q5	I have a strong desire to be an entrepreneur		.542	.616
SEI Q6	I am a self-motivated person		.243	.693
ToSE	Type of entrepreneurship	0.816		

ToSE Q1	Independent Contractor		.620	.780
ToSE Q2	Temporary Worker		.519	.815
ToSE Q3	Seasonal Staff		.786	.722
ToSE Q4	Alternative Schedule Professional		.622	.774
ToSE Q5	Independent Business Owner		.532	.800
PoESE	Purpose of engaging in entrepreneurship	0.822		
PoESE Q1	To have Control Over All Business Aspects		.461	.810
PoESE Q2	To Use Skills		.580	.801
PoESE Q3	To Solve problem		.485	.808
PoESE Q4	Increased Earning Potential		.506	.806
PoESE Q5	Job Security		.524	.804
PoESE Q6	Flexibility in choosing entrepreneurship		.387	.817
PoESE Q7	Improved Quality of Life		.355	.818
PoESE Q8	Tax Benefits of Entrepreneurship		.421	.816
PoESE Q9	Potential for Growth and Learning		.681	.791
PoESE Q10	Connections with customers		.585	.799
PoESE Q11	Sense of pride		.459	.811
AoLISECC	Adequacy of LIS Entrepreneurship Course Content	0.915		
AoLISECC Q1	Awareness about entrepreneurship courses offered during the undergraduate programme		.466	.919
AoLISECC Q2	Registration and participation in the LIS entrepreneurship course during undergraduate		.445	.922
AoLISECC Q3	Appropriateness of the course curriculum		.688	.907
AoLISECC Q4	The content of the course meets expectations		.776	.901
AoLISECC Q5	The course content motivates me to embark on entrepreneurship after school		.842	.897
AoLISECC Q6	The entrepreneurship course techniques in promoting entrepreneurship are adequate		.756	.903
AoLISECC Q7	The entrepreneurship course content is clear		.801	.902
AoLISECC Q8	There are enough hours allocated to teach the course for clarity		.725	.906
AoLISECC Q9	The course content has enough practical skills		.687	.907
AoLISECC Q10	The course content is integrative into the modern entrepreneurial practices		.784	.901

A factor analysis was conducted to show the internal consistency of the items in the research instrument. It was found through the scree plot that all the factors are well loaded based on 0.7 eigenvalues used for extraction.

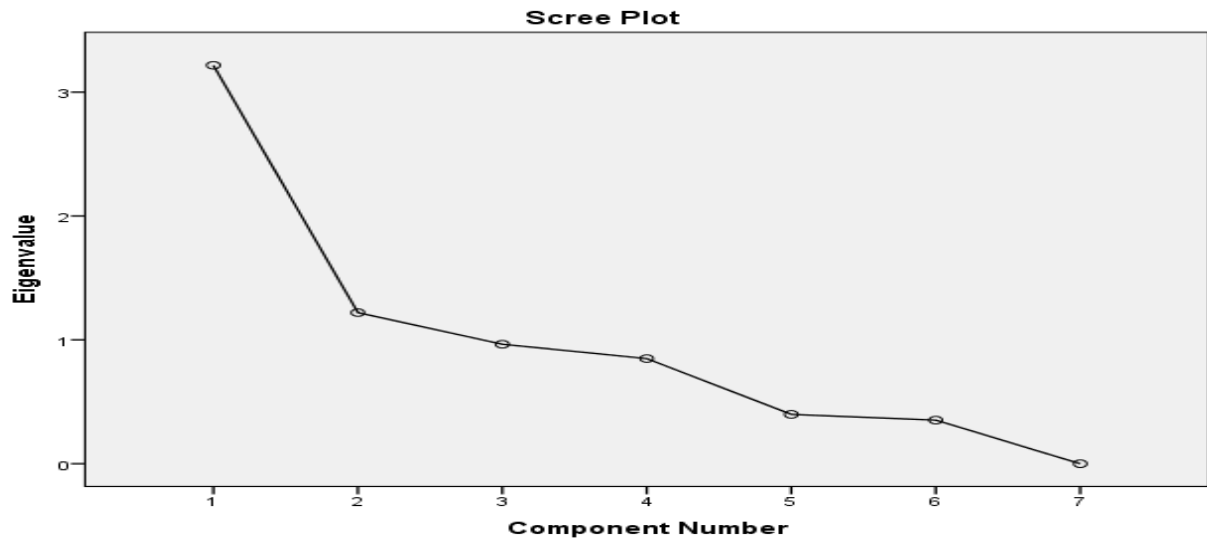


Figure 2: Scree Plot Showing the factor analysis

The commonalities of the subscales indicated that each had a commonality above the threshold of 0.7 set for the coefficient. See Table 2.

Table 2: Normality of the data variables

Communalities		
	Initial	Extraction
Perceived adequacy of LIS entrepreneurship courses	1.000	.961
Entrepreneurial Intention	1.000	.990
Self-Employment Intention	1.000	.761
Type of Self-Employment	1.000	.798
Purpose of Engaging in Self-Employment	1.000	.854

Extraction Method: Principal Component Analysis.

Data were analysed using simple linear correlation and multiple linear regression. Firstly, in order to achieve the normality test of the instrument so that parametric tests could be conducted, the skewness and kurtosis of the data were performed using the independent and the dependent variables. Perceived adequacy of LIS entrepreneurship course content and entrepreneurship intention yielded a Skewness of 0.443, and a standard error of 0.637 showing the skewness Z-Value of 0.695 which is neither below -1.96 nor above +1.96 standard thresholds. The Kurtosis values of -0.728 and standard

error of 1.232 indicating the Z-Value of -0.59 is confirmatory of the Skewness value. The Kolmogorov-Smirnov 0.200 and Shapiro-Wilk 0.210, both significant at 0.05 level showed that the two variables are fairly normally distributed.

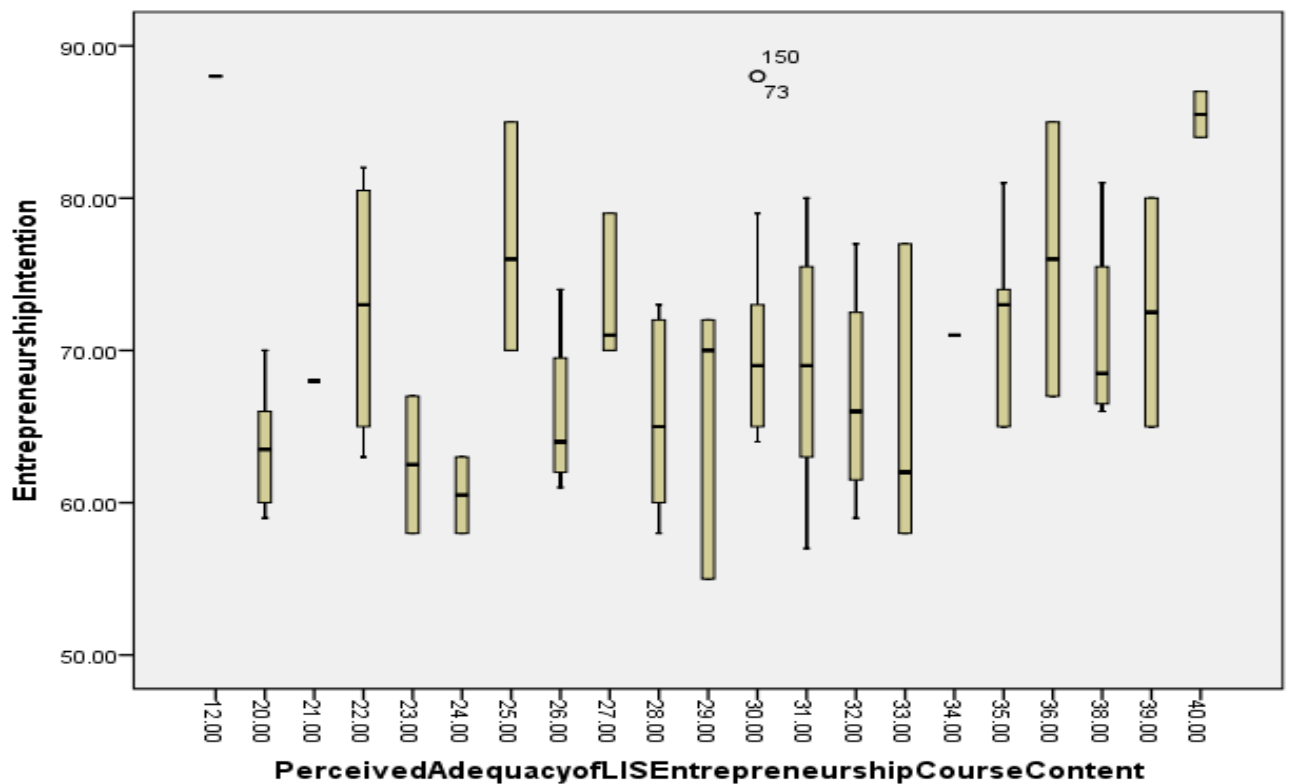


Figure 3: Normality test on Perceived Adequacy of LIS entrepreneurship course content

Data Analysis

Demographic details of the respondents

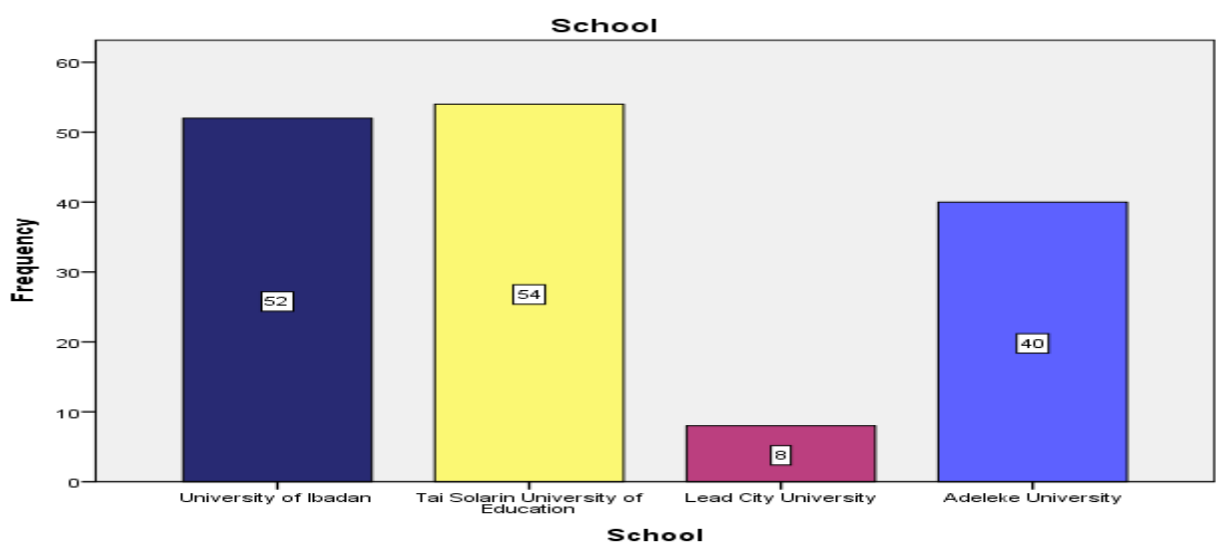


Figure 4: Distribution of respondents by School

A total of 154 respondents participated in the survey. The majority, 54(35.1 %), were from Tai Solarin University of Education, Ijebu-Ode, Ogun State, Nigeria, followed by 52(33.8%) from the University of Ibadan. Adeleke University, Ede, Osun State, Nigeria equally had 40 participants representing 26%, while, Lead City University, Ibadan, Oyo State, Nigeria, had the lowest representation with 8(5.2%).

Gender

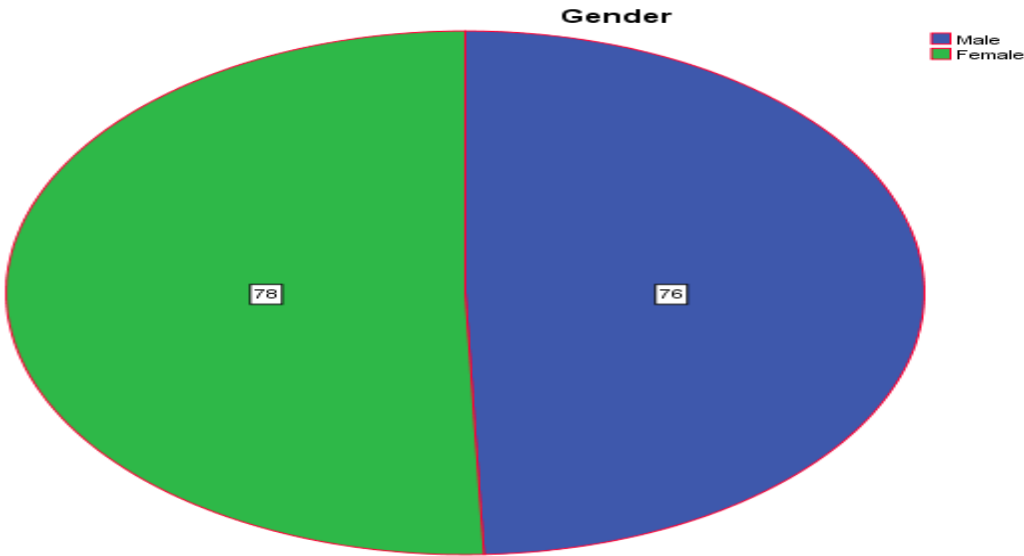


Figure 5: Gender of the respondents

There were more females 78(50.6%) than males 76(49.4%), though the disparity is infinitesimal.

Age group

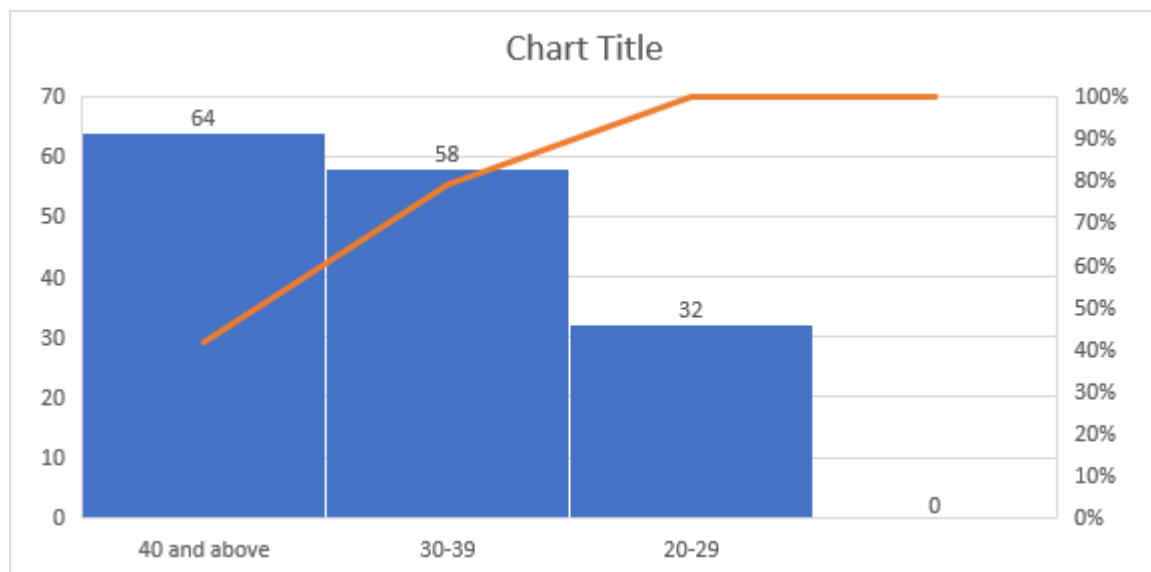


Figure 6: Age distribution of the respondents

The majority of the respondents were 40 and above (64, 41.6%), followed by those within the age range of 30 to 39 (58, 37.7%), and the last category was within the range of 20 to 29 age range (32, 20.8%).

Hypothesis

Hypothesis 1: There is no relationship between entrepreneurship courses offered and the entrepreneurship intention of LIS graduates.

Using the Pearson Product Moment Correlation Coefficient, the relationship between entrepreneurship courses offered and the entrepreneurship intention of LIS graduates.

Table 3: Correlation matrix

Variables	N	r	P. Value	Remarks
Perceived adequacy of the course content of entrepreneurship courses offered ↔ Entrepreneurship intention	154	.158	.051	Not Sig.

The null hypothesis was accepted. The P. Values of perceived adequacy of the course content of entrepreneurship offered and entrepreneurship intention ($r = 0.158$, $P = 0.051$, $p\text{-value} > 0.05$) showed that the perceived adequacy of the course content of entrepreneurship offered by the students during their undergraduate days does not relate with entrepreneurship intention.

Hypothesis 2: There is no relationship between entrepreneurship courses offered and the type of entrepreneurship LIS graduates engages in.

Table 4: Correlation between entrepreneurship courses offered and the type of entrepreneurship LIS graduates engages in.

Perceived adequacy of the course content of entrepreneurship courses offered	Type of Entrepreneurship adopted/likely to adopt	154	.128	.113	Not Sig.
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The null hypothesis was accepted. The P. Value of perceived adequacy of the course content of entrepreneurship offered and type of entrepreneurship ($r = 0.128$, $P = 0.113$, $p\text{-value} > 0.05$), showed that the perceived adequacy of the course content of entrepreneurship offered by the students during their undergraduate days does not relate with types of entrepreneurship adopted or to be adopted by the students.

Hypothesis 3: There is no relationship between entrepreneurship courses offered and the purpose of engaging in entrepreneurship by LIS graduates.

Perceived adequacy of the course content of entrepreneurship courses offered	Purpose of engaging in Entrepreneurship	154	.140	.083	Not Sig.
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The null hypothesis was accepted. The P. Value of perceived adequacy of the course content of entrepreneurship offered and purpose of engaging in entrepreneurship ($r = 0.140$, $P = 0.083$, $p\text{-value} > 0.05$), showed that the perceived adequacy of the course content of entrepreneurship offered by the students during their undergraduate days does not relate with the purpose of engaging in entrepreneurship by the students.

Hypothesis 4: There is no relationship between entrepreneurship courses offered and the joint constructs of entrepreneurship intention of LIS graduates.

A linear Pearson Product Moment Correlation Coefficient was conducted to determine the relationship between the perceived adequacy of the content of the entrepreneurship course offered by the students and entrepreneurial intention. Table 6 showed the result.

Table 6: Perceived adequacy of the content of the entrepreneurship course offered by the students and entrepreneurial intention

Variables	Mean	Std.	N	r	P	Sig. (P)	Remark
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		Deviation					
Perceived adequacy of the content of the entrepreneurship course offered by the students	29.2078	5.81262	154	0.173	.031	< .05	Sig.
entrepreneurial intention	69.7403	8.01372					

Table 6 presents the relationship between the Perceived adequacy of the content of the entrepreneurship course offered by the students and entrepreneurial intention. To establish the relationship between the Perceived adequacy of the content of the entrepreneurship course offered by the students and the entrepreneurial intention of library and information science graduate students in South-west, Nigeria, a Pearson product-moment correlation was conducted. The results above show that there was a significant positive correlation between the Perceived adequacy of the content of the entrepreneurship course offered by the students and the entrepreneurial intention of LIS graduates in South-west, Nigeria. ($r = 0.173$; $P = .031$; $p < 0.05$). This means that an increase in the Perceived adequacy of the content of the entrepreneurship course offered by the students will affect LIS graduates' entrepreneurial intention. Therefore, the null hypothesis that states that there is no significant relationship between the Perceived adequacy of the content of the entrepreneurship course offered by the students and entrepreneurial intention is not accepted and it is concluded that there is a statistically significant relationship ($p < 0.05$) between Perceived adequacy of the content of the entrepreneurship course offered by the students and entrepreneurial intention of LIS graduates in South-west, Nigeria.

Summary and discussion of findings

This study aimed at connecting the correlates of entrepreneurial intention and the perceived adequacy of the entrepreneurship course offered among graduates of Library and Information Science (LIS). The course content of entrepreneurship courses offered by the students does not influence the self-employment intention, types and purpose of entrepreneurship adopted or likely to be adopted among LIS graduates when taken individually or singly, however, had a very weak correlation with the correlates of entrepreneurship intention when taken together. This finding contradicts the aim of entrepreneurship courses taught in LIS schools which is aimed at exposing LIS graduates to taking up information-related entrepreneurship opportunities including

abstracting, indexing, publishing, database development and management, collection management, knowledge management, organization of knowledge, current awareness services, staff recruitment and development, the conduct of researches, bibliographic and metadata searching, journals and book business, materials conservation and preservation, generation of ideas, etc. (Ekoja and Odu, 2016, Nwosu, 2019 and Chukwuji and Umeji, 2019). It however supported that of Ikolo and Ogbomo (2019) who reported that LIS students in Edo and Delta States, Nigeria are only willing to take up paid employment after graduation though, a good percentage are aware of the benefits entrepreneurship can offer.

The entrepreneurial intention in this study (which is the combination of self-employment intention, type and purpose of engaging in entrepreneurship) is predicted by the course content of LIS entrepreneurship courses offered during the undergraduate programmes. This finding could be as a result of amalgamating the entrepreneurial intention scales into one. This finding contrasts the submission of Abioye (2020), Ogueri, and Edem (2017), Olorundare and Kayode (2014), Onoh (2013), and Imonikhe (2012) who reported that entrepreneurship curricula in Nigeria are defective. Though, the earlier finding indicated that the adequacy of the LIS entrepreneurial course does not affect the entrepreneurial intention factors subsists.

Conclusion and recommendation

This study correlated the perceived adequacy of entrepreneurship courses offered and constructs of entrepreneurial intention (self-employment intention, types and purpose of entrepreneurship practised or to be practised) of library and information science graduates in the Southwestern part of Nigeria. A weak correlation exists between the perceived adequacy of entrepreneurship course content and correlates of entrepreneurship intention when taken together, while no correlation exists between the perceived adequacy of entrepreneurship course and each of the constructs (self-employment intention, types and purpose of engaging in entrepreneurship). Therefore, the entrepreneurship courses offered by the graduate students during the undergraduate programmes have not effectively contributed to the entrepreneurial intention of the students. Based on this, the following recommendations are made.

1. The curriculum of LIS entrepreneurship courses should be reviewed generally by all stakeholders including LIS lecturers, entrepreneurs, policymakers, and others

to inculcate the new trends and practical activities that will engage the students in having practical experiences.

2. The government at all levels should develop a policy guideline that will make the students have a compulsory industrial experience for post-graduation use. Such industrial experiences should include hands-on, and students are given documents such as practical books, teach-yourself, user manuals, and related materials that will help them in the field of practice.
3. Start-up capital should be provided to willing students in order to start a business venture upon graduation. The start-up capital could be provided by the government at all levels or governments mandating and regulating banks and other lending organisations to make accessing start-up capital easy.
4. Training, workshops, practical sessions, and other programmes that can make students gain confidence in engaging in entrepreneurship upon graduation should be organised by relevant bodies including universities, firms, non-governmental organisations, government agencies, and others to promote the love for entrepreneurship among the students.

Implications of this study

This study reveals the inadequacies of the LIS entrepreneurship courses offered by the students during undergraduate programmes, therefore, LIS educators are challenged to review the courses' contents and structure them in line with recent developments. The study also has policy implications for the government at all levels. The LIS graduates indicate a positive disposition to entrepreneurship compelling the government to draw up policies that will aid the positive disposition of the students toward entrepreneurship.

Suggestions for further studies

Upcoming studies should focus on other variables not included in this study.

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Article 6

A case study of the challenges and successes in the implementation of
blended learning in Eswatini schools as perceived by teachers

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Abstract

The covid-19 pandemic served as a harsh wake-up call for Eswatini; at the time, the country's education system, particularly its schools, suffered greatly from a lack of a sound strategy to support online and distance learning. After discovering the value of this pedagogy, certain schools in Eswatini have made an effort to incorporate blended learning. Blended Learning implementation is one of the short-term objectives of the Eswatini education policy document, "2018 ICT Strategic Framework." This study employed a case study in Eswatini schools that have already adopted blended learning. The three phases of blended learning were divided into three categories for schools: (1) exploration; (2) early phase of blended learning; and (3) mature phase of blended learning. The purpose of the case study was to identify and elaborate on challenges and benefits of the implementation of blended learning in Eswatini Schools as perceived by teachers. It also sought to ascertain whether teachers in Eswatini schools are familiar with the 2018 ICT strategic framework that is found within the education sector policy. According to the research, phase 1 of blended learning, which is the exploration phase, was being used by all three of the selected schools. The study also revealed that there is a breakdown in communication between school administrators and instructors. All the teachers noted a number of benefits and difficulties with using blended learning.

Keywords: Eswatini, blended learning, policy, challenges & successes

1.0. Introduction

Technology integration in education has grown in importance over the past ten years, impacting education not only in developed but also in developing nations. The majority of Sub-Saharan African countries have a national policy on technology in education and a plan for implementation, according to Tilya's (2008) review of the development of technology in education policies in Sub-Saharan Africa. Some of these nations have organizational frameworks in place that are in charge of implementing technology. Eswatini is one of the Sub-Saharan African nations with a national technology in education strategy and implementation plan. The Eswatini administration, in particular the Ministry of Education, recognized the value of ICT in education and views technological literacy as a catalyst for rapid progress in the education sector.

Eswatini received a harsh wake-up call from the covid-19 pandemic. Because there was no effective plan in place to support online and distant learning at this time, the country's educational system, particularly from the elementary school level to the high school level, suffered greatly. For almost a full year, government schools were closed completely. A majority of the public schools in Eswatini are currently undergoing the technology introduction phase. The 2018 Education and Training Sector Policy from the Eswatini Ministry of Education and Trainings (MOET) was the first document in the nation to lay the groundwork for sector advances by giving strategic guidance in a single document. It was indicated upon Cabinet approval that it would be revisited every five years. The Education and Training Sector Policy is regarded as a practical, guiding instrument designed to empower every individual and interest group in the sector. It provides an articulate vision for teaching and learning and identifies an overarching goal and set of linked objectives – all combined to give direction to the education and training sector and its sub-sectors (Eswatini education sector policy, 2018).

Information and Communications Technology Strategic Framework is a part of this policy. The short-term and long-term objectives for ICT in education are clearly laid out in this framework. The short-term objectives are particularly concerned with

implementing blended learning in educational institutions. ICT is currently a core subject in junior high schools where ICT resources are available and an elective subject in Eswatini high schools, both of which include ICT facilities. All other subject areas are not required to include ICT into teaching and learning, and doing so depends entirely on the availability of resources for such a project.

Eswatini is still developing when it comes to technology and some schools do not have any ICT resources available within the schools to facilitate ICT integration into teaching and learning. On the other hand, many higher institutions and private schools have embarked on the journey of ICT integration to a certain level varying from including computer literacy in the school curriculum, to the use of computer aided tools for teaching and learning and the use of learning management systems. The government realizes the importance of integrating technology into the curriculum at all levels. The government and other stakeholders such as partnering countries have invested in procurements of computers and establishment of computer laboratories in some high schools. According to Agyei & Voogt (2011), Computer literacy is not only introduced as a new subject in a curriculum, but also as a tool to enhance teaching and learning. An initiative has recently been done by the Ministry of Education to equip a selected number of teachers across the country on ICT integration and blended learning.

This program first chose 12 instructors from each of the core disciplines included in our national curriculum; the teachers come from various schools throughout Eswatini's four regions. The Eswatini curriculum consists of 5 basic subjects: English, mathematics, Siswati (home language), and religious education. This program included training on how to create online lessons, upload and use these lessons in the classroom, and operate the learning management system, which is currently being used in a few pilot schools around the nation. Teachers were given a free internet dongle with unlimited data as an incentive for their involvement and inspiration. All ICT instructors in schools must be certified and have received the necessary training from their higher institutions. Despite this, a significant percentage of instructors in other curriculum areas, including

the humanities, arts, and some sciences, continue to lack proper ICT training from the government or any other organization.

Technology is future-oriented, and we live in a time when all generations may access and utilize it, from youngsters with access to smartphones to adults in their job, home, and business contexts. These are just a few of the key elements of technology in relation to education. Through its engaging characteristics for both teachers and students, technology helps learning to become more participatory and exciting. Skills such as communication, digital learning, self-learning, appreciating diversity, teamwork, technology intelligence, and global awareness can all be improved by technology. Through classroom activities, the use of technology in education can promote teamwork and collaboration. Within the classroom or with peers elsewhere, students can collaborate and share resources.

The use of ICT (Information and Communication Technology) in education, how it can be incorporated into the teaching and learning environment, and what effects it may have on the teachers and students in Eswatini must all be investigated in light of the aforementioned. In order to achieve the maximum success in integrating technology into education, it is also critical to establish an ICT implementation strategy and evaluate the progress, obstacles, and successes of this implementation.

2.0. ICT Integration and Blended Learning

In the realm of the plan towards transforming education, the teaching and learning environment is embracing a number of innovations and at the heart of these innovations is the use of technology through Blended Learning (Kintu, Mugenyi, Chang, & Kagambe, 2017). Even though ICT integration and blended learning each have their place in education, they are not the same. Technology integration is using technology as a tool to enhance education and allow students to demonstrate a deep understanding of content, (Fernando, 2020). Effective IT integration must happen across the curriculum and support four key components of learning: active engagement, participation in groups, frequent interaction, feedback and connection to the real-world experts, (Fernando, 2020). On the other hand, Blended Learning takes technology

integration further. It is an instructional methodology, a teaching and learning approach that combines face-to-face classroom methods with computer mediated activities to deliver instruction (Sharma, 2018.) Blended Learning is the educational practice of combining digital learning tools with more traditional classroom teaching. Resources such as video lectures, podcast, recordings, links of articles are utilized in this practice. Technology is a crucial element in the entire process; thus, this new teaching-learning and educational process of the Education Policy is expected to be backed by adequate technologies and blended modes of acquiring knowledge (Sharma, 2018).

Eswatini Government schools rely on funding from government and donations for adequate technologies and equipment from governments partners and stakeholders. The Implementation of Blended learning relies on the availability of such ICT resources along with other factors including capacity training of teachers on ICT implementation, guidelines and policies on use of ICTs for technology integration and ICT policies within schools and government structures. A majority of schools that have made an effort towards ICT integration and blended learning in Eswatini have at least some equipment to start with the approach, even though in some circumstances the resources may be minimal. In planning for ICT integration in education, policymakers would do well to begin by determining the education purposes that technologies are served before they are brought on board. This implies that the justification and road map for technology integration should be the clarification of overall educational policy. As is the case in the Kingdom of Eswatini, government and ICT integration advocates frequently view infrastructure investment as a magic bullet for ICT requirements for educational institutions without proper plans for how they will be used or without a clear understanding of the capacity deficit that will affect its successful implementation. The mere focus of most studies on availability of technology and what students learn through the technology has left a gap in understanding the capacity requirements that will ensure effective utilization of the technology in order to improve the quality of education processes in learning institutions. (Eswatini education sector policy, 2018). The kingdom has a lot of work to do towards providing an enabling environment in the

form of infrastructure and equipping personal and management with the appropriate attitude, skill and knowledge. An oversight in these factors and variables renders policymaking weak. Improvements need to be made to increase uptake and utilization of ICT resources. Quality improvements and equal access to ICT integration must be accompanied by a wide range of educational reforms. Strategic planning, policy and budget implementation is very critical in seeing that the mission, goals and objectives of Eswatini Education and Training Sector Policy (2018 ICT strategic Framework) are attained.

According to research done by (Simelane, 2020) on the factors influencing ICT implementation in inclusive primary schools in Manzini Region Eswatini. It was found that factors that slow down the rate of ICT integration in schools are the lack of support for resources from government, lack of organizational support in the schools, lack of training and skilled individuals in the field of ICT and dysfunctional ICT tools in some of the schools. Simelane also identified lack of teacher motivation as a contributing factor to the limitation of ICT implementation in Eswatini schools. From her research, Simelane suggested that further research on factors influencing ICT implementation in rural schools of Eswatini from the same region or even in all the four regions needs to be undertaken. She further suggests that research could be done to determine why the government is not prioritizing actively encouraging ICT integration in all schools. In today's` classroom, teachers are expected to be able to endow their students with technology-supported learning opportunities. The revised Eswatini Education and training Sector Policy –Information and Communications Technology Policy Rationale 2018 succinctly outlines short-term policy goals and the first three goals are stated as;

- To introduce blended learning in all learning areas
- Support capacity strengthening for teachers on ICT
- To develop guidelines to safeguard ICT equipment

It is important to study the role of local ICT policies on actual ICT integration in education. (Tondeur, Van Keer, Van Braak & Valcke, 2007).

It was crucial to look into whether instructors were aware of the ICT policy, accepted it, and used it in practice, particularly in the classroom, in order to identify the challenges and successes associated with the implementation of blended learning in Eswatini schools. This study reviewed literature on ICT policy, classroom integration, blended learning, and the challenges and successes associated with its implementation.

2.1. ICT policy and ICT Integration in the classroom

When teachers share the values expressed within a school-related policy and understand the implications, the policy is able to influence practice. Around the world, schools are leveraging technological tools to make learning simpler, more immersive and effective. Schools use technology optimally to enhance the learning experience and optimize time. Although ICT integration is considered a commendable objective, previous literature indicates that there are numerous conspicuous gaps between policy and practical changes in classroom advancement. A study by Tondeur, Van Keer, Van Braak & Valcke, (2007) found that teachers in schools with explicit ICT policy that stresses shared goals are using ICT more regularly in their classroom; however, only teachers' perceptions regarding the content and not the actual school ICT plan had impact on use of ICT in the class, as a consequence an ICT policy plan seemed to be an important incentive to foster the integration of ICT use in the classroom but only when teachers are aware of its content. Lastly the study also pointed out that decision and change models currently do not acknowledge the pivotal role of the teacher effecting the change. ICT policy implementation can best be assured when teacher professional development includes specific skills and tasks that incorporate ICT into their everyday classroom practices and explicitly connect these practices to ICT and broader education policies (Kozma, n.d.). Adjacent to teachers' acceptance and value of an ICT policy is the teachers understanding of the concept of blended learning and how it may be beneficial to the teaching and learning process.

2.2. Concept of Blended Learning

Blended learning is a new, foreign and underutilized term, especially in primary and secondary levels although the implementation has long since begun (Yeop et al., 2019).

Blended learning is an instructional teaching and learning process that involves the use of both traditional classroom teaching and learning and the use of online learning within one curriculum plan. The two methods are combined to develop one complete learning structure for a program or a subject. Although Blended learning has been a buzz word in recent educational reforms and structures. It poses both challenges and successes from the initial implementation stages across to stages considered to be mature more mature in terms of implementation. According to, Yeop et al. (2019), in order to enhance the acceptance and use of the blended learning approach among teachers, it is important to identify feedback of teachers on the implementation of blended learning as well as other factors that may influence their intentions. The study further found that teachers with over ten years of teaching experience have a higher behavioral tendency to implement blended learning even though ICT facilities and technical support may be minimal. In this study it was found that experienced teachers demonstrated more confidence in implementing the blended learning approach in any facilitating conditions. The role of administrators towards successful policy implementation in the classroom should not be over looked. Without well-trained, ICT-capable principals, the integration of ICT into school curricula will remain deficient, (Tondeur et al., 2007). Teachers look up to school principals for support, this support may vary from ensuring the availability of adequate resources for ICT implementation, facilitating capacity training for teachers and emotional support as some teachers face challenges and do not know how to handle them. Principals have to develop a more collaborative approach when defining a school level policy (Tondeur et al., 2007). This highlights the importance of a shared and school-wide vision about ICT integration that reflects the opinions and beliefs of the principal, the ICT coordinator, and the teachers. Change cannot be achieved by an individual but change is a result of collaboration throughout the school hierarchy. Though blended learning has been praised for having the potential to bring many positive changes to an institution the process of changing from traditional face to face classes to a blended technological approach may also come with some challenges.

2.3. Challenges and Successes of Blended Learning

Kaur (2013) identified some challenges for Blended learning as the following:

1. Technical Challenges: technical challenges consist of ensuring the success of the programme by utilizing and supporting appropriate technologies (Kaur, 2013). These may include Guaranteeing that participants can successfully use the technology and opposing the urge to use technology only because it is available.
2. Organizational challenges: Management may feel that blended learning is the correct direction for training initiatives, but it may fail to understand that this is not an easy process and needs thought beyond an individual programme. Organizational challenges include omitting the belief that blended learning is not as effective as traditional classroom learning, redefining the role of the facilitator(teacher) and managing and monitoring all teachers and learner's progress.
3. Instructional design challenges: Instructional design challenges occur when learning tools and technologies are first introduced. Attention may be highly focused on the technology implementation, whereas the design of the actual appropriate content is also of equal importance. This may lead to leaving too little time and budget to create a successful programme. Instructional design challenges include considering how to teach and what to teach, matching the best delivery medium to the performance objectives, ensuring online offerings are interactive and not just dominated by a single participant, ensuring participants are commitment and follow-through with "non-live" elements and making sure all the aspects of the blend are coordinated.

As it was mentioned above, literature shows that against its challenges blended learning has its advantages. Kaur (2013) identified some of these challenges as the following:

1. It encourages change from passive learning to active learning. The focus of the classroom shifts from a teacher centered narrative approach to one of active learning.

2. It allows learners the opportunity to work collaboratively and apart. Blended learning brings together the online and face-to-face classroom components.
3. The Blended delivery system allows learners to learn and access material in a range of modes which is an important feature because learners are diverse and have different learning styles. This may lead to an increase in learners' chances of meeting course outcomes compared with fully online and fully face-to-face modes of teaching by decreasing the rate of dropouts and increasing learner motivation.
4. Blended learning adds a human touch to online teaching. The interactive content allows the teacher to create a high level of interest, accountability, and real assessment.
5. It encourages individualization, personalization and relevance by letting the teacher tailor learning content to the unique needs of different learners.
6. Blended learning is an effective, low-risk method aimed at meeting the challenge of the transformational changes that technological growths bring to higher education.

In view of the above-mentioned challenges and advantages and considering the status of Eswatini schools in terms of ICT integration and blended learning which can be described as "still in the crawling stage" because a large number of schools in the kingdom are yet to still implement blended learning and ICT integration. This is mainly due to lack of resources in most schools. It is important to look into the challenges and successes of those school that have already started with the blended learning initiative as findings may serve as guiding tool to plan for those schools yet to implement the strategy.

2.4. The purpose of the study and research questions

The Eswatini government, specifically the Ministry of education, realizes the need for concrete investment into educational ICT tools and infrastructure for the purpose of elevating the countries education system to a level that is in par with- global standards and improving the efficiency of the Kingdoms educational system. According to research done by Simelane (2020), on the factors influencing ICT implementation in

inclusive primary schools in Manzini Region Eswatini. It was found that factors that slow down the rate of ICT integration in schools are the lack of support for resources from government, lack of organizational support in the schools, lack of training and skilled individuals in the field of ICT and dysfunctional ICT tools in some of the schools, Simelane also identified lack of teacher motivation as a contributing factor to the limitation of ICT implementation in Eswatini schools. From her research, Simelane suggested that further research on factors influencing ICT implementation in rural schools of Eswatini from the same region or even in all the four regions needs to be undertaken. She further suggests that research could be done to determine why the government is not prioritizing actively encouraging ICT integration in all schools.

Although great effort has been made in improving education in Eswatini over the years, much remains to be done to elevate education in the digital age (Dlamini, 2020). As per the case for a majority of countries, the Covid-19 pandemic was an intense wakeup call for education systems in terms implementation of backup strategies that could facilitate continuous, effective teaching and learning regardless of learner and teacher location, specifically the importance of distance and online learning facilities and strategies. Dlamini (2020) showed that it is crucial for the Eswatini government to evaluate its policies with the aim of revolutionizing the education system in Eswatini at all levels to realize parity with other nations in digital education.

Given the foregoing, it is crucial to determine whether teachers in Eswatini schools are familiar with the ICT Strategic Framework and to assess the degree to which these schools have succeeded in implementing blended learning across all learning areas, which is the first policy goal of the Framework. In order to plan for future changes that could be made to hasten the successful implementation of this strategy across all schools in the Kingdom, it is equally crucial to analyze and identify challenges and successes toward achieving this goal. The education sector policy serves as a roadmap for implementing policies in educational institutions. The educator must be aware of, comprehend, and accept the policy before they may adapt and apply it. Consequently, this paper aimed to ascertain whether teachers are familiar with the ICT Strategic

framework and its goals as well as to identify the challenges and successes of blended learning implementation in Eswatini schools as perceived by teachers.

A case was used in this study to 1: ascertain whether Eswatini teachers are familiar with the education sector policy and the 2018 ICT strategic framework which is found within the education sector policy. 2: To identify and elaborate on challenges and advantages of the implementation of blended learning in Eswatini Schools, where schools are categorized into three main categories of blended learning: (1) exploration, when schools have not clearly defined a strategy or guidelines to implement blended learning but have explored with different options using both face to face and online learning in some subjects estimated to be between 0 to 5 years of Blended learning initiative. (2) early phase of blended learning, when administrators and teachers encourage blended learning and developed some sort of strategy and guidelines within schools to implement blended learning in willing departments estimated to be between 6 to 10 years of blended learning experience, and (3) mature phase of blended learning, where there is continued promotion of blended learning from administrators and teachers, and a formal guideline or policy is used for Blended learning implementation and schools strategically to facilitate widespread department implementation estimated from 10 years and above of experience.

3.0. METHODS

3.1. Study Site

The study site was in the kingdom of Eswatini formerly known as Swaziland. The kingdom is divided into four regions being Manzini, HHohho, Lubombo and Shiselweni. Four teachers participated in this research which was conducted in three schools which were named school A, school B and school C for the purpose of this research. A table of the teacher's demographic information can be found in table 1 below. The schools were selected from 1 region out of the four regions of Eswatini (Manzini Region), which is the biggest region in the country. The region is located in the center-west of the country and has an area of 4,093.59km. In 2020 There was a population of 355,945, (Wikipedia

contributors, 2022, April 23). The three schools are all situated in Manzini's urban core. School A is a public primary school and school B and C are public high schools.

TABLE 1: Teachers Demographic Information

Name	School	Gender	Age	Qualification	Teaching Department	Teaching experience	BL experience	Trained in ICT
		M/F/Other	20-35 36-50 above 50				In years	yes/No
Muzi	School A	Male	20-35	Primary Teachers Diploma	Social	3	1	No
Mpho	School A	Female	20-35	Diploma In I.T	Math's/Science /ICT	12	1	Yes
Thoko	School B	Female	20-35	Bachelor of science in computer science	Math's/Science /ICT	10	3	Yes
Kyle	School C	Male	36-50	BA Humanities	Social	18	2	No

The selection of teacher's professional areas/ subjects taught was according to the general Subject classification common in all Eswatini high schools; (e.g. Mathematics, Physics, Chemistry, Biology, Geography, History, Accounting, Business Studies, Religious Education, ICT, Languages) ensuring that teachers observed in a single school are from different teaching departments.

Teaching departments were classified as follows;

1. Math's/Science/ICT department: Math's, Science, Biology, Physics, Chemistry, ICT
2. Social department: Geography, History, Religious Education, English, Siswati.
3. Practical subjects: Consumer science, Agriculture, Design & Technology
4. Business Education: Business Studies, Economics and Accounts.

Since goal number one of the ICT strategic framework states that blended learning should be implemented across all learning areas. The purpose of choosing teachers from several departments was to guarantee that the findings were balanced, reflecting of the implementation status of blended learning across all subject areas, and unaffected by the condition of any particular department.

3.2. Study Design

Due to the nature of the problem being examined— which is the execution of a government policy, in this case the Eswatini 2018 ICT Strategic framework. The study utilized a qualitative case study technique. Only schools that have already included ICT and blended learning into their teaching, learning, and assessment were the subject of the study. The qualitative research gave the researcher the opportunity to conduct in-person, semi-structured interviews with each teacher, allowing the participants to freely express their thoughts and describe their experiences of implementing blended learning. The interviews lasted 45 minutes to an hour because the discussions were lengthy. You can find the interview questions in appendix A. The researcher approached the principals of the relevant schools and officially obtained their consent before beginning the interviews.

3.3. Research Tools

The study was designed to have one set of questions for teachers, which were in the form of semi-structured interview questions. These interviews were recorded using a laptop in video format and the videos were saved and used as evidence files. The questions were aimed at finding out if teachers were familiar with the 2018 ICT strategic framework and its goals and finding the core challenges and advantages experienced by the teachers through the process of blended learning implementation.

3.4. Data collection procedures

Semi-structured interviewing takes time to conduct and to record. In order to avoid difficulties with not finishing the intended number of interviews, the researcher had to make sure that data collection time was planned for and handled efficiently. Every interview was conducted face-to-face, and the researcher scheduled an appointment for each interview day in accordance with their availability. A laptop was used to video record each interview. Some participants were initially hesitant to perform in-person interviews because they desired to remain anonymous, but they accepted after being assured of secrecy. It was difficult for the researcher to find and download transcription apps. As a consequence, the researcher employed "google speech recognition" from Google Docs as an alternative transcription tool that could understand and type out speech from the recorded interview videos. Transcripts and other study-related supporting papers were saved in the researcher's research folder.

4.0. Findings and Discussion

This case study was intended to evaluate three schools in Eswatini, each of which represented a different stage of blended learning. The purpose of the case study was to identify and elaborate on challenges and benefits of the implementation of blended learning in Eswatini Schools as perceived by teachers. It also sought to ascertain whether teachers in Eswatini schools are familiar with the 2018 ICT strategic framework that is found within the education sector policy. The objectives listed above are covered in the paragraphs that follow. The author of this study is a Swazi student pursuing a Master of E-Learning leadership and management at National Chung Cheng University. As a school inspector for ICT, I work for the Ministry of Education. There were four participants in this study, which took place in three distinct schools. The participants were Mandisa, a female ICT teacher from School A (a public primary school), and Muzi, a male French teacher. Thoko from school B is also a female ICT teacher. Kyle, a male English and History teacher from school C, was the last contestant. High schools B and C are also public institutions.

4.1. The Three Stages of Blended Learning Implementation

All three of the chosen schools were discovered to be in the first phase of blended learning, which is the exploration phase. None of the schools had a clear plan or set of criteria for implementing blended learning; instead, they were still experimenting with different ways to combine face-to-face instruction with online learning in some courses.

School A is still testing a mixed learning approach that is funded by the National Curriculum Centre of the government and a private sponsor, McMillan. The pilot project employs the Ultura app as a learning platform and has only been in operation for a year. Whether the school will permanently use this BL strategy when the pilot is finished has not been decided.

Although School B has experimented with many blended learning platforms and methodologies, it has not yet decided which platform it will employ indefinitely. The school has yet to come up with a solution that all teachers concur is the ideal strategy to employ with regard to students, teachers, and the school as a whole.

School C has explored with different Blended learning strategies and platforms and has temporarily abandoned the BL strategy after the Covid-19 pandemic passed due to the challenges the school faced with the implementation of BL.

4.2 Teachers knowledge of the Education Sector Policy and ICT Strategic Framework.

One of the aims of this research was to determine if teachers in Eswatini schools are familiar with the Education Sector Policy and the 2018 ICT strategic framework which is found within the Education Sector Policy. The first policy goal of the ICT strategic Framework is for blended learning to be implemented in ALL learning areas in Eswatini schools. Research indicated that there is a lack of clear communication between the policy makers and the teachers in schools. Out of the four teachers that were interviewed only Mandisa from school A had brief knowledge the ICT strategic framework which she obtained from an Eswatini ICT teachers WhatsApp group. Muzi who is also from school A was the only teacher that had brief knowledge of the Education Sector Policy which he obtained from a shallow briefing that was given to him by his school principal. None of the Ministry of Education supervisors or the

school's administration had previously formerly informed all the teachers about the policy. Strategic policies can provide a rationale, a set of goals, and a vision for how education systems might be with the introduction of ICT and how students, teachers, parents and the general population might benefit from its use in the schools. These strategic policies can motivate change and coordinate disparate efforts so as to advance the nation's overall educational goals (Kozma, n.d.). It will be challenging for teachers to work toward reaching those goals without clear awareness, comprehension, and acceptance of the aforementioned policies, which offer the aims and vision for the Eswatini educational system.

