International Journal of Education and Practice
2025 Vol. 13, No. 1, pp. 1-17
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v13i1.3938

Secondary school learners' academic achievement in mathematics through a practical instruction teaching approach in the Kigezi and Ankole regions of Uganda

Frank Murangira[1+]
Alphonse Uworwabayeho[2]
Innocent Twagilimana[3]

[1]*University of Rwanda - College of Education, African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science, Kayonza, Rwanda.*
Email: murangira1234@gmail.com
[2]*Department of Early Childhood and Primary Education, University of Rwanda-College of Education, Rwanda.*
Email: a.uworwabayeho@ur.ac.rw
[3]*Department of Foundations, Management and Curriculum Studies, University of Rwanda-College of Education, Rwanda.*
Email: i.twagilimana@ur.ac.rw

(+ Corresponding author)

Article History
Received: 13 September 2023
Revised: 29 August 2024
Accepted: 26 September 2024
Published: 1 January 2025

Keywords
Academic achievement
Assessment
Attitude
Learners
Mathematics
Practical instruction
Real objects
Teachers.

ABSTRACT

Addressing the challenge of subpar mathematics achievement levels in secondary education has gained global attention. Due to teachers' inability to teach mathematics without real objects to explain it in real life, learners take the subject as very abstract, hence