4.3. Challenges of Blended Learning

The teachers noted a number of difficulties with implementing blended learning. These difficulties are caused by a variety of factors in different schools, including the school's use of a blended learning system or application, the quantity of teachers' blended learning training, the amount of user support provided to teachers using a blended learning platform, and managing students while using a blended learning system or application.

1. Blended learning management system/application: Each of the four teachers who took part in the study acknowledged having some difficulties using their learning management systems. These difficulties included teachers receiving only a limited amount of training on how to utilize the learning management system, which left them with little familiarity with it. While utilizing the systems, several technical difficulties were also observed. Due to their low system expertise, all teachers reported using a small number of the system's capabilities. As a result, they were unable to utilize the system to its full potential, which occasionally caused lesson planning to be delayed.
 - Blended learning management system challenges for School A: Both teachers in school A reported that they had to self-discover some of the features and tools of the system as they used it, it was a learning curve for Muzi, who is passionate about ICT, to self-discover some of the features

and tools of the system as they used it. However, he also shared that some of his colleagues felt that doing so took time away from teaching, which is why they occasionally reverted to traditional teaching methods in some subjects when they encountered difficulties. When using the system, Muzi and Mandisa had similar technical difficulties that prevented them from performing several tasks. For instance, a Google age restriction meant that certain primary school students could not create their own email address, forcing teachers to come up with an alternative approach for activities that require email. Because of this, they both expressed their gratitude for their technical support team, which was crucial in ensuring that their issues were resolved as quickly as possible.

- Blended learning management system challenges for School B: Thoko from School B talked about how difficult it was for her and other teachers to create and upload instructional materials on their system. This was because the learning materials for each lesson and learning activity had to be planned, chosen, prepared, organized, and uploaded by the teachers themselves rather than being pre-loaded on their system. This was very tedious for them and they felt a pre - customized learning system would be more efficient to use. In her own words she said "From my experience the challenges that I have observed with blended learning is that you need to prepare all the lessons that go online, they must be well-executed from the planning stage to actually sending the work to the kids. That takes a lot of time to do, it takes a lot of time from the teacher so I think that is the biggest challenge. You may find that you don't have enough time to actually put the work together, to find the relevant videos or relevant resources to share with the kids".

2. Blended Learning Training: The lack of adequate training on how to use the blended learning technologies in the school's caused frustration in all four of the teachers, who stated it. Teachers believed that their lack of knowledge, particularly their limited understanding of the BL management systems,

prevented them from performing some tasks in an efficient manner. Muzi and Mandisa From school A expressed the yearn they had to use all the features of their BL system especially the assessment tool but they failed because they had not received enough training on the tool. Thoko from School B also shared how some of the teachers did not use the ICT tools given to them by the school because they had minimal training on how to use these tools. This is what she had to say "The problem is we received training but it was too short and because it was too short a lot of information was pumped into us in a short space of time. I would recommend that next time we have training, we should have a training that is properly planned and gives enough time for us to get a grip of what we are learning. It should not be rushed. Actually, when we left the training, we all felt like we are not sure what we are going to do when we get to the school but we found our feet by helping each other."

If teachers and learners are not trained on how to use the various ICT tools available for this learning, blended learning could be frustrating for both parties. To make sure that lessons go well and are pertinent, the instructor has a major responsibility. Due to this, teachers must be proficient in using, managing, and manipulating their learning management system. Without the teachers receiving training, this cannot be done. All of the school's teachers mentioned how much they would value more comprehensive instruction on how to utilize their BL systems. Mandisa from school A shared how her colleagues had requested their BL system sponsor to facilitate a follow up training because they still wanted to learn more on how to use the system to its maximum potential. Kyle from school C shared that the school teaching staff felt the training they had received from their BL System provider was very minimal and hence generally felt the BL system was difficult for them to use. In his own words he elaborated as follows "As a school we tried one of the service providers who had made available a platform for blended learning

during the Covid era but unfortunately post the training, staff members felt it was too complicated for them and concluded it would have been even worse for the students to try and understand.” Thoko from school B shared similar sentiments and expressed how in both platforms that they attempted to use, they were just learning through using the platform, the teachers would gain more experience as they used these platforms. Often teachers would find that there are some additions that were not mentioned by the instructors who trained them hence they learnt through the frequent use of the platform.

3. BL system/application support: Technology offers both benefits and drawbacks. One disadvantage pointed out by teachers was that sometimes the learning equipment may have technical issues that need to be attended to by an I.T professional or the BL system specialist. Mandisa and Muzi reported a smooth sail with regards to technical issues because they had a good support system from their I.T technicians provided by the BL pilot sponsor. Whenever the teachers encountered a software or technical challenge the support team would assist them as promptly as possible. Because of the lack of support at their respective schools, Kyle and Thoko were unable to make as much progress in their BL teaching and learning and occasionally had to switch to face-to-face instruction until problems were resolved.
4. Availability of resources and network coverage: Each of the four teachers acknowledged that network coverage issues occasionally plagued them. Internet access is required for online education. Some regions of the nation, particularly those that are isolated, have relatively poor internet coverage. Some learners found this difficult because they couldn't attend the classes from where they were. Additionally, this required the teacher to exert extra effort to make sure that those students had a different way to learn. In schools B and C, students' inability to access devices that support online learning, such as laptops, tablets, or smart phones, presented a problem. For the students to utilize at home, neither of these schools offered any

technology. These devices were supposed to be purchased by parents for their children.

5. Financial costs of BL Tools: Kyle explained that the school had to abandon its attempts to implement blended learning because it lacked the resources to buy tablets for each student. Many students were unable to participate in lessons during their attempt to implement BL since they did not have tablets or computers at home. Most parents find these devices to be out of their price range, especially if they have multiple children in the same school. Both schools B and C do not give data for students to use at home; instead, parents are required to buy the data. Some parents find this difficult since they cannot afford to regularly buy the data.

4.4. Advantages of Blended Learning

Blended Learning also has its advantages. Teachers noted a number of benefits of blended learning. Among them were the following:

1. Time efficient: The use of BL management systems reduced lesson preparation time for Muzi and Mandisa as their system had learning content preloaded onto their LMS. They also commended the BL Management system they were using for its built-in text book tool. The teachers did not have to prepare notes and handouts before class. They also did not have to draw diagrams on the chalk board but could just simply send a link to the learners which directed them to a website of the specific learning diagram they wanted to use for the lesson. This allowed for the teacher to spend more time on the actual teaching.
2. Reduces strain of textbooks: Learners have to carry a lot of textbooks every day. This is a health hazard for the learners. Learners sometimes purposefully do not carry their books to school because they are too heavy. Having textbooks preloaded on the LMS eliminated this problem and because of the excitement learners have towards their gadgets, learners would always bring their gadgets to school. The online textbooks also reduced the time it takes for teachers to present learning content. Teachers no longer had to draw diagrams and notes

on the chalk boards which dug into teaching time, but would simply refer to learners' online books or project content.

3. Learners' engagement: All of the teachers reported that learners were generally excited about learning with tablets, laptops and other ICT tools. For this reason, learners were more attentive during class and the technology also encouraged them to participate in class activities as they were inquisitive on what could be done with their learning apps. Mandisa and Thoko reported a visible improvement in learners' grades for their subject. They even reported that learners not only participated more but became more open to express their opinions in online classes. Thoko further shared an example of a learner that is very quiet and withdrawn in face-to-face classes. She said "This learner does not express herself much in class but during the online class the learner seems to come out of her shell. She participates actively, voices out her opinions and answers questions. This was a pleasant surprise for me"
4. Flexibility: Another advantage was the flexibility of BL. This method of learning allows for learners and teachers to be able to have classes beyond just within the classroom. This meant that teachers could even teach on weekends while still at the convenience of their home. This is an advantage to both the learners and teacher as they saved on transport and meal costs for that day. All teachers from the three schools said they appreciated that they could leave questions for learners to answer at their own time, also the learners could post questions as they encountered challenges with their assignments at home. This not only allowed for the teacher to answer questions but encouraged collaboration amongst learners as they also could share ideas with each other.
5. Built in assistive tools of Learning management systems: Muzi expressed his excitement for the assistive tools which are built into their LMS. Specifically, the speech recognition tool. This tool is very exciting for him as a French teacher and overall useful for teaching in the language department especially when teaching a foreign language such as French, Afrikaans amongst others. The tool allowed for learners to type out words and it would pronounce the word for them

ensuring they get the pronunciation correct. The tools also allowed for learners to speak out a word and it would type it out for them on the screen ensuring they get the spelling correct.

6. Exciting method of learning for learners: All four teachers that participated in the study mentioned that BL was an exciting method of learning for the learners. The key mandate of all teachers is to ensure that the learners gain some knowledge from every lesson and enjoy their learning. All the teachers shared how the learners generally love ICT gadgets such as smartphones, laptops and tablets and look forward to learning with them.

- Comments from School A: Mandisa said "Learners were more focused definitely, they wanted to learn more they were eager to discover things that were on the tablet, they were just eager to do all activities that were done on the tablet even when you are assessing them by walking around during the class while they are doing class activities you would find all the learners doing the activity that they are expected to do. That's not very common when we are doing face-to-face classes."
- Comments from School B: Thoko said "The kids enjoy this, I enjoyed it to. Sometimes I see that they are tired while at school, especially on the last period of the day, since they really enjoy learning online, I could give them work to do without me at home ". This meant that even though the teachers would not physically be there at their homes, the online aspect the learning system allowed the teacher to still communicate with the learners.
- Comments from School C: Kyle said "It is a space where they enjoy themselves especially if you expand it to a Facebook, to your tik-tok your WhatsApp and many other things".

This was a blatant example of how using BL technologies encouraged students to participate and pay attention in class activities.

5.0. Conclusion

In light of the research on the use of blended learning in Eswatini schools and the familiarity of Eswatini teachers with the 2018 Education Sector Policy. It is clear that Eswatini instructors need training on the educational regulations that control how Eswatini schools operate. Blended learning can be implemented in a variety of ways. In order to guarantee that all users are able to use and explore the system to its full potential, it is crucial that schools choose a blended learning system that will suit to the functional requirements of the teachers and students within a school.

Additionally, it is crucial that system users receive enough training on blended learning methodologies and the chosen blended learning system. Lack of training may provide difficulties for users and demotivate them. It is crucial to have a user assistance system that assists users with all software and technical issues. Users of the BL system may become frustrated by these problems and stop using these tools altogether.

Blended learning has expenses that cannot be ignored. The deployment of blended learning calls upon pricey technology, including tablets, laptops, and the internet. Any institution that wants to implement blended learning must fund for it and plan accordingly. Schools should take into account how students will use home computers to access instructional platforms. Due to the persistently high poverty rate in the nation, schools must be mindful that not all parents will be able to afford devices and data for students.

On the plus side, blended learning has demonstrated several fascinating benefits. The allure of technology draws students in and motivates them to engage in learning activities. BL can lead to increased student grades if used and managed properly. Blended learning is time-effective and has the potential to increase learning time while decreasing lesson preparation time. One benefit among many is clearly the transition from sharing learning materials on chalkboards to digital devices.

5.1. Further Research

Semi-structured interviews were employed in this study to gather data. Further study might incorporate classroom observations for data gathering in order to acquire a fuller and more in-depth understanding of the implementation of blended learning in schools. Through these observations, the researcher would be able to have firsthand knowledge of the teaching and learning taking place in classes. In addition to observing actual teaching and learning in the classroom that incorporates ICT, the purpose of these observations is to determine which I.T. infrastructure and tools are being used in the classroom by both instructors and students. There is a need to perform additional study that includes schools in outlying sections of the city as the research was done in schools in Manzini's major business center. Researchers would then be able to assess whether urban schools face comparable difficulties and benefits to their rural counterparts. The researcher might then evaluate whether metropolitan areas have any benefits over rural ones when it comes to implementing blended learning. Additional research on blended learning management systems may be possible, according to this study. Schools have employed several BLM systems and run upon problems that are specific to each system. Further study on which BLM approaches and systems would function best in Eswatini Schools in accordance with the Kingdom's curricula would be advantageous to Eswatini.

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Article 7

TVET Innovations for Livelihood Improvement in the Informal Settlement: A Case Study of Eldoret Town

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Introduction

Renzaho et al.2020 indicated that in 2018 more than one billion people (1.033 billion) lived in slums globally, and by 2030 an estimated 3 billion people will require adequate and affordable housing and decent income. Efforts to reduce the number of people living under us\$1 per day has been a focus of undp millennium development goal 1 targeting to reduce it to 50% by the year 2030. However, this has not been achieved especially the sub-saharan africa where people living below the poverty line have since increased as did the number of undernourished people. It is estimated that by the year 2050 half of the world population will be living in urban areas. With increase in urbanization, the poor-urban poses a serious challenge to the achievement of the mdg 1.this is because of mash rooming of informal settlement in towns. In 2007, the world population hit a landmark with more than 50% of people now residing in urban areas. While sub-saharan africa remains predominantly rural, most countries are projected to be more than 50% urban by the year 2030 (unhabitat, 2004). Because most cities are unable to keep up with the need for infrastructure and formal employment, urbanization often leads to the growth of informal settlements, the informal jobs sector, and a growing number of urban poor. Current estimates suggest that nearly 1 billion people worldwide reside in informal settlements or slums, without adequate access to food, shelter, water and sanitation (un-habitat, 2010). Cities are centers of political, social, and economic opportunity in most countries, but they are also home to growing numbers of poor people.

Covid 19 pandemic has too complicated life in the slums. According owuor 2006, life in the urban areas has become more expensive while employment in the formal sector has decreased and real wages have diminished to absolute terms. Many urban households are facing a serious decline in their purchasing power. People have responded in various ways, most notably by diversifying their income sources, ondati. 2021. In order to cope with current situation, a wide range of activities are being employed, with crop cultivation and livestock farming dominating. Apparently if countries are to address rapid urbanization and the growth of urban poverty, they need to support and empower livelihood strategies that the urban poor have developed to survive. Predominantly urban agriculture is one livelihood strategy used by the urban poor to improve their well-being, in combination with other livelihood strategies. Numerous studies of urban and peri-urban agriculture worldwide have demonstrated that it is effective in improving household food security (binns & lynch, 1998; crush, hovorka, & tevera, 2011;

Studies so far have revealed that urban agriculture contributes to household food and nutritional security, the creation of informal employment, income diversification through sales of surplus worse produce or savings on food expenditures, and more broadly promotes urban food supply systems and, at least in potential, environmental sustainability (mougeot 2000; foeken et al. This urban farming especially in the informal settlement area is characterized by smaller plots, poorly developed farm structures and lack of professional advice (african studies centre 2006). In sub-saharan africa, studies on urban agriculture have been limited, but those that have been done generally suggest that approximately one-third of households are engaged in some form of urban agriculture, and that two thirds of the farmers are women (prain, karanja, & lee-smith, 2010).

In kenya studies have been conducted on improving livelihoods of people in slums while at the same time monitoring the growth of informal settlement in towns. Recently a study in kibera slums of nairobi established that sack gardening as one of the livelihood survival strategy has impactfully empowered slum dwellers economically (karanja & njenga, 2011). Evidently, this is a proof that new innovations and technologies can change the livelihoods in informal settlement. Although quite a lot of research on urban agriculture in sub-saharan africa has been done (obudho & foeken 1999). The

study on how innovations and technologies from TVET can be used to improve livelihood through urban agriculture has not been reported.

The TVET sector whose key pillar is anchored on skill development for generations of innovations and technologies to address society challenges, has not been effectively utilized. TVET sector with its mandate and goals stands a chance to improve socio-economic well-being of urban dwellers. Annually, TVET institutions churn out new innovations and technologies during regional, national and international TVET fairs competitions. Some of these innovations and technologies can be suitable for urban environment thus improving the livelihood of slum dwellers and enhancing food security. The innovations and technologies range from electrical, mechanical, ICT to agribusiness/ agricultural technologies among others. However some of these innovations and technologies have not been fully applied to solve problems facing humanity. Whereas a number of these innovations especially from mechanical, electrical, and ICT have been scaled out for industrial and commercial production, very few, if any have been used to address challenges faced by people who live in the slums. Although agricultural innovations have great potential in addressing challenges facing slum dwellers, very few have been embraced.

Our study therefore, aimed at assessing the best agricultural innovations that would at least improve the livelihood of the informal settlers in Eldoret town, Uasin Gishu county. A survey was conducted in the two slums and appropriate innovations were developed. A modern chicken coop was developed to address poultry challenges highlighted by the slum dwellers.

Methods

Survey

According to Uasin Gishu county information database and Chebet (2016) Munyaka and Langas slums have a population of about 22000 and 396 households. Our study targeted at least 396 households both in these two areas. A sample size of 196 was determined based on 95% confidence interval and a margin error of 5% ([sample size calculator](#))

A questionnaire (schedule interview) was developed and piloted before administration following the integration of the questionnaire online Kobo-Collect app (<https://www.kobotoolbox.org>), and linked to the phones of interviewers. The piloting of

the questionnaire was conducted at kipkorgot estate of Eldoret town, with 27 randomly sampled respondents participating. A few modifications and adjustments were made and a final questionnaire was ready for use. A total of 207 households in Langas and Muniyaka were interviewed.

Identification and designing of tailored made innovation

Agricultural-related structural innovations were selected from previous exhibitions at TVET fairs. They were assessed on a number of parameters including size, security, feeding supplementation, convenience on use and poultry management. Modifications were done and the final product produced.

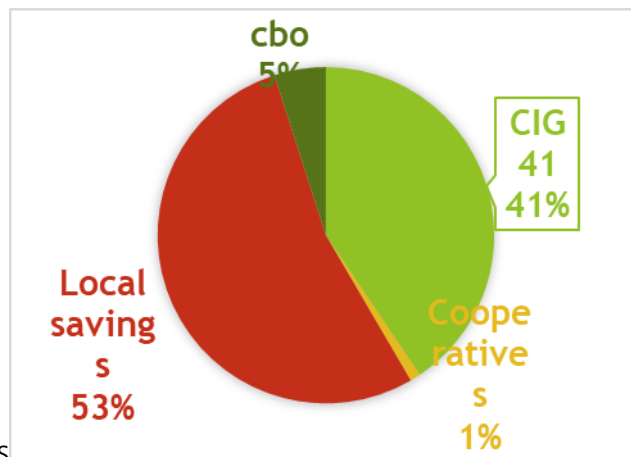
Data analysis

Data collected was analyzed using Kobo-collect system and Excel program.

Results

Upgrading slums through associations

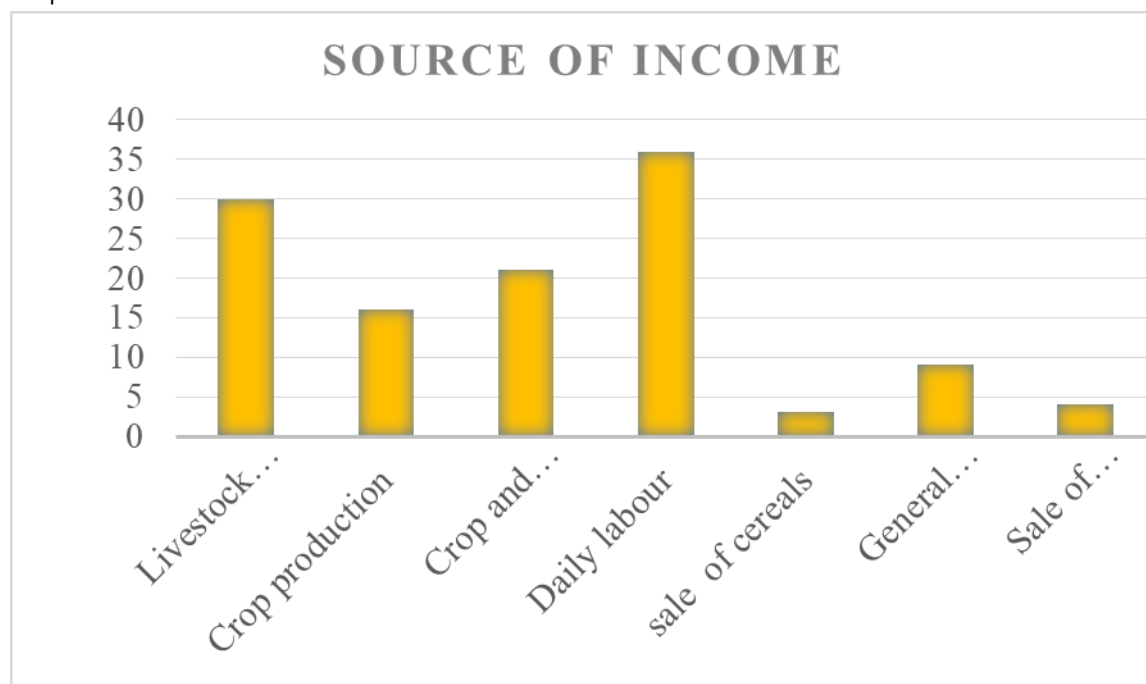
In order to build foundations of the urban poor's survival strategies and about what needs to be done by both the public and non-governmental sectors, slum dwellers have been grouped into common interest groups, community based organizations and local savings groups. According to UN-Habitat report 2003 on challenges facing slum dwellers, the efforts on grouping informal settlers is bearing fruits in improving their livelihood. In our findings, all classes of groupings were represented both in Muniyaka and Langas slums of Eldoret town. Local savings called table banking and merry go round were prominent about 53% while the common interest groups based on crop or livestock practiced featured favorably. The prominence was reported to have been facilitated by financial institutions which lend money to these groups while county government and other NGOs established CIGs through their agricultural extension approach.



Informal settlement associations

Main source of income

Our findings established that there were a number of income generating activities. Whereas daily menial jobs featured prominently of about 36%, farming and limited space was a common practice with slum dwellers. With small spaces they have, livestock and crop farming was apparent with respondents of about 30% preferred livestock while crop was 17% and mixed farming was about 22%. At least each respondent had a side hustle to support his daily expenses. In assessment of the (Placeholder1)ese activities revealed that profitability was not considered but handled these activities as a fall back in case of the outdoor activities don't yield enough money to meet daily requirement.



Farming activities in the slums

Apparently not all slum dwellers own the houses or spaces they carry out their activities. However 64% of the slum dwellers own the place they live while 43% rent the space. On this space several activities are obvious such as vegetable garden, stores and other structures for livestock.

Among the livestock kept, chicken was leading followed by pigs. Very few to none had kept cattle. The reason suggested for this scenario is because of space available, feeding requirement and labour required to tend for these livestock. For instance, chicken management is not demanding because, most respondents put them on free range system and come back to sleep in the same house. Those with poultry structures were poorly constructed and exposed chicken to insecurity and diseases.

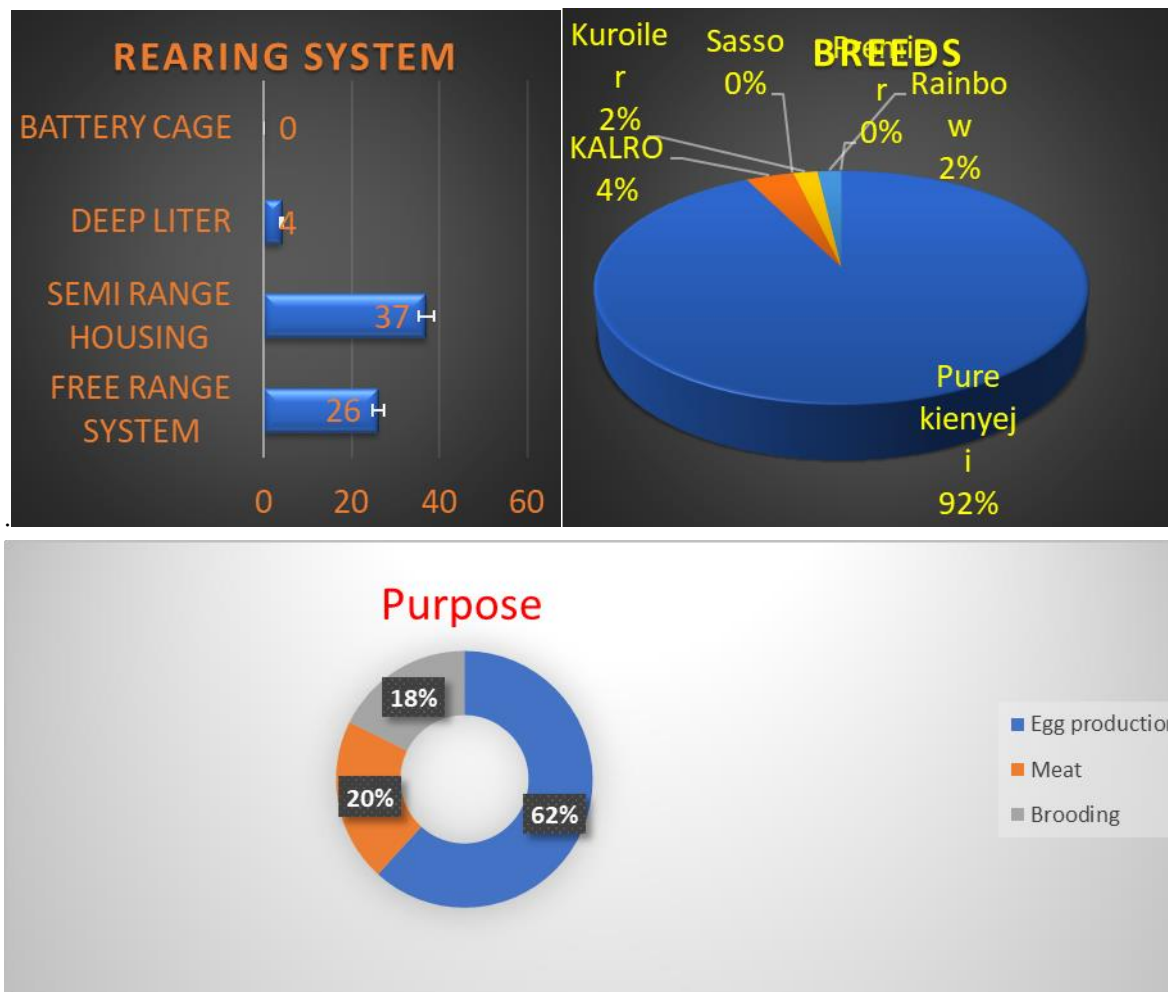
Type of breed and rearing system

Most breeds kept here are pure kienyeji (local) 92%, with insignificant numbers of kuroiler, kalro sasso and rainbow rooster breed. On inquiring whether they are aware of the advantages of these breeds over the local breeds, majority of the respondent confirmed in the affirmative citing the challenges of these improved breeds. Some of the challenges highlighted included vulnerability to diseases, parasites and commercial feed constraints.

It was evident that no specific systems of rearing breeds was adopted however semi-range system(37%) featured. This is where birds are freed for some time and enclosed in a structure during the night while supplementing their feeding as they freely forage out there. For free range system, 26% of the respondents confirmed practicing this system while battery cage and deep litter systems were insignificant fig;

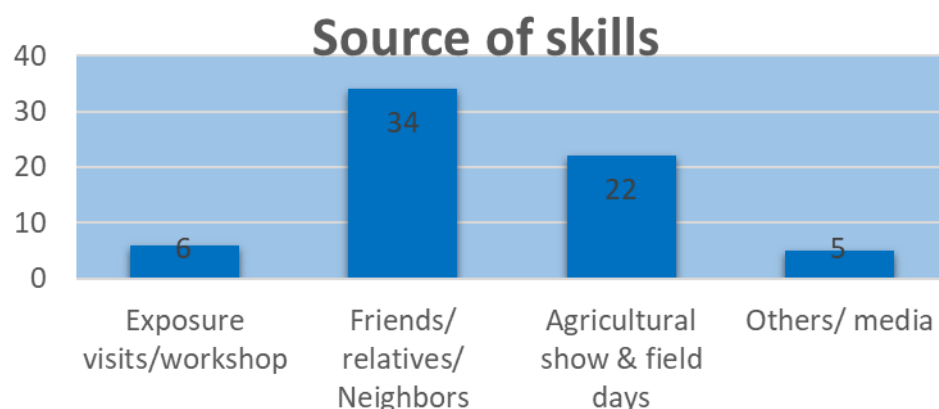
Purpose of keeping chicken

Our findings why they keep chicken were varied. About 60% of the respondents said that they keep chicken for eggs production which either they sell or consume. The rest of the respondents keeps chicken for meat (20%) and rearing chicks from day old to one month for selling(brooding 18%).



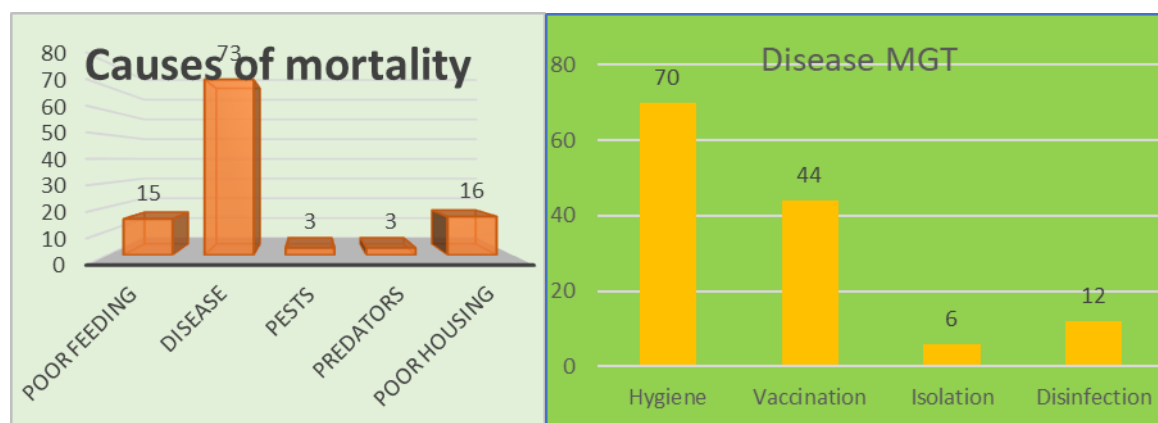
Knowledge on modern methods of rearing poultry.

In order to understand if these people have information on poultry keeping, it was important for us to inquire the source of information and skills they have. This was to inform the entry point for capacity building. 34% of the respondents said that they learned the skills from friends and relatives, 22% mentioned that they occasionally attend agricultural shows and fairs organized by county government while some learned from social media and radios/tvs etc. Our survey found that none had formal training on poultry production or general agriculture. Given this situation it was crucial to find out if they experience challenges in poultry farming.



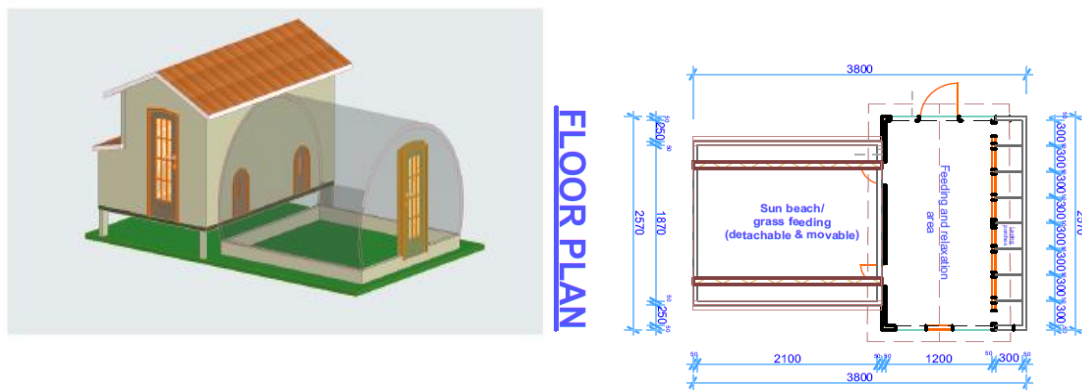
Poultry production challenges

According to their responses, there was a high mortality rate. The causes of mortality were ranked as diseases followed by poor feeding poor housing among others. In order to understand how they manage the challenges, respondents attributed disease in poultry could be managed by proper hygiene, vaccination and isolation. On inquiring on who practiced these practices, 70% of the respondents observed hygiene, 44% vaccinated their birds and others carried out isolation and disinfection of their houses. According to kalro report 2015, proper housing could reduce mortality in poultry to as low as 7%.this prompted us to find out whether they thought the same way. Poultry structures identified were possibly responsible for high mortality. These structures were constructed by the slum dwellers themselves with no information on the size and nature of a proper poultry structure.



Poultry coop for limited space

In order to address challenges associated with poultry production in slums, rift valley technical training institute (rvtti) developed a poultry structure suitable for this condition. The structure provides for supplementation feeding, enhances security and reduces disease incidences while maximizing chicken performance. Figure below shows the structure designs on its pilot stage with slum dwellers. The structure (poultry coop) has a resting place where they can also feed measuring 2mx1m for at most 20birds, with laying nests, perches, drinkers and feeders. The run section which is detachable allows free foraging for supplement feeding.



Discussion

The existence of informal settlement in towns is a global phenomenon. Social scientist postulated that, slum is the by-product of modern era. Whereas the slums population is needful, informal settlement has become an impediment to urbanization(ashraf et al., 2013). Upgrading of such habitats should be a priority to any urban area that wants to attain city status. An entry point to elimination of slum habitats must begin from improving the livelihoods of people living in these informal settlements through housing improvement, income generation, while promoting and facilitating broad-based partnerships utilizing consensus building and consultation among all the stakeholders(meredith & macdonald, 2017) . In our studies munyaka and langs , slums in eldoret town(sylvia, 2016) provided an opportunity to TVET institutions to participate in development of these environments through innovative and technical approaches. Apparently engaged here to improve livelihoods such as income generating activities are outdated and void of modern approaches. It's therefore critical to establish why such activities are carried out yet innovations and new technologies exist. Sensitization

meetings held with slum dwellers indicated that impediment to adoption of new technology relates to lack of information, limited space and costs attached to it which discourage adoption. This is in congruent with a survey conducted by feder (1985), on adoption of technology in developing countries (feder et al., 1985).

In meeting their daily basic needs, slum dwellers employ a number of coping strategies which include but not limited to borrowing from friends or loans from groups, table banking, small farming activities and casual jobs among others. (rachman, 2018) (sylvia, 2016). Our findings depicted the same scenario with previous studies however casual jobs, farming both crop and livestock was major. These were their main sources of income and a food security strategies (rachman, 2018). The income generating activities seem to generate little to meet their needs as evidenced by the quality of life (qol) observed. According to (renzaho et al., 2020) informal settlement are characterized by poverty with a cycle of activities which maintain status quo. The outdated farming activities call for concerted efforts to integrate them with innovative modern techniques to improve productivity. Because, according to the inhabitants of this place keeping poultry is the easiest way of generating income, it was later discovered that this farming is only amenable to meet other daily income generating activities.

Informal settlement creates opportunity for TVET institutions for their innovations and learning sites. In working with slum dwellers, TVETs will have a chance to tailor-make and customized innovations to address challenges faced by slum dwellers. This will include reskilling and equipping the dwellers with skills to enable them earn a better living thus improving their life. As a way of forging partnership and collaboration, rvtti developed a poultry structure (coop) to address challenges facing poultry farmers in slums. This structure is designed to utilize the small space and provide easy management of stress in birds while in the structure. Although others have been developed, the rvtti structure has provision for feeding supplementation called the run which will cut cost of production. Furthermore, the structure will be movable meaning that in case of relocation, the owner can move with it.

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Article 8

Should Universities in Africa Ban the Use of ChatGPT in teaching and learning?

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Abstract

The integration of Artificial Intelligence (AI) technologies, such as ChatGPT, into higher education has sparked a contentious debate. This paper explores the question of whether universities should ban the use of ChatGPT in teaching and learning contexts. The discussion delves into various facets of this issue, including the potential benefits and drawbacks of ChatGPT, ethical considerations, and its impact on academic integrity. Drawing upon a comprehensive review of the existing literature and empirical studies, this paper provides insights into the multifaceted nature of the debate. While some argue that ChatGPT offers valuable educational support and fosters inclusivity, others express concerns about its potential for misuse and its impact on critical thinking skills. Ultimately, this paper seeks to contribute to a nuanced understanding of the role of ChatGPT in higher education and offers recommendations for universities to make informed decisions about its usage. It underscores the importance of striking a balance between leveraging AI for educational enhancement and addressing the associated challenges to ensure the integrity and effectiveness of the learning environment.

Key words: ChatGPT, Artificial Intelligence, higher education, teaching and learning

Introduction

In recent years, the advent of Artificial Intelligence (AI) has ushered in a transformative era in education, offering innovative tools and solutions to enhance teaching and learning experiences worldwide (Anderson et al., 2020; Watson & Jones, 2021). One such AI application is ChatGPT, a powerful conversational model that has garnered substantial attention in the educational landscape. ChatGPT, with its ability to engage in interactive conversations, generate text, and provide instant answers, holds the potential to revolutionize pedagogical approaches in higher education (Smith & Brown, 2022). However, as institutions across the globe grapple with the integration of AI technologies into the classroom, the question arises: should universities in Africa ban the use of ChatGPT in teaching and learning?

The debate surrounding ChatGPT's role in African higher education is nuanced, encompassing a multitude of factors unique to the region. Africa boasts a diverse educational landscape characterized by varied linguistic backgrounds, resource constraints, and distinct cultural contexts (Alabi et al., 2019; UNESCO, 2020). Against this backdrop, the adoption of AI technologies like ChatGPT presents both unprecedented opportunities and significant challenges.

This research endeavors to delve into the heart of this pressing question, seeking to elucidate the potential benefits, drawbacks, and ethical considerations associated with ChatGPT's deployment in African higher education institutions (Mbae, 2021). By examining the implications of ChatGPT on pedagogy, academic integrity, accessibility, and the evolving role of educators, this study aims to provide valuable insights into the decision-making processes of universities in Africa (African Union, 2017). Furthermore, it aims to shed light on how ChatGPT can be harnessed to address the unique educational needs and aspirations of the African continent while preserving the integrity of higher education systems (UNESCO, 2019).

There is a gap in understanding the existing policy and regulatory frameworks, if any, governing the use of AI technologies in education across African countries. An analysis of these frameworks and their alignment with ChatGPT usage is crucial.

This research aspires to contribute to the broader discourse on AI in education by offering region-specific insights and recommendations, fostering informed decisions, and

ultimately ensuring that the adoption of ChatGPT aligns with the educational aspirations of Africa's diverse student body and the academic missions of its institutions.

Literature Review

This is from my own literature review

K. Malinka, Martin Peresíni, Anton Firc, Ondřej Hujňák, Filip Janus

(2023) evaluate the influence of ChatGPT on university education, with a primary focus on computer security-oriented specialization. Their data was the effectiveness and usability of this tool for completing exams, programming assignments, and term papers. Their findings showed that ChatGPT can be used to cheat, however, they indicate the potentially significant benefits to the educational system. For instance, it might be used as an aid (assistant) to discuss problems encountered while solving an assignment or to speed up the learning process. Alfonso Renato Vargas-Murillo, Ilda Nadia Monica de la Asuncion Pari-Bedoya, Francisco de Jesús Guevara-Soto (2023) the results of their literature analysis afforded the conclusion that that ChatGPT can potentially enhance both academic- and librarian-related processes, although it is important to reconsider the ethics of using technology such as this. This is because this kind of AI technology also has the potential to modify the way people take on different jobs, tasks, and processes at an academic level, for which the correct and responsible use of ChatGPT needs to be assessed in the field of higher education.

Table 1. Summary of current literature review

Authors	Paper title	Abstract summary	Study type	Outcomes measured
K. Malinka, Martin Peresíni, Anton Firc, Ondřej Hujňák, Filip Janus (2023)	On the Educational Impact of ChatGPT: Is Artificial Intelligence Ready to Obtain a University	ChatGPT can be used to cheat.		•Effectiveness Of Chatgpt For Completing Exams •Effectiveness Of Chatgpt For Completing Programming Assignments

	Degree?			•Effectiveness Of Chatgpt For Completing Term Papers •Levels Of Tool Misuse
P. A. Rospigliosi(2023)	Artificial intelligence in teaching and learning: what questions should we ask of ChatGPT?	The purpose of ChatGPT is to invite questions.		
Alfonso Renato Vargas-Murillo, Ilda Nadia Monica de la Asuncion Pari-Bedoya, Francisco de Jesús Guevara-Soto (2023)	Challenges and Opportunities of AI-Assisted Learning: A Systematic Literature Review on the Impact of ChatGPT Usage in Higher Education	ChatGPT can potentially enhance both academic- and librarian-related processes in higher education.	Review	
C. Lo (2023)	What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature	ChatGPT has the potential to serve as an assistant for instructors and a virtual tutor for students.	Review	•Chatgpt'S Performance Across Subject Domains •Chatgpt'S Potential Use As An Assistant For Instructors •Chatgpt'S Potential Use As a Virtual Tutor

				For Students •Challenges Associated With Chatgpt'S Use
Junaid Qadir (2023)	Engineering Education in the Era of ChatGPT: Promise and Pitfalls of Generative AI for Education	The use of generative AI in education raises ethical concerns.		
Pethigimage Perera, M. Lankathilaka (2023)	AI in Higher Education: A Literature Review of ChatGPT and Guidelines for Responsible Implementation	Natural language models like ChatGPT present numerous advantages and disadvantages for higher education.	Systematic Review	
Malik Sallam (2023)	ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising	The use of ChatGPT should be conducted with extreme caution in health care	Systematic Review	•Benefits Of Chatgpt •Improved Scientific Writing And Enhancing Research Equity And Versatility •Utility In Health Care Research

	Perspectives and Valid Concerns	education, research, and practice.		(Efficient Analysis Of Datasets, Code Generation, Literature Reviews, Saving Time To Focus On Experimental Design, And Drug Discovery And Development) •Benefits In Health Care Practice (Streamlining The Workflow, Cost Saving, Documentation, Personalized Medicine, And Improved Health Literacy) •Benefits In Health Care Education Including Improved Personalized Learning And The Focus On Critical Thinking And Problem Based Learning
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M. AIAfnan, Samira Dishari, Marina Jovic, Koba Lomidze (2023)	ChatGPT as an Educational Tool: Opportunities, Challenges, and Recommendations for Communication, Business Writing, and Composition Courses	ChatGPT skillfully paraphrases regenerated responses in a way that is not detected by similarity detection software.	• Opportunities And Challenges Of Chatgpt As An Educational And Learning Tool • Accuracy And Reliability Of Chatgpt As a Replacement For Search Engines • Platform For Students To Seek Answers To Theory Based Questions • Platform For Students To Generate Ideas For Application Based Questions • Integration Of Technology In Classrooms • Ability Of Instructors To Differentiate Between Meticulous And Automaton Dependent Students • Achievement Of Learning Outcomes • Effectiveness Of
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Opara Emmanuel Chinonso, Adalikwu Mfon- Ette Theresa, Tolorunleke Caroline Aduke (2023)	ChatGPT for Teaching, Learning and Research: Prospects and Challenges	ChatGPT delivers rapid and instantaneous response to search queries.	Review	
Maia Japoshvili- Ghvinashvili, Dr. Nazia Suleman (2023)	Assisting ELT Teachers: Designing Activities for the Use of ChatGPT in Teaching and Learning	The study aims to contribute to the development of innovative and effective pedagogical practices that leverage the power of language models in education.	Review	
Mehmet Firat (2023)	What ChatGPT means for universities: Perceptions of scholars and students	The potential benefits of AI in education as well as the challenges and barriers that may arise from its integration are discussed in the context		•Perceptions Of Scholars And Students Regarding The Implications Of Chatgpt For Students And Universities •Evolution Of Learning And Education Systems •Changing Role Of

		of existing literature.		Educators •Impact On Assessment And Evaluation •Ethical And Social Considerations •Future Of Work And Employability •Personalized Learning •Digital Literacy And Ai Integration •Ai As An Extension Of The Human Brain
Mohanad Halaweh (2023)	ChatGPT in education: Strategies for responsible implementation	Educators can implement ChatGPT in teaching or research.		
Md. Mostafizer Rahman, Y. Watanobe (2023)	ChatGPT for Education and Research: Opportunities, Threats, and Strategies	ChatGPT offers exciting opportunities for students and educators.		•Personalized Feedback •Increased Accessibility •Interactive Conversations •Lesson Preparation •Evaluation •New Ways To Teach Complex Concepts

				•Possibility Of Cheating On Online Exams •Human Like Text Generation •Diminished Critical Thinking Skills •Difficulties In Evaluating Information Generated By Chatgpt •Programming Skills Improvement
Marta Montenegro Rueda, José Fernández-Cerero, J. Fernández-Batanero, Eloy López-Meneses (2023)	Impact of the Implementation of ChatGPT in Education: A Systematic Review	Implementing ChatGPT in the educational environment has a positive impact on the teaching-learning process.	Systematic Review	•Impact Of Chatgpt Tool In Education •Positive Impact On The Teaching Learning Process •Importance Of Teachers Being Trained To Use The Tool Properly
Hao Yu (2023)	Reflection on whether Chat GPT should be banned by academia from the perspective of education and teaching	Universities should ban the use of ChatGPT in teaching and learning.		

David Shaw, P. Morfeld, T. Erren (2023)	Turing, Djerassi, "athletics" & ethics: The (mis)use of ChatGPT in science and education: Turing, Djerassi, "athletics" & ethics.	ChatGPT is an amazing advance in technology.		
Lingyao Li, Zihui Ma, Lizhou Fan, Sanggyu Lee, Huizi Yu, Libby Hemphill (2023)	ChatGPT in education: A discourse analysis of worries and concerns on social media	Twitter users generally expressed a positive attitude towards the use of ChatGPT in education.		•Concerns Related To The Use Of Chatgpt In Education •Academic Integrity •Impact On Learning Outcomes And Skill Development •Limitation Of Capabilities •Policy And Social Concerns •Workforce Challenges
Mizanur Rahman, H. J. Terano, Nafizur Rahman, Aidin Salamzadeh, S. Rahaman (2023)	ChatGPT and Academic Research: A Review and Recommendations Based on Practical Examples	ChatGPT could be an effective tool for academic scientific research.	Review	

Reza Hadi Mogavi, Chaohua Deng, Justin Juho Kim, Pengyuan Zhou, Young D. Kwon, A. H. Metwally, A. Tlili, Simone Bassanelli, A. Bucchiarone, Sujit Gujar, L. Nacke, Pan Hui (2023)	Exploring User Perspectives on ChatGPT: Applications, Perceptions, and Implications for AI-Integrated Education	ChatGPT is most popularly used in the contexts of higher education, K-12 education, and practical-skills learning.		•Primary Applications Of Chatgpt In Education •Various Perceptions Of The Technology
Simone Grassini (2023)	Shaping the Future of Education: Exploring the Potential and Consequences of AI and ChatGPT in Educational Settings	The impact of ChatGPT on the education sector has elicited mixed reactions.		
B. Lund, Wang Ting (2023)	Chatting about ChatGPT: How May AI and GPT Impact Academia and Libraries?	ChatGPT has considerable power to advance academia and librarianship in both anxiety-provoking and exciting new	Review	•Benefits Of Chatgpt •Improving Search And Discovery •Reference And Information Services •Cataloging And Metadata Generation •Content Creation •Ethical

		ways.		Considerations •Privacy •Bias
A. Shoufan (2023)	Exploring Students' Perceptions of ChatGPT: Thematic Analysis and Follow-Up Survey	ChatGPT can and should be used for learning.		•Students' Perceptions Of Chatgpt •Students' Evaluation Of Chatgpt •Students' Opinions On Chatgpt'S Capabilities •Students' Opinions On Chatgpt'S Limitations •Students' Opinions On Chatgpt'S Impact On Learning •Students' Opinions On Chatgpt'S Impact On Academic Integrity •Students' Opinions On Chatgpt'S Impact On Jobs •Students' Opinions On Chatgpt

Grace H. Sun, Stephanie H. Hoelscher (2023)	The ChatGPT Storm and What Faculty Can Do	Faculty should understand the potential benefits and limitations of ChatGPT.		
F. R. Baskara (2023)	The Promises and Pitfalls of Using Chat GPT for Self-Determined Learning in Higher Education: An Argumentative Review	Chat GPT promises to improve self-determined learning by offering individualised feedback, resources, and assistance to learners that can foster their acquisition of knowledge and skills.	Review	
R. Firaina, D. Sulisworo (2023)	Exploring the Usage of ChatGPT in Higher Education: Frequency and Impact on Productivity	The use of ChatGPT in learning can be an interesting and effective alternative.		•How The Use Of Chatgpt Affects Learning •Reasons For Choosing Or Not Choosing The Technology •Impact Of Chatgpt On Productivity •Learning Efficiency

Chen Zhu (2023)	How to harness the potential of ChatGPT in education?	ChatGPT has limitations in the quality of its output.		
S. Fergus, Michelle J Botha, M. Ostovar (2023)	Evaluating Academic Answers Generated Using ChatGPT	ChatGPT is not considered a high-risk technology tool in relation to cheating.		•Quality Of Chatgpt Generated Responses
Hyunsu Lee(2023)	The Rise of ChatGPT: Exploring its Potential in Medical Education.	ChatGPT has the potential to increase student engagement and enhance student learning.		

Arguments favoring the use of ChatGPT for teaching and learning in the Universities in Africa

Universities in Africa should not hastily ban the use of ChatGPT in teaching and learning but instead consider it as a valuable tool for enhancing education across the continent. Several compelling reasons support the integration and responsible use of ChatGPT in higher education in Africa:

1. *Accessibility and Inclusivity:* ChatGPT can play a pivotal role in making education more accessible and inclusive in Africa. The continent is characterized by linguistic diversity, and ChatGPT's ability to communicate in multiple languages can bridge communication gaps and provide personalized support to students whose primary

language may not be English. This inclusivity aligns with the principles of equitable education (UNESCO, 2020).

2. *Addressing Resource Constraints:* Many African universities face resource constraints, including shortages of teaching staff and educational materials. ChatGPT can alleviate some of these challenges by providing additional instructional support, thereby helping universities maximize their existing resources and improve the quality of education (Alabi et al., 2019).
3. *Enhanced Learning Support:* ChatGPT can serve as a valuable learning aid, offering students immediate access to explanations, information, and resources. This can empower self-directed learning and supplement classroom instruction, ultimately contributing to improved learning outcomes (Watson & Jones, 2021). Junaid Qadir (2023) One promising development in this field is the use of generative artificial intelligence technology, such as the ChatGPT conversational agent. ChatGPT has the potential to offer personalized and effective learning experiences by providing students with customized feedback and explanations, as well as creating realistic virtual simulations for hands-on learning.
4. *Cultural and Contextual Relevance:* ChatGPT can be customized to incorporate culturally relevant content and materials, ensuring that education remains contextually appropriate for African learners. By tailoring content and examples, educators can make learning experiences more relatable to local cultures and environments (UNESCO, 2019).
5. *Teacher Support and Workload Reduction:* Instead of replacing teachers, ChatGPT can assist educators by automating routine administrative tasks, grading assignments, and providing valuable insights into student performance. This support can enable educators to focus on higher-order pedagogical activities (Smith & Brown, 2022).
6. *Global Competitiveness:* Equipping African students with AI literacy and experience in using AI tools like ChatGPT can enhance their global competitiveness in the job market. As AI continues to shape various industries, students proficient in AI-driven technologies may have a competitive advantage (African Union, 2017).

7. *Flexibility and Adaptability:* ChatGPT can adapt to diverse learning styles, pace, and preferences. It offers personalized learning experiences that cater to individual needs, fostering a more student-centric approach to education (Smith & Brown, 2022).
8. *Long-Term Skill Development:* Instead of inhibiting critical thinking skills, ChatGPT can be integrated in a way that enhances students' critical thinking and problem-solving abilities. By encouraging students to engage critically with AI-generated content, universities can promote skill development (Miller, 2020).

Universities in Africa should consider banning the use of ChatGPT in teaching and learning due to several concerns and challenges associated with its implementation:

1. *Digital Divide and Infrastructure Limitations:* A significant portion of Africa still grapples with limited access to the internet and technology infrastructure (Alabi et al., 2019). Integrating ChatGPT into the educational system may exacerbate the digital divide, leaving students without reliable access to the necessary technology at a disadvantage.
2. *Linguistic and Cultural Mismatch:* ChatGPT, primarily designed for English, may not align with the linguistic diversity of Africa. Many African languages and dialects are not adequately supported by ChatGPT, making it less effective for students who prefer or require instruction in their native languages.
3. *Quality and Reliability of Information:* ChatGPT generates responses based on the data it has been trained on, which may include inaccuracies or biases. Depending solely on ChatGPT for information may lead to misinformation, as it cannot independently verify the accuracy of the information it provides (Smith & Brown, 2022).
4. *Dependency and Reduced Critical Thinking:* Overreliance on ChatGPT may diminish students' critical thinking skills. Relying on an AI tool for answers may discourage independent research, analysis, and problem-solving, which are essential skills for lifelong learning and success (Miller, 2020).

5. *Privacy and Data Security:* Integrating AI tools like ChatGPT raises privacy concerns, as students' interactions and data may be stored and analyzed. Safeguarding this data against potential breaches and misuse can be challenging, especially in regions with limited data protection regulations.
6. *Academic Integrity and Cheating:* ChatGPT's capabilities to generate text and answers could lead to academic dishonesty, with students using it to complete assignments, exams, or even plagiarize content. Maintaining academic integrity becomes a pressing concern (Smith & Brown, 2022). Junaid Qadir (2023) Additionally, the use of generative AI in education raises ethical concerns such as the potential for unethical or dishonest use by students and the potential unemployment of humans who are made redundant by technology
7. *Loss of Teaching Positions:* The increasing automation of tasks through AI technologies, including grading and content generation, may reduce the demand for teaching positions. This could lead to job losses in the education sector, impacting educators' livelihoods.
8. *Ethical Concerns and Bias:* AI models like ChatGPT may inadvertently perpetuate biases present in the data they were trained on, potentially reinforcing existing inequalities and stereotypes in education (UNESCO, 2020).
9. *Overlook of Cultural Pedagogy:* Relying on AI tools might lead to a disregard for traditional African pedagogical methods, which often emphasize community, oral traditions, and interactive learning. The introduction of AI can undermine the preservation of cultural teaching practices (African Union, 2017).

Recommendations for the use of ChatGPT in teaching and learning in higher education,

1. *Provide Clear Guidelines and Training:* Universities should offer comprehensive guidelines on the appropriate use of ChatGPT in educational settings (Smith & Brown, 2022). Additionally, faculty and instructors should receive training to effectively integrate ChatGPT into their teaching methods.
2. *Promote Ethical Usage and Academic Integrity:* Institutions should emphasize the importance of ethical AI use and uphold academic integrity standards. Students should be educated about responsible AI usage to prevent misuse of ChatGPT (Smith & Brown, 2022).

3. *Foster a Balanced Approach to Learning:* ChatGPT should be used as a supplementary tool to enhance the learning experience rather than a complete replacement for traditional instruction methods (Anderson et al., 2018).
4. *Tailor ChatGPT to Individual Learning Styles:* Instructors should encourage students to personalize their interactions with ChatGPT, allowing for a more adaptive and tailored learning experience (Smith & Brown, 2022).
5. *Leverage ChatGPT for Specialized Learning Support:* ChatGPT can be particularly beneficial for students with disabilities, providing customized assistance to accommodate various learning styles and needs (Anderson et al., 2018).
6. *Implement Continuous Assessment and Feedback:* Regular assessments and feedback mechanisms should be integrated to monitor the effectiveness of ChatGPT in achieving learning outcomes (Watson & Jones, 2021).
7. *Encourage Critical Thinking and Problem-Solving:* Instructors should ensure that the use of ChatGPT supports and enhances critical thinking skills rather than replacing them (Miller, 2020).
8. *Safeguard Privacy and Data Security:* Institutions should implement robust data protection measures to safeguard the privacy and security of both students and faculty when using ChatGPT (Smith & Brown, 2022).
9. *Engage in Ongoing Research and Evaluation:* Universities should actively participate in research endeavors to continuously assess the impact and effectiveness of ChatGPT in different educational contexts (Watson & Jones, 2021).

In view of these considerations, African universities should conduct a thorough assessment of the potential drawbacks stemming from the integration of ChatGPT into their teaching and learning environments. Striking a well-balanced approach that effectively addresses these challenges while harnessing the advantages of technology is imperative for safeguarding the standard and inclusivity of education across the continent.

In summary, despite the valid concerns and obstacles associated with the adoption of ChatGPT in higher education institutions in Africa, an outright ban may disregard the substantial benefits it can bring. Universities should instead adopt a judicious and

responsible approach, harnessing ChatGPT as a valuable tool to tackle educational hurdles, broaden access, and enhance the quality of education in Africa. A meticulously planned integration strategy can empower both educators and students, fostering inclusive and forward-looking learning environments."

User

can you give detail "recommendations for the use of ChatGPT for teaching and learning in the higher education" if possible with intext citations and full references as list at the end
Which response do you prefer?

Your choice will help make ChatGPT better.

recommendations for the use of ChatGPT for teaching and learnin

ChatGPT

Response 1

Certainly! Here are detailed recommendations for the use of ChatGPT for teaching and learning in higher education, along with in-text citations and a reference list at the end:

Recommendations for the Use of ChatGPT in Higher Education

Implement Ethical Guidelines:

Universities should establish clear and comprehensive ethical guidelines for the use of ChatGPT in teaching and learning (Smith & Brown, 2022). These guidelines should emphasize responsible AI usage, discourage academic dishonesty, and promote transparency in the use of AI tools.

Educate Students on AI Ethics: It is crucial to integrate AI ethics education into the curriculum (Smith & Brown, 2022). This will help students understand the ethical implications of AI technologies like ChatGPT and encourage responsible usage.

Encourage Responsible Use: Instructors should actively promote responsible use of ChatGPT by providing guidance on when and how it can be utilized effectively as a learning aid (Smith & Brown, 2022). They should emphasize that ChatGPT is a tool to assist and enhance learning, not a replacement for critical thinking.

Provide Training for Educators: Universities should offer training programs for educators to ensure they are proficient in using ChatGPT as a teaching aid (Smith & Brown, 2022).

Educators should be equipped with the skills to integrate ChatGPT seamlessly into their teaching methods.

Foster Collaboration: Encourage collaboration among students when using ChatGPT. Assign group projects or activities that require students to work together and use ChatGPT as a supplementary resource (Johnson & Smith, 2019).

Monitor and Prevent Misuse: Implement measures to detect and prevent misuse of ChatGPT, such as plagiarism (Johnson & Smith, 2019). Universities can employ plagiarism detection tools and promote academic integrity.

Evaluate Learning Outcomes: Conduct ongoing assessments to measure the impact of ChatGPT on learning outcomes. Universities should analyze whether ChatGPT enhances student performance, critical thinking, and problem-solving skills (Watson & Jones, 2021).

Encourage Innovation in Teaching Methods: Encourage instructors to explore innovative teaching methods that leverage ChatGPT, such as flipped classrooms, personalized learning, and AI-enhanced assessments (Watson & Jones, 2021).

Promote Inclusivity: Ensure that ChatGPT is accessible to all students, including those with disabilities. Universities should provide accessible versions of ChatGPT and offer training on accessibility features (Anderson et al., 2018).

Maintain Data Privacy: Universities should prioritize data privacy and security when using ChatGPT. Protect student data and ensure compliance with relevant data protection regulations (Smith & Brown, 2022).

Regularly Update and Improve ChatGPT: Universities should collaborate with AI developers to ensure that ChatGPT evolves to meet the changing needs of educators and students (Smith & Brown, 2022).

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Article 9

Assessing mathematics teachers' integration levels of Information and Communication Technology: a case of Ongha circuit, Ohangwena region, Namibia

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Background of the study

The integration of Information and Communication Technology (ICT) into the Namibian basic education curriculum is a pivotal aspect of the educational landscape, with the Ministry of Education, Arts, and Culture [MoEAC] highlighting its significance (MoEAC, 2016). ICT has the potential to transform education, not only reshaping the roles of teachers and students but also enhancing the quality of mathematics instruction (Zakaria & Khalid, 2016). This integration offers educators the tools to improve lesson planning, teaching methodologies, and pedagogical knowledge, making it a critical consideration for the Namibian education system.

In line with the developmental goals outlined in National Development Plans 2 and 3 (NDP 2 and 3) and Vision 2030, the Government of the Republic of Namibia (GRN) has introduced various ICT initiatives. These include programs like Tech/Na, NETSS, X-net secretariat, the ICT Literacy Foundation Curriculum for Literacy, ICT for Education (ICTED), and the Millennium Challenge Account (MCA). The MCA initiative, in particular, aimed to improve infrastructure in ten schools in Ohangwena and provided training to educators on utilizing ICT facilities (MCA-Namibia, 2014). Despite these provisions, the extent of ICT integration in mathematics education in MCA-affiliated schools remained uncertain. This study thus sought to assess the level of ICT integration among secondary mathematics educators in MCA-supported schools within the Ongha Circuit of the Ohangwena Region. The evaluation employed the SAMR model and aimed to assess the actual implementation levels, address any obstacles hindering the

assimilation of ICT into mathematics classroom instruction, and propose strategies to overcome the challenges associated with integrating ICT into the educational framework of MCA-supported schools in the Ohangwena Region.

SAMR Model

According to Puentedura (2014), the SAMR model is intended to be a tool through which one may describe and categorize basic education teachers' use of classroom technology. The model consists of Substitution and Augmentation level which are enhancement level, as well as the modification and redefinition level, which represent the transformation levels (Hamilton et al., 2016). For every SAMR level, a teacher must reflect on and recognize the value that technology has added to the learner's learning process (Gorman, 2016). This then means, the teacher is ranked based on what he or she can do and also on what learners can do with the teacher's help. Therefore, the SAMR model aided the study to categorize levels of ICT integration among secondary mathematics teachers at MCA schools in Ongha Circuit of Ohangwena Educational Region.

Literature

The teachers' level of ICT integration

The attainment of mathematics teaching and learning as well as performance and achievements in mathematics could be achieved by a high level of ICT integration in teaching and learning processes (Maharjan et al., 2022). Reviewed studies revealed low ICT integration in teaching (Simon & Ngololo, 2018; Odiakaosa et al. 2017; Amuko 2015; Naufal et al., 2015). In addition, others studies also revealed low ICT integration in mathematics due to the fact that teachers choose the technology that they feel is in line with their instructional goals based on the administrative and pedagogical purposes as well as the lesson objectives, learners' learning needs, and the availability of the ICT tools at school (Agyei et al., 2022 ; Amunyela 2020 Jatileni & Jatileni, 2018). Furthermore, the finding of the study by Wijaya et al. (2021), highlighted that teachers integrated ICT in statistics lessons at low level of SAMR model with very few reaching the highest level, during COVID-19 pandemic. Moreover, Budiman et al. (2018) & Jude et al., (2014) also revealed that teachers have been integrating ICT at the enhancement level of SAMR model, and that they hardly achieve the transformation levels. It seems that the ICT integration is at a low or moderate level. It also seems that the modifications and redefinitions levels are rarely reached.

Challenges to ICT Integration

The lack of access to ICT tools and infrastructure gives teachers reasons for not integrating ICT in the teaching and learning processes (Angula et al., 2019; Ugulu, 2019). In addition, Gupta & Gupta (2011) cite a lack of access to resources, as another challenge that prevents teachers from effectively integrating ICT during teaching and learning processes. Further, the inadequate or poor ICT facilities make it hard as it creates worries in teachers when they are using available ICT facilities (Amuko, 2015; Nendongo, 2018). Furthermore, reviewed studies also revealed that teachers face challenges in developing their own technological skills, knowledge, and self-training in the use of ICT in their teaching (Amuko, 2015). In addition, some studies also found challenges in teachers, such as the lack of technical skills to develop digital mathematical contents (Das, 2019) and to prepare teaching materials based on technology (Martin & Nobis, 2021), as well as a lack of knowledge about ways to integrate ICT in lessons (Agyei et al., 2022; Nendongo, 2018).

Mitigation strategies to curb the challenges hindering integration of ICT in teaching

Babbie (2014) claim that challenges come in different forms and that each challenge comes with a different mitigation strategy. He further added that teachers should be provided with professional development opportunities in order to collectively demonstrate a shared commitment to digital technology in educational circles. In their study Maryuningsih et al. (2020) also found that good ICT skills provide a great opportunity to apply learning with good ICT. Furthermore, training of educators should be adequate to invigorate facilitators in order to function as computer literate facilitators in a society that calls for the knowledge and skills inclined to technology (Gray, 2014). More, professional development activities on the educational use of ICT should focus on the long-term involvement of teachers at the grassroots level and convey the benefits of the use of ICT as well as promote teacher collaboration (Li et al., 2019). Moreover, school's management team must ensure that available computers are shared and used equitably and that the school timetable provides for the introduction of technology to learners. In a study about the assessment of computer and ICT skills

among secondary school teachers, Oyeronke and Fagbohun (2013) asserted that teachers are the primary agents of educational innovation. Therefore, they should be provided with ICT tools and adequate ICT integration training. Further, Grove et al. (2013) suggests that a holistic approach to the development of digital technology in education plans and policies has to be taken, and it should include support for digital technology at both the national and individual school level. Moreover, Holloway (2015) highlighted the need for policymakers to ensure that all materials needed for ICT integration are provided. Resources for a policy to be implemented can be in the form of material and human resources. There is also a need for teachers to undergo ICT integration training, either specifically or in-serviced, for their subject area or the new policy to be implemented (Gussa & Gundula, 2019). This view is supported by Nchindo (2019), who in his study recommends that in-service professional development about ICT integration into mathematics teaching be offered.

Methodology

The study utilized a qualitative research design. The study employed a case study approach that focused on the case of three MCA schools. In addition, the study targeted a population of seventeen (17) MCA secondary school mathematics teachers in ten (10) MCA schools in the Ohangwena region. A purposive sampling was selected in this study and three MCA schools in Ongha Circuit were purposefully selected with the sample of six secondary school mathematics teachers at the selected schools.

The study utilized observations and interviews as data collection methods to investigate the integration of information and communication technologies (ICTs) in mathematics classrooms. During observations, the researcher employed observation sheets and memos to guide the process. These observations were conducted during mathematics lessons, with each participant having two lessons observed. The researcher recorded how ICTs were utilized for various classroom activities, such as note delivery, assessments, and topic-related feedback. After the observations, face-to-face interviews were conducted with each participant. Voice recorders, interview guides, and checklists were used to ensure comprehensive data capture.

The data collected from observations and interviews were analyzed through an interpretive approach, employing the SAMR ranking system to assess the level of technology integration by teachers.

For observation data, the researcher combined all participants' data to determine the most frequently occupied SAMR level. Interview data were used to identify integration levels for various teacher activities, employing a checklist. The combined data were tabulated, and overall integration levels were determined by examining the most frequently occupied level among teachers. Interview data were transcribed verbatim and categorized into themes based on the research questions.

Ethical clearance was obtained from the University of Namibia (Certificate number: RUC0001), and approvals were secured from relevant educational authorities and school principals. Participants were informed about the research's purpose, their roles, benefits, and procedures, and they signed informed consent forms. Pseudonyms were assigned to maintain participant confidentiality, and data was kept securely on the researcher's personal computer with a password known only to the researcher. COVID-19 protocols were strictly adhered to throughout the research to prevent virus transmission. Participants were treated with respect and dignity, adhering to principles of justice.

Results & Discussions

Theme 1: Teachers' level of ICT integration in mathematics classrooms

The study examined how teachers in MCA schools in the Ongha circuit of Ohangwena region use technology in their teaching. The findings revealed that all the teachers mainly substituted traditional teaching methods with technology, placing them at the substitution level of the SAMR model (Puentedura, 2014). This level involves using technology as a direct replacement without changing the function of the teaching activities. However, four of the participants were found to have made some improvements when using technology, categorizing them at the augmentation level of the SAMR model, where technology enhances teaching methods. None of the teachers reached the modification or redefinition levels of the SAMR model, which involve more significant changes and transformative uses of technology. These results align with previous studies that also found participants predominantly at the enhancement levels of the SAMR model (Budiman et al., 2018; Jude et al., 2014).

Theme 2: The challenges impeding the integration of ICT in the teaching of mathematics

The study found that teachers faced significant challenges when it came to integrating information and communication technology (ICT) into their mathematics teaching.

These challenges were consistent with studies by Zakaria and Khalid (2016) as well as Babbie (2014), which highlighted teachers' inadequate ICT integration skills, the absence of integration guidelines, and limited training opportunities. The study emphasized that addressing these obstacles is crucial for effective ICT integration in mathematics education at MCA schools.

Additionally, the study identified time constraints as a barrier to effective ICT integration, as teachers struggled to cover a packed curriculum within a limited timeframe. This finding aligned with those of Simon and Ngololo (2018) as well as Das (2019), who also noted time-related challenges due to overloaded syllabi and tight schedules.

Inadequate ICT resources and limited internet access further hindered teachers' ability to integrate technology effectively, consistent with findings by Gupta and Gupta (2011) and Amuko (2015). Technical difficulties and a lack of technical support compounded these issues, as teachers lacked assistance in resolving ICT-related problems.

The study also revealed a shortage of specialized ICT teachers in schools, with most ICT educators focusing solely on their subject areas. This lack of dedicated ICT instructors contributed to teachers' reluctance to incorporate ICT into their lessons, a challenge noted in previous studies (Okumura, 2017; Otieno, 2018).

Language barriers were another hindrance, as ICT terminology was challenging to translate and comprehend for learners who were already struggling with the language of instruction. Similar finding was recorded by Otieno (2018).

Lastly, the study emphasized the importance of professional development activities and programs for fostering teacher collaboration. It noted that the absence of continuous professional development (CPD) opportunities hindered teachers from working together, which is crucial for sharing ideas and addressing challenges in the teaching process, as supported by research by Li et al. (2019).

In summary, the study highlighted various obstacles to effective ICT integration in mathematics education, including teachers' inadequate skills, time constraints, resource limitations, technical difficulties, language barriers, and a lack of professional development opportunities and collaboration. Addressing these challenges is essential for improving the integration of ICT in mathematics teaching.

Theme 3: Strategies that can be used to overcome the challenges of ICT integration

The study emphasizes the importance of providing adequate ICT (Information and Communication Technology) training for educators. It suggests that teachers should receive training in ICT to equip them with the necessary skills. The research highlights the need for the Ministry of Education and Culture (MoEAC) to offer in-service training to teachers so they can effectively integrate ICT into their teaching subjects. This recommendation aligns with previous studies by Nchindo (2019) and Maryuningsih et al. (2020) that also stressed the importance of providing relevant ICT training and guidelines for teachers.

Furthermore, the study underscores the significance of teachers having good ICT skills, as this boosts their confidence in using ICT in their teaching. Additionally, it identifies a need for accessible and reliable ICT resources, as well as infrastructure that supports ICT integration. This aligns with the findings of Gupta & Gupta (2011) and Holloway (2015), who also recommended providing teachers with sufficient ICT tools and supportive documents to prevent frustration and obstacles in ICT integration.

The study also suggests that schools should have ICT technical support officials to assist with ICT malfunctions, setup, and maintenance. This recommendation is consistent with previous research by Gray (2014), Nchindo (2019) and Okumura (2017), all of whom proposed the presence of ICT specialists in schools to address various ICT-related issues faced by teachers.

Conclusion

The study found that secondary school mathematics teachers mostly use technology in their teaching at the substitution and augmentation levels of the SAMR model. They allow some learner control and collaboration through social interactions, aligning with constructivist learning principles. However, they face challenges like lacking ICT skills, time, tools, support, language barriers, and collaboration opportunities. The study recommends the Ministry of Education to offer teacher training, provide ICT resources, and create integration guidelines. The study's limitation is its small sample size and suggests future research to assess ICT integration among mathematics teachers nationally.

Recommendations

The study suggests several recommendations for improving the integration of ICT (Information and Communication Technology) in education:

Firstly, the Ministry of Education, Arts, and Culture (MoEAC) should offer guidelines for integrating ICT into teaching and make ICT a subject that is actively promoted to enhance the teaching process. Secondly, the MoEAC should allocate funds for teachers to receive in-service training on how to effectively incorporate ICT into their teaching methods, across all subjects. Lastly, the study recommends that further research should seek to evaluate the extent to which teachers are integrating ICT into the teaching of mathematics at MCA schools on a national scale.

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Article 10

Influence of Coaching Teaching Style on Biology Examinations in Public Secondary Schools in Molo Sub-County, Kenya

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Abstract

The study investigated the influence of coaching teaching style on achievement of Biology in Kenya Certificate of Secondary Education (KCSE). in public secondary schools in Molo Sub-County. Objective was to examine the influence of coaching teaching style on achievement in biology assessment test (BAT); Anchored on constructivist theory by Lev Vygotsky, randomized pre-test, post-test with control quasi-experimental design was adopted. 191 students were purposively sampled from a population of 2800 form two students from four schools which were randomly assigned experimental group or control group with students in their intact classes. BATs and questionnaires were used to collect data from students and interview guides from teachers. Instruments validity was assessed through expert judgment and reliability through split-half method. The calculated r was 0.865 for the theory BAT and 0.823 for the practical BAT. The experimental group were taught using Coaching Teaching Style while the control group were taught using the conventional methods. The two groups of students undertook another BATs to establish the knowledge gained after undergoing a six-week lesson. SPSS version 25.0 was used in data analysis. Descriptive statistics and independent sample t-test results revealed that students taught using coaching method had a statistically significant higher mean score in both theory and practical BATs than counterparts taught using conventional method. The study

concluded that coaching improves students' achievement in examinations. It recommended that teacher training institutions should integrate coaching teaching style and hire more biology teachers to reduce class size.

Keywords: Coaching teaching, biology, achievement test, secondary school, Kenya

1. Introduction

1.1 Background of the Study

Coaching is an instructional method that seeks to inspire learners to actively engage in learning, thereby offering an authentic learning environment that encompasses flexible, interactive, and inquiry-based learning (Fazel, 2013). The coaching strategy emphasizes on student focused activities that promote independence, positive behavioural management, and positive classroom environment. It relies on classroom activities such as setting learning goals, active listening, providing learners with challenges and support that will lead to realization of goals, asking questions, receiving and giving feedback, and supporting the learning of others (Briggs & Nieuwerburgh, 2011). In this instructional strategy, student-educator relationships are characterized by frequent interaction, collaboration, and trust that leads to positive student outcome (Leanna, 2011).

Coaching is often associated with training of adults particularly in professional or organizational set-up. This concept has however found application in the education of non-adult and supporting learning in basic education setup. Passmore and Brown (2009) found that coaching was an effective tool for enhancing examination achievement and address social disadvantage that limit the academic achievement of children from low socioeconomic backgrounds. Key features of the coaching strategy include setting specific learning goals, giving tasks aimed at helping students develop the desired knowledge and skills, soliciting feedback, encouraging learners to critique themselves, and displaying empathy (Kissel *et al.*, 2011). It emphasizes on developing trust in the learner, being present whenever the learners need to inquire, listening actively, clarifying, empathizing, being succinct, asking the best questions, and giving feedback (Fazel, 2013).

Dorrington and Nieuwerburg (2015) argued that one of the features that make coaching a successful instructional strategy is the quality of the relationship between the instructor and the learner. Coaching emphasizes the creation of a relationship of trust, commitment, and mutual respect between the coach and the learner. This relationship tends to increase motivation for learning. Feedback is another vital component of the coaching instructional strategy (Hattie, 2009). Teachers are required to furnish their students with information regarding their achievement so as to facilitate improvement and prepare them for further challenge. Feedback should not necessarily come from the teacher as the coaching approach may be designed in a way that students evaluate each other's work and provide feedback (Darrington & Nieuwerburgh, 2015).

Apart from evaluating peer work, students may also assume the coaching role. The practice of student-to-student coaching is gaining impetus in the USA where students are equipped with skills to work together, reflect on their learning goals, share ideas, and teach each other how to solve problems (Kissel *et al.*, 2011). Another vital feature of coaching is the use of formative assessment. The assessment should assess learning progress and provide information on how learning activities should be adjusted in order to move the student closer to the intended goals (Fazzel, 2013).

Coaching differs from the traditional methods of teaching such lecture and demonstration in that it is cyclical rather than a straight-line activity that seeks to nurture a particular skill or know-how among students (Orr & Sonnadara, 2019). This means that coaching is only used when there is a precise and specific goal. For instance, it may be used to help a student understand a specific topic in biology that he or she is having difficulties. This differentiation implies that coaching is hand-on personalized approach of teaching that requires the teacher to adjust instructions according to the individual needs of each student (Walpole, McKenna, Zarain & Lamitina, 2010). This is because students have difficulties in different areas and thus the teacher must focus on each student, identify his or her area of difficulty, and help him or her achieve the required mastery. This aspect also suggests coaching requires teachers to build personalized and strong relationship with learners that will foster openness and collaboration.

Most traditional methods of teaching use one-way model of communication where information mainly flow from the teacher to the students (Coburn & Woulfin, 2012). On

the other hand, coaching uses two-way model of communication that is characterized by symmetrical exchange of information between the students and the teacher. The teacher gives instructions to the students and also obtain feedback from them that he or she uses to inform subsequent instructions (Czajka & McConnell, 2016). Traditional methods also focus on introducing new knowledge and ideas while coaching focuses on helping students to unlock and utilize the knowledge and ideas that they already possess in different ways.

Coaching may target different stakeholders within the learning institution including students, teachers, administrators, and parents. The current study focuses on coaching directed to students. Student coaching or academic coaching focuses on examining the students learning style, working habits, and existing difficulties and then creating strategies for overcoming the difficulties, build new skills, refine and expand existing skills, and reflect on their learning goals (Timonen & Ruokamo, 2021). It emphasizes on heightening the students' awareness and creating supportive relationships. The ultimate goal of any student coaching program is to institutionalize reflective practices and offer continuous improvement among learners.

Students' coaching has become a popular instructional strategy for promoting the development of secondary school students in many parts of the globe. In the United States of America (USA), numerous private agencies have been established to provide one-on-one coaching to students especially during the transition from secondary school to college. According to Devine, Meyers, and Houssemand (2013), several students coaching approaches have been successfully applied in the (USA) and the United Kingdom (UK). The most common coaching approaches observed in these regions include behavioural coaching, solution-focused coaching, cognitive coaching, and peer coaching. Behavioural coaching is mainly applied in the UK education sector mainly to minimize students' anxiety, increase test achievement, and managing stress (Short, Kinman & Baker, 2010).

Behavioural coaching is easy to teach and learn and hence it's wide application. Solution-focused coaching is mainly used to develop life-skills among students (Green, Grant & Rynsaardt, 2007). It is usually blended with other coaching approaches to enhance students' problem-solving skills. Cognitive coaching focuses on developing

students' reflection, self-evaluation, and self-analysis capability (Palmer & Szymanska, 2007). Peer coaching involves students learning from colleagues through observation, modelling, feedback, and reflective dialogue (Knight, 2009). Peer coaching is common in the UK where older students assume the responsibility of coaching younger students. Peer coaching is not only of benefit to the coachee but also benefits the student coach by enhancing his or her study skill, communication competence, leadership capabilities, self-confidence, and emotional intelligence (Nieuwerburg & Tong, 2012). Sezer (2016) explains that in coaching, the educator relates with the learner as a partner rather than as an authority, healer, or expert. The role of the coach is to support the learners' construction of knowledge by inquiring the learners' problems and directing him or her in exploring probable solutions.

In Africa, the concept of coaching in the education sector has mainly been limited to the professional development of teachers (Namamba & Rao, 2017). The coaching process is viewed as professional development strategy rather than a teaching methodology. It mainly targets teachers rather than students with the view of improving the teachers' instructional practices. In Malawi, a five-month intervention for literacy teachers that encompassed directive coaching, workshops, and complementary teaching and learning materials resulted in changes in attitudes and beliefs about their teaching abilities, though no shifts in instructional practices were observed (Sailors et al., 2014). Other targeted areas were the teachers' engagement with their students and teaching practices, but no significant differences were observed between the intervention and control groups in these aspects. In Ethiopia many efforts were put in place towards improving student-centred pedagogy with the teacher coaching programme increased learning outcomes modestly, it failed to increase student-centred pedagogical practices.

In Kenya, there is increased emphasis on shifting from the traditional British-modelled curriculum and pedagogy especially in science education (Ooko, 2015). However, the system that is current in use in secondary schools is still teacher-centred and overly exam driven. Teacher coaching is one of the approaches that have been explored in effort to transition the teaching practices in Kenyan education set-up. Several teacher coaching programmes have been implemented in the country such as the Kenya Primary Math and Reading Initiative and the Tusome programmes that sought to improve delivery of reading and mathematics instructions in primary schools (Piper &

Zuilkowski, 2015). Student coaching is however a limited practice in Kenyan learning institutions. It is in this light that the proposed study seeks to examine the influence of introducing coaching as teaching style on the achievement of secondary school students in biology examination in Molo Sub-Coun

Objectives of the Study

The general objective of the study was to determine the influence of coaching teaching style on achievement in biology examinations in public secondary schools in molo sub-county, Kenya

1.5 Research Hypotheses

The following hypotheses were tested at the 0.05 level of significance

H₀₁: There is no statistically significant relationship between coaching as a method of teaching biology and students' achievement in theory biology assessment test in secondary schools in Molo Sub County.

H₀₂: There is no statistically significant association between coaching as a method of teaching biology and students' achievement in practical biology assessment test in secondary schools in Molo Sub-County.

1.10 Theoretical Framework

This study was anchored on Lev Vygotsky constructivist theory, who opines that learners are active participants in the generation of knowledge (Roberts & Potrac, 2014). The theory contends that individuals create their own knowledge by engaging in authentic and interactive situations and reflecting on these situations (Vygotsky, 1978). On the other hand, teachers play a facilitative role where they guide the learners in constructing knowledge. According to Pavlovic (2019), coaching as an instructional method integrates the four principles of constructivist learning: viewing people as open information systems, taking people as active makers of meaning, seeing people as social being, and making reference to epistemological and ontological construction. These principles are consistent with the coaching method of teaching.

On the other hand, Diggelen, Doulougeri, Puente, Bombaerts, Dirks, and Kamp (2019) outlines that coaching entails establishing where a student is currently on a given topic, determining where the students should be, and implementing strategies for moving the student from the current point to the desired point. This implies that coaching views

each student as an individual and seeks to administer interventions that address the specific gap that a particular student exhibits. This perspective is also consistent with Lev Vygotsky constructivist theory, which opines that each learner constructs own knowledge (Vasileva & Balyasnikova, 2019). Consequently, all learners cannot be at the same level at any given time when it comes to a given topic. Consequently, instructors ought to establish the point at which each learner is on given topic and implement interventions that will address any gaps.

Diggelen et al. (2019) also emphasizes that coaching requires continuous dialogue between all key stakeholders and application of conversational skills. It requires close engagement between the learner and the instructor. This is also consistent with constructivist learning theory, which emphasizes the need to create consistent and stable emotionally supportive relationships between the learners and the instructors that will enable students to take appropriate risks and develop self-sufficiency (Vasileva & Balyasnikova, 2019).

The results of using a coaching method to teach biology in secondary school are therefore not immediately apparent, necessitating the need for this study.

2. Methodology.

2.1 Research Design

A randomized pre-test post-test with control quasi- experimental design and survey design was used in this study. Two research designs were necessary because one design could not address all research questions. Randomized pre-test post-test control research is an experimental design that focuses on creating two groups (treatment and control), taking measurement of the outcome variable before the onset of the study, administering the intervention to the treatment group, taking measurement of the outcome variable for the second time, and comparing the difference between the experimental and control group based on the measurement (Johnson & Christensen, 2014). The study was carried out in four secondary schools in Molo County in Kenya

2.2 Target Population

The population consisted of all form two students doing biology and all biology teachers in Molo Sub-County. According to the Molo Sub-County Director of Education, there was an average of 2,800 form-two students taking biology in Molo

Sub-County and 134 biology teachers spread across 39 secondary schools. Table 1.1 presents a summary of the target population:

Table 1.1: Target Population

No.	Category	Target Population
1	Teachers	139
2	Students	2800
3	Schools	39

Source: Molo Sub-County Director of Education (2022)

2.3 Data Collection Instruments

Four data collection instruments were used: theory biology assessment test (BAT), practical BAT, interview for teachers, and questionnaire for students.

2.4 Theory Biology Achievement Test (BAT)

A theory BAT prepared by the researcher was used to collect data regarding effect of coaching on achievement of biology students. The test focused on assessing improvement in the students' knowledge and skill on form two topic of Transport in Animals. The test was administered before and after the six-week lesson focusing on this topic.

2.5 Practical BAT

Later on, practical tasks were administered separately. The test focused on assessing in the students practical skills related to the topic of Transport in Animals after the six-week lessons. The pre-test is the base test. The test was administered before and after the six-week lessons.

2.6 Validity and Reliability of Instruments

2.6.1 Validity of the Instruments

Validity expresses the degree to which a measurement measures what it purports to measure (Cohen et al., 2018). Validity of research instrument was enhanced through expert judgement where the researcher consulted the university research supervisors and other faculty members who have deep expertise in the subject area. The researcher

asked the supervisors and faculty members to assess the relevance, accuracy, and comprehensiveness of the items included in the instruments. The supervisors and faculty members agreed that both the theory BAT and practical BAT were relevant and comprehensive in testing the students' understanding of the topic. They also agreed that the questionnaire and interview guide were adequate.

2.6.2 Reliability of the Instruments

Reliability refers to the degree to which an instrument can give consistent results when used to measure the same object in similar circumstances. Reliability of the instruments was assessed by assessing the pilot study data using the test-retest method. This method entailed administering the researcher instrument to the same respondents twice in a span of two weeks in line with the recommendation by Paiva, Borroso and Lopez (2014) that two-weeks is often considered an appropriate time interval for test-retest. The results of the first wave to that of the second wave of data collection were compared using the Pearson correlation method (Berchtold, 2016). The set criterion was that a coefficient of 0.7 or above would indicate that the instrument is reliable. The analysis was done using the Statistical Program for Social Sciences (SPSS). The theory BAT test had a correlation coefficient of 0.865 while the practical was 0.823. Since the coefficients were above the 0.7 criterion, the tests were considered to be reliable. Only the assessment test was subjected to the reliability analysis.

2.7 Data Analysis

Data that was collected through the assessment test was sorted, coded, and entered into the Statistical Packages for Social Science (SPSS) software version 25.0 where it was analysed using descriptive and inferential statistics. Inferential statistics were used to examine the influence of coaching on students' achievement in theory and practical BATs. The independent sample t-test was used to conduct the inferential statistics. The mean score gain for the treatment group were then compared with that of control group using the independent sample t-test. The independent sample-test also compared the net score of female and male students that were taught through coaching. The hypotheses of the study were tested at the 0.05 level of significance.

A total of 191 students completed the study, who were classified into either the experimental (2 schools, n=93) or the control group (2 schools, n=98) with the students being in their intact classes. Students in both the control and experiment groups took a biology theory test (BAT) on the topic of transport in animal at the onset of the study.

The test was marked out of a highest possible score of 20, which were converted into percentage to make comparison easily understood.

Table 2 presents students' scores in the pre-test.

Table 2: Theory Pretest Mean Scores

Group	N	Mean	SD	SE	t	p
Experimental	93	21.29	14.083	1.460	2.653	.588
Control	98	15.97	13.635	1.377		

Table 2 shows that students in the experimental group had a mean score of 21.29 percent in the theory pre-test while the control group had mean score of 15.97 percent. The independent sample t-test shows that the difference in the mean scores of the two groups is not statistically significant ($t=2.653$, $p= .588$). This implies that students in the experimental and control group had the same baseline knowledge on the topic of Transport in Animals before the six-week lesson. Establishing the baseline knowledge that students in each group had was essential in determine gain in knowledge after the six-week lesson. Students in the experimental group were taught the topic of Transport in Animals using the coaching method while those in the control group were taught using the conventional method. After the six weeks students were given the same test and their scores registered. Table 3 presents a summary of the students' performance in the theory post-test.

Table 3: Theory Post Test Mean Scores

Group	N	Mean	SD	SE	t	p
Experimental	93	64.95	14.083	16.126	20.742	.000
Control	98	18.27	13.635	14.976		

Table 3 shows that students in the experimental group had a mean score of 64.95 percent while those in the control group had a mean score of 18.27 percent. The independent sample t-test indicate that the difference in the mean scores of the two groups is statistically significant at the 0.05 level of significance ($t=20.742$, $p<.001$). This

implies that on average students in the experimental group had greater knowledge on the topic of Transport in Animals at the end of the six-week lessons than those in the control group. The researcher then obtained the difference between the pre-test and post-test score of the students to obtain the mean score gain by the student after the lessons. This difference represents the theory knowledge that the students have gained during the six weeks lesson. The independent t-test was conducted to determine whether the difference in mean score gain by students in the two groups is statistically significant. Table 4 presents the results of the independent sample t-test.

Table 4: Comparison of Theory Mean Score Gain by Experimental and Control Groups

Group	N	Mean	SD	SE	t	p
Experimental	93	43.66	21.241	2.203	17.545	.000
Control	98	2.30	8.316	.840		

Table 4 shows that students in experimental group had average mean score gain of 43.66 while those in the control group had an average mean score gain of 2.30. This statistics indicate that students in the experimental group had greater gain in knowledge after the six weeks lessons. The independent sample t-test shows that there is a statistically significant difference between the mean score gain of the experimental group (mean gain=43.66) and that of the control group (mean gain=0.46) at the 0.05 level of significance ($t=17.545$, $p<.001$). This result leads to the rejection of the first hypothesis of the study, which stated that there is no statistically significant relationship between coaching as a method of teaching biology and students' achievement in theory biology assessment test in secondary schools in Molo Sub County. Results show that experimental group had a significantly higher mean score gain than the control group. This finding leads to the conclusion that coaching as a teaching method has a positive and significant effect on students' achievement in theory BATs. This means that using of the coaching method to teach biology improves acquisition of biology theory knowledge.

The findings are congruent with Madden et al. (2011), who found that students taught using the coaching method were more engaged in classroom than those who were taught using conventional methods. They also found that coaching had a positive impact on other areas that may be indirectly connected to academic achievement such

as creativity, teamwork, perseverance, love for learning, and curiosity. Current findings are also consistent with Green et al. (2007), who also found that coaching was associated with cognitive hardiness and hope in a sample of female high school students in the USA. Students in the coaching group had significantly higher levels of cognitive hardiness and hope, as well as, lower levels of depression than their peers in the control group.

On the other hand, the findings contradict the Kenny and Faunce (2004) who found that elementary and secondary school students who had received out-of-school coaching performed equally as those who had not received the coaching in English, mathematics, and science tests. It is probable that there are factors that determine the effectiveness of the coaching method in enhancing the academic achievement of students and that one of these factors is the student's motivation. If coaching lead to greater motivation to learn, then the student is likely to record a positive change in academic achievement. This position is supported by questionnaire data presented in Table 5.

Table 5: Experiences of Students taught using the Coaching Method

SN	Statement	N	Mean	S.D
3A	Coaching method made it easier for me to understand concepts clearly and in details.	93	4.13	.837
3B	I found the class to be more interesting due to the use of the coaching method	93	4.34	1.027
3C	I was able to sustain interest in the subject for a longer period of time due to the use of coaching method.	93	4.13	.992
3D	The coaching method helped me to understand difficult concepts.	93	3.94	1.275
3E	The coaching method helped me to integrate the outside world into classroom learning.	93	3.76	1.237
3F	The coaching method helped me to relate theoretical and practical concepts	93	4.09	1.090

3G	I was able to maintain high levels of attention during the lesson due to the coaching method	93	4.05	1.126
3H	I find it easy to remember concepts taught using the coaching methods	93	4.08	1.106

Table 6 shows that item 3B had a mean of 4.34, which indicates that on average, the students in the experimental group agreed with the statement that they found the class to be more interesting due to the use of the coaching method. Item 3C also had a mean of 4.13, which illustrates that students were in agreement that they were able to sustain interest in the subject for a longer period of time due to the use of coaching method. Students rating on these two items are an indication that one of the ways in which coaching enhances students' academic achievement in theory BAT is by making lessons more interesting and enjoyable to the learners. This increases the love for learning as well as the motivation to learn.

Also Table 4.6 shows that respondents on average agreed that coaching method made it easier for them to understand concepts clearly and in details (mean= 4.13, SD= .837). In addition, respondents were in agreement that the coaching method helped them to understand difficult concept (mean=3.94, SD= 1.275). According to Bloom's Taxonomy, understanding is one of the three lower levels learning that a student begins with before moving to high order thinking. Bloom's taxonomy defines understanding as the process of constructing meaning from oral, written, or graphic messages through interpretation, comparison, inferring, and explaining. It is the second layer of learning with the first one being remembering; which is the recollection is of information from long-term memory. This issue of memory is also captured in item 3H, where students on average agreed that the found it easy to remember concepts taught using the coaching method. These findings suggest that coaching help to promote low order learning in biology.

3.0 Conclusions and Recommendations.

From the findings, the study concludes that coaching has a positive and statistically significant influence on students' achievement in biology theory test. The study established that students who are taught using the coaching method record higher

mean score gain in biology theory tests than those taught using conventional method. This implies that the coaching method facilitates the construction of biology theory knowledge among students. Consequently, coaching should be considered as an appropriate method for teaching biology theory in secondary schools. To promote development of low order theoretical skills in biology, schools should encourage the use of the coaching approach in teaching of biology.

Universities and other institutions that train secondary school biology teachers should integrate coaching as a method of instruction into their teacher training curriculum. These institutions should equip biology trainee teachers with the knowledge and skills that they need to implement the coaching method of teaching. The teacher service commission (TSC) should incorporate coaching into biology teachers' professional development modules. TSC usually offers the teacher professional development (TPD) modules to teachers who are already at work with view of updating and improving their knowledge and skills. TSC should develop a module that seek to training existing biology teacher on how to implement coaching as method of teaching biology to secondary school students.

Principals and head of departments in charge of the biology subject within the secondary schools can also organize internal training to equip biology teachers with the skills and knowledge needed to implement coaching in the teaching of biology. Equipping biology teachers with coaching skills should also be integrated into the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme and the School Based Teacher Support System (SBTSS).

This study was confined to public secondary schools in Molo Sub- County. To support the generalization of findings, future researcher should consider replicating this study in other sub counties. Future studies should also replicate the study in private secondary schools in facilitate comparison and generalization of findings to all secondary schools.

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Article 11

Utilization of Virtual Physics Labs in Tertiary Education in the COVID-19 Era: Opportunities and Challenges

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Abstract

As the world grapples with the novel coronavirus the COVID-19 pandemic. Virtual laboratories (V-labs) have been touted as an alternative to the real laboratory. The study investigated the opportunities and challenges of utilization of virtual Physics laboratory by trainees in the Craft Certificate in Science Laboratory Technology (CCSLT) in tertiary Physics in Kenya. The model of the study was founded on David Kolb' experiential learning. The study targeted all CCSLT trainees in Kenya and their trainers. The sample consisted of fifty-three (N=53) Second Year Physics trainees and four trainers from The Kisii National Polytechnic, Kenya. A survey research design was applied in the study. A questionnaire for trainees and an interview schedule for trainers were used to collect data. The instruments were validated by experts before use. A Spearman's Correlation Coefficient of reliability was calculated as $r = 0.79$ for the trainees' questionnaire and $r = 0.75$ for the trainers' interview schedule respectively. The collected data was analyzed using the Statistical Package for Social Sciences, SPSS-23.0 and results presented in tables and discussed thematically. It was established that virtual labs make trainees to enjoying learning physics, understand content better and as a result boost academic achievement. Virtual labs do not favour a trainee of any gender. Virtual labs allow the user to get experiences that are not attainable in the actual world; Allow for experiments to be done without any fear of depletion and also v-labs are a 'non-tiring teacher' and good for revision. V-lab help trainees retain content better but had no effect on retention of content based on gender. The challenges v-labs pose include;

financial constraints, low internet bandwidth, lack of technical skills on e-learning by both the trainers and trainees and lack of interest and commitment among the trainers to use v-labs. The study recommended that trainees be given an opportunity to engage in hands-on Physics as it enhances learning by the trainees and innovative ways to be applied to mitigate challenges due to v-labs. The results of this study will be beneficial to future researchers and educators who are interested in using v-labs in physics and related subjects at tertiary level of education.

Key words: Achievement, retention, hands-on, COVID-19, V- lab

Introduction

COVID-19 is a novel coronavirus which is an infectious agent that causes severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which led to lockdowns and closures of all aspects of life including education in the countries the world over. Because this disease has rapidly spread to more than 8 million people worldwide in almost all the parts of the whole world and already killed several hundreds of thousands (over 600,000 by June 2020) of the human race within a short period of time and the numbers still counting, the World Health Organization (WHO) declared it a pandemic and gave guidelines to be followed that include but not limited to a 1.5 metres distance from a person to another when in public. Anderson, Heesterbeek, Klinkenberg and Hollingsworth (2020) see these as aimed at preventing the pathogen from its rapid spread. However, still over 2 billion children worldwide have been kept out of schools and colleges with a number of uncertainties in their education. In Kenya alone over 15 million students were thrown out of the classes. Many governments resorted to online instruction from the time schools and colleges closed in March 2020 so as not to disrupt the school calendars. But how to access the laboratory work in the Sciences, Technology and Mathematics (STEM) education has posed enormous challenges. The virtual laboratory has been suggested as the best alternative for carrying out near-real life hands-on activities in the STEM subjects during the pandemic. However, there is little amount of research available on their efficacy especially in the TVET tertiary level of education not only in Kenya but worldwide.

1.2 Statement of the Problem

COVID-19 has made the World Health Organization (WHO) to not only issue guidelines on how to reduce its spread but has caused lockdowns of various facets of our live,

education included. As a consequence, schools and colleges have been closed and online teaching and learning has been suggested. However, how learners are to meet their hands-on needs in STEM subjects has remained a challenge. To this effect virtual laboratories have been touted as possible means to avert this challenge. Being new to most educators and learners, there is not much literature on the utilization of v-labs especially in tertiary TVET programmes. Much literature that is available is in either the secondary segment of education or the university. There is also a massive debate on their effectiveness in skills training with some researchers feeling that the v-labs contribute positively while others see the otherwise. Before any technology can be utilized, it is imperative to establish that it will obtain that which it claims to. This is as far as issues of how achievement in academics is influenced by use of v-labs for learning Physics and their potentiality to be a replacement or in complementing the activities in the conventional or the physical laboratory in tertiary TVET education in Kenya. Therefore, this study was performed to study the opportunities and challenges associated with the use of v-labs in training CCSLT trainees.

1.3 Objectives of the Study

The following five objectives guided the study:

1. To establish the opportunities that exist in the utilization of virtual Physics laboratory in teaching and learning Physics during the COVID-19.
2. To investigate if there was any perceived difference in learning Physics between male and female trainees exposed to virtual Physics laboratory.
3. To find out if there was any perceived difference in retention of content of Physics between virtual Physics laboratory and real Physics laboratory.
4. To find out if there was any perceived difference in retention of content of Physics between male and female trainees exposed to virtual Physics laboratory.
5. To establish the challenges faced in the utilization of virtual Physics laboratory in teaching and learning Physics.

1.4 Research Questions

To achieve the research objectives five research questions were formulated:

1. What opportunities exist in the utilization of virtual Physics laboratory in teaching and learning Physics during the COVID-19?

2. Was there any difference in perceived learning of Physics between male and female trainees exposed to virtual Physics laboratory?
3. Was there any difference in perceived retention of content of Physics between virtual Physics laboratory and real Physics laboratory?
4. Was there any difference in perceived retention of content of Physics between male and female trainees exposed to virtual Physics laboratory?
5. What challenges faced trainees in the utilization of virtual Physics laboratory in teaching and learning Physics?

2 Literature Review

2.1 Virtual laboratories and Academic Achievement

To keep children learning during the COVID-19 pandemic shutdowns, e-learning has been suggested and is being implemented world over. E-learning has been defined as asynchronous and synchronous communication that is mediated electronically with the sole aim of making learners construct their knowledge (Garrison, 2011). A virtual laboratory comprises of computer simulations that copy the real environment and present it in the virtual environment.

There are strong points on why virtual laboratories should be utilized as compared to the physical labs. Firstly; experiments can be executed within a shorter time than the same experiment can be done in real labs, execution of experiments that pose dangers can be carried out in a safe environment, physical experiments can be reproduced in a virtual reality platform so that what is not easily attainable in real life can be simulated in virtual reality, v-labs are an amicable alternative to the expensive real labs, through which the learner is enabled to proceed at own pace as they cover content, so affording learners immediate feedback for cross-checking their own progress in knowledge and skills acquisition (Rutten, Joolingen, Jan & Van, 2012; Saldikov et al, 2017).

Second, Tatli and Ayas (2013) and Zacharia and Olympiou (2013) have found v-labs to improve the learners' performance significantly as compared to learning using the physical laboratory learning. Third, in matters costs the v-labs are a cheaper alternative to the real labs that students can use to experience their physical world, some harmful activities can also be simulated and presented in a safer way in virtual reality, whence bridging the gaps that exist with the real labs (Achuthan & Murali, 2015). Again sharing of equipment or experiments can be shared instead of each of the institutions of

learning establishing its own lab. Finally, v-labs supplement the activities in real world, as the real world components can interact with real ones. It has also been documented that utilization of computer simulations make the students become more motivated to learn subject (Gambari, Gbodi, Olakanmi & Abalaka, 2016). Research does not wholly agree on the influence of v-labs to learning. For instance, there are researches that did not find any significant difference between the real labs and the virtual labs in terms of academic achievement (Bayrak, Kanlı & Kandilingeç, 2007; de Jong, Linn & Zacharia, 2013). The researchers in this study have a feeling that though the v-labs may help mitigate the issues that exist with the establishment and utilization of physical laboratory and the equipment therein, they cannot replace these pertinent items in the study of STEM. Therefore, there is need to find out how best the v-labs can be applied in the learning of practical skills especially when physical distance does not allow or again when there is time difference between two zones of the learners and their teachers. The COVID-19 lockdown presented the whole world with such a scenario abruptly. Hence the need for this study that sought to establish the opportunities and challenges in utilization of v-labs by CCSLT trainees' in Physics.

2.2 Virtual laboratories and Trainees' Academic achievement by gender

Issues to do with gender affect every part of our lives. Having realized this the United Nations' Sustainable Goals (SDGs) have a component of gender incorporated in SDG-5 that deals with gender equality, and empowerment of girls and women (UNESCO, 2017). Kenya has also factored it in its constitution (Republic of Kenya, Constitution, 2010). Gender inequality is seen as a system where men always try to dominate women in every aspect of life (Gin, 2011). In matters education, when formal schooling started many nations had single sex schools with those ones of males offering science and engineering based subjects while those for girls dealing with subjects meant to develop one to a care taker, a cook or a nurse (Trueman, 2015). In the present world governments have tried to offer the same or nearly similar opportunities to learners of both genders, but still girls opt for subject areas that deal with the social being of the human race as boys go for those that involve STEM, because of 'gendered' education (Hill, Corbett & Rose, 2010). Gender inequality results from the unfair treatment that rises from political, social, cultural and at times processes in the economy and organization which degrade the terrain of quality education offered (Aikman & Unterhalter, 2012).

Baye and Monseur (2016) using the Trends in International Mathematics and Science Study (TIMSS) based on a 20-year trends at the fourth grade and the eighth grade; and TIMSS Advanced by 2015 for learners who were registered in special advanced physics and mathematics subjects and in their final year of secondary school for countries that were evaluated in the first assessment in 1995 found that male learners were overrepresented and their performance was better than that of their female counterparts in mathematics and science. Sjaastad (2012) opines that two kinds of people influence the choice of STEM courses by learners, those that the learners perceive as role models or as definers. The role models include but not limited to professionals in STEM, lecturers of STEM, parents and anyone displaying a STEM professional entity while all those who guide them to set goals, define ethos identifying more strongly the aspects of educational choices such as such as parents and others are considered to be definers. In Africa, inequality against females in STEM has been documented (Nwona & Aogun, 2015). Ssempala (2005), established that in laboratory assignment there were gender imbalances. In Kenya, Akeyo and Achieng (2012) documented the existence of serious gender disparities gender in enrollment, retention, achievement and transition in STEM fields.

On the other hand, however, Espinosa (2011) found that for those female trainees who have persisted and have been consistent in the STEM fields comfortably perform as well as their male counterparts. Orabi (2007) maintains that when the scientific method is applied in instruction, young ladies outperform their male classmates. Orabi (2007) does not find gender to be impacting achievement in academics for learners. In the recent past, male trainees have been outperforming their female counterparts in the Kenya National Examination Council results in Physics Techniques (Kenya National Examinations Council CCSLT Report, 2010, 2012, 2018).

To lure more women to STEM several efforts at either the global, regional or national level have been made. STEM and Gender Advancement (SAGA) is one such a worldwide initiative with an ultimate goal to closing the gender gap in STEM fields (Meinck & Brese, 2019; UNESCO, 2017). The girls' only workshops for the United Kingdom brings together girls only to act as scientists under the facilitation by female tutors to boost the interest in STEM subjects for girls and finally get to related careers. In Ghana; Science, Technology and Mathematics Education (STME) Clinics brings together female scientists who act as role models for girls brought from secondary school across the country.

After Kenya conceiving the one-week STEM campus, it is being implemented in which STEM activity fair girls are taken through exciting experiments and also provided with opportunity of visiting STEM based companies (Meinck & Brese, 2019; UNESCO, 2017). These programmes are not going to be spared by the COVID-19 as WHO health protocols ban all socializations. If the virtual labs and other e-learning platforms are well organized and utilized these issues will be mitigated.

Some engineering courses have been set up in women only universities. Such is the case of the Kiriiri Women University for Science and Technology in Kenya. At the TVET tertiary level of education, the Women in Technology and Engineering Education (WITED), programme is in place which is part of the activities of the Commonwealth Association of Polytechnics in Africa (CAPA, 2013). This targets to boost women's enrollment in the varied programmes in the TVET institutions, promote equity in education, empower women with formal and informal skills which will finally boost the economy.

Male and female trainees learn differently when differently methods of instruction are applied Orabi (2007) did not discover any significant difference across gender in academic achievement when v-labs were applied in training students trained with v-labs. On the contrary, however, Gunawan et al. (2017) found female students who utilize virtual laboratory to outperform their male counterparts. The study by Keter et al. (2016) affirms this in their research that established that computer assisted experiments motivate girls as well change their attitudes of learning chemistry.

Research seems to be inconclusive on the opportunities and challenges that come with the utilization of v-labs and academic achievement by gender. This area of research is of great importance to education in science especially at this time when COVID-19 has and continues to wreak havoc throughout the whole world, not just for utility it may have during this time but because of the existing controversies over whether there are differences in achievement based on gender when v-labs are utilized (Scantlebury, 2012). Minimal literature exists on influence virtual laboratory on academic achievement and on this achievement by gender at the TVET tertiary level of education not only in Kenya but worldwide. The researches that exist were in either university or secondary school settings. It is against this backdrop that the researchers got moved and investigated how achievement in academics is influenced by virtual Physics laboratories and how these labs impact on

achievement by male trainees and their female counterparts in the TVET Physics courses. As far as the Kenyan education system particularly at tertiary level, virtual lab is an innovative way of carrying out experiments, therefore, this study examined the influence of v-lab on the academic achievement by trainees in tertiary in Physics Techniques subject in Kenya. The researchers feel that virtual laboratory can make learners to learn better than with the physical labs as they allow both female and male trainees equal opportunities to perform experiments and again reduce the dominance of male trainees in the experiments. Hence the need for this research that dealt with the influence of v-labs on the CCSLT trainees' academic achievement in Physics Techniques.

2.3 Challenges faced in implementation of virtual laboratories in TVET

Balci and Soran (2009) opine that there are limitations of 'ICTs' and 'e-learning' in the teaching and learning process. There have been identified 43 barriers of utilization of ICTs and e-learning in developing countries (Touray, Salminen & Mursu, 2013) and these have been classified into eight critical success factors; socio-cultural, infrastructural, political and leadership, legal and regulatory, economical, educational and skills, security and safety and technical. Al-Ghaith, Sanzogni and Sandhu (2010), posit that the Internet quality in Saudi Arabia was an influencing factor to consider for the adoption and usage of e-learning. In Pakistan, Nawaz and Kundi (2011) established that there are several factors have an impact on the adoption of use of ICTs. They include but not limited to: the ability of the teachers to integrate technology into meaningful learning activities, development approaches and attitudes, project management techniques, user participation, user training, change management. Oye, Salleh and Iahad (2011) add that other aspects such as frequent blackouts, lack of connection to electric power, knowledge and training of staff on the use of ICTs, motivation, bandwidth and connection to the Internet impact on e-learning development at the university level in Nigeria. Most of these challenges are common to all developing countries and affect so much the implementation of e-learning. The Government of Kenya has gradually improved the integration of ICT using the ICT Policy. In 1999, the Kenya Education Network Trust (KENET) was established by the government, with the aim of providing internet that promotes the utilization of ICT in Teaching, Learning and Research in Higher Education Institutions in Kenya. The KENET interconnects all the universities,

tertiary and research Institutions in Kenya by setting up a cost effective and sustainable private network with high-speed access to the global Internet. An E-Readiness survey for universities was carried out in 2013 to which effect there was born a report. Kashorda and Waema (2014) in the E-Readiness Survey of Kenyan Universities (2013) Report, established that for available networked PCs there were 3.8 PCs per 100 students in Kenyan universities, which was considered quite low. It was established that in the 30 universities, there were 423,664 students against 16,174 student lab computers and only 17% of students accessed computers from their campuses. Over 200,000 laptop computers were owned by students in the 30 universities which translates to 53%. Equally, apart from the low PC ratio, the students considered the campus networks slow and unstable (Kashorda and Waema, 2014).

3 Research Methodology

3.1 Research Design

A mixed methods descriptive research design was applied in this study. The major purpose of descriptive research is description of the state of affairs as it exists. Descriptive research design was appropriate for this study because the study involved collection of qualitative data from a varied number of respondents by interviewing or administering a questionnaire to a sample of individuals.

3.2 Population, Sample and Sampling Techniques

All the Year II Physics Techniques trainees in the course, Craft Certificate in Science Laboratory Technology (CCSLT) course and their trainers in all tertiary TVET institutions in Kenya were targeted for this study. One TVET institution was sampled using purposive sampling – they had just been introduced to virtual labs before the sudden closure due to COVID-19. The sample was 53 CCSLT Year II Physics Techniques trainees of The Kisii National Polytechnic in Kenya (16 male and 37 female trainees) and four (4) trainers were also sampled.

3.3 Research Instruments:

3.3.1 Questionnaires

Questionnaires are commonly used as practical tool for collecting survey information, providing structured, often numerical data. A four-point Likert-type scale of items was used to collect data on participants' satisfaction, or attitudes about a specific issue; for example, trainees' satisfaction with using v-labs in the learning process. A questionnaire

for trainees – trainee's feedback – virtual lab was used to solicit information on the teaching and learning experiences during the Physics lessons. It was structured to capture information required in helping to get information about the utilization and challenges encountered in learning Physics at tertiary level. Trainees' views were sought on several areas that affect the use of virtual Physics laboratory to study Physics. The questionnaire consisted of closed-ended and open-ended questions and sought information about the respondents: gender, age and attitude towards Physics subject and its activities, academic and general ability in Physics; information about the teaching and learning practices in Physics practicals such as: ease of v-labs and their influence on; academic achievement, academic achievement by gender and retention of content> The challenges utilization of v-lab poses to trainees was also sought.

3.3.2 Interview schedule

This is an oral administration of a questionnaire, which involves a face to face interaction. The interview schedules were administered to trainers of Physics. The interview schedule was intended to collect information on v-labs' suitability in use to teach both academic and in training of technical skills. This helped to bring out how v-labs influence the acquisition of knowledge, skills and attitudes in Physics at the tertiary level. It also sought information about trainers' and trainees' ICT Skills, trainers' preparedness for instruction using v-labs and the special skills the Physics trainers possess. The trainers in Physics are best placed to give correct information as concerns the required information as they not only directly teach but also have some understanding of the subject and the processes involved in the acquisition of the concepts in Physics. The interview schedule for the trainers in v-lab Physics were based on objectives of the study and research questions; they sought the background information on gender, professional qualification, major teaching subjects, teaching experience, academic achievement, gender of trainee, retention of content and challenges that trainees encounter in utilizing v-labs.

3.4. Method of Data Collection

The researchers sought to be permitted to carry out the study and cooperation from The Kisii National Polytechnic to conduct the study there. Respondents were requested to complete a questionnaire comprising both open-ended and closed questions that were arranged thematically. The questions were formulated according to a model

established during the literature study. The interviews were administered to the trainers in physics by the researcher in person.

3.5 Data Analysis

The Statistical Package for the Social Sciences (SPSS) - version 23.0 was used to analyse the collected data. Mean scores and standard deviations applied to get the general perception of the users of the v-labs on the various aspects that the research had set out to study concerning the utilization of virtual Physics laboratories. The trainees' perceptions on the utilization of v-labs were analyzed by gender to get a feeling of how the affect male and female trainees.

4 Results and Discussions

4.1 Virtual laboratories and Trainee's Academic Achievement

The virtual labs make the trainee to visualize, contemplate and explain abstract concepts and phenomena. Objective number one of the study was to investigate the opportunities v-labs can afford the trainees in learning physics at tertiary level during the COVID-19 pandemic. In an attempt to achieve this objective, the study sought information on the opportunities the trainees perceive as coming from the utilization of the virtual Physics laboratory.

4.1.1 Results from trainees' perceptions on Achievement of Trainees

The study sought the trainees' perceptions about the influence of the virtual laboratory on academic achievement. The rating involved the following trainees' Academic Achievement. The responses were rated on a four point Likert scale where 1 = Agree; 2 = Tend to Agree; 3 = Tend to Disagree and 4 Disagree. Table 4.1 gives the summary of the findings. A mean score of 1.0 to 1.49 means strongly agree, that of 1.5 to 2.49 means tends to agree, that between 2.50 and 3.49 means tend to disagree and therefore will be treated as not agreeing while lastly 3.50 to 4.0 will be treated strongly disagreeing.

Table 4.1. Trainees' Perspectives on Virtual Lab and Academic Achievement

Statement	Minimum	Maximum	Std.	
			Mean	Dev.
My understanding the content of the experiment properly by performing it in virtual lab	1	4	1.19	.491
Virtual lab can improve decreases my anxiety with experimentation while helping me learn new concepts	1	4	1.04	.196
Experiments in v-lab make physics concepts easy to				

understand	1	4	1.35	.797
Experiments in virtual lab is fun, but trainer is around to direct me. This may not lead me to understand better	1	4	1.31	.788
Virtual labs assist me make sense of unfamiliar phenomena	1	4	1.12	.326

Source: Fieldwork, (2020)

The trainees felt that through performing experiments via virtual labs they are enabled to improve in their understanding of the content of the experiment properly. The mean, M of 1.19 and standard deviation, SD of 0.491, show that the trainees agree strongly to the statement that virtual labs make them understand the content well. Virtual lab decreases the trainees' anxiety with experimentation while helping them to learn new concepts. The trainees agree ($M = 1.04$, $SD = 0.196$) that v-labs lower their anxiety as they perform experiments and learning new concepts. To whether experiments in virtual lab make physics concepts easy to understand, the trainees agreed ($M = 1.35$, $SD = 0.797$). This means that the trainees perceive that by doing experiments in v-lab the understanding will be better than when done in the conventional lab. Trainees find v-labs being fun ($M = 1.31$, $SD = 0.788$), but trainer is needed to direct the trainees implies that the trainer needs to be there for the trainees to benefit optimally from these labs. Otherwise they may digress and get to non-beneficial activities as far as academic achievement is concerned. Finally, they agree that virtual labs make their understanding to become better because the labs assist them make sense of unfamiliar phenomena ($M = 1.12$, $SD = 0.326$) means that the respondents agree strongly to the statement that v-labs make it easy for learners to visualize what is not easy to visualize. This could be linked to the fact that v-labs helps the learner to access places or situations that are not normally attainable. For example, microscopic scale phenomena of current flow can also be accessed by the learner through the simulations. This increases imagination and improves memory of the learner as far as some given content is concerned.

4.1.2 Results from Trainers' perceptions on Achievement of Trainees

V-lab is an alternative answer for expensive labs, empowering students to advance at their own pace, giving students quick feedback with the goal that they can check their learning (Rutten et al., 2012). On how v-labs assist trainees to understand content better,

the trainers said; V-labs give learners an opportunity to perform experiments that are not possible to carry out because of the dangers involved hence understand the content better. This makes them to conceptualize content better and therefore making them to score higher grades. This is perfect agreement with the findings that virtual labs kept students' enthusiasm by upgrading their basic reasoning and enhancing the process of learning (Saldikov et al, 2017). Computer simulations makes the learners become motivated towards the subject and also change their attitude towards the subject (Gambari, Gbodi, Olakanmi & Abalaka, 2016). Again v-lab can allow the trainees to perform experiments that are dangerous or the equipment is quite costly. This is so because with v-lab no fragile or costly items are involved. The environment is safe, hence the trainees can repeat the experiment a number of times, thus failing in a safe to fail environment. That some experiments in the physical lab which may pose dangers or which can easily cause accidents can now be done in the v-lab, experiments such as those involving high voltage, radioactivity and the like can be carried in a safe to fail environment. This is in conformity to the earlier establishments that virtual environment is a safe way of doing experiments that may pose health and environmental challenges, hence the gaps that exist in the traditional labs can be bridged (Achuthan & Murali, 2015). By slowing down the speed or hastening it, a learner is allowed to work at his or her own pace, thus it could bring more comfort in learning than the usually timed synchronous classes. This is in line with Rutten et al. (2012), that v-labs can assist in executing time-consuming experiments in a shorter time-frame, completing dangerous experiments in a safe environment, reproducing events that would be difficult to be observed in physical laboratory virtually.

The trainers observed that virtual lab decreases trainees' anxiety, learn new concepts thus scoring more in tests. By performing the experiments in v-lab and seeing how physical phenomena and processes occur the learner not only gets firsthand information but feels like he has constructed information by himself or herself. It was perceived by the trainers in the v-lab group that by performing the experiment in virtual lab decrease your trainees' conceptual load. That virtual labs offer the trainees with an opportunity to figure the experimental procedures or structures of items in more detail. For example, the inside of an atom, the flow of electrons or the internal structure of a nuclear reactor can be simulated and the trainees can access what is not possible with the conventional laboratories. Virtual labs have also been found to foster attention in

the learners, which will in turn make the learners to get interested in the content. As for the ease with which trainees understand the experimental procedure in virtual lab, the trainees find it easy to perform experiments in the virtual lab as compared to performing the same experiments in the conventional laboratory. This is in agreement with the findings of Gambari, Gbodi, Olakanmi and Abalaka (2016) and Tatli and Ayas (2013). Trainers said that virtual labs help your trainees to understand physics concepts more easily therefore making them to have a better score the theory examinations. On how the v-labs assist trainees to understand Physics concepts the trainers had this to say: v-labs offer the trainees the chance to perform experiments in an environment that is like that of the conventional laboratories. They can manipulate materials and equipment which will develop their psychomotor skills just like in the real laboratory. This makes them follow the scientific method and the allied skills that the method comes with; thus the basic skills in the scientific method – problem identification, hypothesizing, setting experiment, observation and measurement, data analysis, reporting and communication can be fostered. The trainees are again offered the opportunity to repeat the experiment any number of times because the supplies in the v-lab are boundless and not like in the real lab where the supplies are either inadequate or lacking, but also deplete altogether. This is in agreement with the results of Tatli Ayas (2013).

4.2 Virtual laboratories and Trainees' Academic Achievement by Gender

Research has shown that when female students utilize virtual laboratory the outperform their male counterparts. This is in agreement with Keter et al. (2016) who obtained similar results in a study by that found computer assisted experiments motivate girls as well change their attitudes of learning chemistry. The second objective was to investigate if there was any perceived difference in learning Physics between male and female trainees exposed to virtual Physics laboratory. To attain this objective, a questionnaire and interview schedule were administered to the trainees and the trainers respectively.

4.2.1 Results from trainees' perceptions on Achievement by gender

The study sought the trainees' perceptions about the influence of the virtual laboratory on academic achievement by gender. The rating involved the following trainees'

Academic achievement by gender. The ratings are as for Table 4.1. The summary of the findings is given in Table 4.2.

Table 4.2. Trainees' Perspectives of V-Lab and Achievement by Gender

Statement	Minimu m	Maximu m	Mea n	Std. Dev.
By using virtual labs to learn, male trainees will score a higher mark than female trainees	1	4	3.15	.675
Virtual lab can help female trainees achieve higher grades because they engage in play male dominated activities	1	4	1.12	.558
Virtual labs do not treat trainees preferentially by gender so they are likely to score similarly	1	4	1.14	.368
Male may score higher than female trainees as virtual labs are more appealing to male trainees-are like ICT games they play	1	4	1.08	.272

Source: Fieldwork, (2020)

From Table 4.2 the mean of 3.15 and standard deviation of 0.675 to the statement that v-labs favour male trainees in terms of score was rejected by a great percentage of trainees. This implies male and female trainees are likely to be affected the same way by virtual labs in terms of academic achievement. The result is in conformity with that of Keter et al. (2016), assert that when female students utilize virtual laboratory they outperform their male counterparts. To the statement that virtual lab can help female trainees to achieve higher grades because it allows them to engage in play activities that are male dominated, the low mean of 1.12 and standard deviation of 0.558 means that female trainees are likely to gain more by using v-labs than the traditional labs as v-labs afford them the opportunity of practicing what is considered as 'male activities'. This tries to break the 'gendered education' problem where girls and women are treated as a 'weaker gender', not for specific roles and activities. Once this is weakened, girls and women and in this particular case, female trainees are likely to do better utilizing v-labs than the conventional ones. This fits well to the findings by Keter et al. (2016) who found computer assisted experiments motivate girls as well change their

attitudes of learning chemistry. The respondents again agree strongly that virtual labs make trainees of both gender to improve in examination score alike because they do not do not treat trainers preferentially based on gender ($M = 1.14$, $SD = 0.368$). This means that unlike in the conventional laboratory, where the teacher may have preferential treatment, the virtual laboratory does not have such. This fits well to the findings by Keter et al. (2016) who found computer assisted experiments motivate girls as well change their attitudes of learning chemistry. Thus it will allow male and female trainees explore to their best of ability and knowledge. This makes it more friendly to both gender in terms of acquisition of knowledge, practice and conceptualization. However, to whether male scoring better in examinations than female trainees who practiced in the v-labs, most respondents felt that because the virtual labs are more appealing to male trainees, because the v-labs are like ICT games male trainees normally play. Respondents feel that male trainees have an advantage over the female trainees ($M = 1.08$, $SD = 0.272$) in that the male trainees from time to time keep playing computer games that are related to the virtual laboratories that both gender are now exposed to. This could mean that although we assumed that both gender had been introduced to ICT in year one of their training, male trainees may be having superior skills of manipulation as compared with their female counterparts.

4.2.2 Results from Trainers' perceptions on Achievement by gender

On how female trainees compared with male trainees in using the v-lab better their results in academic achievement, the trainers had these to say; the understanding by female trainees and that of the male counterparts were almost at par. This is in agreement with the findings of several studies that have found virtual lab can therefore be treated as an equalizer not only in the connection of the circuit, but also in the acquisition of theoretical knowledge. The result is in conformity with that of Keter et al. (2016), assert that when female students utilize virtual laboratory they outperform their male counterparts. The results contrast the works of Salta and Tzougraki (2004) who found that girls have negative attitudes as far as the cognitive load of these courses are concerned. They have been socialized to believe that men are born scientists and technologists. Various studies have shown that men have not only traditionally outnumbered women in fields STEM but outperformed the women because of 'gendered' education, with all the societal and environmental factors (Hill, Corbett & Rose, 2010; Orabi, 2007).

4.3 Virtual laboratories and Trainee's Retention of content

Kara (2008) posits that utilizing computer assisted instruction led to better in content retention of students in science education. The third objective of the study was to investigate the perception on retention of content by trainees exposed to virtual Physics laboratory. To answer the question of whether trainees who studied using the virtual Physics laboratories retained the content that they have learnt longer than their physical Physics laboratory the data from the study was analyzed and interpreted.

4.3.1 Results from trainees' perception on Retention of content

The study sought the trainees' perceptions about the influence of the virtual laboratory on retention of content. The rating involved the following trainees' retention of content. The ratings are as for Table 4.1. The summary of the findings is given in Table 4.3.

Table 4.3. Trainees' Perspectives on Virtual Lab and Content Retention

Statement	Minimum	Maximum	Std. Mean	Dev.
Virtual laboratory makes me to remember more of what I was taught than if I learnt it otherwise	1	4	1.04	.196
The organization of the content in virtual lab assists me remember what I have learnt	1	4	1.02	.198
My learning skills have been improved by v-labs - I remember more of content taught	1	4	1.23	.514
I can score more because I remember more content obtained through v-labs by forming mental maps	1	4	1.08	.272
My score Physics has improved because I easily recall how I practised through the content using v-labs	1	4	1.27	.452

Source: Fieldwork, (2020)

From Table 4.3 and as far as retention of content that has been learnt is concerned, the mean for this statement was 1.04 with a standard deviation of 0.196. This means the trainees cherish v-labs if they are to remember more of what they were taught. This could be attributed to the fact that in v-labs much of the content acquisition is by constructivism, where the learner constructs information by himself or herself thereby making meaning of the information gathered. The low mean of 1.02 and the low standard deviation of 0.198 mean very strong agreement to the statement that information that is normally presented in the v-labs is well researched and its arrangement evaluated well before it is presented. This makes it to be easily followed. This agrees Lux (2002) who found that there was an 80% increase in the rate of retention when learners have been exposed to virtual laboratory throughout microbiology class. Kara (2008) posits that utilizing computer assisted instruction led to better the academic achievement and retention of students in science education. The students have the capacity of seeing the internal working of the system and have the capacity of changing or modifying conditions, makes the v-labs capable instruments for students to form internal schema.

The trainees feel that they are able to score better because v-labs improve their learning skills and thus they are able to remember more of content taught ($M = 1.23$, $SD = 0.514$). The values in the bracket indicate a very strong agreement to the statement of v-labs improving the (retention) score by improving how the trainees learn. The trainees agreed strongly ($M = 1.08$, $SD = 0.272$) that they understand content better because they are able to remember more content obtained through v-labs by forming mental (concept) maps of what they have already been taught via v-labs. They also strongly agree ($M = 1.27$, $SD = 0.452$) that their scores in Physics are likely to improve because they easily recall how they practised through the content using v-labs. The results obtained here are in agreement with those of Lux (2002) found that there was an 80% increase in the rate of retention when learners have been exposed to virtual laboratory. This could be explained as v-labs allow the learner to experience situations that are not in real life attainable. For instance, seeing an electron flow through wires or seeing the depletion layer in the p-n junction increase when the p-n junction is reverse biased and narrowing when it is forward biased can be easily shown in v-labs.

On whether the v-labs have the potential of replacing the physical laboratories the trainees feel that though they can serve the purpose of meeting the needs for hands-on activities, especially during situations such as this of COVID-19 pandemic and when the learner and the teacher are separated by distance and time. However, they feel there is need for the trainers to be there for them and be more supportive to them.

4.3.2 Results from Trainers' perceptions on Retention of content of Trainee

Trainers affirm that the organization of the contents in virtual lab is aiding your trainees' learning and retention. V-labs have a configuration that is interactive which can attract and maintain the interest. By repeating the experiments, the trainees gain better understanding not only of the procedure of performing the experiments but the content in the labs. By the fact that the v-lab has a non-depletable supply of components and equipment, the trainee can do and redo experiments without a limit that exists with the conventional laboratory. The experiments can be done anywhere, any time and not necessarily requiring the teacher or trainer to be present like in the physical lab where the trainer/teacher must be there, arrange the materials early enough and be there to see that accidents or misuse of materials do not occur. By such a repetition the trainee can be more proficient and again can retain more content that is learnt. That because of the visual and audio effects of the v-labs the trainee is engaged, creates and maintains interest in the content being learnt and subsequently remembers more of the content hence a higher retention of content is expected. To how using v-labs improves trainees' learning skills, the trainees felt: By utilizing v-labs a trainee has a chance of interacting with a near real environment, from which to acquire information. There may be situations a trainee will wish to ask a question concerning what if we try this and that, but has a fear of asking the trainer. The trainee can try that on the v-lab by self and thus can get the satisfaction needed. These results agree with Lux (2002) who found that there was an 80% increase in the rate of retention when learners have been exposed to virtual laboratory throughout microbiology class. The v-labs are again in such a way that they reinforce the learner/trainee appropriately because the system does not get tired saying "well done", "sorry try again", "check again". This is unlike the human teacher/trainer who may have emotions and the emotions may affect the reinforcement and therefore learning. This is in agreement with what Tatli and Ayas (2013) found out in their study that the students can inquire about uninhibitedly inside a to a great extent within a given structure. However, to the

question of whether trainees find in the v-lab experiments and on the trainees working on assignments off the class, the trainers reported that a number of trainees find the v-labs fun but if they are not well supervised they start doing their own searches in the internet. Thus they are derailed from the core business intended of the internet and the v-labs. Therefore, it may work better if the trainees do the lab while the trainer is present and supervising the lab work. This works negatively on the acquisition of content and the retention of content.

4.4 Virtual laboratories and Trainees's Retention of content by Gender

The fourth objective was to investigate if there were any differences in perception on retention of content based on the trainees' gender for trainees exposed to virtual Physics laboratory. Kara (2008) did not find out any sexual orientation distinction in retention of students trained with virtual laboratory methodology and computer-assisted instructional bundle with microbiology and science.

4.5 Trainers' perceptions on Retention of content by gender

To how female trainees compared with male counterparts in retaining content as result of having used v-labs the trainers have a feeling that trainees of both gender have equal chances of retaining content although male may get it easier doing slightly better because the virtual environment is almost similar to the games they normally play. The results matched with those of Kara (2008) who did not find out any sexual orientation distinction in retention of students trained with virtual laboratory methodology and computer-assisted instructional bundle with microbiology and science. However, they further feel that for female trainees who sometimes play games in their mobile phones will do well equally as their male counterparts. By practising in the v-lab the trainees who play games on their mobile phones on other electronic gadgets are likely to do better. In daily life men play these games. This could be the reason there is a slight difference in perceived understanding of physics concepts between male and female trainees after utilizing v-labs.

4.6.1 Trainees' perceptions on Challenges faced in utilization of v-labs

The fifth objective was to establish the challenges users of v-labs encountered while carrying out hands-on in v-labs. The following are the findings.

Financial constraints

The study established that trainees are constrained financially so they do not have smart phones and sometimes they cannot ~~have enough data bundles to sustain the~~ (have enough data bundles to sustain the

performance of the v-lab experiments. The v-labs do not only require one to invest in an expensive (smart) phone but also require a great deal of data bundles to accomplish online experiments.

Low Internet bandwidth

The trainee respondents indicated that strength of the internet is normally low and sometimes it is unavailable all together, being one of the challenges that hinder the utilization of v-labs by trainees. For successful utilization of v-labs faster connectivity to the internet is critical.

Lack of technical skills on e-learning by the trainers and trainees

The trainee respondents feel that their trainers do not possess the requisite technical skills on the utilization of v-labs to offer them the necessary help they require during the hands-on virtual labs. This could be attributed to inadequacy or lack of training in skills required for e-learning among most trainers. Therefore, there is every need for the trainers to undergo in-service training in ICT integration in STEM. Again, in the pre-service training ICT integration in education should be infused. This finding is in line with that of Tarus (2011) who established that in Kenya most academics in universities have low ICT and e-learning skills because most of them were trained in the absence of ICT environment. Again, the trainees do not feel having been well prepared to use e-learning, especially v-labs in conducting practical sessions. There should be time that is dedicated to the ICT skills and more so those that impact directly on the use of the internet and v-labs.

Lack of interest and commitment among the trainers to use v-labs

The study also established that the trainees perceive majority of their trainers as having low interest and commitment to use e-learning, v-labs inclusive in their teaching as another hindrance to the utilization of v-labs. This could be attributed to lack of motivation among the trainers.

4.6.2 Trainers' perceptions on Challenges faced in utilization of v-labs

The trainers, with their experience in teaching and possessing the physics content, their input was quite instructive. Trainers in Physics identified the challenges that face with the real laboratory as: Shortage of apparatus or in some case totally lacking, it is difficulty to handle a large group of students-especially now that the government of

Kenya is highly subsidizing the TVET trainees, time constraints affect the use of labwork in teaching as the National examinations are mainly theoretical, so trainers brush over the content because of the pressure due the examinations and again being that even the time that is allocated by the Kenya Institute of Curriculum Development (KICD) per topic does not tally to the actual time that is available. Unmotivated trainees-some trainees joined the course without the full knowledge of what the course entailed. It happens that most of them had dropped the Physics Subject in Form Two during their secondary school, means they did not have interest in the subject. Apparatus used in real laboratory are prone to errors, which the virtual lab removes. These statements are in agreement with results of a number of earlier studies the found out that utilization of different Information Technology (IT) innovations in science instruction (Rutten et al., 2012), permitting to sort out both asynchronous and synchronous methods of communication. Again the trainers indicated that there are some experiments which they themselves either never had a chance to conduct or it was new content that they did not meet during their school days. Marking the trainees reports and supervision during real lab sessions becomes very taxing, especially with the ever enlarging classes. That sometimes differentiating the components was an issue to some trainees; especially the pin diode and zener diode could not be differentiated by some trainees. Again there are times when serious misconceptions were caused, for instance in the half-wave rectification or the full-wave rectification, the peak is drastically lowered in the display as compared to real-life, one of the trainers observed that the fact was brought up by one of the trainees during one of the practical sessions.

5.1. Recommendations

Based on the findings of this study the utilization of v-labs by TVET trainees has many instructive advantages and many challenges as well are faced by its users. Virtual laboratories were found to enable trainees perform time consuming experiments within shorter period; they offer user a safe to fail environment for dangerous experiments; real events or procedures of experiments can be reproduced virtually; an alternative the expensive real labs or when physical equipment is unavailable; allow trainees to work at their own pace; feedback on their trials are immediate and whenever the trainee and the trainer are separated by time and geographical distance or social distance especially during the lockdowns due to COVID-19 learning can continue. V-labs were perceived by trainees as helping both gender learn physics better, retain more content than it is with the physical labs. (The several challenges discussed stand on the

way of successful utilization of v-labs by TVET trainees in Physics. It is against this backdrop that the study recommends that the challenges v-lab users face should be addressed by the Kenyan public TVET institutions for successful utilization of v-labs. The following are among the strategies that were recommended by the respondents:

- (a) Exposure by the TVET institutions to the teaching staff and trainees to the possible virtual laboratories that they can use for teaching their courses.
- (b) The TVET colleges should avail computers, laptops, networks and other relevant infrastructure that will improve accessibility to e-learning.
- (c) Kenyan TVET institutions should partner with Internet service providers especial KENET to get the staff and trainees affordable Internet maybe through government subsidy.
- (d) TVET institutions should develop and operate an operational e-learning policies which include the use of v-labs in the STEM subjects.
- (e) Pre-service and In-service training to the trainers in the utilization of v-labs should be done comprehensively as they are key to the successful utilization of v-labs.
- (f) Compulsory courses in ICT and e-learning need to be introduced in first year of study to all trainees so that the trainees can be equipped with ICT and e-learning skills.
- (g) Look for innovative ways so that every trainee can own a smartphone or a laptop computer or tablet so that their ICT skills are developed and access to the internet are eased. By partnering with computer and mobile phone manufacturers can be done by TVET institutions so as to negotiate with them for cheaper acquisition of phones and laptop computers by trainees.

5.2. Conclusion

The paper investigated the opportunities and challenges in the utilization of v-labs by trainees of TVET tertiary Physics in Kenya during the COVID-19 crisis. It emerged that the utilization of the v-labs utilization has many advantages however, again there are several challenges that the users are faced with. Virtual laboratories were found to enable trainees perform time consuming experiments within shorter period; they offer user a safe to fail environment for dangerous experiments; real events or procedures of experiments can be reproduced virtually; an alternative the expensive real labs or when physical equipment is unavailable; allow trainees to work at their own pace; feedback on their trials are immediate and whenever the trainee and the trainer are separated by time and geographical distance or social distance especially during the lockdowns due to COVID-19 learning can continue. V-labs were perceived by trainees as helping both gender learn physics better, retain more content than it is with the physical labs. However, the study again established several challenges encountered by the users of v-labs in learning TVET physics in Kenya. These include but not limited to expensive internet, financial constraints, costly ICT and e-learning infrastructure (smartphones), low Internet bandwidth, lack of technical skills on e-learning by teaching staff, lack of interest and commitment among the

teaching staff. Based on these findings it can be concluded that for successful utilization of v-labs the advantages need to be understood and challenges be addressed. This paper suggests that trainers need to find out the v-labs that are usable with their trainees and adopt them for use with their trainees in Kenyan public TVET institutions. Again having identified the challenges that face hindering the utilization and look for innovative ways of dealing with them can lead to successful utilization of the v-labs. This is because the study established that safe for the challenges, utilization of v-labs holds a substantial opportunity for Kenyan TVET trainees of expanding their accessibility to hands-on for the STEM fields at a lower cost and remotely especially during the shutdown due to COVID-19 as a way of mitigating the issues of social distancing, lack or inadequacy of equipment and materials for practical work in the Physics subject, safety in the laboratory for those experiments that require use of toxic substances or high voltage.

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Article 12

Use of e-learning management systems: A student perspective

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Abstract

This study aims to understand how students perceive the usage of learning management systems. A descriptive survey design was used. A sample of 50 students was randomly selected from the Information Systems department. For data triangulation, 10 lecturers were purposively selected for the study. For data collection semi-structured questionnaire, focus group discussions, and online survey were engaged. Descriptive statistics were used to analyse quantitative data while qualitative data was manually analyzed according to emerging themes. Research findings show that implementation of LMS is at times punctuated with challenges such as poor Internet connectivity, exorbitant data, lack of knowledge and skills as well as insufficient student orientation. Furthermore, students showed that they were satisfied with the implementation of LMS and acknowledged through improved pass rate. The study recommended that training and workshops as well as investing more in appropriate mobile devices are an integral component in improving LMS implementation.

Keywords: E-learning, Learning Management Systems, Student perspective

Introduction

With the development of technology, teaching and learning methods have changed regularly. Since the late 1990s, the quickly evolving technologies have altered how teaching and learning are done in educational institutions (Pishva et al., 2010).

Information and communication technologies (ICTs) have transformed conventional classrooms into smart learning environments as a result of their rapid development. The notion of education has undergone major change, and e-learning is both the source and the effect of these changes (Peters, 2003). These changes have also affected how people think about how education should be organized and managed. Although the connection between students and teachers has been facilitated by the integration of technologies into the educational setting, new obstacles have also been created (Pishva et al., 2010).

In order to support instructional endeavors, many Higher Education Institutes (HEI) use the common information system known as Learning Management Systems (LMS). A web-based system called an LMS has a wide variety of educational and course administration tools (Yakubu, 2019). The system can accommodate classes taken on-campus, courses taken online, and naturally a combination of these. The notion of education has undergone major change, and e-learning is both the source and the effect of these changes (Peters, 2003). These changes have also affected how people think about how education should be organized and managed. Today's LMSs have become a crucial part of the educational systems at most universities, and interest in hybrid strategies that combine in-person and online learning is growing (Pishva et al., 2010). A LMS's primary function is to augment traditional lectures with course material that may be accessible online or on campus; it is not meant to replace the traditional classroom environment (Landry et al., 2006). Numerous research has been conducted in the area of LMSs that have centered on LMS as a technology and tool to manage and transfer knowledge in educational institutions (Abu Shawar, 2009).

An LMS serves as a support for both traditional classroom instruction and distance learning by giving teachers and students a set of tools for enhancing the learning process and its administration (Stantchev et al., 2014; Al-Busaidi, 2011). Educational institutions now frequently run their own Learning Management Systems (LMS) and offer a variety of online smart learning capabilities for a wide range of students. LMS can facilitate group conversations, discussions, document sharing, assignment submission, quizzes, grading, and course evaluations through these educational technologies (Bove & Conklin, 2020).

Previous studies have focused on identifying various learning features of LMS that can influence students' learning outcomes. However, it seems that the results of previous studies were controversial with inconsistent learning outcomes of the students. One possible reason can be due to the lack of thorough understanding on students' learning preferences, needs and diverse backgrounds. As the essence of an LMS is to facilitate self-regulated learning (Douglas & Alemanne, 2007), there is a need for analyzing and understanding users' preferences when applying LMS in educational contexts which will serve various learning needs of the students.

It is now widely accepted that ICTs play an important role in teaching and learning norms in HEIs (Nawaz et al., 2011). Despite the significant role of ICTs in higher education and the continued implementation of LMS (such as Tsime, Changamire, myHope, myVista, Sakai, Blackboard) to improve teaching and learning, the uptake of these technologies remains low in most developing countries (Touray, Salminen, & Mursu, 2013). Most higher education institutions have managed to heavily invest in ICT infrastructure to support LMS implementation. However, achievement of the expected benefits has not always materialised due to poor policy frameworks, implementation plans, and ineffective communication of these benefits to intended users, resulting in conflicts between users, managers and implementers (Sakala, 2019). Most HEIs in low-income countries have implemented ICTs in their workplaces to embrace the benefits afforded by technology (Broadband Commission, 2017). To date, most of these institutions have implemented ICT projects such as LMS or other applications to support teaching, research and learning activities (Canchu, Singer, & Ha, 2010). Against this background, the study wants to understand how students perceive the usage of learning management systems.

Purpose of the study

This study aims to understand how students perceive the usage of learning management systems.

Objectives of the study

The study has the following objectives;

1. To identify the factors that influence students' decisions to engage with e-learning management systems.
2. To explore the challenges that students face when using e-learning management systems and how they can be addressed.

3. To assess students' satisfaction with e-learning management systems and their perceived value in relation to traditional face-to-face instruction.

Literature review

In higher education institutions all around the world, information and communication technology (ICT) is being used and accepted as a pedagogical aid in teaching and learning. The Sustainable Development Goals (SDGs) were developed by the United Nations in 2000, emphasising the role that information and communication technology (ICT) plays in the agenda for international development. In this context, the demands of Sustainable Development Goal (SDG) number four, which calls for high-quality education, suggest that in order to achieve sustainable development, it is necessary to ensure that the benefits of new technologies are made available to everyone.

Theoretical Framework

The study adopted the use of the Unified Theory of Acceptance of Use of Technology (UTAUT). The UTAUT model combines eight preceding theories, including the Theory of Planned Behavior (TPB), Theory of Reasoned Action (TRA), and the Technology Acceptance Model (TAM), according to Arora, Malik, and Chawla (2020). It seeks to clarify the elements that affect how well people adopt and employ technology, including e-learning management systems. The model combines eight previous models, including the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), and Theory of Planned Behavior (TPB). The TPB postulates that an individual's attitude toward a behavior, subjective norms, and perceived behavioral control all have an impact on their intention to engage in that action (Ajzen, 1991). The TRA expands the TPB by taking into account the impact of outside circumstances on an individual's attitude toward engaging in a behavior (Fishbein & Ajzen, 1975). The TAM, in contrast, emphasizes perceived usefulness and simplicity of use of technology as factors in determining its acceptability (Davis, 1989).

The UTAUT model proposes that, in the context of e-learning management systems, four critical variables—performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), social influence (subjective norms), and facilitating conditions (perceived behavioral control)—have an impact on students' acceptance and use of such systems. The level to which students think that utilizing e-learning management systems will enhance their academic performance is referred to as performance expectancy. The notion of the systems' perceived usability is referred to as

effort expectation. Social influence describes how peers, teachers, and other outside forces affect how pupils feel about utilizing the systems. The apparent availability of the tools and assistance needed to operate the systems efficiently is referred to as a facilitative state. The UTAUT model will help academics better understand the elements that affect students' acceptance of and use of e-learning management systems. The design and implementation of such systems can be enhanced by educators and administrators to better suit the requirements and preferences of students with the aid of this information.

LMS overview

In the past few years, e-learning management systems (LMS) have gained popularity as more educational institutions adopted them to support teaching and learning activities. The global e-learning market, which was estimated to be worth \$144 billion in 2019 by Research and Markets.com, is anticipated to grow to \$374 billion by 2026, driven in part by the growing use of e-learning management systems (Research and Markets.com, 2021). An LMS behaves as a platform to distribute and oversee pedagogical material (Watson & Watson, 2012). LMS functions include promoting specially designed information for capturing learner progress in meeting expectations (Oakes, 2002; Watson & Watson, 2012). An LMS platform cultivates an environment for engagement and learner achievement, allowing learners to register for classes, track their grades, and check updates and course announcements (Al-Fraihat et al., 2020; Oakes, 2002; Watson & Watson, 2012).

Alecu, Marcuta, Marcuta, & Angelescu (2011) revealed the ability of the LMS to: make learning easier and faster when compared with traditional classroom learning thereby promoting interactive and collaborative learning experiences that encourage one to learn at his/her own pace. The notion that LMS offer easy and faster mode of learning was also supported by Mödritscher, Andergassen and Neumann (2013) who noted that there is a positive correlation between students' commitment in using LMS in learning and their academic performance. The ease and flexibility with which students can access course materials and complete assignments is one of the factors contributing to the popularity of e-learning management systems. According to a study by Bolliger and Martin (2018), students have access to a variety of multimedia resources through e-learning management systems, such as videos, podcasts, and interactive simulations, which can increase their motivation and engagement. Many students find it appealing

that e-learning management systems give them access to resources around-the-clock and the freedom to work at their own pace (Hartnett et al., 2011; Wang & Li, 2011).

An LMS also provides a structure for synchronous delivery methods with the use of video and online conferences (Alzahrani, 2019). Learners can see their instructors through video, online discussions, live chat, in addition to presentations and word files (Alzahrani, 2019). On the other side, asynchronous delivery methods allow learners to interact with course materials and with each other without needing to be in the same physical location at the same time, according to instructor and student perceptions. An LMS provides a structure for asynchronous delivery methods that include emails, discussion groups, audio discussion presentations, and newspapers to cultivate positive interactions (Alzahrani, 2019). Asynchronous delivery methods allow learners to communicate with each other without the distraction of being separated through distance and time (Alzahrani, 2019). Alzahrani (2019) further explains that asynchronous delivery techniques are especially advantageous for students who have conflicting commitments, such as work or family obligations, because they allow them to access course materials and interact with other students whenever it is most convenient for them, however, asynchronous communication can result in delayed feedback and decreased student participation (Means et al., 2010; Gunawardena et al., 2001). Both asynchronous and synchronous methods use an LMS to provide learners with positive effects to facilitate their learning (Alzahrani, 2019). This adaptability aids students in efficiently allocating their time and juggling their competing obligations.

Factors that influence students' decisions to engage with e-learning management systems

One critical factor that influences LMS usage is user-friendliness. Studies have shown that students are more likely to engage on a technology such as LMS when they perceive them as easy to use and navigate (Al-Fraihat et al., 2020; Kim & Lee, 2018). A user-friendly LMS can improve students' engagement and motivation to participate in online learning activities (Chen & Chen, 2020). Hence, it is essential to ensure that LMS platforms are designed with user-friendliness in mind to encourage adoption and usage of the technology by students.

It is evident from previous research that the characteristics of the learner have a significant effect on E-learning acceptance (Al-Busaidi, 2012; Selim, 2007; Sun et al., 2008). According to Al-Busaidi (2012), factors such as learner's computer anxiety,

technology experience, and personal innovativeness to use new technologies have significant effect on the learner's perception regarding the use of LMS. Gender is another personal characteristic that can influence students' use of LMS. Some studies have found that female students are more likely to use LMS than male students (Al-Fraihat et al., 2020; Waseem & Hameed, 2020). To add more, Al-Azawei (2019) found that female students were more concerned with ease of use, whereas male students were more concerned with technology usefulness. However, other studies have found no significant differences in LMS usage between male and female students (Kim & Lee, 2018).

Age can also affect students' preferences for learning environments and their willingness to use technology (Lin & Liang, 2020). Similarly, income can impact students' access to technology and their willingness to use LMS (Al-Fraihat et al., 2020). Culture includes elements such as language, customs, social behavior, and religion, and it influences how individuals relate to the world..." (Hunt and Tickner, 2015, p. 27). Hofstede (1986), highlighted four dimensions of cultural behaviors or characteristics; 'small versus large power distance', 'individualism versus collectivism', 'masculinity versus femininity', and 'tolerance of uncertainty and ambiguity versus uncertainty avoidance'. According to Swierczek and Bechter (2010), learning characteristics in high power distance cultures are more oriented towards one-way, directive, and instructor-based learning.

However, one of the most significant challenges that students may face when using LMS is technical difficulties. Technical problems such as slow internet connectivity, malfunctioning software, and difficulty navigating the LMS platform can hinder students' ability to access and engage with course materials (Wang et al., 2021; Sife *et al.* 2007). To add more, online learning can be isolating, as students may miss out on the social interactions and sense of community that is often fostered in traditional face-to-face classroom settings (Wang et al., 2021). These challenges must be addressed to ensure that students can effectively and efficiently use LMS platforms to enhance their learning experience. Lim (2021) advocated for the following strategies to encounter challenges; proper support for the use of an LMS by the school leadership, understanding of the existing school culture, imbedding the preexisting software in the school into the LMS, proper training of the users, adequate knowledge of the limits of the school's LMS, and

creating support links for users, as ways through which some of the challenges could be overcome.

Several studies have examined students' satisfaction with LMS and found that it is generally high. Studies by Al-Fraihat et al. (2020) and Wang et al. (2021) found that students were highly satisfied with the LMS they used, with over majority reporting that they found the system helpful, easy to use, and navigate. However, some studies have found that students may prefer traditional face-to-face instruction over online learning environments because it provided them with more opportunities for interaction and feedback from instructors and peers (Hew and Cheung, 2014; Wang et al., 2021). To address these concerns, educators can design online courses that incorporate interactive and collaborative learning activities to foster student engagement and interaction (Hew & Cheung, 2014). They can also provide opportunities for feedback and support to students to help them stay motivated and on track with their learning goals.

Methodology

A descriptive survey design was used for the study. Descriptive survey design seeks to explain people's perceptions and behavior on the basis of information obtained at a point in time (Fraenkel & Wallen, 2009). A mixed method approach was used under an interpretivist epistemology to investigate post-LMS adoption perceptions at a selected Zimbabwean institution of higher learning. A sample of 50 participants was randomly selected from a population of 255 students. Students from the Information Systems department participated in the study and for triangulation purposes, 10 lecturers were purposively selected. The study used both primary and secondary data collection methods. Self-administered questionnaires, group discussions, and semi-structured interviews were used to collect data from the participants. The questionnaire was adopted from Azlim et al, (2014) and Buzzetto-More (2012). The questionnaire was divided into four sections, section 1: demographic data, 2: factors that influence students' decisions to engage with LMS, 3: challenges to the use of LMS 4: students' perceptions towards the use of LMS. The items in the questionnaire consisted of a 5-point Likert-type scale 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree. A pilot study was done on 14 students to test the reliability of

the instrument. Statistical Product and Service Solutions (SPSS) and Microsoft Excel were used for quantitative data analysis in this study.

Findings and Discussions

This section illustrates the demographic information of respondents, their responses on the use of e-learning implementation in learning activities are presented below. Table 1 shows the demographic information of respondents.

A. Demographic information of Respondents

Table 1

Demographic information of Respondents

Item	Variables	Frequency	Percentage
Gender	Male	7	14
	Female	43	86
Year of study at University	First Year	20	40
	Second Year	16	32
	Third Year	2	4
	Fourth Year	12	24
Source of data to engage on e-learning	From University	10	20
	Own savings	5	10
	Access Wi-Fi from University	30	60
	<i>Other</i>	5	10
Device used	Smart phone	32	64
	Laptop	10	20
	Desktop	5	10
	<i>Other</i>	3	6

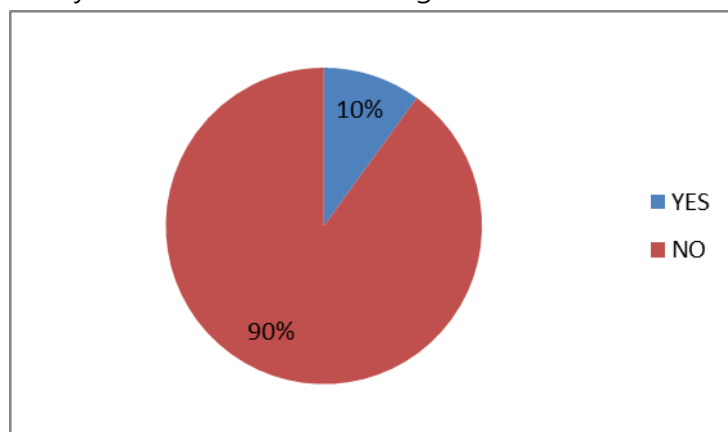
A total of 50 participated in the study and a significant number of them being females (86%) with as few as (14%) being males. A significant number of respondents were selected from females since Women's University in Africa implement 85%-15% female-male enrolment. Slightly below half (40%) of respondents were selected from the First year and (32%) were selected from the Second year. An insignificant number of

respondents (4%) were selected from Third years since most Third-year students are on industrial attachment. Again (24%) of respondents were drawn from the Fourth year. A significant number of respondents (60%) acknowledged that their source of data to engage on the e-learning platform was Wi-Fi from University and only (20%) indicated that they get data from the university. However, an insignificant number of respondents (10%) acknowledged getting data from their own savings. In terms of devices used to access e-learning, the majority of students (64%) used their smartphones in accessing the e-learning platform during learning activities, and only (20%) acknowledged using laptops. The results also show that desktops were rarely used (10%) in accessing e-learning material.

Figure 1

Factors that Influence Students' Decisions to Engage with E-Learning Management Systems

Policy Awareness on LMS Usage



The majority of respondents (90%) acknowledged that they were not aware of any policy that governs the implementation of e-learning at Women's University in Africa and an insignificant number of respondents (10%) indicated awareness of policy governing LMS as shown in Figure 1 above. One of the respondents had this to say:

..... I have heard of the policy document but I am not aware of the contents of the policy.....

The findings of the study clearly showed that a policy awareness campaign on LMS implementation was in great need especially when it is cascaded from the senior management up to students.

Table 2

Factors that Influence Students' Decisions to Engage with E-Learning Management Systems

Variable(s)	Agree	Strongly Agree	Disagree	Strongly Disagree
A user-friendly learning platform	50% (25)	50% (25)	0%(0)	0%(0)
Availability of data	20% (10)	68% (34)	12% (6)	0%(0)
Training & workshops on usage	20%(10)	80%(40)	0% (0)	0% (0)
Availability of mobile devices	20% (10)	76% (38)	4% (2)	0%(0)
Easy way of submitting assignments	30% (15)	62% (31)	6%(3)	2%(1)
Time saving & convenient learning platform	24% (12)	76% (38)	0% (0)	0%(0)

Respondents, the majority of respondents from an employee point of view strongly agreed that training and workshops, availability of appropriate devices, and availability of data (80%, 76%, and 68%) respectively were the major factors that influence the use of LMS in institutions of higher learning as shown on Table 2 above. Furthermore, respondents pointed out that LMS exposes students to an easy way of submitting assignments as shown by (76%) of respondents who acknowledged that LMS is a time-saving and convenient learning platform and it gives opportunity to students to interact with learning material at any given time. One respondent highlighted that:

".....LMS saves time and is one of the convenient learning modes....."

Therefore, LMS is viewed by respondents as a user-friendly learning platform, especially for students who would want to access learning material as well as submit assignments from a remote sight. To further support factors influencing the use of LMS, 10 lecturers who were purposively selected in the study viewed LMS as a vital assessment tool in teaching-learning activities.

The findings of the study indicated that respondents approach the IT department, department chairs as well as department coordinators on issues to do with LMS during learning activities. However, some respondents highlighted that some of the link persons are not readily accessible when there is a challenge in LMS usage, especially during course registration.

C. Challenges that students face when using LMS and how they can be addressed

This section presents the results that students face when using LMS and how they are addressed.

Table 3

Challenges that students face when using LMS

	Agree	Strong agree	Disagree	Strongly disagree
Poor internet connectivity	16%	80%	4%	0%
Erratic electricity	68%	26%	6%	0%
Exorbitant data	72%	22%	4%	2%
Lack of skills and knowledge	60%	12%	20%	8%
Only fully paid students access e-learning platform	70%	8%	20%	2%
Insufficient orientation	52%	30%	18%	0%

The table provided shows the challenges that students face when using e-learning management systems and how they can be addressed. Most respondents, more than 96% agreed that poor network connectivity, and 94% admitted that erratic electricity was also a challenge when using LMS. Again, the majority about 72% agreed that inadequate skills and knowledge hinder LMS use, and 94% noted data challenges that are exorbitant. About 78% of the respondents noted that the lack of adequate school fees especially at the beginning of the semester hinders them from effectively using LMS and more than 80% agreed that the lack of adequate orientation for LMS. However, a minority of the respondents about 28% disagree that they lack relevant skills to use LMS. To add more, below are some of the samples of responses from group discussions;

"I do not have the technical skills to use the LMS."

"No practical orientation was done on how to use the LMS, so I cannot navigate through the system properly"

"I am only able to connect to the LMS when I am on campus, due to lack of data bundle."

"Some lecturers mainly use the traditional face-to-face mode to deliver lectures and only use LMS to capture coursework marks."

The findings imply that students face challenges when using LMS and they need to be mitigated for effective use to occur.

How discussions on e-learning are structured.

The majority of the respondents agreed that discussions were done online, and were interactive although asynchronous delivery methods were mainly used. A fair number of respondents also highlighted that the structure of the discussion on e-learning platforms was not effective because some students were not able to participate due to network problems. The minority of the respondents also noted that if marks were being awarded depending on one's contribution to the discussion sometimes, they end up logging in using the classmates' usernames so that they will be awarded marks too. The majority of the students agreed that face-to-face discussions were more interactive and they could get a quicker response than an online discussion.

Mitigating factors that can be employed against challenges encountered by students on e-learning implementation.

Table 4

Mitigating factors that can be employed against challenges encountered by students on e-learning implementation

	Agree	Strong agree	Disagree	Strongly disagree
Bring your own device policy/method	12%	88%	0%	0%
Make use of IT department as focal person on e-learning specialists	74%	20%	6%	0%
Avail policy and regulations on e-learning activities	70%	24%	4%	2%
Wifi of data availability to both lecturers and students	68%	22%	6%	4%
Introduce examinable module/short courses on e-learning implementation	70%	18%	10%	2%
Electricity backup facilities	62%	30%	6%	2%

The table above shows that the majority, 100% of the respondents agreed that bring your own device (BYOD) policy can mitigate challenges encountered and more than 94% of the respondents noted that there is a need for a focal person to assist LMS users. However, a minority 6% disagreed that a focal person is of importance to LMS users. To add more, the majority, 94% of the respondents agreed that there is a need for policy and regulations on e-learning activities, and 6% disagreed. Also, 88% of the respondents agreed that there is a need for the institution to assist LMS users with Wi-Fi or data, and about 10% disagreed. The majority 88% of the respondents also noted that introducing an e-learning implementation course mitigates the lack of skills challenge, however, 12% disagreed. Finally, the majority of the respondents 92% agreed that electricity backup facilities like generators need to be in place in order to address blackouts and only 8% disagreed.

The findings imply that LMS users face are aware of some strategies that can be implemented to address the challenges they are facing in effectively using the LMS.

D: Students' satisfaction with e-learning management systems and their perceived value in relation to traditional face-to-face instruction

The majority of the respondents more than 75% highlighted that advent of LMS increased student pass rate. To add more, majority more than 95% also indicated that LMS promote ubiquitous learning and timeous assignment submission. To add more, below are some of the samples of responses from group discussions;

"LMS promote learning 24/7 and allows assignment submission to be flexible."

"LMS enable student to interact with the other student and instructor at any time, whenever he gets the chance to go online"

The findings imply that students are satisfied with LMS and they acknowledge their value in relation to traditional face to face instructions.

Discussion and Conclusion of results

Findings also highlighted that trainings and workshops, availability of appropriate devices and availability of data in institutions of higher learning were among the influencing factors that contribute to use of LMS in teaching- learning activities. Factors such as technical expertise and user friendliness of LMS were among other highlighted influencing factors and this was also further supported by Al-Ismaiel (2013). The need to have technical support for both students and lecturers from the I.T department on LMS implementation was also mentioned as vital. The study revealed most of the challenges faced in LMS implementation as emanating from technical aspects and users' computer literacy in manipulating LMS in teaching-learning activities. The findings concur with previous studies that have shown that poor internet connectivity and data costs can impact the effectiveness of e-learning (Al-Fraihat et al., 2020; El-Masri & Tarhini, 2019; Mtebe & Raphael, 2018; Drent and Meelissen 2008). Respondents in the current research suggested intensifying training and workshops as well as bringing your own gadget methods as well as electricity backup facilities. However, student-student and student-content interaction were among other strategies that were suggested by respondents during the study to improve LMS usage in teaching-learning activities. Furthermore, respondents indicated great satisfaction in using LMS since it offers ubiquitous learning and timeous assignment submission, hence LMS has turned modern classrooms into a 'paperless' environment. This notion concurs with Doyle & Delaney (2009) who revealed that the new normal era in higher education is being made to adapt to online learning methods with the aim to reduce physical contact as well as avoid crowds to ensure a healthy lifestyle. Respondents also indicated that LMS enables easier interaction in real-time and it creates an atmosphere of a conducive learning community enabling students to share their knowledge and difficulties and assist each other via forums and chats. The study, based on semi-structured interviews conducted at WUA in the department of Information Systems and Computer Science, revealed a consensus on the wide gap in policy awareness of LMS implementation in educational institutions among students and lecturers. To accomplish pedagogical goals, universities

should promote the usage of LMS and put a strong emphasis on learning methodologies through their wealth of tools and features.

Recommendations and Areas of Further Study

The study recommended that training and workshops as well as investing more in appropriate mobile devices and ICT infrastructure are an integral component in improving LMS implementation. Institutions need to come up with clear policies that guide the implementation of LMS. The study suggests that further studies, which include other departments and other campuses be carried out so as to come up with an all-encompassing insight pertaining to best practices in LMS implementation in institutions in Zimbabwe.

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Article 13

Online Learning Modes and learner safety concerns in Zimbabwe's marginalised schools

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Abstract

Technological advancement has compelled transformation of classroom communication methods and modified instruction strategies. Online learning has made teaching and learning interactive and collaborative instead of the traditional teacher- talking and students listening approach. It is against this background that descriptive survey design was engaged to gain an in-depth insight on the effectiveness of implementing online learning activities in one peri-urban community. Sample was drawn from one peri-urban community population and 60 residents were selected using stratified random sampling procedure. The sample comprised 5 community I.T experts who were purposively selected. For data triangulation, 20 parents/guardians were randomly selected for the study as well as 20 teachers in the community under study and 15 secondary school students were selected into the study. For data collection semi-structured interviews and focus group discussions and online survey were engaged. Descriptive statistics were used to analyse quantitative data while qualitative data was manually analyzed according to emerging themes. Mobile Learning theory and TAM formed the lens through which this study was observed. The analysed data revealed

that online implementation was an important component in this information age in Zimbabwe as it facilitates ubiquitous learning environment. Research findings also show that to large extent stakeholders were not aware of online learning policies that govern learning activities. Furthermore, online activities showed some aspect of negative unhu/ubuntu in the community under study. Findings also revealed that integration of online learning face challenges such as lack of appropriate technological gadgets, exorbitant data and inappropriate technological knowledge and skills. Parent-teacher engagements during online learning activities were among strategies cited to reduce challenges. Therefore, the study recommended that training and workshops as well as designing systems that monitor learners online in learning institutions are an integral component in communities. The study suggests that further studies, which includes urban and rural location be carried so as to come up with an all-encompassing insight pertaining to best practices that enhance safety of learners online in Zimbabwe.

Key words: Online Learning, Mobile Learning Theory, Concern, TAM, Learner, Cultural Practices, Online Protection, Policy, unhu/ubuntu

Introduction

Teaching-learning activities world-wide is becoming increasingly dependent on Information Communication Technologies - ICTs (Wanshiv, 2020). In this paper, ICTs refer to the computer and internet connections used to handle and communicate information for teaching-learning purposes (Sharma, 2020). In other words, these are online communication apps (WhatsApp, radio, television, cell phones, computer and network hardware, satellite systems, and various services available with them, such as video conferencing and distance learning) that can enable interaction between teachers and students or students amongst themselves. In addition to giving opportunities for social connection, interactive online classrooms are supporting the continuation of education for all students through distant learning. In this context, ICTs are seen as having the potential to increase students' access to quality teaching-learning in developing countries (Tinio, 2002). In this sense, ICTs extend students capacity to perceive, understand and communicate information in teaching-learning (Mohammed, 2022). Therefore, ICTs are making dynamic transformations in teaching-learning, since they are providing both students and facilitators with more opportunities in adapting to individual needs.

However, this new teaching-learning mode has its own dangers to the students (Moskal, et al., 2013, Vezne, et al., 2023). Various studies (Chigudu, 2015; Dzimiri & Marimo, 2015; Makaye, 2014; Makuvire & Khosa, 2021) provide empirical evidence on safety concerns encountered in the implementation of online learning activities from the learners' perspective. As students use ICTs in their teaching-learning they might be exposed dangers (i.e., cyber-bullying, obscene material, online child grooming, etc.). However, there is dearth in literature gap concerning students' safety in marginalised schools as they use ICTs in teaching-learning. It is against this background that this sought to interrogate the identified research gap guided by the following main research objective: To establish students' safety concerns as they engage online learning modes. The following sub-objectives were derived from the above-mentioned objective:

- To identify online learning modes used in teaching-learning
- To establish how these online learning modes are used in teaching-learning
- To identify risks when using these online learning modes in teaching-learning
- To recommend mitigatory measures that can be applied to minimize the impact of these challenges on online teaching-learning

Literature review

Davis proposed the Technology Acceptance Model (TAM) in 1989. TAM focuses on two major factors: perceived utility and perceived ease of use. According to Davis (1989), if users view technology as useful, they are more likely to accept and adopt it for their requirements; similarly, if a technology is perceived as simple to use, users are more likely to accept and embrace it (Davis, Bagozzi, & Warshaw, 1989). TAM argues that users' behavioral intentions to utilise technology are impacted by their views of usefulness and ease of use. Users are more likely to use a technology if they view it to be useful and simple to use (Venkatesh, & Davis, 2000). TAM also recognizes that extrinsic elements such as social influence and enabling conditions can have an impact on users' acceptance and adoption of technology. According to Venkatesh (2003), social influence is the impact of other people's ideas and recommendations, whereas facilitating conditions are the availability of required resources and support for technology use.

Many school learners in Zimbabwe dropped out of school due to covid 19 outbreaks and this paves way for online learning to be harnessed to promote flexible teaching and

learning. The Family Aids Caring Trust Zimbabwe (Fact), pegged the figure of schools dropouts since pandemic began in 2020 at 20 000, while the Human Rights report (2021), estimated that 840 000 children dropped out of school during the COVID-19 pandemic. Online learning (e-learning) describes any form of teaching and learning delivered using digital technology. In online learning environments learners interact with learning materials, their instructors and other learners from various locations and often at various times using network technologies. It can also include independent, facilitated, or collaborative approaches to learning. According to Wan Aziaris, (2015) online pedagogy can also facilitate group learning, and the assistance of instructors within specific fields.

Online learning in this study is described as a method of instruction and learning involving teachers and students that uses various technological tools such as "Whatsapp," "Zoom," and "Google Classroom." Mat Dawi et al. (2016) discovered that, in the era of globalisation and the expansion of ICT, technologically driven and online learning is strongly supported. ICTs have proven to be effective in supporting student-centered learning by providing diverse, well-organised, and visually pleasing educational content (Alenezi, 2019). Learning infused with ICTs excites learners and allows them to participate in activities that promote co-viewing and participation (Wahab, 2020). Students can discover new material through interactive online learning through using electronic libraries and websites. According to Allen and Seaman (2017), online courses provide greater scheduling and location flexibility, allowing students to fit their coursework around jobs and other obligations. Furthermore, because online courses may be tailored to specific learning needs, they are generally more accessible to students with impairments (DeBruler, 2021) and also adapt to each student's unique demands and learning styles (Liu et al., 2020).

However, with the increased use of technology and the internet, challenges related to online safety have also arisen, particularly in the context of students in marginalised learning institutions. According to Wang et al. (2021), online students frequently feel lonely and alienated from their friends, which can have a severe impact on their mental health and academic performance. Furthermore, lacking the framework and support of conventional educational setting, students may struggle to remain engaged (Bolliger & Inan, 2012). Another issue with online learning that has impacted many marginalised learning institutions throughout the world is that many learners do not have devices to

use during the length of the online program (Joubert & Snyman, 2017). The matter of using technology instruments for learning must be examined through the lens of two groups of people: the "haves" and the "have-nots." In reality, not every learner has a personal device to utilize for online learning, not because they choose not to have one, but because of financial difficulties in their families (Gilbert, 2015). According to Aboagye, Yawson, & Appiah, (2020) accessibility, connectivity, a lack of appropriate devices, and social issues represented by a lack of communication and interaction with teachers and peers were among the main challenges the students faced on online learning. To add more, McCabe et al. (2016) highlighted that, students in online courses are more likely to participate in academic dishonesty, such as plagiarism, than students in traditional courses.

To address these concerns, educators can design online courses that incorporate interactive and collaborative learning activities to foster student engagement and interaction (Hew & Cheung, 2014). They can also provide opportunities for feedback and support to students to help them stay motivated and on track with their learning goals.

Methodology

A qualitative approach was employed and semi-structured interviews were administered to a sample drawn from one peri-urban community: Zimunya community in Mutare, Manicaland province, Zimbabwe. Semi-structured (face-to-face) interviews and open and closed ended questionnaires were conducted with community I.T specialists, secondary school teachers, parents/guardians and secondary school students of the peri-urban community under study. A sample of five (5) I.T experts, twenty (20) parents/guardians, twenty (20) teachers and fifteen (15) secondary school students were selected for the study. The selection of the components of the sample was guided by the author's determination to enrich the research community and make it reflect as much as possible the real situation of all online learning experiences in secondary schools. Interviews were conducted between 01/02/2023 and 30/03/2023. The challenge of distance between the researcher and the participants was overcome by electronic interviews; however, for teachers and students the researchers took advantage of the school term calendar. Ten (10) semi-structured electronic interviews were conducted through emails. Some participants were contacted prior to the interview through phone

calls and other social media platforms and invited to participate in a short 15-20 minute discussion on online learning experiences.

The employed interview guide was designed under the influence of the TEDS Approach (tell, explain, describe, suggest). Designed instruments were pilot tested to iron out irregularities and remove ambiguity issues in the final instruments. The interview data was ready for analysis through qualitative data analysis (QDA) computer software "Hyper Research" which was partially engaged while manual procedure compensated on data which was found to be incompatible with the employed software and data analysis was done under the guidance of interpretivism paradigm. According to Moyo and Takavarashe Jnr (2020), qualitative approach and interpretivism research enable researchers to study the players in online learning experiences in their natural settings to achieve a deeper understanding of the phenomena under study. It also enabled researchers to interpret the online ecologies and risks in terms of the meanings that the participants on online learning reported.

Results and Discussion

Researchers found it necessary to divide this section in five (5) thematic sections based on the data obtained during the interviews:

- Demographic information
- Online learning modes used in teaching-learning activities
- How online learning modes are being used in teaching-learning activities
- Risks encountered during online teaching-learning activities
- Mitigatory measures that can be applied to minimize the impact of risks in online teaching-learning activities

A. Demographic information

Table1:1 Interviewee's Demographics

Position of Respondent	Number of Respondents	Gender	Estimated age (years)	Level of education	Knowledge/experience of online learning
Teacher	20	12 M, 8F	30s	College & University	20=YES
I.T expert	5	5M	20s	College &	5=YES

				University	
Parent/guardian	20	14M, 6F	40s	Secondary & tertiary	15=YES, 5=NO
Secondary school student	15	8F, 7M	15s	Secondary	13=YES, 2=NO

F=female, M=male

Source: Primary data

Table1:1 above presents the demographic information of respondents in this study. It can be inferred that more males than females are involved or more concerned with online learning in institutions. Results also showed that the study was characterised by mature people and majority of the respondents acknowledged that they were engaging in online learning activities.

B. Online learning modes used in teaching-learning activities

This section discussed results gathered from respondents in online learning modes used in teaching-learning modes in Zimunya community in Zimbabwe. The discussions during the interview sessions with various stakeholders from Zimunya community in Zimbabwe with various positions showed that the most common online modes used in teaching-learning include but not limited to the following:

Findings of the study highlighted online learning (e-learning) as a form of pedagogy delivered using digital technology. Results indicated that the most common methods used in online learning mode were visual graphics, text, animations, videos and audio. Furthermore, results from the current study concur with results from Wan Azaris (2015) who noted online pedagogy as group learning platform with instructors as facilitators in the teaching-learning environment. One respondent revealed that:

.....commonly used online modes in teaching-learning activities include Zoom, Google Classroom, WhatsApp, e-libraries, e-books, websites.....

From the findings, it can be concluded that online learning does not refer to direct learning alone but encompasses assignments or activities that are provided by the teacher online such as any form of electronic repository. Current research findings concur with findings from Wehab (2020) who noted that electronic libraries, websites and Moodle learning were common online learning platforms. Research findings also revealed that cell phones, computers, network hardware, satellite systems and various

services which include conferencing and any form of distance learning that include digital technology.

C. How online learning modes are being used in teaching-learning activities

This section discusses various methods on how online teaching-learning activities are used in the current technological charged world.

Research findings indicated that online learning mode encourage student-centred approach to learners. Findings of the study can be confirmed by previous study from Alenezi (2019) who confirmed student-centred approach through implementation of visual pleasing educational content and these facilities included video conferences, YouTube and other audio and visual tutorials.

Results showed that online learning modes are used to facilitate ubiquitous teaching-learning environment to both learners and educators. Current research results can further be confirmed by research study from Allen and Seaman (2017) who revealed that online learning mode provide greater scheduling and location flexibility to both teachers and learners. In addition to ubiquitous learning, online learning mode improves student capacity to engage in academic activities as well as various interactions such as learner-learner interaction, teacher-learner interaction and learner-content interaction. Findings of the current study concur with findings from Mohammed (2022) who noted that online learning mode is an enabler to conducive teaching-learning environment in the contemporary digital society.

D. Challenges encountered during online teaching-learning activities

This section discussed results gathered from respondents on risks when using online learning modes in teaching-learning in Zimunya community in Zimbabwe. The discussions during the interview sessions with various stakeholders from Zimunya community in Zimbabwe with various positions showed that the most impeding risks to online learning include but not limited to the following:

Cultural Reservations and Obscene material Online

Contrary to developed nations, developing nations such as Zimbabwe have a culture of avoiding online business due to lack of confidence, lack of technological knowledge and skills and ultimately technological phobia in the online teaching-learning environment. Some have a habit of avoiding Internet transaction where possible for some cultural reasons such as the notion that the Internet is a source obscene material. As a result learners in Zimbabwe are not spared:

'..... I belong to an apostolic sect, and I once tried to engage on online learning, but I was shocked by large volumes of obscene material and I vowed not to use online learning technologies in my learning activities. However, I think if appropriate education is castigated to us I can try using the technology again.....'

From the above results, researchers concluded that cultural beliefs and incidence of obscene material on the Internet are some of the challenges that lead to online learning mode as unsafe to learners. Consequently, this notion can be related synopsis from TAM where 'attitude towards using' a technology has a bearing on adopting online learning mode in marginalised learning institutions in Zimbabwe. Furthermore, lack of appropriate ICT policy for online learning mode use in Zimbabwe coupled with lack of education are challenges that expose learners to anti-educational and anti-cultural material during online learning. The findings of this study are in tandem with the findings by Bolliger and Inan (2012) who pointed out that lack of framework and support was a major barrier to online learning mode which leaves students exposed to unsafe learning material during online learning mode, hence the results of the current study can be generalised to a larger population.

Inadequate Awareness Campaign and Rampant Incidents of Online Fraud

Campaign for online learning mode is not being done rigorously or is not being given the attention it deserves in the current high e-learning uptake and learners in Zimbabwe are found lagging behind in using online learning platforms due to rampant incidence of online fraud thereby exposing the learner to unsafe environment when using online learning:

'..... I personally lack knowledge on online learning and there is virtual no one, neither the teacher nor the school that put awareness campaign to learners, hence I feel unsafe to use the technology during learning. Another reason for shunning online learning is an increase in a number of fraudsters and a rise on bogus online institutions

Learners under study need rigorous awareness campaign on online either from the radio, TV or even on social media and the campaign should include aspects from TAM such as 'usefulness' of online learning to learners and more importantly there is need for security assurance to online users which is an aspect that lack in the TAM deliverables. Therefore, inadequate awareness as well as rampant incidence of online

fraud is regarded as the major drawback to online learning mode. The current findings concur with results from Wang et al (2021) who revealed that trust and insecurity hindered online learning mode usage in many developing countries. As a result, researchers concluded that online learning mode awareness as well as insecurity is basically still at the low level across learning institutions in Zimbabwe.

Cyber-bullying and Online child grooming

The study revealed that respondents view cyber bullying and online child grooming as emerging problem found in online learning mode platforms from lower learning institutions to higher learning institutions and one of the respondent had this to say:

‘.....incidence of cyber bullying is common when we use online learning mode, especially when we use social media platforms such as WhatsApp, chat rooms.....’

From the study discussion, researchers are compelled to conclude that cyber bullying and online child grooming pose as threats to learners when they are engaged on online learning and some I.T experts and parents acknowledged that some mental health problems, withdrawal syndromes and poor academic performance were common signs of cyber bullying and online child grooming among learners who use online learning modes. The current study can be compared to a study by Kowalski et al (2014) who noted that in 2006, 38.8% of high and middle school student engaged in online learning were victims of cyber bullying, hence the findings of the current study can be confirmed for generalisability to a larger population.

Lack of inclusive education

The study showed that online learning mode is prone to challenges to students living with disabilities. Findings from the study revealed that, students who are blind may need assistive technology, such as screen readers to access online content. Students with disability may face challenges in communication. Findings from the current study concur with findings from Supratiwi, Yusuf, & Anggarani, (2021) who postulated that teaching students with disabilities in an online environment can be challenging, since the students face additional challenges in accessing and participating in online learning. The deaf and dumb may need to use sign language or CART (Communication Access Realtime Translation) services to participate in online learning discussions (Wazalwar, & Shrawankar, 2021). Therefore, students with disabilities may need more individualized

and specialised support than other students which can be very difficult to provide in an online environment, where educators may not have as much contact and as much skills and knowledge to handle students with disabilities.

E. Mitigatory measures that can be applied to minimize the impact of risks on online teaching-learning activities

This section discussed results gathered from respondents on mitigatory factors that can be employed to reduce impact of risks when using online learning modes in teaching-learning in Zimunya community in Zimbabwe. The discussions during the interview sessions with various stakeholders from Zimunya community in Zimbabwe with various positions revealed some of the following mitigatory measures

Training and Workshops

From the findings of the study, respondents noted that for learners and educators to fully embrace online learning mode, there is a need to embark on training and workshops on the adoption of e-commerce implementation.

'..... while we may want to use online learning mode, lack of skills and knowledge on manoeuvring its features draws us back and we need regular training on the technology

From the findings, researchers can conclude that trainings and workshops are vital for for both learners and educators in this current e-learning environment.

Formulation of ICT Policy and ICT Security Framework

Results of the current study revealed that the use of online learning mode is incomplete without a proper policy put in place that governs the implementation of the technology by various players.

'..... There is a cause for concern to have a working ICT policy which guides online learning and the policy contents should also include our input, hence a need for open dialogue or consultative forums with the concerned stakeholders.....'

Further discussion with respondents also revealed that learners and educators shun engaging in online learning mode due to insecure features from fraudsters, respondents strongly highlighted the need to put in place a working ICT security Framework that protects online learning users.

'..... I think there is a need for legislators to put in place some heavy penalty or heavy fines on online fraudsters or anyone who engage in cyber bullying activities so that no one will ever dare engage in online fraud or crimes. Special trainings should also be put in place for I.T specialists who deal with cybercrimes.....'

From the discussion above, the researchers can conclude that ICT policy as well as ICT security framework such as the Children's Internet Protection Act (CIPA) which was signed into law in 2001 to enforce all stakeholders to work hand in hand to ensure a user friendly online learning platform.

Monitoring of learners' activities by parents and educators

Research findings highlighted that besides implementing filters in online platforms, there is need for a holistic approach from both educators and parents to monitor learner's activities in online environment. One of the respondents noted that:

.....besides discussing digital technologies with my children, I also install software on my children's electronic gadgets which alerts me whenever they try to visit undesirable sites..... and I am always aware of my children's activities on the Internet.....

There the study can conclude that monitoring of learners online by both educators and parents can be viewed as an effective mitigatory measure to reduce the impact of risks associated with the use of online learning modes in the contemporary online environment.

Use of assistive technology

Findings revealed that there is need for assistive technology to cater for students with disabilities, such as visual impairments or hearing impairments. The study established that assistive technology such as screen readers which can help to provide students with access to learning material and to participate in class when using online learning platforms. The assistive technologies that can be used include use screen readers as well as use voice-to-text software by students with visual impairments and physical disabilities to read the text on the screen and type the text respectively. In addition to the use of screen readers as well as use voice-to-text software, the study also revealed the use of magnification software that can be used on visual impaired students to enlarge the text on the screen.

Conclusion

In conclusion, researchers query the rampant use of online learning platforms against learners' safety in marginalised Zimbabwean learning institutions. Researchers in the current study concluded that due to the outbreak of diseases such as COVID 19 IN 20220, most institutions including marginalised schools were compelled to adopt online learning mode without enough assessment of the safety aspect. WhatsApp, Zoom, Google classroom, educational sites and electronic libraries were among the online modes used in teaching- learning. Research findings highlighted that online learning mode promote learner-centred approach through visual pleasing educational content and support of ubiquitous teaching-learning in resource restrlCTed environment. However, the study also established some risks with online teaching-learning mode such as cyber bullying, ant-cultural content, obscene material, online child grooming, lack of inclusive education, rampant incidents of online fraud, cultural reservations and lack of policy guiding the use of online learning mode. The study established strategies that can be implemented to minimise impact of risks faced on online learning mode such as formulation of policies guiding implementation of online learning mode, software that monitor learners online as well as coming up with software that detects and prevents uploading of undesirable content on educational websites. The study concluded that that though there are a number of risks associate with the implementation of online learning mode in marginalised Zimbabwean schools, the benefits of adopting online learning mode in this technological charged world outweigh the risks, resource mobilisation and massive education on online learning should be a priority in marginalised schools so that ICTs become a fully-fledged catalyst in online learning mode.

Recommendation

The study recommended that educators and all stakeholders should design clear policies that govern the implementation of online learning modes as well as investing more in appropriate mobile devices and software that detects and prevent uploading of undesirable content on educational sites. The study suggests that further studies, which include both the "haves" and the "have not" pertaining online learner safety be carried out so as to come up with an all-encompassing insight pertaining to best practices in unpacking online learner safety in learning institutions in Zimbabwe.

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Article 14

Assessment of Students Learning Difficulties and Misconceptions in Electricity among Senior Secondary School Physics Students (Male & Female) in Ondo State

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Abstract

Efforts are being made by physics teachers and science education researchers to improve students' achievement but less attention is being given to misconceptions which most times impair students' conceptual understanding. This study therefore seeks to assess students' learning difficulties and misconceptions in electricity among senior secondary school physics students' in Ondo state. This study adopted descriptive survey research design. Purposive sampling technique was used to select six (6) secondary schools of the schools in Ondo West local government area of Ondo state involving 50 randomly selected students from each of the schools making a total of 300 senior secondary school two (SSSII) students. The research instrument used was a Simple Electric Circuit Diagnostic Test (SECDT) which was administered to test what they have been taught in the past. The data collected were analyzed using descriptive statistics of frequency count and percentage, and inferential statistics (t-test) was used to test the hypotheses. The results revealed that students find areas related to workable connection, magnitude of currents, and brightness of bulb difficult to understand and comprehend. Also, the study showed that there is significant difference in the male and female students' difficulty in electricity, and that students from private schools had higher difficulty than their counterparts in public schools. It is therefore recommended

that; teacher should always identify the misconceptions in topics they want to teach so that learning hurdles will be removed and students will be able to learn with ease.

Key words: Learning difficulty, Electricity, Misconception, Gender, School type

Introduction

Physics is the study of matter, energy and the interactions between them. Results from physics lead to the birthing of technological applications. All of the technology we utilize today, including mobile phones, mp3 players, and DVDs, is based on a theoretical understanding of electrons that was developed around the turn of the 20th century Institute of Physics (2012). Physics is the foundation for any technological inventions, manipulations and discovery. Hydroelectricity, nuclear power, digital computer, satellite (usually in the D or E region of the ionosphere) which enables telecommunication; and in the area of health care, it concerns the imaging, screening, diagnosis and treatment, that is the reason Ukoh (2021) describes physics as a link between science and technology. Physics has broken the barrier of limitations in many fields, brought explanations to myths and mysterious happenings, removed the covering of superstitions from our minds and unveiled the conceptual approach to life.

Physics is perceived to be a difficult subject by most students because of its abstract nature (Adeyemo, 2010 and Ukoh, 2016). However, for a nation to adequately utilize the benefits of physics, correct conceptions of the contents of the subject is required but this seems to be grossly lacking at the secondary school level because of the perceived difficulty and abstract nature of the subject. (Ornek, Robinson and Haugan 2008) and Ukoh (2021) submitted that students find physics difficult because they have to contend with different representations such as experiments, formulas and calculations, graphs, and conceptual explanations at the same time. Some even go as far as memorizing algorithms involved in solving problems in a particular topic, when given a test, they score well, and their performance masks their ignorance of the correct conception. If such student is given problems which require the application of the knowledge of the topic, their ignorance will be revealed, also showing their conception about the topic which is usually wrong.

In 21st-century science, pedagogy emphasizes constructivism to form conceptual structures among school-going children. The process of constructing a concept about how things go together is called concept formation. Science (physics) teacher plays a key role in scientifically correct concept formation in the student's brain. Concepts present in any subject act as a linking bridge between prior knowledge and new knowledge in the conception process. Concepts are mental images that assist children in classifying his/her experiences and which continually change as his/her experiences accumulate. Academic scholars such as Esra and Mustafa, (2009), Haynes (2009), Pragle, (2010), Freudenthal, (1973), have confirmed that students should not be considered as plain paper waiting to be written on. This is because students have a wealth of knowledge already gained before coming to classes. When students enter physics class, they arrive with many notions about the physical world in general and electricity specifically. These ideas may be a result of previous experiences, everyday language, or prior study, and oftentimes, they affect how students perceive instruction hence influencing learning outcomes. Most of the time, these ideas or notions are misconceptions or alternative conceptions that have resulted from common sense explanations, instruction by teachers, or language lacking precision or accuracy.

Misconception in the context of this work is defined as an idea that is clearly in conflict with scientific conceptions and is therefore misleading. Misconceptions are beliefs that contradict the accepted scientific theories. They cause characteristic difficulties in the instruction of natural sciences subjects for example physics, chemistry, biology, and mathematics is not an exception either. Misconception in physics gives seemingly true explanations for correlations and phenomena, but they actually are not consistent with experiments. They are based on superficial, commonplace considerations. An Alternative conception is defined as an idea that is neither conflicting nor compatible with scientific conceptions but which has its value and is therefore not necessarily wrong (Abimbola and Baba, 1996). When alternative conceptions are identified, they can be corrected to form a scaffold for a correct conception. Borich (2004) expressed that dealing with misconceptions and alternative conceptions in science is one of the hardest tasks in science teaching.

Teachers face students' misconceptions, but it is not guaranteed, that they think of the necessity of taking conscious action against them. Halim, Meerah and Halim. (2009)

state that to build an effective model of teaching and learning physics it should begin by exploring or identifying difficulties and misunderstanding faced by students using diagnostic tests. Several studies have found that misconception still exists at primary and up to university level (Styer, 1995, Abell and Lederman, 2007). This show that normal or regular teaching and learning process is unable to overcome misconception if the focus of the teaching is not targeted on the misconception. The study of students' misconceptions in physics has become both an important concern for physics education research and a valuable tool for the practicing physics teacher. Although some misconceptions are difficult to overcome, teachers should be aware about the existence of the misconception and keep addressing to overcome students' misconceptions so that students will have conceptual understanding.

For about 20 years, the roles of misconceptions and alternative conceptions in learning science have been investigated extensively, numerous interviews with students at various levels have been conducted and it was found that misconceptions were frequent (Mohsin 2011). Misconceptions like resistors consume charge because of the reduction in the flow of current normally noticed when a resistor is introduced are not uncommon amongst students. Alternative conceptions have been perceived as difficult to erase, and hard to correct, often students hold on to their alternative conceptions and close their minds to correct conceptions. They may have memorized formulas, diagrams, and even explanations of concepts but there is usually no in-depth understanding behind the facade of stored factual knowledge. For example, an alternative conception like "current comes out from the positive (+) pole of the battery and enters to the bulb where it is consumed to light while the bulb which is not affected by the second wire connected between the negative (-) pole and itself" is common among students, it is easily noticed during small experiments involving cell (battery), connecting wires, bulb.

A familiar example from elementary school is students' understanding of the relationship between the earth and the sun. While growing up, children are told by adults that the "sun is rising and setting," giving them an image of a sun that moves about the earth. In school, students are told by teachers (years after they have already formed their mental model of how things work) that the earth rotates. Students are then

faced with the difficult task of deleting a mental image that makes sense to them, based on their observations and replacing it with a model that is not as intuitively acceptable. This task is not trivial, for students must undo a whole mental framework of knowledge that they have used to understand the world. The example of the earth rotating rather than the sun orbiting the earth is one of many that teachers refer to collectively as misconceptions. Misconceptions can be categorized as follows: Preconceived notions, nonscientific beliefs, Conceptual misunderstanding, Vernacular misconceptions and Factual misconceptions (Gooding and Metz 2011, Fang 2014). Suparno, 2005; Wandersee, Mintzes, and Novak, 1994 in their investigations reported 700 misconceptions, 300 on mechanics, 159 on electricity, 70 on heat, optics, and the properties of materials, 35 on earth and space, and modern physics. Misconceptions can also occur due to errors in teaching materials. Written mistakes will be easily digested by students, and thus they will get misconceptions (Lambi, 2009; Suparno, 2005).

Electricity is said to be one of the areas of physics most studied in terms of learning difficulties (Dorneles, Veit, and Marco, 2010). A significant part of these studies refers to the teaching of a simple electric circuit and, according to these studies, students even after formal instruction are not able to analyze and predict the steps involved in such circuits. Electricity is a form of energy that can build up in one place (static) or flow from one place to another. Other kinds of electricity include thermoelectricity and bioelectricity. When electricity gathers in one place it is called static electricity, when it moves from one place to another is called current electricity. Static electricity happens often times when a person rubs things together. For example, if a person were to have a balloon and the person rubs the balloon against his/her cloth about 20 or 30 times, moving the balloon back and forward. The energy from the person's hand makes the balloon move, as he/she rubs it against the cloth, some of the electrons in the rubber molecules are knocked free and gathered on the person's body. This leaves the balloon with slightly too few electrons since electrons are negatively charged, having too few electrons makes the balloon slightly positively charged the cloth meanwhile gains these extra electrons and becomes negatively charged. The cloth is negatively charged, and the balloon is positively charged. Opposite charges attract, so the cloth sticks to the balloon. Electricity is a versatile energy source, a fundamental driving force of our society. Quite

unfortunately, gaining an understanding of electricity seems to be challenging for students at various academic levels.

Students' misconceptions in physics concepts, specifically electricity, is what leads to students' learning difficulties, for instance a student with misconceptions in a particular topic will find it difficult in learning that topic. This implies that when we assessed student learning difficulties, several factors are necessary. But for this study, learning difficulties are restricted to the one that has to do with misconceptions.

Statement of the Problem

Students' performance in physics in West African secondary school certificate exam (WASSCE) and National Examination Council (NECO) Examination has been poor, due to factors which may include misconception or alternative conception. Students have a lot of misconceptions about physics concepts which brings about learning difficulties. If misconceptions are not properly handled, it can hinder the learning of physics in senior secondary school. This study therefore assessed students' learning difficulties and misconceptions among senior secondary school physics students.

Research questions

1. What proportion of students has difficulty with electricity?
2. What are the students' misconceptions in electricity?
3. Does gender influence students' difficulty with electricity?
4. Does school type influence students' difficulty with electricity?

Methodology

This research study adopted the descriptive survey research design. The population of the study was drawn in Ondo state, precisely Ondo West Local government area. The sample consisted of three hundred (300) senior secondary school two (SSSII) students offering physics in six selected schools. A purposive sampling technique was used to select the six (6) participating schools. Fifty (50) students were randomly selected from each school.

The research instrument used for this study is simple electric circuit diagnostic test (SECDT). The instrument was adapted from Pesman and Eryilmaz 2010. SECDT is made up of two sections, Section A contains questions on background information on the name of the school, school type, and gender, while section B contains eight items; each item is a two-tier questions. The first tier consists of eight content questions in multiple-choice formats with three choices. Each item of the test includes one correct choice and two distractors. The second tier consists of four possible reasons for a possible answer to the first part: two erroneous reasons, one scientifically acceptable reason, and the last option is for students to provide their reason if not agree with any of the three reasons supplied.

Item 1



Figure 1

1. Will the bulb in Figure 1 light?

- a) Yes, it will
- b) NO, it will not
- c) Yes, but very low

Reason

- a) The battery and the bulb are connected by the wire.
- b) An extra wire must be connected from the negative terminal of the battery to the screw base of the bulb so that the positive and negative charges meet in the bulb.
- c) An extra wire must be connected from the negative terminal of the battery to the screw base of the bulb so that the electric current passes through the bulb
- d).....

Sample item in SECDT

Source: Pesman and Eryilmaz 2010

Validation of Instrument

The instrument SECDT for this study was validated by two physics teachers, the researcher's supervisor, and one expert in science education. The expert was asked to judge the quality of the items concerning clarity, sentence structure, and comprehension. To determine the reliability of the instrument, the test was carried out using a test-retest method by an administered instrument to twenty (20) students of senior secondary school two (SSII). The test was re-administered to the same students after a week interval. The data obtained was subjected to the Pearson Product Moment Correlation to get a coefficient of 0.7 to ascertain the reliability of the instrument.

Scoring of the Instrument

The student's responses to the two tiers of multiple-choice questions were scored two (2) marks. One (1) mark for the content-related question and one mark for the reason. One mark was awarded if the first tier which content-related question is correct. No mark was awarded if the first tier which is content-related question response is wrong even if the students choose the right option in the second tier. Quantitative data collected were analyzed using descriptive statistics which include frequency count and percentage, and t-test was employed to provide answers to the research questions.

Results

Research question 1: What proportion of students has difficulty with electricity?

Table 1: Distribution of the students with difficulty and students without difficulty

Electricity Difficulty	Item No	Students with difficulty		Students without difficulty	
		No	%	No	%
Workable connection	4	271	90.3	29	9.7
	1	184	61.4	116	38.6
Magnitude of Currents	3	226	75.2	74	24.7
Brightness of Bulb	6	298	99.3	2	0.7
	8	197	65.7	103	34.3

Amount of current	2	282	94.0	18	6
	5	269	89.7	31	10.3
	7	281	93.7	19	6.3

Table 1 revealed that under workable connection among the 300 respondents, 90.3% (271) have difficulty with the connection of a bulb, similarly in item 1 (61.4%; 184 out of 300). Item 3 among the 300 respondents, 75.2% (226) have difficulty with the magnitude of current (rate of flow of electrons). For the brightness of a bulb, among 300 respondents in item 6, 99.3% (298) have difficulty, similarly in item 8 (65.7%; 197 out of 300). For the amount of current, among 300 respondents in item 2, 94% (282) have difficulty, similarly, in item 5(89.7%; 269 out of 300), in item 7 (93.7%; 281 out of 300).

Research Question 2: what are the students' misconceptions in electricity?

Table 2: number of students making right or wrong responses to the two tiers multiple choice items on electric circuit

Responses	1 st Tier		2 nd Tier	
	Right	Wrong	Right	Wrong
Item 1	177(59)	123(41)	116(38.6)	184(61.4)
Item 2	92(30.7)	208(69.3)	18(6)	282(94)
Item 3	126(42)	174(58)	74(24.7)	226(75.2)
Item 4	72(24)	228(76)	29(9.7)	271(90.3)
Item 5	143(47.7)	157(52.3)	31(10.3)	269(89.7)
Item 6	20(6.7)	280(93.3)	2(0.7)	298(99.3)
Item 7	145(48.3)	155(51.7)	19(6.3)	281(93.7)
Item 8	153(51)	147(49)	103(34.3)	197(65.7)

Item 1 and 4 are related to workable connection, 61.4% and 90.3% of the students respectively shows misconceptions from the reason picked from the second tiers, it was discovered that most of the students did not consider if the bulb and battery are well connected they were only concern about the contact of the bulb with the battery. However they did not know that the positive and negative terminal of the battery must be well connected to the positive and negative terminal of the bulb; because an electric

bulb has two terminals. At the very end of the light bulb, there is a small round tip which is the positive terminal. The outer threaded part of the base of the bulb is the negative connection terminal surface.

Item 3, 75.2% of the students had misconception which is related to magnitude of current, it was discovered from the second tier that most of the students thought that the closer the bulb is to the battery, the brighter the bulb is and they also thought that the current in the circuit are not equal because of the distance from the battery. However, in circuit in series, magnitude of the current is the same at any point and the current flowing through all components is equal. Therefore, if the current was measured at any point in the circuit, it should always be equal and that makes the brightness of the bulb in A and B the same.

Item 2, 5 and 7 are related to amount of current in circuit, 94%, 89.7% and 93.7% of the students respectively shows misconceptions, this is due to lack of conceptual understanding of circuit arrangement. In a situation whereby the circuit is in series, same amount of current flows through all the components placed in it and in parallel circuit, the components are placed in parallel with each other in which the circuit splits the current flow. The students' responses show their wrong perception of the principle and were unable to apply it appropriately.

In item 6 and 8, 99.3% and 65.7% of the student respectively held wrong idea about brightness of bulb, some think it is the closeness of the bulb to the battery that increase the brightness, some think it is the number of bulbs which does not agree with circuit arrangement.

Research question 3: Does gender influence students' difficulty with electricity?

Table 3: Difference in students' difficulty in electricity based on gender

Gender	N	Mean	Std.d	Df	T	P value	Remark
Male	168	5.85	1.51	298	-6.613*	0.000	Sig.
Female	132	6.87	1.05				

* denotes significance at $p < 0.05$

Table 3 revealed that gender significantly influenced students' difficulty with electricity ($t = -6.61$; $p < 0.05$). This means that there was a significant difference in the male and female students' difficulty with the electricity concept. Table 3 further revealed that female students had a higher difficulty mean score in electricity (6.87), while their male counterparts (5.85) had a lower difficulty mean score in electricity.

Research question 4: Does school type influence students' difficulty with electricity?

Table 4: Difference in students' difficulty in electricity based on school type

School type	N	Mean	Std.d	Df	T	P value	Remark
Public	150	6.05	1.61	298	-3.055*	0.002	Sig.
Private	150	6.55	1.16				

* denotes significance at $p < 0.05$

Table 4 showed that school type significantly influenced students' difficulty with electricity ($t = -3.06$; $p < 0.05$). This indicates that there was a significant difference in public and private schools' difficulty with the electricity concept. Table 4 also showed that students from the private school had higher difficulty mean scores in electricity (6.55), while their counterparts in public schools (6.05) had lower difficulty mean scores in electricity.

Discussion

The findings of this study revealed that students have misconceptions in electricity which is as a result of lack of conceptual understanding which conforms to the findings of Suchai and Thasaneeya, (2012) who in a study on students understanding of the brightness of a bulb in a simple electric circuit revealed that students have difficulty understanding the concept of the brightness of a bulb and had even more difficulties in relating connection in a simple electric circuit to the brightness of a bulb when an electrical tool like the resistor is added to the circuit.

The findings of this study also revealed that female students had higher difficulty with

electricity which conforms to the findings of Wangu (2014) who determine that male students outperform their female counterparts in task completion, attendance and assertiveness. Meanwhile, the result also seems to reject the findings of some other scholars like; Orabi (2007), Dayioglu and Turut (2007), and Khwaileh and Zaza (2010) who have identified significant gender differences in the academic performance of students especially female students out-performing their male counterpart in task completion, attendance and assertiveness.

The findings also revealed that school type influences students' difficulty with electricity. The result of this study does not conform to the belief Olasehinde and Olatoye (2014) and Tooley and Dixon (2005) that in a private school, there is greater regularity of students in the class, having good facilities, like sufficient materials in the library and science laboratory, using modern technology, and actively involving the students in discussion.

Recommendation

Based on the above findings and conclusions, the following recommendations are made:

1. Teachers should identify possible misconceptions in each topic before the class so as to know how to present the lesson to the students.
2. Teachers should develop student's conceptual understanding before solving practical problems.
3. Teachers should make use of diagnostic test so as identify students' areas of misconceptions and difficulties
4. The teacher should engage the students in hands on activities during the class so as to have mastery and right conceptual understanding of the topic.

Conclusion

The aim of teaching and learning physics is not limited to writing and passing examinations but to preparing and equipping students with problem-solving skills which is one of the scientific attitudes. If the misconceptions of the learners are not diagnosed and corrected, the learners may not have an in-depth understanding and solve problems relating to the topic. Hence the new movement and ways of teaching and learning electricity and other concepts of physics in Senior Secondary Schools

should incorporate efforts that will solve problems related to students' misconceptions. Therefore, added to the role of physics teachers is the role of misconception diagnosticians and doctors who use the right strategy and methodology of teaching to solve the diagnosed misconception for a better understanding of the concept.

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Article 15

Analysis of Academic Performance Trends in Mathematics: A Study of
Tanzania's Certificate of Secondary Education Examination for Eight-Years
(2015-2022)

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Abstract

Mathematics plays a pivotal role in shaping students' future prospects, particularly in fields reliant on strong quantitative skills like engineering, computer science and accountancy. This study aimed to: determine the Mathematics trend enrolment in Certificate of Secondary Education Examination (CSEE) from 2015 to 2022, analyse performance trends in Mathematics during this period, examine mathematics failure rate trends, and project future pass rates in Mathematics for the next eight years, from 2023 to 2030. An ex-post facto research design was used whereby all students sat for CSEE for the specified years (2015 -2022) constituted a sample size. The analysis done using Statistical Package for Social Sciences (SPSS) revealed a consistent rise in student enrollment. The pass rate was low as it never exceeded 21% throughout this period, while failure rates consistently exceeded 78%. Furthermore, the study predicted that pass rates will continue to be low from 2023 to 2030. The study recommends provision of teacher training in pedagogical practices and assessment, review of mathematics curriculum, improving learning environments, and hiring mathematics teachers in schools.

Keywords: Academic Performance, Mathematics, National Examination Council of Tanzania, Certificate of Secondary Education Examination.

Introduction

Mathematics plays a crucial role in higher education, serving as the foundational language for various fields like engineering, computer science, and accountancy. Having a strong mathematical background from secondary education is essential for students to succeed in the aforementioned fields at the university level (Gravemeijer et al., 2017). It also prepares them for specialized courses in science, technology, and artificial intelligent, where advanced topics like calculus, linear algebra, and probability theory are necessary (Lamba et al., 2021). However, there have been concerns regarding the academic performance of students in mathematics in different countries in the world. The unsatisfactory trend of students' academic performance in mathematics has garnered attention worldwide. Numerous international assessments, such as the Programme for International Student Assessment (PISA), the Trends in International Mathematics and Science Study (TIMSS), and the International Mathematics Olympiad (IMO), have shed light on the performance levels of students in mathematics across different countries.

According to the PISA 2018 results, which assessed students' competencies in mathematics, science, and reading, several countries have consistently demonstrated strong performance in mathematics, including Singapore, Hong Kong, China, and South Korea (Lee & Borgonovi, 2022). But on the other countries, including Tanzania, students seemed not to achieve satisfactory results, indicating the need for comprehensive analysis and interventions to improve mathematics learning in schools.

In Tanzania, the Certificate of Secondary Education Examination (CSEE) serves as a critical evaluation of students' academic achievements at the ordinary secondary level. Mathematics is one of the core subjects assessed in the CSEE and holds significant importance for students' future academic and career prospects. It provides a foundation for further studies in the fields that require must pass in mathematics such as engineering, doctors, pharmacy, agriculture, accountancy and Information and Communication Technology (ICT) which are crucial for the country's scientific and technological development.

Students are not allowed to pursue the aforementioned fields when has scored "F" grade to continue with studies in the particular fields. Normally to be selected needs

students to have good performance in mathematics which serves him/her as one of the criteria to pursue these fields. In Tanzania the grades are "A", "B", "C", "D" and "F". The last grade is "F" which is the grade which makes students not to continue with studies measuring in the fields mentioned above while the remaining can be allowed while with "A" will have a highest chance to pursue the fields compared to other grades. Therefore, the current study sought to; determine the trend of students who sat for the certificate of secondary education examination in Mathematics from 2015 to 2022, analyze the performance trends in Mathematics among secondary school students in the certificate of secondary education examination from 2015 to 2022, analyze the mathematics failure rate trends among students in the certificate of secondary education examination from 2015 to 2022, and predict the future trend of student pass rates in Mathematics for the next 8 years, from 2023 to 2030 in the certificate of secondary education examination.

Research Questions

The study achieved the following research questions.

1. What is the pattern of students who sat for Mathematics in the certificate of secondary education examination from 2015 to 2022?
2. What is the trend in mathematics performance among secondary school students in certificate of secondary education examination from 2015 to 2022?
3. What is the trend in the mathematics failure rate in the certificate of secondary education examination from 2015 to 2022?
4. What will be the predicted trend of student pass rates in Mathematics in the certificate of secondary education examination over the next eight years, from 2023 to 2030?

Methodology

The study employed a quantitative research approach and an ex-post facto research design. This design helped to analyse the existing data from the National Examination Council of Tanzania (NECTA) website, which did not require data manipulation (Yin, 2018). The target population consisted of all students who registered for and took the CSEE from 2015 to 2022. Students' scores were obtained from the NECTA website and thus were valid and reliable.

Statistical Package for Social Sciences (SPSS) version 26 was used to analyse data where by descriptive statistics such as means, standard deviations, and frequency distributions

were computed. Furthermore, linear regression was used to predict the future trends of student pass rates in Mathematics for the next eight years, from 2023 to 2030.

Findings

Students' trend enrollment and sat for CSEE from 2015 to 2022

The first research objective was to determine the trend of students who sat for the Certificate of Secondary Education examination in Mathematics from 2015 to 2022. It revealed an increase in students who took the CSEE in Mathematics from 2015 to 2022, as shown in Table 1.

Table 1. Students sat for CSEE in Mathematics from 2015 to 2022

Year	2015	2016	2017	2018	2019	2020	2021	2022
Students	383,851	349,202	317,444	360,225	422,332	435,345	487,365	520,332

Source: NECTA (2023)

Table 1 suggests that the students' enrollment increased each year because the number of students who were administered to sit for the CSEE was increasing. There was an increase of 136,481 students from 2015 to 2022. This implied good improvement in students' enrollment in secondary schools for the specified years.

The analysis was further performed to find the means, standard deviation and variance, the results is shown in Table 2

Table 2. Mean, Standard and Variance of Students sat for CSEE

Duration (Years)	Mean	Standard deviation	Variance
8	409512.0	70076.9	4910766616.0

Table 2 shows the findings of eight-year period from 2015 to 2022, the mean number of students who took the Certificate of Secondary Education Examination (CSE) in Mathematics was 409,512.0, indicating the average enrollment over this timeframe. However, the substantial standard deviation of 70,076.9 signified notable year-to-year variations in student participation, with some years experiencing higher or lower enrollment than the mean. Additionally, the high variance of 4,910,766,616.0 implied the significant dispersion of enrollment figures around the mean, highlighting the presence of substantial deviations in student enrollments across the eight-year span. The number of students who sat for CSEE is also visualized in Figure 1

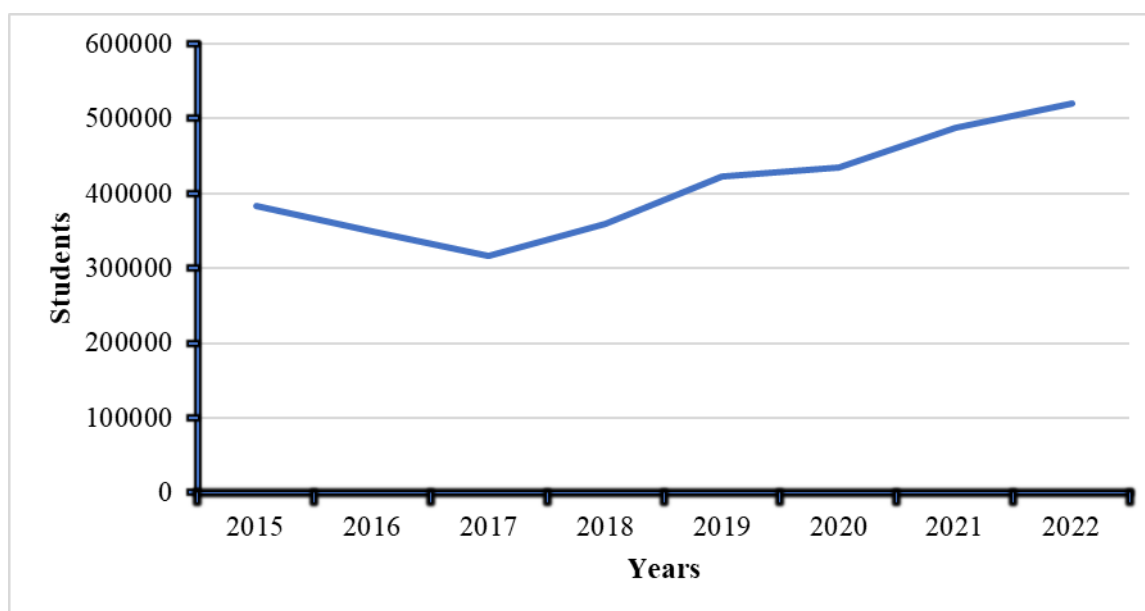


Figure 1: Students' trend enrolment from 2015 to 2022

Students' performance trends in CSEE from 2015 to 2022

The second research objective was to analyze the performance trends in Mathematics among secondary school students in the Certificate of Secondary Education Examination from 2015 to 2022. The findings revealed that students' pass rate was low, as it had never been higher than 21% for the specified years, as shown in Figure 2.

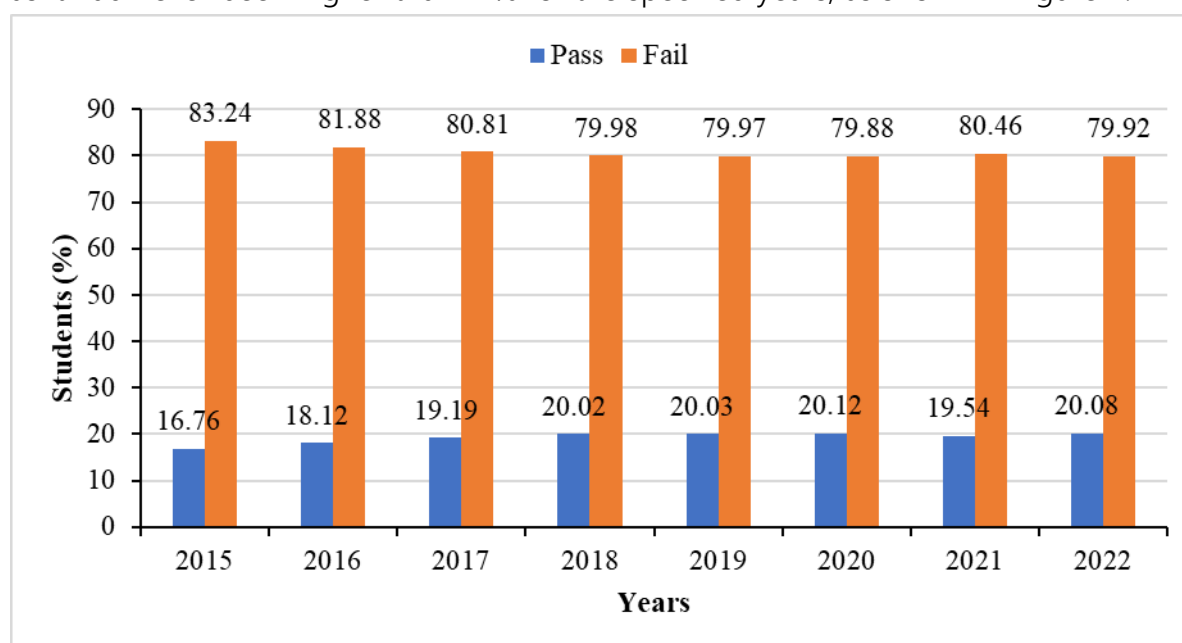


Figure2: Students' pass rate and fail

Figure 2 shows that for the specified years, 2015 to 2022, the majority of students (more than 78%) completed CSEE with poor mathematics performance. The analysis was

further performed to find the pass rate in terms of means, standard deviation and variance, the results is shown in Table 4

Table 3. Mean, Standard and Variance of Students' pass rate in CSEE in Mathematics

Duration (Years)	Mean	Standard deviation	Variance
8	19.2	1.2	1.5

Table 3 shows that mean pass rate in Mathematics for secondary school students who took the CSE from 2015 to 2022 was 19.2%. This value represents the average pass rate over the specified eight-year period. The standard deviation of 1.2 indicates the degree of variation in pass rates among students from year to year. A lower standard deviation suggests that pass rates had relatively less fluctuation over the eight-year period. The variance of 1.5 quantifies the extent of variability in pass rates. Less variance in pass rates suggests that the performance of students in mathematics in CSEE is relatively consistent over the given time frame of 8 years. It indicates that there is less fluctuation or inconsistency in the pass rates, and students' performance tends to cluster around a central value, which is the mean pass rate.

Students' failure rate in CSEE from 2015 to 2022

The third research objective was to analyze the mathematics failure rate trends among students in the Certificate of Secondary Education examination from 2015 to 2022. The magnitude of students' failure rate was high as shown in Figure 2

Figure 2 suggests that the magnitude of students' failure rate was from 2015 to 2022 was high. Despite the decreases in failure rate, for example, from 83.34% in 2015 to 79.92% in 2022, the magnitude remained high when compared to the pass rates.

Table 4. Mean, Standard and Variance of Students' failure rate in CSEE

Duration (Years)	Mean	Standard deviation	Variance
8	80.8	1.2	1.5

The mean failure rate in Mathematics for students who took the CSE from 2015 to 2022 was 80.8%. This value represents the average failure rate over the specified eight-year period. The standard deviation of 1.2% indicates the degree of variation in failure rates among students from year to year. A lower standard deviation suggests that failure rates had relatively less fluctuation over the eight-year period. A small variance of 1.5

among the failure rate of students for eight years means that the failure rates for students in each of these eight years are relatively close to each other and to the average failure rate. In other words, there is not much variation or difference in the failure rates from one year to the next within the dataset. A small variance suggests that the failure rates are consistent and stable over the eight-year period, with little deviation from the mean 80.8% failure rate.

Prediction the future students' trend pass rate for the next 8 years, from 2023 to 2030

The fourth research objective was to predICT the future trend of student pass rates in Mathematics for the next 8 years, from 2023 to 2030, in the certificate of secondary education examination. Linear regression analysis was conducted to predICT the future trend of students pass rates in Mathematics for the next eight years, from 2023 to 2030. The model summary is shown in Table7.

Table 5. Model Summary

Model	R	R ²	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	0.8	0.64	0.58	0.78	640

The R value of 0.8 indicates a strong positive linear relationship between the "Year" variable and the "Pass Rate (%)" variable. This suggests that the year can be a good predictor of changes in pass rates in Mathematics. The R Square (R²) value of 0.64 means that 64% of the variance in pass rates can be explained by the year variable in this predictive model. This indicates a substantial portion of the variance in pass rates is accounted for by the year variable. The adjusted R Square value of 0.58 adjusts the R Square value for the number of predictors in the model. It suggests that 58% of the variance in pass rates can be attributed to the year variable, while accounting for model complexity. The standard error of the estimate of 0.78 represents the average error or the degree of variability in predicting pass rates using the year variable. The findings revealed that students' pass rates will remain low for the next eight years as shown in table 8.

Table 6. Projected Students' pass rate in next 8 years, in the CSEE from 2022 to 2030

Year	2023	2024	2025	2026	2027	2028	2029	2030
Pass rate	21.01%	20.78%	20.32%	19.74%	19.66%	19.81%	23.86%	23.77%

Table 6 implies that low mathematics performance will persist for the next 8 years to come from 2023 to 2030.

Discussion

The study sought to analyse students' performance in mathematics in the CSEE for eight years from 2015 to 2022 and predict the future performance within the next eight years from 2023 to 2030. The study found that enrollment was consistently increasing; however, their performance remained persistently low. Throughout the specified period from 2015 to 2022, mathematics performance never exceeded 21%, as indicated in Figure 2. Additionally, a significant number of students continued to experience mass failures.

Moreover, the study indicated that in the next eight years mathematics performance will remain low making losing the students opting science related course in higher levels of education. Actually, this is a big problem as the majority of the students will not join science fields such as health education engineering, computer science and any other courses that require must pass in mathematics. This is consistency with past studies which found increased enrollment of students in science, technology and mathematics (STEM) subjects but with fluctuating performance (Onanuga & Saka, 2018; Sakiyo & Badau, 2015; Umoh, 2016). Probably the failure rate was attributed with STEM subjects being compulsory for all students at that level of education in line with UBE policy and their experiences at this level will determine their future enrollment (McDonald, 2016).

Also, in the current study showed that the students' performance in mathematics kept fluctuating and low as pass rate had never reached 21% for the selected years. This probably could be attributed by overloading students as the number of students found to increase each subsequent year. Probably the number of mathematics teachers has not matched with students increase. These findings are consistency with the previous years conducted in other countries (Bakasa, 2011; Bullard, 2011; Onanuga & Saka, 2018). In these studies, it indicated that students' size in classroom impacted students'

performance as teachers did not manage to handle the large class size. In fact, if the class size is very big, and the number of teachers are few it becomes very difficult for teachers to attend each students' learning needs. Due to increase of students' enrollment also tend to require more teaching staffs, additional teaching and learning resources.

Basically, the teaching and learning resources must increase with the number of increasing of students so as to make students have access and interact with the materials, if this is not done can lead to poor academic performance students cannot access the material on right time as they will need to share them.

The findings also predicted that in the next 8 years pass rate will be almost constant for years 2024 to 2025 while from year 2026 to 2028 will drop in the range of 19.66% to 19.81%. And in the years 2029 to 2030 the performance will start increase to 23.77%. Although the performance shown that there will be an increase yet this trend did not show good performance as the magnitude of failure is still high. For example, in 2029 the pass rate predicted to be 23.86% while in 2030 the performance predicted to be 23.77%. Despite showing improvement compared to previous years, yet the magnitude in failure is still big as was predicted failure rate to be 76.14% in 2029 and 76.23% in 2030.

Conclusion and Recommendations

Conclusion: The findings of this study has provided significant insights into the trends and patterns related to students' participation, performance, and failure rates in the Mathematics subject in the Certificate of Secondary Education Examination (CSEE) from 2015 to 2022, as well as a projection for the period from 2023 to 2030. It showed a consistent increase in the number of students sitting for the CSEE Mathematics subject from 2015 to 2022, indicating improved enrollment in secondary schools over these years. However, the pass rates remained alarmingly low throughout this period, with the majority of students failing to attain satisfactory performance. The pass rate has never exceeded 21% during the study period. High failure rates were a prevailing concern, with over 78% of students failing the subject each year. Although there was a slight decrease in failure rates from 2015 to 2022, they remained substantially high. The projection for the next eight years (2023 to 2030) indicated that low pass rates will persist, with no expectation of reaching even 24%

Recommendations:

The government should ensure frequent training programs are conducted to equip teachers with the updated skills and knowledge necessary to effectively teach mathematics particularly in the areas of pedagogical practices and assessment. Mathematics curriculum should be reviewed to eliminate irrelevant topics as the world keeps on changing. The government should ensure that students' learning environment are conducive by making teaching and learning materials available and classrooms accommodate the reasonable number of students in the class. Again, hiring mathematics teachers in schools is recommended to match with enrollments of students in schools as found in this study that students have been increasing almost in every year as shown in Table 1. Thus, this increase should also be reflected on the number of teachers in schools.

Teachers should identify students with difficult in mathematics at an early stage and provide them with targeted intervention and support. This can help prevent long-term academic difficulties. Heads of schools with the collaboration with school academic masters should make sure that they effectively monitor and follow up on each students' learning progress.

Limitations and Future research Direction

The analysis focused solely on enrollment, pass rates, and failure rates in Mathematics. Other factors influencing student performance, such as teaching quality and socio-economic factors, were not explored. Therefore, other studies should be conducted that could investigate a broader range of factors influencing student performance, including teaching quality, socioeconomic status, assessment practices and individual student characteristics. Also, comparative study with other regions or countries to identify best practices and potential solutions for enhancing Mathematics education should be conducted.

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Article 16

Exploring Effective ICT Integration Strategies in Education: A Case of Two Public Primary Schools in Mombasa, Kenya

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Abstract

The contemporary education landscape is undergoing a significant transformation, largely driven by the integration of Information and Communication Technologies (ICT). This paper explores the experiences of educators as they incorporate ICT into teaching and learning. The study was conducted in Mombasa City, Kenya, and utilized qualitative research methods, including in-depth interviews, focus group discussions, and classroom observations, in a case study design involving two urban primary schools. The research meticulously documented the experiences of 16 participants. The findings of the study highlight several advantages of using ICT in teaching and learning, including easy access to information, interactive and personalized learning opportunities, as well as collaboration. However, the data also revealed significant challenges faced by educators, such as unstable electricity, inadequate ICT gadgets, internet fluctuation, and Lack of skills to integrate ICT into teaching. Educators consistently stressed the importance of continuous support and professional development to enhance their ICT integration skills. Furthermore, the research emphasized several promising recommendations, including the Installation of alternative sources of electricity, sourcing for additional ICT devices, Supervising learners while using ICT gadgets, conducting professional development initiatives tailored to the creation of a collaborative community of practice (COP), which have the potential to effectively address these challenges. To fully leverage the potential of ICT for enriching the learning experience, equipping students with essential digital skills, and preparing them for a digital-centric world, educational institutions, and policymakers must prioritize investments in technological infrastructure, and foster a culture of innovation and collaboration among educators.

Keywords: ICT, ICT integration, computer, teaching, and learning

Background of the Study

In today's rapidly changing digital landscape, the integration of Information and Communication Technology (ICT) in education has become a crucial element of teaching and learning. As technology continues to reshape our daily lives, work, and communication, its role in education has become indispensable (Greenhow et al., 2022). The effective incorporation of ICT tools and resources has the potential to revolutionize the educational experience by increasing student engagement, expanding learning opportunities, and preparing students for the challenges of the 21st century.

ICT integration in education refers to the incorporation of digital tools, such as computers, tablets, software applications, and the Internet, into the teaching and learning process (Saal & Graham, 2023). It encompasses a wide range of practices, from the basic use of technology for administrative purposes to innovative approaches that redefine pedagogical paradigms. The significance of ICT integration lies in its potential to enhance educational outcomes by facilitating personalized learning, collaboration, and critical thinking (Farrokhnia et al., 2023): (Bruneau et al., 2023).

Greenhow et al. (2022) highlighted the responsibility of teachers to provide students with a strong foundation in modern technological knowledge, encompassing computer technology and various media forms. Hafifah (2019) also argues that integrating information and technology in the classroom can enhance students' understanding of the material and their ability to retain information. Additionally, Mamolo (2022) asserts that, when ICT is integrated into lessons, students become more engaged in their work due to the diverse opportunities for interactive and enjoyable teaching methods.

However, despite the potential benefits, the successful integration of ICT in education remains a complex and multifaceted challenge. Bhuiyan and Mollik (2023) from Bangladesh contend that educators worldwide face various obstacles that hinder their ability to fully harness the potential of ICT in their classrooms. This paper highlights challenges that educators encounter when attempting to integrate ICT tools and resources into their teaching methods.

This paper aims to answer the following research questions:

- (1) How do teachers perceive the integration of ICT in teaching and learning?
- (2) What strategies do teachers use for integrating ICT in teaching and learning?

- (3) What challenges do teachers encounter when integrating ICT in teaching and learning?

Literature Review

Information and Communication Technology (ICT) has now become an indispensable component of contemporary education, holding the promise of enriching the teaching and learning processes, stimulating student involvement, and equipping learners for the digital era (Das, 2019): (Naluwooza et al., 2023). Despite the widely acknowledged advantages of incorporating ICT in education, educators confront a multitude of obstacles when endeavoring to use these technologies to their fullest potential within the classroom setting. This literature review seeks to delve into the present state of research concerning the integration of ICT in education, with a particular focus on elucidating the difficulties encountered by educators and presenting potential solutions to overcome these challenges.

Benefits of ICT Integration

Numerous studies have underscored the advantages of integrating Information and Communication Technology (ICT) into education. For teachers, ICT can streamline administrative tasks, grant access to a wide range of educational resources, and provide opportunities for professional growth (Asrin & Utami, 2023): (Fernández-Batanero et al., 2022). A study conducted in Indonesia by Azizan et al. (2022) elucidated that students can reap the rewards of heightened engagement and improved digital literacy. Indah et al. (2022) supported this by noting that ICT enhances learning experiences through multimedia content and interactive tools.

A recent study conducted in South Africa by Nwosu et al. (2023) highlighted the advantages of using information and communication technology (ICT) in education. The research emphasized its application in academic settings and how support staff utilize various tools related to the Fourth Industrial Revolution (4IR). This utilization encompasses virtual or hybrid classrooms, artificial intelligence, feedback mechanisms, and access to educational materials. These findings were substantiated by a study carried out by Rodríguez-Jiménez et al., (2023), which demonstrated improvements in students' performance, motivation, and problem-solving skills when ICT was integrated into the classroom.

In Tanzania, Pima (2019) uncovered that teachers are motivated and willing to integrate ICT into their teaching methods. This willingness has the potential to lead to enhanced teaching practices and ultimately result in positive learning outcomes. Additionally, Macharia (2022) reported that the integration of ICT into primary education in Kenya has facilitated convenient access to information for both educators and students. Furthermore, it has fostered learner-centered teaching methodologies, making a substantial contribution to improved learning outcomes.

Generally, scholar posits that Integrating ICT into teaching and learning offers numerous benefits. However, it seems ICT integration in teaching and learning primarily benefits students whose teachers have access to ICT tools and resources. This leads to situations where some teachers can cooperate ICT in teaching and learning and thus benefit their students, while other teachers in an ICT scarce context fail to do so and therefore disadvantaging their students.

Perception of teachers toward ICT integration

A study conducted in Mombasa-Kenya by Nabangi (2021) states that utilizing gamification represents a highly effective method for instructing grammar. While the use of a gamification strategy prioritizes the needs of students and effectively maintains their focus, it is primarily feasible within affluent private schools that possess advanced Information and Communication Technology resources. Public primary schools face significant obstacles, as not all students can actively participate due to the absence of sufficient devices suitable for gamified teaching methods.

However, the success of ICT integration in teaching and learning does not only depend on the availability of ICT infrastructure such as computer labs, but it also calls for teachers with positive perceptions on ICT integration in education (Mwendwa, 2017).

It is evident that most teachers hold a favorable outlook on the integration of ICT into their teaching methods for instance a study conducted by Bakari and his colleague in Tanzania pointed out that 80% of teachers had positive attitude towards ICT integration in teaching and learning (Bakari & Ali 2023). Nonetheless, there exists a notable contingent of teachers who harbor a pessimistic view regarding ICT integration, perceiving it as an inefficient use of time within the teaching and learning process. This skepticism may stem from a fear of technology (technophobia) or the desire to adhere to a strlCT curriculum schedule.

Common Challenges in ICT Integration

Despite the potential advantages, educators face several challenges when integrating ICT into their teaching practices. These challenges are categorized into three main areas:

Technical Challenges in Education

Teachers frequently face a lack of the necessary technical skills and confidence required for proficiently utilizing ICT tools (Boonmoh et al., 2022). Additionally, issues related to compatibility, software glitches, and a shortage of adequate technical support pose significant barriers to the seamless incorporation of technology into the classroom setting (Aithal & Aithal, 2023). A study conducted in Uganda by Habibu (2012) revealed that teachers often lacked the essential ICT competencies essential for integrating technology into their teaching approaches, and they also experienced inadequate administrative support.

Despite the Kenyan government's proactive efforts to promote the integration of Information and Communication Technology (ICT) in the education sector, educators in the country encounter a multitude of challenges hindering their ability to meet this mandate. These obstacles encompass deficiencies in essential ICT training, the presence of unfavorable attitudes among teachers regarding ICT integration, and a lack of electrical infrastructure, particularly in rural primary schools, leading to difficulties in charging government-provided tablets (Mutisya, 2020).

Regardless of the technical challenges highlighted in the relevant literature, challenges differ from one school to another. Some schools possess ICT facilities but lack the required expertise, while others have well-trained teachers but lack essential ICT devices. It seems therefore that achieving effective ICT integration in the classroom necessitates the availability of both ICT resources and teacher training.

Pedagogical Challenges

In their recent study Lasito and colleagues highlighted pedagogical challenges as barriers in integrating ICT in teaching and learning (T/L) Lasito et al. (2023). Similarly, the research conducted in Tanzania by Ngao et al. (2022) underscores that teacher educators often lack the essential professional training required for seamless technology integration, leading to difficulties in incorporating technology effectively.

Barasa (2021) noted shortage of training is a significant barrier to the successful integration of ICT into teaching practices. When educators are not adequately equipped with the requisite ICT skills and knowledge, their confidence in utilizing technology in the classroom tends to be low. Consequently, they often refrain from integrating ICT tools and techniques into their teaching methods, thereby thwarting the potential educational benefits that ICT could offer.

Resource-Related Challenges

A study conducted in Rwanda by Harerimana and Mthali (2018) highlights that educators, especially in resource-limited settings, face substantial challenges due to inadequate access to ICT resources, including hardware, software, and internet connectivity. Additionally, the implementation of effective ICT strategies is impeded by funding limitations and budget constraints, as noted by (Gupta et al., 2022). In Kenya, research conducted by Lysenko et al. (2022) focused on the use of interactive technology for teaching mathematics in grade-one classes.

Generally, literature seems to indicate that there are various benefits in integrating ICT in teaching and learning, however, challenges also persist. The challenges seem to differ from one context to the next, and it seems these challenges may lead to discrepancies in the type and even the quality of education offered in the same country even though a similar curriculum is used. This paper will focus on the Kenyan context as a way of building on the existing body of literature on ICT integration in teaching and learning. The Kenyan context seems to indicate that integration of ICT in teaching and learning goes beyond the dichotomy of teachers having ICT skills or not, it encompasses systemic challenges which should not be brushed aside in the quest for effective ICT integration in teaching and learning.

Methodology

This study employed a qualitative research approach to investigate social and human issues within their specific contexts (Kyngäs, 2020). Specifically, a case design approach was utilized, offering researchers the invaluable opportunity to engage with respondents in authentic, real-world settings within selected schools (Gray, 2021). The study was conducted in Mombasa County, Kenya, specifically in the Mvita sub-county, with two public primary schools.

Within the scope of this study, the research population comprised a total of 16 participants, encompassing 10 teachers and 6 administrators. The selection process

involved the utilization of convenience sampling for the schools' selection and purposive sampling to identify the administrators and teachers. The latter category consisted of teachers who actively integrated ICT into their teaching methodologies.

To gather data effectively, the researchers employed three primary methods namely observations, interviews, and focus group discussions. The observational approach, facilitated by an observation checklist, was instrumental in collecting information concerning the presence and utilization of ICT devices and facilities in the selected schools. One-on-one interviews were conducted to extract insights from the six administrators, three from each of the chosen schools. To complement this, one focus group discussion per selected school comprising of five teachers each was initiated to capture the lived experiences of a total of ten teachers who shared their perspectives on the experiences of teachers while integrating ICT into their teaching methodologies.

The ensuing data from one-on-one interviews and Focus Group Discussions were meticulously transcribed, aligning with the predefined research questions and the findings from the existing literature review. Subsequently, these transcripts were systematically organized in conjunction with the data obtained from the observation guides. The data were methodically categorized and grouped, giving rise to discernible patterns and overarching themes. This comprehensive data analysis process culminated in a comprehensive and detailed description of the challenges encountered by teachers when integrating ICT into their teaching practices.

Findings and discussion

Benefits of Integration of ICT in Teaching

Enhances interactive learning, fosters critical thinking and retention of knowledge

Interactive learning methods, including hands-on experiments, simulations, and interactive technology, are effective in capturing the attention and interest of young learners. When students are engaged in such activities, they tend to be more attentive and enthusiastic about learning, which, in turn, promotes critical thinking. During an interview with teacher 5 school Y, integration benefits were highlighted.

"Interactive learning encourages students to actively participate in the learning process. They become involved in experiments, discussions, and problem-solving activities, which fosters a deeper understanding of scientific concepts".

Teacher 1 of school X had the following to say about advantage of ICT in classroom setting:

"... you know, ICT plays a pivotal role in improving collaboration and communication among students...this is achieved through its inherent nature of promoting group or pair work, which nurtures and enhances collaborative and communicative abilities".

Also, during the interview teacher 4 school Y was quoted narrating:

"Students can have high knowledge retention when they can see information instead of just hearing it."

Simplified, Personalized and Collaborated Learning.

ICT simplifies and personalizes the learning process by providing tailored resources and interactive tools. During a one-on-one interview, teacher 5 of school X also shared his thought by saying that:

"ICT in teaching simplifies learning by offering easy access to a wealth of information and resources online, making it easier for students to find relevant content and study materials. Additionally, it allows for self-paced learning, enabling students to progress at their own speed and revisit challenging topics as needed".

The deputy headteacher from the same school expressed their preference for using computer software material in simple teaching. He stated:

"Using projectors or computers in the classroom helps students learn more easily by providing them with a clear pICTure of what the teacher teaches. This reduces the need for teachers to expend excessive energy to ensure students understand the material".

During the interview with the senior teacher from school X, he also stressed the importance of integrating ICT into teaching and learning.

"I think there are some topics that you cannot teach theoretically, such as the topic of reproduction in science. Some teachers find that they are unable to teach about this subject, but if you use an ICT tool and the students see the lesson with their own eyes, their understanding will improve".

The concept of personalized learning is supported by educational research as noted by Kallick and colleagues that the recent movement toward personalized learning needs students to become more active in understanding and charting their learning pathways

(Kallick & Zmuda, 2017). Also, the study of Dukuzumuremyi (2014) shows that the use of technology promotes collaborative learning. All the teachers sampled for this study, speak to the afore cited scholarly work. They were able to explain the benefits of integrating ICT in teaching and learning. Thus, whether they effectively integrated ICT in teaching and learning or not is due to other factors but not because they do not know or see the significance of integrating ICT in teaching and learning.

Strategies teachers use when integrating ICT in teaching and learning

Projecting lessons using PowerPoint

The study reveals that among the techniques employed by teachers in ICT integration, one common strategy is the projection of their lessons. This method proves superior to the conventional teaching approach. Nevertheless, teachers still tend to be the focal point unless the lesson is prepared with a more interactive design. The statements below highlight the ICT integration techniques used in teaching and learning.

"I create my instructional materials using PowerPoint slides, which I subsequently display in the classroom using a projector..." (Teacher 2 from school X, who teaches grade 3 science).

A similar sentiment was shared by the senior teacher from school Y, who teaches grade 4 mathematics.

"Typically, when I have lessons that necessitate the use of ICT devices, I bring my students to the computer lab where I show video clips related to the topic I teach. While this approach makes the lesson more engaging, there is an issue with the size of the ICT lab, which is smaller than our regular classrooms, leading to overcrowding".

The use of animation

According to interviews with teachers, animation was used to explain topics like reproduction. Teacher 4 from school X expressed satisfaction when students grasp science concepts with the help of animations, as they make lessons enjoyable and enhance understanding. Teacher 1 from school X emphasized how animations visually present abstract concepts for better comprehension. Additionally, in a focus group discussion, teacher 3 from school Y highlighted that animations facilitate the

understanding of complex concepts and processes while also aiding in information retention.

The use of computer

Finding from Focus Group Discussion (FGD) about how teachers integrate ICT during teaching math's in the classroom, teacher 3 from school Y noted:

"I display the table of math by using computer to explain the concepts of numbers. I also use video from You-Tube to show my learners how students from other schools can do math".

Moreover, teacher 1 from school Y was asked about how she feels when she uses a projector in the class, she had the following to say:

"I hope my students understand better when I use a computer in the classroom. The computer makes it easier for me to teach ... for instance teaching I do not use a lot of effort to make the students grasp the contents".

The finding shows that projectors and computers are the gadgets that are mostly used in integrating ICT in teaching and learning. Mostly it is the teachers who engage with these gadgets and not learners limiting the acquisition of digital literacy skills for learners. What seems to be going on in these contexts is the use of ICT in teaching and learning and not ICT integration in teaching and learning. However, there are few teachers who engage learners and offer opportunities for learners to manipulate electronic gadgets. For instance, teacher in school X noted that:

"I use Whiteboards to teach basic math concepts like addition and subtraction. Students could physically interact with the board, dragging and grouping virtual objects to solve problems. This hands-on approach made learning more engaging and helped young learners grasp mathematical concepts more effectively".

Challenges faced by teachers in integrating ICT

Unstable electricity

The incorporation of ICT integration within educational settings necessitates the utilization of electronic devices that rely on a consistent and stable supply of electricity. Nevertheless, there are occasions when the reliability of electricity is compromised, posing a potential disruption to the seamless integration of ICT tools within the classroom environment. This issue was brought to light during a recent focus group discussion by teacher 2 school X.

"There have been numerous instances where I have diligently prepared my lessons, intending to deliver them using ICT tools to engage the students effectively. However, this plan is often thwarted by sudden power outages."

A challenge related to the availability of reliable electricity. Electricity. This was also shared by teacher 5 school Y who reported:

"My school uses pre-paid electricity. Sometimes the token is exhausted before the lesson ends disrupting the class. This is very embarrassing as the lesson is cut short".

Electricity outages are a critical problem that significantly hinders ICT integration, according to the replies that were gathered. Teachers cannot effectively employ ICT in their teaching practices when there is no electricity or when it is unstable. This aligns with the study by Sahoo (2020) and Shrestha et al. (2022) who cited lack of electricity as an impediment to online learning which is part of the use of ICT in educational settings.

Inadequate ICT gadgets

The research findings notably highlighted the deficiency of sufficient ICT devices as an additional impediment hindering teachers' efforts to effectively integrate ICT into their teaching practices. The researchers observed that in both schools there were some unused ICT devices in the computer laboratories while others were faulty. Additionally, during an interview with the head teacher at School X, she offered the following insights on this matter.

"Our school currently faces a significant limitation in terms of ICT resources. To put it into perspective, an average classroom at our school accommodates around 30 to 40 students. However, we possess only four tablets." for ICT use, which proves to be quite inadequate, especially when it comes to sharing these devices among larger groups of students".

The senior teacher from school Y added:

"During a lesson that incorporates ICT integration, students have access to a limited number of gadgets. Unfortunately, most of the tablets provided by the government are non-functional, leaving teachers with no choice but to rely on a single laptop and a projector for instructional purposes".

It seems despite the government's efforts to provide ICT gadgets, find facilities, and build ICT infrastructures in schools the challenge of limited, factional ICT devices persists, and unreliable electricity adds fuel to the flame.

Internet fluctuation

ICT integration and internet connectivity are inherently intertwined. However, the absence or interruption of internet access can disrupt the seamless utilization of ICT in the teaching and learning process. This concern was voiced by the headteacher from School Y during his statement.

"Frequently, we rely on data bundles or Wi-Fi for internet connectivity. Nevertheless, occasional occurrences of internet delays or outages can disrupt teaching activities".

This sentiment was also shared by teacher 5 from school X:

"I have noticed that occasionally, when I am streaming a video during my lessons, there is buffering, and it causes delays. It can be frustrating when this issue continues, as it results in an incomplete lesson, with the next one starting before you've finished teaching what you intended to cover".

This research discovered that a sluggish internet connection has an adverse impact on teaching, which corresponds with the findings of Flack et al. (2020). However, it is important to note that the latter study primarily concentrated on online learning.

Lack of Skills

The study has revealed that a deficiency in digital literacy skills poses a hindrance to the successful incorporation of ICT in the classroom, particularly among older educators. While these older teachers do incorporate ICT in their teaching practices, they often rely on the expertise of younger colleagues who are more proficient in ICT integration. In response to this issue, the deputy head teacher at school Y attributed it partly to age, although it can be ultimately attributed to insufficient training. Here is her perspective:

"Age presents a significant challenge when it comes to teaching ICT effectively. Personally, I find that my age hinders me from working with computers as swiftly as my younger colleagues. It often takes me a longer time to set up and connect the devices due to this factor".

The headteacher from school X during a one-on-one interview also pointed out that the lack of continuous professional development courses in using ICT to teach is a challenge that affects employing it in the classroom.

"The teachers received training on utilizing laptops and computers for teaching some time ago. However, technology is evolving rapidly, and some of our students are already well-versed in the latest advancements. Teaching effectively with ICT would be challenging without attending refresher courses to keep up with these technological changes".

The responses clearly show that a deficiency in essential skills has a detrimental effect on the integration of ICT in classrooms. Limited digital literacy skills pose challenges to the integration of ICT in teaching and learning. Li and colleagues noted that successful ICT integration necessitates that educators participate in Continuous Professional Development programs to stay updated on the latest trends in utilizing ICT for teaching and learning (Li et al, 2019).

Moreover, Murithi and Yoo (2021) argue that, even though many educators have undergone training in incorporating ICT into their teaching methods, there remains a necessity for ongoing professional development since a significant portion of them continue to struggle with ICT integration in their teaching practices. What is of concern is when teachers view ICT as a "thing" for the younger generation teachers. This kind of perception might lead to "withdrawal" where teachers give up trying or making efforts toward improving their technological pedagogical skills. Thus, we argue that negative views on ICT integration should not be ignored but rather they should be addressed.

Conclusion and recommendations

The findings of the research were quite remarkable. It revealed that teachers actively incorporate ICT into their teaching methods and acknowledge the numerous benefits it brings to the educational process. However, they also candidly highlighted certain challenges they face when integrating ICT into their instructional approaches.

One notable discovery from the study is that despite having received training on the incorporation of ICT in teaching and learning, teachers expressed a persistent need for additional training to enable them to effectively integrate ICT within the classroom setting. Data seems to indicate that one may have the knowledge but applying that knowledge to improve practice depends on the existence of conducive teaching and learning environment. Thus, we argue that effective integration of ICT in teaching and learning calls for a multifaced approach which brings on board different educational stakeholders from parents, government, national and international organizations.

Based on these findings, we propose several recommendations to mitigate these challenges effectively. Firstly, to address the issue of unstable electricity, we suggest that school leadership, in collaboration with the Board of Management (BOM), should engage various stakeholders to install alternative power sources such as solar panels and backup generators. This proactive step will ensure that lessons are not disrupted due to electricity outages, promoting uninterrupted teaching and learning.

Furthermore, addressing the scarcity of ICT devices necessitates the acquisition of additional devices from government sources, corporate entities, and philanthropic individuals. Schools can also encourage parents to permit students to bring their personal digital devices from home, implementing a Bring Your Own Device (BYOD) strategy. By doing so, even when students share devices, it will prevent overcrowding on a single gadget, enhancing accessibility.

Moreover, to tackle the issue of internet instability, schools should consider investing in Wi-Fi infrastructure or partnering with reliable internet service providers to ensure consistent and uninterrupted internet access. Achieving this objective may require collaborative efforts involving school administrators, parents, and local community leaders.

Finally, to address the issue of insufficient skills for effective ICT integration, teachers should consider enhancing their expertise by actively participating in Continuous Professional Development (CPD) programs. While the government occasionally organizes such refresher courses, teachers should not rely solely on government initiatives. Instead, they should take the initiative to acquire additional skills by sharing experiences, engaging in peer teaching, and seeking mentorship within a Community of Practice (COP).

In conclusion, by implementing these recommendations, we believe that teachers will achieve effective ICT integration, which will have a positive impact on teaching and learning. This, in turn, will contribute to learners acquiring digital literacy, one of the essential 21st-century skills advocated by the competency-based curriculum (CBC).

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Article 17

A reflection on the implementation of STEM approach in Mozambique

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Abstract

In actual society, characterized by systematic changes caused by the evolution of science and technology, the improvement of more challenging pedagogical practices based on contextualized and interdisciplinary approaches becomes fundamental to awaken curiosity and stimulate students' creativity in the teaching and learning process, science, and mathematics. This study aims to reflect on the implementation of the STEM (science, technology, engineering, and mathematics) approach in the Science and Mathematics classroom in Mozambique. The adopted methodology was characterized by a qualitative approach supported by a bibliographical review of the subject in study. From this reflection, the challenges in implementing this approach stand out: the lack of adequate teaching resources for curricular integration, the low participation of women and the limited capacity of the teacher to introduce teaching innovations and significant changes in curricular revisions, anchored to the development of transversal skills, considered fundamental for any citizen to face the challenges of the 21st century.

Keywords: STEM approach; Meaningful Learning; Creativity; Didactic innovation.

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1. Introduction

The challenges and systematic changes of the society we live in, lead us to reflect on teaching activities with a view to assuming contextualized and interdisciplinary approaches that contribute to student learning process in a significant way. For this to be effective, the learning space must be considered a place that accepts the unknown, trials and errors, encouraging collaborative work and critical thinking, and forming capable citizens both to respond to the challenges of the present and to overcome the demands of the future, with predictably complex, uncertain, and multifaceted contours.

The effective application of these approaches could help to break preferential asymmetries in scientific areas, as according to (MCTES, 2022), "currently, the majority of students do not prefer to study STEM areas, and the rate of students approved in the 12th grade until 2017 in the science area, was far from the scheduled goals".

The use of STEM approach in the classroom can stimulate significant changes in curricular revisions because it is anchored to the development of skills and abilities in a contextualized way, based on learning perspectives, on constructivism and social constructivism. (Santos & Silveira, 2021), giving students the opportunity to make decisions and evaluate results, through interdisciplinary projects that seek to solve real-world problems.

The teaching and learning of Science and Mathematics based on the STEM (science, technology, engineering, and mathematics) approach, becomes a transformative potential in the classroom, as it can increase student's protagonism and creativity, encourage innovation and collaboration, strengthening student's learning.

It is from this perspective that the aim of this study is to reflect on the implementation of the STEM approach in the Science and Mathematics classroom, to understand possible challenges faced when teaching, in a dimension of integrated approach that allows the development of essential skills for the 21st century.

A bibliographical research was used to carry out this study, based on materials produced by Anjo (2018), Moreira (2018), Lorenzin (2019), Correia (2021); (Batista et al., 2021) , Santos et al., (2022), MCTES (2022) among others. The adopted methodology was characterized by a qualitative approach.

2. STEM Education

The thought of STEM Education emerged around the 90s, in the United States of America, when there was a concern about, technological growth and students' lack of interest in pursuing scientific careers. With a view to boosting the economy and increasing competitiveness, the acronym STEM emerged in education, composed of the integration of knowledge of Science, Technology, Engineering and Mathematics, aiming to guarantee qualified labor in these segments, as a strategy coming from outside the school to the educational space (Batista et al., 2021).

STEM Education is an area of great relevance for the 21st century, since technological advances shape and improve the quality of life of individuals, inspiring a society connected with knowledge. These individuals need to experiment new ways of learning and improve skills that allow permanent investigations in their areas of activity with a view to learning about other fields of knowledge and acquiring new experiences.

Considered innovative for education, the STEM approach allows the content of STEM disciplines to be analyzed in an integrated manner with a view to arising students' interest in scientific disciplines, where the challenges of these areas are related to everyday life, (Ross, 2017).

This approach promotes interdisciplinarity and allows working simultaneously on several curricular areas, giving to students the opportunity to meet new and diverse concepts. Through STEM education, teachers and students can engage with the reality in which they are inserted, thus facilitating participation in projects, and solving real live problems that unite knowledge from the four areas of Science, Technology, Engineering and Mathematics.

Consequently, when reflecting on the STEM approach to teaching Science and Mathematics in Mozambique, we intend to understand how it is being implemented in schools, with a view to improving the quality of teaching and the engagement of students in acquiring knowledge in a meaningful way.

3. Implementation of the STEM approach in Mozambique

The STEM approach has been widely discussed and adopted around the world as a strategy to promote included and interdisciplinary teaching in these areas. The implementation of the STEM approach is a complex process within the educational

institution, and must involve the entire educational community and family, so that it becomes a permanent teaching component in the institution (Correia, 2021) .

In Mozambique, the implementation of the STEM approach began in 2006, with extracurricular activities in STEM through "Creating the Scientist of Tomorrow Program" of "Basic Sciences", designed by the then Ministry of Science and Technology and implemented in coordination with the Ministry of Education and Human Development (MINEDH) aiming, to motivate students to like mathematics and natural sciences, to identify and train talented young students in schools, preparing them to continue their studies or enter the job market in STEM areas (MCTES, 2022).

In accordance with the above source, the implementation of the program enabled the training of around 2315 teachers from General Secondary Education, Vocational Technical Education and the Teacher Training Institute in the areas of STEM, having contributed to stimulate the interest of students and teachers in STEM activities such as science fairs and robotics Olympiads, carried out through online platforms.

The curricular reform of primary and secondary education that predICTs the integration of scientific disciplines, through thematic axes, the initial and continuous training of teachers becomes urgent to equip them with skills to use the STEM approach in the classroom, given the teaching models to be implemented in schools.

From 2017 onwards, the STEM approach had a new boost with the development of initial and continuous training actions for Mathematics teachers, supported by technology, using GeoGebra, carried out by the GeoGebra Institute of Portugal and the Organization of Iberian States -Americans for Science and Culture Education (Santos et al., 2022). These actions enabled the creation and installation of the GeoGebra Institute at the Pedagogical University of Maputo, which develops actions to support science and mathematics teachers in the creation and implementation of STEM educational experiences.

The STEM approach favors creative and active learning, giving students the power to make decisions and evaluate results through interdisciplinary projects with everyday problems (Maia et al., 2021). Teaching based on this approach should allow the student to be challenged to seek the concepts necessary to solve certain problems, so that it is possible to develop autonomy, work as a team and be the protagonist of learning.

As known, this approach is concerned with linking knowledge from the four STEM areas in the process of solving a proposed challenge, in addition to stimulating cooperative work, exploring students' creativity and creating structures that represent the proposed themes (Corrêa, 2018).

The integration of disciplines in the STEM approach must go beyond the simple joining of different areas, constituting a challenge in the construction of dynamic and professionally constructive classes, as "the different perspectives of the disciplines constitute knowledge that enables a broad understanding of the concepts and innovation" (Lorenzin ; Assumpção; Rabello , 2015, p. 6). This integration has the potential to strengthen the overcoming of teaching fragmentation and support the perception of information in the construction of concepts.

Learning environments from a STEM perspective must enable learning through creativity, solidarity, collaboration, research, innovation, interaction and *maker culture* and *co-working*, Furr (2018). Hence, teaching science and mathematics from a STEM perspective should focus on solving problems related to the real world and developing skills, critical thinking and creativity for decision-making when faced with future challenges (Lorenzin, 2019).

For this teaching approach to happen successfully, Moreira (2018) recommends that an investment be made in the professional development of teachers in STEM areas, which involves changes in the role of the teacher, from transmitter of knowledge to facilitator of meaningful learning, to help students to identify and use relevant sources of knowledge to solve real-world problems.

In this new pedagogical proposal, the teacher has the role of mediator, creating learning environments that lead students to debate, experiment, collaborate and understand how to learn by reflecting and doing, since the focus of learning is centered on problem solving, cooperative learning, project-based or performance-based tasks.

It is from this perspective that the Ministry of Science, Technology and Higher Education (MCTES), in coordination with MINEDH has been implementing the teacher trainer training program (PCFP) in STEM since this year and scheduled for the period 2023-2025. This training has a view to positively influence the National Education System, providing teachers in STEM areas with the necessary skills to face the challenges of the 21st century, (MCTES, 2022). The training program will stimulate a taste for STEM areas

and ensure a better school-university-employment transition for students, especially girls, in STEM areas.

Eleven modules were produced with transversal thematic contents for the PCFP in STEM, 10 modules on transversal themes (Water I and II, Study of Ecosystems, Fauna and Flora, Sustainable Energy Sources I and II, Agricultural Production I and II, Waste solids, Pollution and Climate Change) and 1 module on educational robotics. This focus on several STEM areas and which will be explored in an integrated way, in order to allow their understanding and practical application in solving problems on a scientific basis, (MCTES, 2022).

The aim of this training is to introduce methodological approaches in Mozambican educational institutions centered on integrated teaching of different areas of STEM, from a perspective of solving everyday problems, based on creativity, critical thinking, formation of values such as solidarity, mutual respect, spirit of teamwork and friendship, (MCTES, 2022). As well as preparing and encouraging Science and Mathematics teachers to work with active teaching methodologies in STEM and ICT so that they feel prepared and motivated to use them with their students.

In this sense, it becomes pertinent to adjust the role of the teacher and, in turn, the student, so that skills in STEM areas are developed, through active and innovative teaching methodologies. Therefore, teaching Science and Mathematics from a STEM perspective requires teachers from different disciplines to collaborate to ensure that they are maximizing student learning, reinforcing similar concepts and information in different classes.

4. Results and Discussion

Though the STEM approach is promising in solving real-world problems through practical projects, it is still uncommon in Mozambique and faces some challenges in teaching Science and Mathematics. Ríordáin et al. (2016) state that the challenges of the STEM approach in Science and Mathematics Teaching may be associated with the following reasons: (1) the school curriculum is usually based on knowledge compartmentalized by several isolated subjects; and (2) teachers' lack of knowledge to articulate the various disciplines.

The first point is related to the fact that some educational institutions are guided by the fragmentation of subjects, where the themes and activities developed are restricted to

direct instruction from the teacher and textbooks. As for the second reason, it is essential that science and mathematics teachers understand the need to collaborate with others and have a predisposition to develop new teaching practices to face the challenges of the 21st century.

Thus, one of the biggest challenges of the STEM approach in Mozambique has to do with the fact that most schools do not keep up with technological and scientific transformations, pedagogical innovations, making science and mathematics teaching centered on a technical model, very far from reality. from the students. This challenge unfolds into the following:

a) Failure to meet approval and entry targets for higher education in STEM areas

The achievement of goals for students in the STEM areas, which is still far from desired, as according to MCTES (2022), until 2017 the pass rate of students enrolled in the 12th class was 15.67%. According to the source, these approval results in Secondary Education influence the entry rates of students in STEM areas in Higher Education, which until 2018 was around 15.15%, which is very far from the target set out in the 2012-2020 strategic plan which was 35% to 40% of students.

A diagnostic study on the obstacles that prevent the successful teaching of natural sciences and mathematics in secondary education in Mozambique, carried out by Anjo (2018), in the Provinces of Manica and Sofala, revealed that the low quality of teachers (lack of scientific knowledge on the subjects to be covered) influences students' learning results. Therefore, the continuous training of secondary school teachers in STEM areas becomes urgent to overcome barriers that may discourage student learning.

b) Training of science and mathematics teachers from the perspective of the STEM approach

Most of the science and mathematics teachers in Mozambican schools still do not have the appropriate training to implement the STEM approach effectively, which leads us to believe that the training of in-service teachers in subjects related to this teaching methodology becomes a challenge for the teaching and learning process. As mentioned (Santos et al., 2022) , although the training of teachers supported by technology, using GeoGebra , has taken place, their training has been slower, based on the assumptions of the processes initiated, and is still ongoing.

The lack of training and/or qualification can contribute to teachers' insecurity in integrating subjects and creating interdisciplinary projects, thus limiting the potential of this methodology, which justifies the need for initial and continued training of teachers in STEM subjects.

It is from this perspective that the training of teachers in the STEM areas is aimed at providing them with the necessary skills to face the challenges of the 21st century as well as improving the quality of initial and in-service training of teachers from different Education subsystems, (MCTES 2022).

It should be noted that the training of teachers in STEM will allow teachers to become familiar with integrated and interdisciplinary teaching, which is already felt in General Secondary Education programs where a given subject can be covered in thematic axes of different disciplines. Therefore, it is expected that the STEM approach will be consolidated in Mozambique in the near future, as Batista et al. (2021) , Correia (2021) statement this is the best approach to the challenges of the 21st century, at the risk of teaching not promoting transversal skills, considered fundamental for any citizen.

c) Curricular integration of STEM in the teaching and learning of science and mathematics

The integration of STEM areas in the teaching and learning process has the potential to develop learning, critical thinking, motivation, commitment and reasoning through solving problems related to the real world (Ríordáin et al., 2016).

From this perspective, the STEM approach requires, on the one hand, careful coordination between teachers in these areas to ensure that the projects to be implemented in the classroom are relevant and offer an enriching learning experience, becoming a challenge for teaching and learning science and mathematics. On the other hand, it requires a significant change in the way teaching is structured, as implementing the STEM approach is a complex process within the educational institution, and must involve the entire educational community and family, so that it becomes a permanent component of teaching in the institution (Correia, 2021) .

Considering that teachers are accustomed to traditional teaching practices, the adoption of new educational methodologies, such as the STEM approach, may encounter resistance within the school institution. Overcoming this resistance and promoting a change in culture at school can be a challenge.

However, understanding the need for collaboration between teachers in order to provide students with meaningful learning is fundamental, as according to (Nadelson & Seifert , 2017) not all teachers feel comfortable applying this methodology, as they are not familiarized with..

d) Low participation of women in STEM areas in Mozambique

The underrepresentation of women in STEM areas in secondary and higher education has been worrying for the Education sector in Mozambique. Lima et al., (2022) states that studies published in journals, reports and scientific events have denounced this situation both nationally and internationally. Bello & Estébanez (2022) state that there are several barriers that interfere with the massive participation of women in STEM areas, including: stereotypes, workload within families, sexual harassment and highlights the negative impact of these on retention and progression in studies.

With a view to reversing this scenario, Mozambique has some initiatives that aim to promote gender, increasing the presence of girls in STEM areas, despite being in small numbers. As an example, the Mozambique Scholarship Institute has annually launched scholarship notices for specific STEM areas for female students with a view to reducing gender inequality.

Final considerations

The STEM approach encourages the use of innovative educational methodologies and technologies to stimulate creative learning in students and give them a critical view of the globalized society in which we live. Its implementation in the classroom is fundamental for the development of students' skills and competencies, which can be applied not only in the school environment, but also in the job market and in everyday life.

The use of the STEM approach in schools can not only make the teaching of Science and Mathematics more attractive, dynamic, and relevant for students, aligning with the demands of contemporary society, but can also encourage women's participation in these areas. However, it is pertinent that the teacher moves from transmitter of knowledge to facilitator of knowledge acquisition, to stimulate creativity and innovation in the classroom as well as prepare students to face the challenges of the 21st century.

Nevertheless, interdisciplinary work teams must be developed that include teachers from different areas and different professionals from the community, to align the

curriculum with standards applicable to the STEM approach. To this end, it is essential to train teachers with in-depth knowledge and mastery of pedagogical skills specific to STEM areas to ensure excellent science and mathematics teaching, hence the need for continuous investment in the professional development of teachers in this area.

The effective implementation of the STEM approach in Mozambique also imposes on education professionals' curricular integration, through interdisciplinary teaching, consolidating the treatment of content by thematic axes in different disciplines, with a view to promoting more meaningful learning for students and allowing them to see the practical usefulness of the curricular contents.

In general, the study provided an insight into the challenges in implementing the STEM method in Mozambique, which can contribute to the educational debate, providing supports to improve pedagogical practices aimed at developing essential skills for today's world. However, overcoming these and other challenges generally requires coordinated efforts from MCTES and MINEDH, and from educational institutions and teachers to support the implementation of the STEM approach effectively.

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Article 18

Empowering the Next Generation through Innovative STEM Education



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Abstract

This research based in Nakuru examines cutting-edge teaching techniques with a focus on career promotion, mentorship, gender, inclusiveness, equity, and technology integration in order to address important concerns in STEM education. Even with advancements in educational access, persistent gaps continue, especially in STEM sectors where female representation is lower, requiring focused interventions. With 270 respondents (teachers, students, and administrators) from secondary and tertiary institutions, the study used a mixed-methods strategy that combines questionnaires, interviews, and in-class observations to provide thorough insights. The theoretical framework; fusing feminist pedagogy and social constructivism acknowledges the value of collaborative learning environments and empowers underrepresented groups. Notably, data from Nakuru schools underscore the difficulties experienced by female teachers and learners, highlighting the necessity of inclusive practices. Significant findings show that there is a professional development gap that affects the quality of education. The advancement of educators is impeded by inadequate mentorship and career development, particularly for women in STEM fields. Furthermore, technology integration shows promise as a driver for inclusive and interesting teaching.

The study's conclusion emphasizes the critical need for focused initiatives to reduce gender inequalities and improve inclusivity in STEM education in Nakuru. Strong professional development activities, increased mentorship programs, and the use of technology into teaching techniques are all advocated for in the recommendations. These steps are intended to create a climate that promotes fairness in education, gives every student support, and moves Nakuru's teachers closer to being world-class STEM educators.

Keywords: Innovative pedagogical strategies, STEM education, Gender disparities, Inclusion, Equity, Teacher professional development, Mentorship, Technology integration, educational access

Introduction

Background Information

Science, Technology, Engineering, and Mathematics (STEM) subjects are crucial in determining the future of education, given how quickly it is changing. The requirement of providing the future generation with a strong foundation in STEM education is growing more and more apparent as societies become increasingly reliant on technological breakthroughs (Falloon et al., 2020). However, there are some setbacks involved. The persistent underrepresentation of certain populations, especially women, in STEM fields is one of the major problems (Piatek-Jimenez, et al., 2018). Gender differences remain to prevail despite improvements in educational access, resulting in an uneven representation of women in STEM-related fields of work (Makarova, et al., 2019). This lack of diversity not only hinders individuals from achieving their full potential personally but also inhibits the capacity of society to innovate and solve problems across all sectors.

Additionally, in order to optimize a diversity of talent, STEM education ought to be inclusive and equitable. It should be equally achievable for students from all backgrounds, regardless of gender, ethnicity, or socioeconomic position, to engage in and succeed in STEM learning environments. Leverage innovative pedagogical approaches like Project-based learning, gamification, design thinking, mind mapping, augmented and virtual reality among others which go beyond conventional teaching techniques and address the many learning requirements of a diverse student body are needed to achieve this inclusion (Johnson, 2019).

In order to address the research challenge, building capacity in STEM education must also be emphasized. Teachers require continuous professional development to stay up to date with emerging educational approaches and technologies because they are the primary knowledge facilitators. In addition, career development programs, coaching, and mentoring are essential elements to help educators—especially women—active and succeed in STEM fields.

Furthermore, the use of technology in STEM education is shown to be a transforming force. Using technology to its full potential not only improves education but also captures the dynamic essence of STEM subjects. Effective technology integration calls for a planned strategy that takes diversity, relevance, and accessibility into account.

To summarize, the research problem centers on the necessity of empowering the next generation through creative STEM education by addressing gender disparities, encouraging inclusion and equity, facilitating professional development for teachers, offering coaching and mentorship, and judiciously incorporating technology into the classroom. With a focus on the big pIcTure, this approach aims to establish a setting where everyone, from all walks of life, can flourish and make a positive impact on the rapidly changing field of STEM.

Statement of the problem

To empower the next generation by addressing concerns like the persistent underrepresentation of women in STEM fields through innovative STEM education is of paramount importance. Gender disparities still exist in STEM fields, hindering diversity and collaborative problem-solving even in the face of increased educational access. The issue highlights the necessity of equitable and inclusive STEM education, necessitating creative pedagogical approaches that take into account a range of student backgrounds. Furthermore, the emphasis on capacity building acknowledges the critical role that continuous professional development for educators plays in advancing STEM education. It emphasizes the value of career development programs, coaching, and mentoring, especially for women in STEM fields. The research problem highlights the need for a strategic approach while highlighting the transformative potential of technology integration in STEM education. The study's overall goal is to establish a comprehensive atmosphere that encourages excellence and contributions in STEM fields, regardless of one's background.

Objectives of the Research

The study's objectives are as follows:

1. Investigate cutting-edge pedagogical strategies that promote diversity in STEM education.
2. Determine what kind of professional development STEM teachers require.
3. Look into the accessibility and availability of mentorship and coaching and career development for women in STEM
4. Evaluate how STEM education is currently integrating technology.

Literature Review

Pedagogical strategies that promote diversity in STEM education

In order to address gender bias and promote inclusion and equity, the changing conversation about innovative pedagogy in the educational setting will be explored. Acknowledging the diverse obstacles encountered by various groups, the research delves into the intricate aspects of creative teaching, specifically in relation to gender parity.

Gender bias draws attention to prevalent problems in classrooms, such as discriminatory teaching materials, unequal opportunities, and stereotyping (Kholmatova, 2022). Specifically, the underrepresentation of women in STEM fields is highlighted, highlighting the necessity of coordinated efforts to guarantee equity in academic endeavors (McGuire, 2020).

As a catalyst for change, innovative pedagogy challenges conventional teaching techniques and places an emphasis on student-centered learning, critical thinking, and active learning. Key strategies to mitigate gender bias are outlined in the discussion, encompassing specific approaches within innovative pedagogy such as technology integration, inclusive curriculum design, and active learning and collaboration (García-Peñalvo, 2019).

Williams (2019) presents case studies and promising practices from educational institutions implementing innovative approaches. These include the use of inclusive language and content, project-based learning, and the flipped classroom model. These illustrations show how creative pedagogy can effectively advance gender equity and inclusivity.

In conclusion gender bias can be addressed and equity can be advanced through innovative pedagogy, which has the potential to completely transform education. Academics, researchers, and legislators need to give equal opportunity and gender parity top priority when they investigate and employ cutting-edge teaching strategies. In the end, innovative pedagogy is viewed as a potent instrument to promotes a more equitable and inclusive learning environment where all students, regardless of gender or background, can succeed.

The study on the role of innovative pedagogy in promoting inclusivity and addressing gender bias is shallow in its examination of inter-sectionality, cultural background, and possible objections to these methods. It ought to explore long-term effects, teacher resistance, and student perspectives in order to provide a more thorough and nuanced understanding of the efficacy of innovative pedagogy in advancing equity in education.

Professional Development for STEM teachers

Teacher Professional Development (TPD) is an essential component of international education systems that includes a variety of activities meant to improve the knowledge, abilities, and competencies of teachers. Scholars like Philipsen et al. (2019), Danijela, M. (2018), and Kohli, R. (2019) emphasize the forms, approaches, and advantages of this approach, highlighting its significance.

TPD is essential to improving the standard of instruction because it helps teachers keep up with changing trends in education and subject matter expertise. In order to promote a positive learning environment, it guarantees that teachers are able to adjust to changes in curriculum standards, assessment techniques, and technological advancements. Additionally, TPD encourages students to pursue lifelong learning by having educators model the value of lifelong learning, instilling a growth mindset, and supporting continuous personal development.

A variety of formats and approaches of TPD are investigated, which includes online learning, peer collaboration, workshops, seminars, formal education and degree programs, and online learning. These pathways provide educators with options for expanding their knowledge and skill sets, whether via postgraduate degrees, short-term courses, online learning environments, or cooperative projects.

The correlation between continued professional development and improved teaching strategies is one of the many ways that TPD benefits students and improves their

outcomes. Additional advantages include classroom management, job satisfaction, and adaptability to technological advancements, all of which contribute to a more productive and driven teaching workforce.

Finally, it is believed that TPD investments are essential to the field of education. It gives teachers the ability to improve their teaching techniques on a regular basis, stay up to date on developments in education, and deliver instruction of the highest standard. Policymakers and educational institutions can have a positive knock-on effect that benefits teachers and students by promoting a culture of lifelong learning.

The debate surrounding Teacher Professional Development (TPD) does not adequately address potential problems or controversies, such as the efficacy of particular TPD models, the long-term effects on student learning outcomes, or potential differences in teachers' access to different TPD opportunities. Taking these factors into consideration would result in a broader viewpoint.

Accessibility and availability of mentorship and coaching and career development for women in STEM

According to Al Hilali et al. (2020), career development, coaching, and mentoring are vital components of both personal and professional growth in a variety of fields. A professional coach uses techniques like active listening and constructive feedback to guide individuals or groups (coachees) toward specific goals through a systematic approach. However, mentorship is a more sustained relationship in which a more seasoned mentor offers a less seasoned mentee comprehensive guidance with an emphasis on career advancement and skill acquisition.

Mentoring and coaching possess numerous advantages. By pointing out areas for development and assisting people in becoming more competent and self-assured, they promote the development of skills. With mentors offering guidance on career paths and coaches assisting in the successful accomplishment of career-related objectives, these practices promote career advancement. Furthermore, mentoring creates profitable networking opportunities by putting mentees in touch with powerful professionals and opening doors for partnerships. According to Keiler et al. (2020), mentoring and coaching promote personal development by improving communication abilities, emotional intelligence, and self-awareness.

Setting clear expectations, selecting the best coach or mentor based on relevant experience, identifying goals, and actively participating in the process are all necessary

when putting coaching and mentorship into practice. In the end, these techniques enable people to reach their greatest potential, confidently pursue their professional paths, and succeed in both their personal and professional lives. All things considered, career development, mentoring, and coaching are effective instruments for all-around development since they give people the direction and encouragement they require to succeed (Michailidi, & Stavrou, 2021).

Potential issues or controversies, such as the possibility of conflicts of interest in mentoring, variations in the effectiveness of coaching techniques, or the impact of these practices on individuals with different backgrounds, are not sufficiently explored in the conversation on coaching, mentorship, and career development. A more sophisticated understanding would result from addressing these factors.

The Integration of Technology in Education

The use of technology in education represents a significant shift in the approaches to teaching and learning. According to Farjon and Voogt (2019), technology integration is the deliberate application of digital tools, devices, and online resources to support educational goals. Blended learning, flipped classrooms, online learning environments, educational applications, and augmented and virtual reality experiences are some examples of integration strategies (Szymkowiak et al., 2021).

Personalized learning, engagement with interactive content, greater access to a variety of resources, improved student collaboration, and data-driven decision-making for educators are all advantages of technology integration. Learners can advance at their own speed with personalized learning, and engaging multimedia content makes learning more pleasurable and approachable. Technology makes it easier to access a multitude of information and encourages teamwork, which develops skills necessary for success in the modern workforce. Moreover, educators can customize interventions according to student performance with the help of data-driven insights (Emre, 2019).

However there are numerous concerns that require to be resolved, like inadequate infrastructure, unequal access to technology, the requirement for professional development for teachers, and worries about security and privacy. To fully utilize technology in education, it is imperative to ensure data privacy, bridge the digital divide, and provide sufficient training.

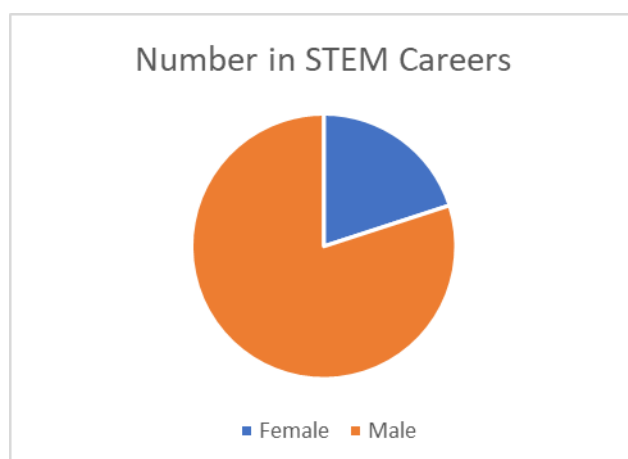
To sum up, technology integration has the potential to revolutionize education and equip students for the digital era. By overcoming obstacles and putting best practices into practice, educators can take advantage of the various ways that technology can be integrated into the classroom to improve student learning and set them up for success in the future.

Potential points of contention, such as the socioeconomic gaps that contribute to the digital divide and the ethical concerns encompassing data security and privacy, are not sufficiently explored in the discourse on technology integration. Furthermore, a more thorough analysis of how technology integration affects learning outcomes over the long run for students could improve the discussion's comprehensiveness.

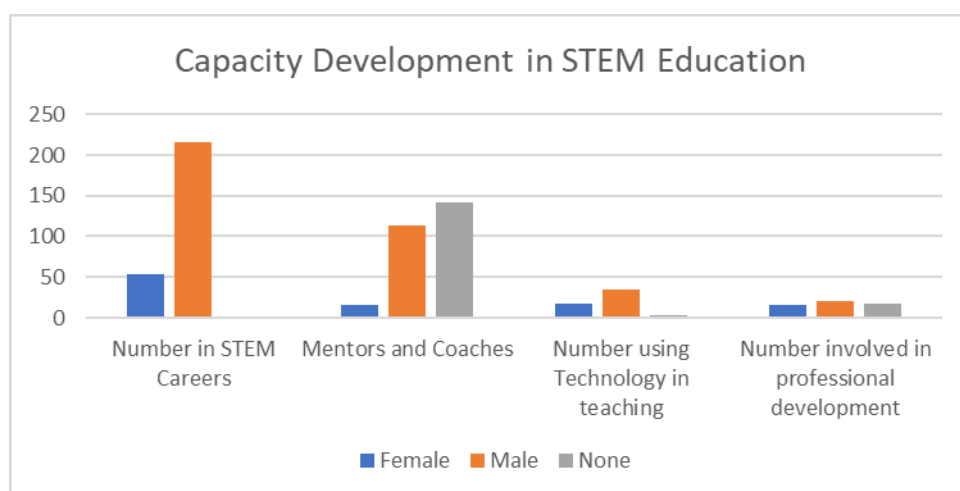
Research Design

The goal of this mixed-methods study is to thoroughly examine the opportunities and problems facing STEM education in Nakuru. Administrators, students, and the teachers in fields related to STEM are among the participants. Structured surveys will evaluate technology integration, professional development, and gender disparities during the quantitative phase. Innovative pedagogical approaches will be the main focus of the classroom observations. To gather complex viewpoints, the qualitative phase includes in-depth interviews and focus group discussions. While statistical analysis reveals patterns and correlations, thematic analysis identifies recurrent themes. By combining these data, a thorough grasp of Nakuru's STEM spaces will be possible, guaranteeing an objective and comprehensive investigation of gender issues, career advancement, mentoring, and technology integration. By providing targeted interventions, this strategy hopes to promote inclusive and equitable STEM education in Nakuru.

Results



There is limited representation of women in STEM Careers



In the graph depicting various indicators from respondents, 55 participants, exclusively teachers, reported on two indicators affecting their profession. The presence of grey color in the graph signifies respondents who reported no involvement in a particular indicator.

Category	Number of Respondents	Key Findings
Respondent Type		- Quality is impacted by the gap in professional development - Inadequate career development and mentoring, particularly for women in STEM fields - Possibility of promoting integrated and inclusive education
Teachers	55	
Students	192	
Administrators	23	
Teaching Techniques - Collaborative learning - Technology		

Integration		
Gender Representation • Female Teachers • Female Students		• The necessity of targeted actions to address gender inequality
Recommendation • Professional Development • Mentorship programs • Technology integration in teaching		• The significance of fostering an environment that encourages equity in education • Significant focus on reducing the gap in professional development • Greater emphasis on teacher mentoring programs, particularly for women in STEM • Promoting the use of technology in the classroom to increase student engagement and inclusivity

Discussion

The research indicates significant aspects of STEM education and highlights a significant teacher professional development deficit that may have an influence on the standard of instruction as a whole. This gap indicates that in order to improve students' learning experiences, Nakuru's educators need to be more knowledgeable about modern teaching techniques, especially in STEM fields. In addition, the study highlights the difficulties that women in STEM face when it comes to career development and mentorship, underscoring the need for specialized support networks to help educators in these fields advance professionally.

One important discovery is that technology integration is acknowledged as a key factor in inclusive and interesting instruction. This suggests that adding technology to Nakuru's classrooms could improve instruction while also making it more engaging and available to a wider variety of students. The ongoing difficulties that female educators

and students in Nakuru schools encounter serve as a stark reminder of the gender disparities that still exist in STEM education and the pressing need to address them in order to foster a more welcoming learning environment.

Similar analyses with currently available research indicate agreement with wider discourses regarding the necessity of ongoing professional growth, the obstacles encountered by females in STEM fields, and the advantageous effects of incorporating technology into education. The findings' implications urge focused educational policies, institutional adjustments, gender-responsive tactics, and cooperative initiatives to close gaps and advance equity, inclusivity, and top-notch STEM education in Nakuru. In conclusion, the study offers insightful information and supports targeted efforts to resolve issues and promote constructive modifications to Nakuru's STEM education environment.

Conclusion

The study highlights potential weaknesses in the current teaching approaches by revealing a clear professional development gap among teachers, particularly in STEM. A lack of mentorship can be detrimental to educators' career advancement, especially for women in STEM fields. One promising factor in the promotion of inclusive teaching is the integration of technology. Targeted interventions are desperately needed, as evidenced by the persistent gender gaps in STEM education.

In order to continuously improve Nakuru's STEM education environment, future research should carry out

1. Longitudinal studies to gauge the sustainability of implemented interventions.
2. Investigate cross-cultural elements impacting gender roles in STEM.
3. Analyze the efficacy of policy implementation and its impact in STEM.

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Article 19

Design and Implementation of Science and Technology Curriculum

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Abstract

Malawi Institute of Education is responsible to design and develop the primary school curriculum and support its implementation. Science and Technology which is currently in use was designed and developed between 2001 and rolled out in 2007. Malawi adopted Outcomes Based Education which focused on learner-centered pedagogy and continuous assessment for improving learner achievement. The reformed curriculum was supposed to be reviewed in 2015 at the end of the eight-year primary cycle to respond to the needs of the Malawian society. However, the curriculum has not been reviewed since. Hence the need for a review of the primary school curriculum. This study forms part of the needs assessment of the curriculum review process to establish areas to be maintained, identify areas to be removed in the curriculum, find out areas new content to be added, establish challenges faced when teaching the subject, explore assessment strategies to be maintained and determine challenges faced when assessing learners in Science and Technology.

The study took the qualitative approach and data was collected from teachers and data was collected using a Teacher questionnaire from 20 teachers from 10 schools in two educational districts, Blantyre Urban and Thyolo. The findings of this survey will contribute to the conceptualization of a new primary school curriculum in Science and Technology.

The main findings of the study include: maintaining all topics with practicality, and real-world applicability, removing topics that are sensitive, redundant, and with no resources, adding new topics with an aspect of practical skills, current issues, technological literacy,

and a strong academic foundation, lack of resources, large class hinder the assessment of the subject.

Keywords: Primary school, curriculum, science and technology

Introduction

Science and Technology is one of the subjects that is offered at the primary school level in Malawi. In Junior classes, Standard 4, is offered in combination with Agriculture, as *Agriculture, Science, and Technology*, and is taught in the local language, Chichewa while in Senior classes, from Standard 5 to Standard 8 it is offered as pure *Science and Technology*. Science and Technology forms the basics and foundation of science in the Malawian Education system. It's a combination of different learning areas which includes Biology, Chemistry, Physics, Technology, and Human ecology.

Malawi Institute of Education is responsible to design and develop the primary school curriculum and support its implementation. Science and Technology which is currently in use now was designed and developed between 2001 and 2009. The rationale for teaching Science and Technology in primary schools is that the subject contributes to the intellectual and practical development of the learners to enable them to manage the changes that modern science and technology, and indigenous knowledge bring to all sectors of the economy. In addition, it enables the learners, through investigation and inquiry, to understand the basic knowledge and skills of science and technology through practice so as to integrate their use in their daily lives both at home and school. Implementing a designed curriculum for primary science can be a complex and challenging task for teachers. Several obstacles can hinder their efforts to effectively deliver science education. Lack of resources can hinder the implementation of the curriculum, as Barman puts it, many primary schools, especially in low-resource settings, may not have adequate materials, equipment, or textbooks to support the curriculum (Barman, 2016). This can hinder teachers' ability to conduct hands-on experiments and engage students in practical science activities.

Another challenge can be a lack of Pedagogical and content Training. Arkerson et al points out that not all primary teachers have a strong background in science or pedagogical training in science education (Akerson et al., 2017). Inadequate training can make it challenging for teachers to effectively convey scientific concepts as the training

caters for all subjects taught in primary school and there is no specialisation especially in Malawian education system.

In addition, language barriers can hinder the effective implementation of the curriculum. Lee and Buxton explain that in multicultural classrooms, language differences can pose challenges in conveying scientific concepts effectively, especially for non-native English-speaking students (Lee & Buxton, 2019). This is the case for most African countries where English is a foreign language and teachers struggle to speak fluently, let alone interpret or transform scientific concepts in order to facilitate learning.

During curriculum review it is important to consult teachers on their views for the curriculum to be developed. As Darling-Hammond puts it, subject teachers are content experts who possess a deep understanding of the subject matter they teach. They have specialized knowledge and insights into the nuances of the subject, making their input invaluable for ensuring curriculum accuracy and alignment with academic (Darling-Hammond, 2017). Teachers have direct experience teaching the curriculum to students, as such, they understand how instructional materials and activities work in practice, enabling them to provide valuable feedback on the curriculum's effectiveness and suitability for diverse learner needs (McCombs & Miller, 2007). On the same, subject teachers are well-versed in effective pedagogical approaches for their specific subject areas. Consulting them ensures that the curriculum is designed with suitable teaching and learning strategies that can enhance student engagement and comprehension (Popham, 2017). In addition, Teachers are experts in assessing student learning therefore, they can offer guidance on appropriate assessment methods and tools that align with the curriculum's learning objectives, ensuring valid and reliable assessment strategies (Stiggins, Arter, Chappuis, & Chappuis, 2006).

1.2 Purpose of the study

The Ministry of Education (MoE) through the Malawi Institute of Education (MIE) has embarked on the process of reviewing the primary school curriculum. MIE carried out a number of activities as part of the review process of the curriculum. One of the activities was conducting a survey on primary schools, colleges, ministry of education departments and relevant stakeholders to find out their views of the current curriculum and their expectations on the coming curriculum. During the survey, the key respondents were subject teachers for various subjects including Science and

Technology. Consulting subject teachers on curriculum review is essential for developing high-quality, student-centered curricula that align with educational goals and standards. Their expertise, practical experience, and understanding of student needs contribute significantly to the success of curriculum development and implementation efforts. The findings of this survey will contribute to the conceptualization of a new primary school curriculum. The primary curriculum was last reviewed in 2009, and it is overdue.

1.3 Objectives of the study

The following were the objectives of the study:

1. Establish areas in Science and Technology subject to be maintained in the curriculum
2. Identify areas in Science and Technology subject to be removed from the curriculum
3. Find out new content to be added to science and technology
4. Establish challenges faced when teaching the subject
5. Explore assessment strategies to be maintained in the subject in the new curriculum
6. Determine challenges faced when assessing learners in Science and Technology.

2.0. Research design and methodology

The study took the qualitative approach and data was collected from teachers.

2.1. Sampling procedures

2.1.1 Sampling of schools

Two districts were sampled for the study of Science and Technology. These districts included Blantyre Urban and Thyolo. A total of 10 primary schools were randomly sampled for the study. The schools were from rural and urban settings.

2.1.2 Sampling of Respondents

At each school, Teachers from junior and senior classes were targeted, since Science and Technology subject is offered in these classes, only 2 teachers were involved in the study, one from the Junior section and the other from the Senior section.

2.2 Instrumentation

A questionnaire was developed to collect data from teachers of the sampled schools. The intention of the questionnaire was to collect information from the teachers about

the areas to be maintained, areas to be removed, challenges they face when teaching, aspects of assessment to be maintained, and challenges they face when assessing the students.

2.0 Findings of the study

3.1 Areas to be maintained in the curriculum

When the teachers were asked to mention the areas that should be maintained, Table 1 shows the response from the respondents.

Table 1: Topics to maintain

No	Area to be Maintained	Frequency
1.	Topics related to technology	10
2.	Food-related topics (Types of food, methods of cooking foods, etc)	6
3.	Scientific investigation	4
4	- Human Digestive system - Machines - Human Development	3
5	- Energy - Properties of light, heat, and sound - Managing weather - Good health habits - Nutritional deficiency diseases	2
6	- Forces - Livestock in the community - Reproduction - Growing up - Laundry - States of Matter - Seed germination	1

From Table 1, it is observed that *topics related to technology* received the highest frequency of responses (10), indicating that a significant number of respondents believe

that technology-related subjects should be retained in the curriculum, when asked why one respondent wrote

'modern technologies help learners to know how farmers can cultivate a large piece of land using technologies like tractors, ploughs, etc'

and another gave the reason that;

'Technological innovation assists learners to design new technologies for solving everyday problems'.

Food-related topics received the second-highest frequency of responses (6). This indicates that a substantial portion of the respondents see the value in teaching students about various aspects of food, which could include nutrition, cooking skills, and dietary habits, which as they indicated helps learners in their daily lives through cooking and appreciating the importance of eating a variety of food.

Scientific investigation topics received a frequency of 4, suggesting that some respondents believe that fostering scientific inquiry and research skills remains important in the curriculum. The other topics that were mentioned included the human Digestive system, Machines, and Human Development and each received a frequency of 3. This indicates that a moderate number of respondents find these topics valuable and advocate for their inclusion in the curriculum. These topics cover a range of subjects, including biology, technology, and human development, suggesting a diverse set of educational priorities.

A range of topics, including *Energy, Properties of light, heat, and sound, managing weather, Good health habits, Nutritional deficiency diseases, Forces, Livestock in the community, Reproduction, growing up, Laundry, States of matter, and Seed germination*, though not commonly mentioned as the top-ranked areas, still have advocates among the respondents, indicating that there is some interest in preserving these topics of the curriculum.

3.2 Topics to be removed from the curriculum

The study also sought to find out the topics or areas that should be removed from the syllabus and the reasons behind their choice.

Table 2 shows the findings from different respondents.

No	Topics to be removed	Frequency	Reasons
1.	Scientific investigation	7	Resource constraints and difficult to understand
2.	Dyeing	4	Resource constraints and difficult to understand
3.	Laundrying	3	Resource constraints
4.	HIV/AIDS	3	- Not age appropriate - Sensitive content - Curriculum redundancy - Not aligned with the core focus of science and technology education
4.	Parts of a plant Seed germination	2	- Lack of resources - More suitable for Agriculture
5.	Human reproduction Forces Vertebrates and invertebrates Machine Worm infection Family size Packed meals Methods of cooking	1	- Sensitive content - More suitable for other subjects - Resource constraints

From Table 2, the most frequently mentioned topic for removal is *Scientific Investigation* (7). Respondents cited resource constraints and the perceived difficulty for learners to understand as the primary reasons for its removal.

Dyeing is another topic frequently mentioned for removal (4). Similar to scientific investigation, respondents identified resource constraints and the complexity of the topic as reasons for its removal.

Laundering with a frequency of 3 was mentioned primarily for removal due to resource constraints. Respondents believe that the topic requires resources that may not be readily available in schools, making it challenging to teach effectively.

HIV/AIDS was also mentioned for removal from the curriculum with a frequency of 3 and respondents offered various reasons. Some respondents argued that the topic is not age-appropriate for the target learners, while others expressed concerns about the sensitive content associated with HIV/AIDS education. Furthermore, respondents mentioned curriculum redundancy, indicating that this topic might be covered in other subjects.

Parts of a Plant and Seed Germination with a frequency of 2 were suggested for removal primarily due to resource constraints. Respondents believe that the lack of resources makes it challenging to effectively teach these topics especially seed germination as it requires a refrigerator. Additionally, some respondents suggested that these topics might be more suitable for the Agriculture subject.

The following topics were mentioned once; *Human Reproduction, Forces, Vertebrates and Invertebrates, Machine, Worm Infection, Family Size, Packed Meals, and Methods of cooking* with various reasons for their removal, which includes sensitive content, more suitability for other subjects, and resource constraints.

3.3 New topics to be added

Another objective of the study was to find out what topics or concepts should be added to the new curriculum. The results of the findings are shown in Table 3.

Table 3: New topics to be added

No	New topics	Reason
1.	Production of Cooking Oil, Soap, Welding, Electrical and Electronics	Beneficial for learners in the future
2.	New Developing Diseases eg covid, new TB	To keep the curriculum up-to-date with current health concerns and medical knowledge
3.	More Practical Topics eg Phone Repairing and Shoe Making, Computer Use	For hands-on and experiential learning that prepares students for real-world challenges.
4.	Agro-Processing and Value Addition	To promote entrepreneurship and

		economic empowerment
5.	Atoms, Molecules and Blood Circulation	Will serve as a foundation for secondary school education
6.	Modern Technologies and Innovations	To prepare learners for secondary education in areas like Chemistry and Industry

From Table 3, the responses indicate a diverse range of suggestions for adding new topics to the curriculum, focusing on practical skills, current issues, technological literacy, and a strong academic foundation.

3.4 Challenges teachers face when teaching Science and Technology

During the implementation of the current curriculum, there might be challenges teachers faced when teaching. Table 4, shows the challenges most teachers face when teaching science and technology in primary schools.

Table 4: Challenges faced by teachers when teaching

No	Challenges faced	Frequency
1.	Lack of resources like books, apparatus, chemicals, laboratory	19
2.	Inadequate knowledge of the subject matter	4
3.	Lack of specialization or expertise	4
4.	Large classes	2
5.	Having the learner's book written in Chichewa while we teach in English.	2

Table 4 shows that lack of Resources is the biggest challenge when teaching science and technology. It is the most frequently mentioned challenge, with a frequency of 19. This indicates that many respondents face difficulties in teaching due to the inadequate availability of essential educational resources such as textbooks, scientific apparatus, chemicals, and laboratory facilities. This shortage of materials can hinder effective teaching and learning, especially in subjects that require hands-on experiences like science. Four respondents mentioned inadequate knowledge of the subject matter and lack of specialization or expertise as challenges. This suggests some teachers feel they lack a deep understanding and do not have specialized training or expertise in the

subjects they are teaching. This can be a significant issue as it may lead to suboptimal teaching quality and negatively impact students' learning experiences. Two respondents mentioned large class sizes as a challenge. Teaching large classes can be demanding for educators, as it can limit personalized attention to individual students and make it challenging to manage the classroom effectively. And lastly, language Mismatch (Chichewa vs. English), having the learner's book written in Chichewa while teaching in English is a challenge. There is a language misalignment between teaching materials and instructional language. Such a mismatch creates confusion for both teachers and students and hinders effective implementation of the curriculum.

3.5 Assessment strategies

Teachers were also asked to mention assessment strategies to be maintained in the current curriculum and the challenges they face when assessing the learners. The majority of respondents pointed out that the assessment strategies should be maintained, and these include formative and summative assessment which makes up the continuous assessment. They pointed out that continuous assessment should be maintained. Continuous Assessment in Malawi comprises two major components throughout the primary cycle formative assessment and summative assessment. Both components are based on assessment activities or tasks that relate to a learner's achievement of the outcomes. These tasks can include oral presentations, practical tasks, reports, research, tests, and examinations and can be carried out not only by teachers but also by learners (self-assessments), peers, parents, or other education stakeholders. (Primary school curriculum and assessment framework, 2009)

On the challenges, Table 5 shows the challenges faced by teachers when assessing the learners.

No.	Challenges faced when assessing learners	Frequency
1.	shortage of practical assessment resources	11
2.	The books contains mostly information questions not practical questions	3
3.	Language barrier	3
4	Large classes	2
5.	Too many tools for assessing the learners which are almost similar eg checklist and rubric	1

From Table 5, the findings reveal that shortage of practical assessment resources is the prominent challenge teachers face in assessing learners with a frequency of 11. Practical assessments are important for evaluating students' hands-on skills, and the shortage of resources hinder the ability to conduct such assessments effectively. Three respondents mentioned that 'books contain mostly information questions, not practical questions' this suggests that the assessment materials, such as textbooks or question papers, primarily focus on testing theoretical knowledge (information questions) rather than practical application. This misalignment between assessment content and the desired learning outcomes is a limitation. Three respondents highlighted language barriers as a challenge. This indicate that learners face difficulties in understanding assessment materials, for example in STD 4 the books are written in Chichewa while teaching is done in English. Two respondents indicated large class sizes as a challenge in the assessment process. Teaching and assessing a large number of students is demanding. It limits personalized attention and effective evaluation of each student's performance. One teacher was quick to mention that there are too many tools for assessing learners, and some of which are similar. The presence of numerous assessment tools that are similar in nature leads to confusion among teachers and most of their time is wasted in updating the assessment records rather than preparing for lessons. Streamlining assessment methods may be more effective.

4.0. Discussion of Findings and Recommendations

4.1 Discussion of Findings

The feedback from various teachers shows a range of opinions on what should stay in the curriculum, but there is a common interest in practicality, skill development, and real-world applicability. The study reveals that technology-related subjects, food-related topics, and scientific investigation are highly valued, and a significant portion of respondents suggest that they should remain in the curriculum. However, there is also a diversity of opinions, with various other concepts or topics receiving support from at least some respondents. These results highlight the complexity of curriculum decisions and the importance of balancing educational priorities and stakeholder perspectives when reviewing and revising curricula.

Sometimes, curriculum developers tend to include concepts that are difficult to implement due to resource, knowledge, sensitivity, or redundancy issues. The study indicates that resource constraints and perceived difficulty in understanding certain

topics, such as "Scientific Investigation" and "Dyeing," are significant factors influencing the desire to remove these topics from the curriculum. Additionally, concerns about sensitive content, age-appropriateness, curriculum redundancy, and alignment with the core focus of science and technology education were raised for topics like "HIV/AIDS" and "Parts of a Plant." Therefore, there is need for careful consideration and potentially revising the curriculum to address these challenges and concerns while ensuring a meaningful and effective learning experience for students. The findings emphasize the importance of teachers' involvement in suggesting what should be added to the curriculum. The study shows a diverse range of suggestions for which topics should be included in the new curriculum, with a focus on practical skills, current issues, technological literacy, and a strong academic foundation. These results underscore the importance of adapting the curriculum to meet the evolving needs of students and society while maintaining a balance between theory and practical application. It is evident from the study that teachers face several challenges when teaching science and technology. The most prevalent issues are related to resource shortages, particularly in science education. Additionally, some teachers have raised concerns about subject matter expertise and language mismatches. Shortage of resources, language barriers, and lack of knowledge hinder the effective implementation of the curriculum. Addressing these challenges is crucial to improving the overall quality of education and enhancing the learning experience for students.

Assessment is a crucial activity for teachers that needs to be well-planned with clear guidelines. However, there is often a gap between planned and actual implementation. Despite having well-planned procedures, the shortage of practical assessment resources poses a significant challenge in evaluating hands-on skills. Other challenges include the nature of assessment content, language barriers, large class sizes, and confusion caused by multiple assessment tools. This highlights the fact that primary school assessments are not being conducted as intended. It is essential to address these challenges to ensure that assessments accurately measure students' learning and skills.

4.2 Recommendations

- Malawi Institute of Education should include concepts that are technologically related, are practical, develop skills, have real-world application, and provide a strong foundation for secondary school science and it should avoid redundancy and sensitive concepts when reviewing the curriculum. The findings have

revealed that for better development of skills, there is a need to include concepts to do with technology, practicality, real-world applicability, and those that can enhance hands-on skills

- The Ministry of Education should provide teaching, learning, and assessment resources for primary science for effective implementation of the curriculum. The findings reveal that there is a shortage of resources for teaching, learning, and assessing learners in primary science.
- The Ministry of Education should ensure that teachers in primary schools specialize in teaching subjects; as reported, most teachers lack knowledge of the subject matter since training is not specialized.

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Article 20

Transforming Teaching and Learning: The Role of Item Analysis Feedback in Instructional Leadership in a Rural School of Central Province

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Abstract

This research paper investigates the transformative potential of instructional leadership in conjunction with item analysis feedback in a rural school located in the Central Province. The study explores how these components influence teaching and learning processes, with a focus on their impact on teacher planning, remedial work, and tailor-made professional development programs. In a dynamic educational landscape, the central question addressed is the extent to which instructional leadership, coupled with item analysis feedback, can catalyze positive change in a rural school setting. The research employs a comprehensive methodology that includes data collection through interviews, surveys, and observations. The findings reveal that item analysis feedback has empowered teachers to: 1. Strategize their teaching methods 2. Deliver tailored remedial work for learners and 3. Actively participate in tailor-made professional development programs. The implications of this study extend beyond the rural school of Central Province, shedding light on the critical role of instructional leadership and feedback mechanisms in improving teaching and learning. This research contributes to

the larger discourse on effective education in resource-limited settings, offering insights into how to optimize available resources for the betterment of learner outcomes. Ultimately, this study contributes to the importance of continued research in educational practices and leadership strategies for sustainable development in rural education.

Keywords: Instructional Leadership, Item Analysis Feedback, Rural Education

1. Introduction

In the realm of educational development, the capacity of school leaders and teachers to transform traditional schools into dynamic organizations that can effectively respond to standardized testing feedback marks a significant step in the evolution of school leadership practices. This transformation is often characterized by a shift towards data-driven decision making, which has been widely acknowledged by researchers and educators (Halverson et al., 2006). The initial stage in understanding this new instructional leadership involves recognizing its role in utilizing data to drive educational improvements. By focusing on data generation and analysis, educators can create actionable insights that directly impact school performance and pupil outcomes (Bernhardt, 1998; Holcomb, 1999; Johnson, 2002; Love, 2002).

The move towards data-driven decision making is pivotal in modern educational practices. It allows for a systematic approach where data is collected, analyzed, and used to make informed decisions about curriculum design, teaching strategies, and resource allocation. This paradigm shift requires that school leaders and teachers are equipped with the skills and tools necessary to interpret data effectively and implement changes that enhance educational quality. Consequently, understanding how to leverage data for school improvement has become a key component of instructional leadership.

1.1. Background

The push for data-driven decision making necessitates that school leaders reshape the central practices and cultures within their schools. This adaptation involves the intentional use of new data types, such as item analysis, to inform instructional

strategies. Item analysis is a method of evaluating pupils' performance on individual test items, which can provide detailed insights into their understanding of specific concepts. This process is critical for identifying areas where pupils struggle and require additional support.

The use of item analysis revolves around utilizing assessment data to make instructional decisions. Farber (2012) asserts that item analysis indicates the percentage of pupils getting a correct answer for a particular item in an achievement test. This data can highlight specific grade-level expectations that pupils have mastered or found challenging. According to Farber (2011;5), "if each item on an assessment is linked to a specific grade-level expectation, teachers can see which concepts individual pupils have mastered". This detailed feedback mechanism allows educators to tailor their teaching strategies to address the needs of their pupils effectively.

In this context, the role of instructional leadership is to guide and support teachers in interpreting and applying item analysis data to improve classroom instruction. This process not only helps in enhancing pupil learning outcomes but also contributes to the professional development of teachers by providing them with the tools and knowledge to use data effectively. The capacity of school leaders to facilitate this data-driven approach is crucial for fostering a culture of continuous improvement within schools.

Hence, this research aimed to investigate the strategies that the school leadership of a rural school in the Central Province of Zambia employs to connect assessment data to mathematics instructional approaches through the use of item analysis. By examining these strategies, the study seeks to understand the impact of data-driven decision making on teaching and learning processes in mathematics.

1.2. Purpose of the Study

This research paper investigates the transformative potential of instructional leadership when combined with item analysis feedback in a rural school in Zambia's Central Province. Specifically, the study explores how these elements influence the teaching and learning processes in mathematics, focusing on their impact on teacher planning, remedial work, and the design of customized professional development programs.

1.3. Significance of the Research

Given the current gap in teacher training programs in Zambia regarding data analysis skills and data-driven decision-making processes. This research is significant. It aims to provide insights into the nature of teachers' proficiencies in using data, which is crucial for offering appropriate training and support. This, in turn, helps teachers effectively use pupil data to inform instructional practices, ultimately enhancing the quality of education.

1.4. Research Questions

The research questions in this study were:

- a. How can item analysis data help teachers identify challenging topics in the mathematics classroom?
- b. How is item analysis data be used for teaching and learning Mathematics?

1.5. Theoretical Underpinnings

The theoretical framework guiding this research is deeply rooted in the concept of Pedagogical Content Knowledge (PCK), as introduced by Shulman (1986). PCK is a critical construct in understanding the effectiveness of teaching practices, especially in complex subjects like mathematics. It encompasses a teacher's understanding of how to present subject matter knowledge in ways that make it comprehensible to students. This involves not just knowledge of the content itself, but also an awareness of the most effective teaching strategies and an understanding of how students typically learn and perceive specific concepts.

PCK integrates several dimensions of teaching knowledge, including content knowledge, pedagogical knowledge, curricular knowledge, and knowledge of students. Content knowledge refers to mastery of the subject matter. Pedagogical knowledge involves understanding teaching methods and educational practices. Curricular knowledge includes awareness of how the curriculum is structured and how different parts of the curriculum interconnect. Knowledge of students involves insight into students' prior knowledge, misconceptions, and learning difficulties.

In the context of this study, PCK serves as a foundational theory to explore how item analysis can inform instructional strategies and professional development. The research investigates how teachers utilize item analysis to identify areas where students struggle and adjust their teaching methods to address these difficulties. This process directly relates to the PCK framework, as it requires teachers to apply their understanding of both content and pedagogy to improve student learning outcomes

2. Literature Review

This literature review explores the global, regional, and national perspectives on data-driven decision making, with a specific focus on item analysis as a tool for improving instructional practices.

2.1. Global Perspectives on Data-Driven Decision Making and Item Analysis in Education

Globally, data-driven decision making has emerged as a vital approach for enhancing educational outcomes. This method involves the systematic collection, analysis, and utilization of data to inform and improve teaching and learning practices (Mandinach, Honey, & Light, 2006). One specific form of data-driven decision making is item analysis, which examines student responses to individual test items to identify patterns of performance and areas of difficulty. Research by Black and Wiliam (1998) and Hattie and Timperley (2007) highlights that formative assessment practices, including item analysis, significantly enhance student learning by providing timely and targeted feedback.

Despite its recognized benefits, the implementation of item analysis globally is often hindered by challenges such as lack of teacher training and insufficient support systems. Brookhart (2010) emphasizes that for item analysis to be effective, teachers must be proficient in interpreting data and applying it to their instructional practices. This necessitates robust training programs and ongoing professional development.

2.2. Regional Studies on Data-Driven Decision Making in Africa

In Africa, the adoption of data-driven decision making and item analysis varies widely across countries. The African Union's Agenda 2063 emphasizes the importance of quality education for sustainable development, advocating for evidence-based educational practices (African Union, 2015). However, studies reveal significant barriers to the effective implementation of these practices.

Research by Ogunniyi, Jegede, and Ogawa (1995) in Nigeria highlights the potential of item analysis to improve science education but identifies significant obstacles, including inadequate teacher training and lack of resources. Similarly, Molefe, Stears, and Hobden (2005) found that South African teachers recognize the value of data-driven practices but often lack the necessary skills and support to implement them effectively. These regional studies suggest that while there is an awareness of the benefits of item analysis, practical challenges such as limited training and resources hinder its widespread adoption.

2.3. National Studies on Item Analysis and Data-Driven Practices in Zambia

Within Zambia, the Ministry of Education has underscored the importance of integrating data-driven decision making into educational practices to enhance teaching and learning outcomes (Ministry of Education, Zambia, 2019). However, the implementation of item analysis in Zambian schools is still evolving, with significant gaps in teacher training and resource availability.

While there is a growing recognition of the need for data-driven practices, there are few comprehensive studies specifically examining the use of item analysis in Zambian schools. This highlights a critical gap in the literature and underscores the need for research that explores how item analysis is being used to inform instructional strategies and professional development in this context.

2.4. Research Gap and Basis for the Current Study

While extensive literature exists on the general benefits of data-driven decision making and item analysis in education, there is a notable lack of comprehensive studies examining the specific application and impact of these practices in African countries, including Zambia. Most existing research tends to focus on broader educational

challenges or isolated case studies rather than providing a comparative analysis or detailed examination of item analysis implementation across different educational contexts.

This study aimed to fill this gap by providing an in-depth analysis of how item analysis is used to inform instructional strategies and professional development in a rural school in Zambia's Central Province. By focusing on the practical application of item analysis and its impact on both student performance and teacher professional development, this research seeks to contribute to the broader discourse on data-driven educational practices in Africa. The study aims to highlight the challenges and successes of implementing item analysis in a specific context, providing insights that can inform policy and practice in similar educational settings.

3. Methodology

3.1. Research Design

This study employs a mixed methods research design to investigate the strategies that the school leadership of a rural school in the Central Province of Zambia employs to connect assessment data to mathematics instructional approaches through the use of item analysis. Mixed methods research combines both quantitative and qualitative approaches to provide a comprehensive analysis of the research problem. By integrating these two approaches, the study aims to capture a holistic view of the effectiveness and impact of item analysis in educational settings.

3.2. Population and Sample

The target population for this study includes pupils and the mathematics teacher at the rural school. Specifically, the sample consists of all 28 pupils in the pure class and their mathematics teacher, making a total of 29 participants. This sample was chosen to ensure that the study could provide detailed insights into the instructional strategies and their outcomes within a specific educational context.

3.3. Research Instruments

The data collection for this study utilized multiple instruments to ensure a comprehensive understanding of the research problem. The instruments included two standardized published pupil achievement tests to measure pupils' performance in mathematics before and after the intervention. Additionally, interviews and observations were employed to gather in-depth qualitative insights into the instructional practices and experiences of the mathematics teacher and the pupils. These focus group discussions and teacher interviews provided rich qualitative data to complement the quantitative test scores.

3.4. Data Collection

Data collection was conducted in two phases. In the pre-intervention phase, baseline data were collected using the published pupil achievement tests to assess pupils' initial performance levels. This phase established a benchmark against which the effectiveness of the intervention could be measured. In the post-intervention phase, after implementing item analysis-based instructional strategies, pupils were re-assessed using the same achievement tests to measure any changes in performance. Additionally, interviews and observations were conducted to capture the lived experiences and perceptions of the teacher and pupils regarding the intervention. This dual-phase approach ensured a robust collection of both quantitative and qualitative data.

3.5. Data Analysis

The data analysis process involved both quantitative and qualitative methods. Quantitative analysis was performed using the t-test to compare the pre-intervention and post-intervention achievement test scores of the pupils, with a p-value of ≤ 0.05 considered statistically significant. This statistical method provided a rigorous examination of the intervention's impact on pupil performance. Qualitative data were analyzed using Interpretative Phenomenological Analysis (IPA), which was applied to the data collected from focus group discussions and teacher interviews. IPA helps understand individuals' lived experiences and how they make sense of them within their

personal and social contexts (Smith & Nizza, 2022). This method provided deep insights into the personal experiences and perspectives of the participants.

3.6. Ethical Considerations

Ethical considerations were paramount throughout the study. Informed consent was obtained from all participants, ensuring they understood the purpose and nature of the research. Participants' confidentiality and anonymity were maintained at all times to protect their privacy. The study adhered to ethical guidelines for conducting research with human subjects, ensuring no harm came to the participants. These measures were essential to uphold the integrity and ethical standards of the research.

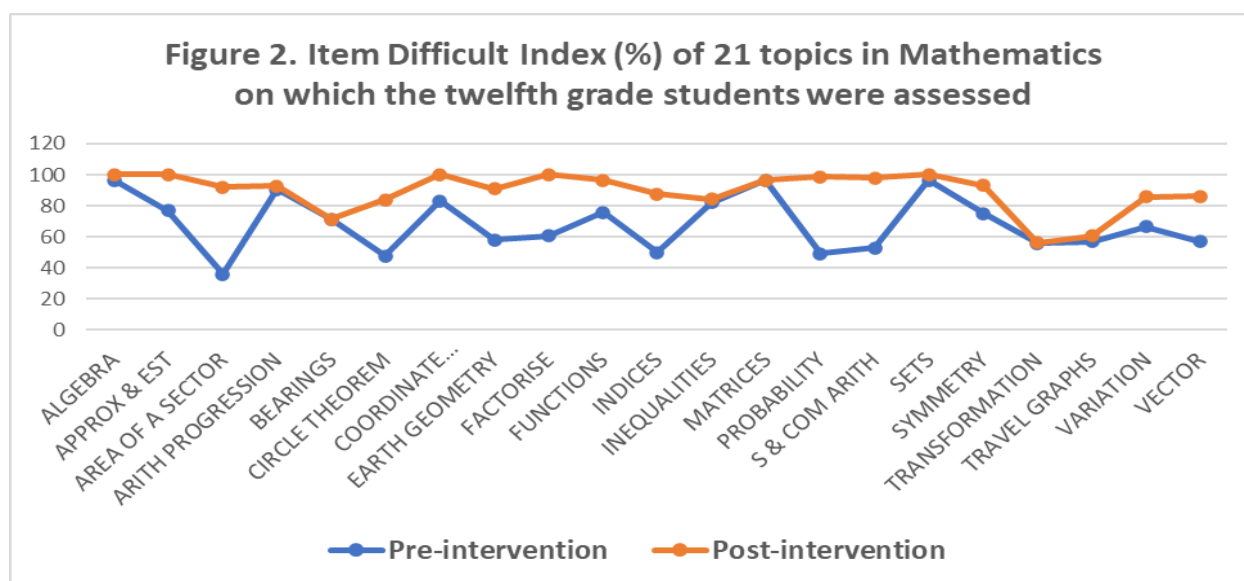
3.7. Limitations of the Study

The study had several limitations which included a small sample size, comprising 28 pupils and one teacher, which may limit the generalizability of the results. Additionally, the research was conducted in a single rural school in Zambia's Central Province, and the findings may not be applicable to other contexts or regions. Another limitation is the short duration of the intervention period, which may not fully capture the long-term impacts of the item analysis-based instructional strategies. Despite these limitations, the study provided valuable insights into the use of item analysis in educational settings and its potential benefits for instructional improvement.

4. Results

4.1. Analysis of Pre-Intervention and Post-Intervention Performance

Figure 2 illustrates the Item Difficulty Index (%) of 21 topics in mathematics on which the pupils were assessed.



The results indicate that during the pre-intervention phase, the performance data indicated that 9 out of 21 topics were below the 60% benchmark, making them particularly challenging for pupils. This highlighted the areas where pupils struggled the most and where instructional adjustments were necessary.

After differentiated instruction, which included re-teaching through collaborative learning and test-taking skills, there was a notable improvement in pupil performance. Post-intervention data showed that only 2 topics remained below the 60% benchmark. This marked reduction in the number of challenging topics indicates the effectiveness of the instructional intervention.

Statistical analysis further supports these findings. The post-intervention learners' achievement mean score ($M = 89.24$, $SD = 12.65$) was statistically significantly higher than the pre-intervention learners' achievement mean score ($M = 68.34$, $SD = 17.96$), with a t -value of 4.362, degrees of freedom (df) of 36, and a p -value of 0.0001. This significant difference demonstrates the positive impact of item analysis-based instructional strategies on pupil achievement in mathematics.

The results indicate that despite these strategic interventions, pupils still faced challenges in two topics. This persistent difficulty may be indicative of teachers' limited pedagogical content knowledge (PCK).

4.2. How Item Analysis Informs Instruction

The second result of the study examines how item analysis informs instructional strategies and continuous professional development (CPD) programs. Item analysis played a crucial role in identifying specific areas where pupils were weak and guiding the instructional focus.

A thick description provided by the teacher illustrates this process: *"After using item analysis, I identified areas where pupils were weak and then prepared a lot of questions on each problematic topic... Thereafter, I would re-teach a particular topic and re-assess the learners on that particular topic until they are able to answer all the questions... on that particular topic."* This approach allowed the teacher to target instructional interventions precisely where they were needed most, thus improving pupil understanding and performance on those specific topics.

4.3. How Item Analysis Informs Continuous Professional Development (CPD) Programs

The use of item analysis also informed the development of CPD programs. Effective teaching of mathematics is influenced significantly by teacher expertise in specific topics. The following thick description from the teacher highlights this point: *"Effective teaching of mathematics is a teacher factor... A teacher cannot be good in all the topics. Just like in universities, you find that you have a lecture in calculus, real analysis... so like vectors here in my school... there is one teacher Mrs. M who is an expert in vectors and I remember... After I taught vectors, my pupils were... still continued getting low marks."*

To address this, the teacher collaborated with a colleague who had expertise in the problematic topic. *"So, I asked Mrs. M to teach my class, while I would sit at the back of the classroom learning from her teaching... Pupils were then re-assessed and their scores were very high... Vectors is a thorn topic to most teachers in schools. So, the best that you can do is... there are teachers who are more knowledgeable and have expertise in problematic topics like vectors... make use of them... let them teach on your behalf."* This strategy not only improved pupil performance in the specific topic but also provided an opportunity for professional learning and collaboration among teachers.

5. Discussion

The findings from this study provide valuable insights into the effectiveness of item analysis-based instructional strategies and their impact on both pupil achievement and teacher professional development. The results indicate significant improvements in pupil performance following the strategic use of item analysis, yet they also highlight areas for further enhancement, particularly in the professional capabilities of teachers.

5.1. Improved Pupil Performance

The pre-intervention and post-intervention data reveal that item analysis can substantially improve pupil understanding and performance in mathematics. Prior to the intervention, 9 out of 21 topics were identified as being below the 60% benchmark, indicating significant areas of difficulty for pupils. This aligns with existing literature that underscores the importance of diagnostic assessments in identifying and addressing pupil learning gaps (Black & Wiliam, 1998; Hattie & Timperley, 2007).

The differentiated instruction that followed, which included re-teaching through collaborative learning and test-taking skills, resulted in only 2 topics remaining below the 60% benchmark. This reduction in the number of challenging topics demonstrates the effectiveness of targeted instructional interventions based on detailed item analysis (Brookhart, 2010). The statistically significant improvement in the post-intervention learners' achievement mean score ($M = 89.24$, $SD = 12.65$) compared to the pre-intervention mean score ($M = 68.34$, $SD = 17.96$) further supports the efficacy of this approach ($t = 4.362$, $df = 36$, $p = 0.0001$).

5.2. Persistent Challenges and Teacher Professional Development

Despite the overall success, pupils continued to face difficulties in two topics even after the intervention. This persistent challenge suggests that while item analysis can guide effective instructional strategies, there may be underlying issues related to teachers' pedagogical content knowledge (PCK) that need to be addressed (Shulman, 1986). Effective teaching requires not only an understanding of subject matter but also the ability to convey complex concepts in accessible ways, which is a core component of PCK (Ball, Thames, & Phelps, 2008).

The thick descriptions provided by the teacher highlight the role of item analysis in informing instructional practices. For instance, identifying weak areas and preparing focused questions for re-teaching specific topics illustrates a data-driven approach to instruction. This method aligns with formative assessment practices that emphasize continuous feedback and adjustment of teaching strategies to meet pupil needs (William, 2011).

Moreover, the application of item analysis extended beyond individual instruction to influence continuous professional development (CPD) programs. The teacher's collaboration with a colleague who had expertise in a problematic topic, such as vectors, exemplifies how item analysis can facilitate peer learning and professional growth. This approach is supported by research on collaborative professional development, which highlights the benefits of teachers learning from each other's expertise to improve instructional practices (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009).

The described practice of having an expert teacher demonstrate effective teaching strategies while another teacher observes and learns underscores the importance of mentorship and collaborative learning in professional development. It also addresses the challenge of varied teacher expertise, ensuring that pupils benefit from the highest quality instruction available (Garet, Porter, Desimone, Birman, & Yoon, 2001).

5.3. Implications for Educational Practice

The findings from this study have several implications for educational practice. First, they reinforce the value of item analysis as a tool for improving pupil achievement through targeted instructional interventions. Schools and educators should consider incorporating item analysis into their regular assessment practices to identify and address learning gaps effectively.

Second, the results highlight the need for ongoing professional development focused on enhancing teachers' PCK. Providing opportunities for teachers to collaborate, observe, and learn from each other can help address persistent challenges in pupil

learning. This approach not only improves individual teacher practice but also fosters a collaborative culture within schools, which is essential for sustained educational improvement (Desimone, 2009).

Finally, the study suggests that strategic interventions, while effective, need to be supported by a robust framework of professional development. This includes not only formal training sessions but also informal learning opportunities such as peer observations and collaborative planning. Schools should create environments that encourage continuous professional growth and the sharing of best practices among teachers.

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Enhancing Motivation of Secondary School Students in Physics Using Gamified Strategy in Ondo Metropolis, Nigeria

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Abstract

Education, yet students often find it challenging, abstract, and unengaging, resulting in low motivation. This study investigates the impact of gamification on the motivation of secondary school physics students. An intact class of Senior Secondary Students Two (SS II) participated, wherein gamified elements like storytelling, points, and levels were combined with clear instructional objectives to enhance the understanding of complex physics concepts. A total of 165 senior secondary school II Physics students from four schools were divided into groups: storytelling, points, and levels (84) and a control group (81). Three physics topics—force, motion, and friction—were gamified. The study adopted a pretest-posttest control group quasi-experimental design and tested two null hypotheses at a 0.05 significance level using Analysis of Covariance. The results revealed a significant main effect of treatment on students' motivation to learn physics ($F_{(2, 165)} = 14.44$; $p < 0.05$, partial $\eta^2 = 0.12$), with a substantial effect size of 12.3%. This means that 12.3% of the 64.0% variation in students' motivation towards Physics can be attributed to the significant impact of the treatment. Students reported that gamified instruction was enjoyable, exciting, highly motivating, and provided a positive learning experience. The study also revealed there was no significant effect of gender on students' motivation. In conclusion, the study recommends the incorporation of gamified elements into physics instruction in educational curricula, as they effectively boost student motivation, encourage sustained learning, and foster desired learning behaviours.

Keywords: Student Motivation in Physics, Gamified Strategy, Gamified Elements, Storytelling

Introduction

Physics is one of the vital subjects required for the economic improvement of any nation as it facilitates the development of information on the natural world (Erinosho, 2013). Consequently, Physics instruction and enquiry play a key role in the search of a country's development. On a more extensive scale, the degree of improvement of any country relies on the degree of its obtaining and use of mechanical developments which in turn cannot be accomplished without working knowledge of Physics (Mbamara and Eya, 2015).

In Nigerian colleges and tertiary institutions, Physics is one of the compulsory subjects for the study of engineering, innovation-related controls, medicine, and other applied science courses. Accordingly, the teaching and learning of Physics should be given due consideration across all degrees of education (Ojediran, 2016). The necessity of the subject for secondary school science students is such that no candidate can be admitted into any institution of higher learning to study engineering, medicine, pure and applied sciences, environmental science and technical education without a credit pass in physics. This is the reason Agommuoh and Ifeanchio (2013) affirmed that Physics is a core science subject that should be given a strong background from secondary school level of education to guarantee that students are equipped with applicable information, abilities and capabilities to pursue other science-related courses that are vital to the development and advancement of nations across the globe.

Regardless of the essential impact of Physics in general advancement of any country, the degree to which expected secondary school students opt for the subject at various degrees of schooling has been on the decrease (Adeyemo, 2010), and this has become a worrisome issue for scholars and other stakeholders in education. This attitude to Physics has extended to a higher level of education. Notably, in Nigerian colleges of education, the Physics department witnessed scarcity of students which has brought about the shortage of Physics educators in secondary schools in Nigeria (Erinosho, 2013; Adeyemo, 2010). In contrast with other science subjects like Biology and Chemistry, fewer students offer Physics at secondary school level, due to what they attribute to the instructional difficulties of the subject.

The dwindling capability of learners to perform as expected in Physics could be attributed to poor motivation to learn the instructional content while lack of interest in the subject matter can largely be associated with the teaching approach employed by teachers in the instructional delivery process. Teacher-centred method takes students far away from Physics concepts and many of them would not be able to apply the knowledge to solve personal and societal challenges in the future. Using the lecture method, as it were, makes Physics concepts abstract and unconnected to real-life situations. In this wise, students are be motivated to learn the instructional content and this could result in loss of interest in the subject matter. The challenge can easily be overcome with the appropriate use of technological tools or technology-based strategies that could motivate learners and stimulate their interest in physics. The application of ICT in physics instructions could help expand learning opportunities, access to educational resources, and facilitate the education process (Millerand Robertson, 2010). Different technology-based strategies like simulation, online instruction, and other interactive packages have been used to facilitate instructional delivery in Physics classroom. Many of these strategies are focused on the need to improve students' academic performance in Physics, especially at the secondary school level.

However, effective teaching and learning of Physics and Physics-related concepts transcend the issue of students having credit passes in internal and external examinations. The instructional content needs to be loaded with motivating components to stimulate students' interest and engage them with the content of the subject. This would lay a solid foundation to pursue this important subject at a higher level of education and perform better in internal and external examinations. It would also strengthen students' capabilities to effectively apply the knowledge and competence gained in the classroom to solve personal and societal challenges. With this step taken, Physics instruction becomes less abstract and more realistic because concepts are connected to real-life situations. Along these lines, spurring students to gain proficiency with the instructional substance could prompt improved students' interest in Physics. Hence, there is a requirement for an instructional-methodology that improves students' degree of motivation .One of the requirements that can be integrated in improving learners' ability is gamification. Werbach and Hunter (2012) define gamification as the use of game elements and game design techniques in non-

game contexts. It is based on the success of the gaming industry, social media, and decades of research in human psychology. Gamification is the application of game mechanics to non-game activities to influence people's behaviour (Bunchball, 2010). Zichermann (2010) defines gamification as the process of using game thinking and game mechanics to engage audiences and solve problems. The aim of gamification is also to engage users in an activity using different game mechanics and elements, including levels, game narratives, quests, progress bars and achievement systems. In the field of education and training, gamification is often deployed to engage students in learning activities by promoting learning, motivating action and helping them solve problems (Kapp, 2012). Gamification allows the use of game elements in instructional delivery. The game elements are the regular design of patterns used to design games. Some of these elements, sometimes described as components, as seen in most of the games nowadays, are points, badges, leaderboards, storytelling, progress bars/progression charts, performance graphs, quests, levels, avatars, social elements, and rewards.

Within the context of this study, the instructional contents were gamified with three game elements to motivate learners, arouse their interest and improve their performance in Physics at the secondary school level of education. These elements are storytelling, points and levels. Storytelling involves the presentation of instructional content in form of story. In the history of mankind and social development, storytelling is used as a tool for the transmission and sharing of knowledge and values, because it is a natural and powerful technique to communicate and exchange knowledge and experience. Behmer (2005) states that storytelling is a learning process that allows students to personalise what they learn and construct their own meaning and knowledge from the stories they hear and tell. Using stories in the classroom has been found to be of great importance to the growth of learners in educational pursuit (Lawani, 2014). People tend to make better sense of complex ideas, concepts, or information when it occurs via storytelling (Chung, 2006). In this context, Ibanez (2003) and Sadik (2008) maintain that storytelling can be used to enhance student's higher-order thinking and literacy skills, thereby increasing motivation and collaborative learning.

Points are one of the elements of games and gamified applications (Zichermann and Cunningham, 2011). They are typical rewards for the successful accomplishment of specified activities within the gamified environment and numerically represent a player's progress (Werbach and Hunter, 2012; 2015). One of the most important purposes of points is to provide feedback. Points allow the players' in-game behaviour to be measured, and they serve as continuous and immediate feedback and as a reward (Sailer, Hense, Mandl, and Klevers, 2013). Gåslund (2011) asserts that students find a points-based gamification system somewhat motivating and quite engaging. This motivation may be due to the fact that points provide learners with instant feedback and recognition for the completion of an activity or task (Mekler, Bruhlmann, Opwis and Tuch 2013a). A game element like points could be used in combination with other components like level to motivate and engage physics students in instructional content. Levels allow a game to be divided into small, separate, attainable pieces and moving up to the next level is often a strong motivator of continued effort (Gåslund, 2011). To implement levels, users must gain points. After gaining a predetermined number of points, users move up a level. Generally, 'levelling up' confers some sort of in-game benefit (Goehle, 2013). Levels positively impact student motivation and engagement. With this in mind, this study investigates the effects of gamifying physics concepts on students' motivation towards Physics within Ondo metropolis, Nigeria.

Hypotheses

Ho1: There is no significant main effect of treatment on students' motivation in physics

Ho2: There is no significant main effect of gender on students' motivation in physics

Methodology

The study was a quasi-experimental pre-test, post-test, control group design. The pre-test was to establish the knowledge baseline of the students used for the study while the post-test examined the possible effects of gamification moderated at two levels. Storytelling, points, levels strategy on senior secondary school II students' motivation in Physics. The design of the study is represented as follows:

O₁ X₁ O₂

O₃ X₂ O₄

X₁ represents storytelling, points, levels strategy (Experimental Group)

X₂ represents the conventional strategy (Control Group)

Where O_1, O_3 , represent pre-test measures for experimental and control group

Also, O_2, O_4 , represent post-test measures for experimental and control group

Two senior secondary schools were purposively selected for the experimental group, while two schools were randomly selected for the control group. This makes a total of four schools that was selected within Ondo city for the study. Intact class of SS II Physics students was used in the selected schools. A total of 165 senior secondary school II Physics students in six schools was assigned to storytelling, points and levels (84) and control (81) groups were used for the study since they were not preparing for any terminal examinations. Gender was used as moderating variable to examine their moderating effect on the learning outcomes.

This instrument was adapted from the instructional materials motivation survey (IMMS) by Keeler (2010). The instructional materials motivation survey (IMMS) instrument has been used to measure learners' motivation. Section A deals with demographic information of the respondents. Section B aims at assessing the motivation of students in the use of instructional materials but it was adapted to learning of Physics with 25 items.

The gamified package incorporates storytelling, points, and levels as critical game elements to teach difficult concepts in Physics. The package began with instructional objectives before the content of the package. There were class activities within the package to engender active engagement and mastery of the contents during instructional delivery. The storytelling element uses traditional stories of the animal kingdom to demystify abstract Physics concepts, the point elements increases as they proceed with the tasks given, they will be motivated to complete the tasks, Levels element is responsible for students' progression in terms of levels.

RESULTS AND DISCUSSION

Testing of Null Hypotheses

Ho1: There is no significant main effect of treatment (instructional strategy) on students' motivation towards Physics

Table 1: Analysis of Covariance (ANCOVA) of Post-Motivation by Treatment and Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10682.453	12	890.204	29.808	0.000	.635
Intercept	2915.593	1	2915.593	97.628	0.000	.322
PreMotivation	9221.234	1	9221.234	308.771	0.000	.600
Treatment	862.304	2	431.152	14.437	0.000*	.123
Gender	97.009	1	97.009	3.248	0.073	.016
Treatment x Gender	0.427	2	0.214	0.007	0.993	.000
Error	6152.049	206	29.864			
Total	1206183.000	219				
Corrected Total	16834.502	218				

R Squared = 0.64 (Adjusted R Squared = 0.61) * denotes significant $p < 0.05$

Table 1 reveals that there is a significant main effect of (treatment) on students' motivation to learn Physics ($F_{(1, 165)} = 14.44$; $p < 0.05$, partial $\eta^2 = 0.12$). The effect size is 12.3%. This shows that 12.3% of the 64.0% variation (Adjusted $R^2 = 0.64$) in students' motivation towards Physics in this model is due to the significant main effect of the treatment. Hence, hypothesis 1 was rejected. To explore the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups were carried out and the result is presented in Table 2

Table 2: Estimated Marginal Means for Post-Motivation by Treatment and Control group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Storytelling, Points and Levels Strategy (SPLS)	78.63	1.03	76.60	80.66
Conventional Strategy (CS)	69.71	1.29	67.16	72.26

Table 2 indicates that students exposed to Storytelling, Points and Levels Strategy (SPLS) treatment group 1 had the highest adjusted post-motivation mean score to learn Physics (78.63) than the Conventional Strategy (CS) control group (69.71). This order is represented as $SPLS > CS$. In order to determine which of the groups caused

the significant main effect, the Bonferroni post-hoc analysis was carried out across the treatment groups and the result was presented in Table 3.

Table 3: Bonferroni Post-hoc Analysis of Post-Motivation by Treatment and Control Group

Treatment	Mean	SPLS	SLBS	CS
Storytelling, Points and Levels Strategy (SPLS)	78.63			*
Conventional Strategy (CS)	69.71	*	*	

Table 3 reveals that the post-motivation towards Physics mean score of students exposed to Storytelling, Points and Levels Strategy (SPLS) was significantly different from those taught with the Conventional Strategy (CS). Table 3 also reveals that the post-motivation to learn Physics mean score of students exposed to the Storytelling, Points and Levels Strategy is significantly different from their counterparts in the conventional strategy. This indicates that the significant difference revealed by the ANCOVA summary is due to the result of the difference between the treatment group and the control group (conventional strategy).

The findings from the study indicated that there was a significant main effect of treatment on SS II students' motivation in Physics and control groups. This implies that gamified strategy has significant effect on students' motivation to learn Physics. In other words, students who were exposed to this strategy had highest post-motivation to learn Physics than students in the control group. The inherent potentials of gamification to actively engage students and stimulate their interest could have been responsible for their motivation towards it after the treatment. From these findings, gamification has proven to actively motivate students and stimulate their interest and could result in improvement in students' motivation to learn Physics. The findings support the research done by Rose (2015) on introductory physics course and made Life Science students to undergo tests using gamified multiple-choice quizzes against a control group. Strong evidence was found to support the hypothesis that students taking gamified quizzes have higher levels of motivation than students taking more traditional quizzes. This corroborates the findings that students placed in a gamified instructional setting showed signs of significant Improvement in student motivation (Grimley et al., 2011; Grimley et al., 2012; Banfield and Wilkerson, 2014). The result is in support of findings by Kuo and Chuang (2016), Mekler et al. (2017) and Hamari (2013). The findings of the

study showed that effects of individual game elements significantly increased academic performance and user's motivation. This is contrary to the findings of Hanus and Fox (2015), De-Marcos et al. (2014) and Ahn and Butler (2014) which showed mostly negative results from gamifying an educational course which found out that students in the gamified course showed less motivation and had lower academic achievement than students enrolled in the non-gamified version of the course. Elements of gamification contribute to increased engagement and motivation for some students; however, these elements cannot stand alone (Deterding, 2014; Gåslund, 2011; Mekler et al., 2013b). Kotluk and Kocakaya (2016), in their study, affirmed that digital stories have positive effect on secondary school students' motivation towards Physics.

Ho2: There is no significant main effect of gender on students' motivation to learn Physics

Table 1 reveals that there is no significant main effect of gender on motivation to learn Physics ($F_{(1, 165)} = 3.25, p > 0.05$; partial $\eta^2 = 0.02$). Hence, hypothesis 2 was not rejected. This suggests that students' gender did not have a discernible impact on their motivation in Physics. It is plausible that the gamified treatment provided equal and conducive learning conditions for both male and female students, enabling active participation in the learning process. These results align with prior research findings by Akingbemisilu (2017), Adedaja and Fakokunda (2015), Oguntunde (2014), Efuwape and Aremu (2013) as well as Aremu and Morakinyo (2009), which similarly found no gender-based discrepancies in students' motivation. However, these results contrast with the findings of Alexander et al. (2010), and Stadler, Duit, and Benke (2000), who suggest that male students tend to exhibit higher motivation levels in learning Physics and related concepts compared to their female counterparts.

Conclusion

Based on the findings of this study, it was established that storytelling, points and levels are more effective in teaching and learning Physics than the conventional method. This study investigated the impact of gamified concepts on motivation towards Physics on senior secondary II students in Ondo metropolis. Gamified package was developed to cover perceived difficult concepts in Physics and this was used on senior secondary school II Physics students. The storytelling, points and levels were found to have contributed significantly to the improved motivation to learn Physics of SS II physics students. This implies that students find gamified instruction to be enjoyable, exciting,

highly motivating, and had a positive experience with gamified physics instruction than the conventional lecture method.

Recommendations

The following recommendations are made based on the findings from this study:

- i. Physics teachers should integrate gamified instruction into the classroom as it has proven to be effective in reducing the level of abstractness associated with the teaching and learning of Physics concepts at the secondary school level of education.
- ii. Gamified elements should be incorporated into the curriculum for the teaching of Physics as it increases student motivation to keep learning to earn more rewards, thereby promoting desired learning behaviours.
- iii. Physics teachers should be adequately sensitised through workshops, seminars and conferences on the use of gamified instruction for instructional delivery at secondary school level.
- iv. Curriculum planners and developers should emphasise the need to continuously use innovative strategies such as gamified instruction to improve instructional delivery.

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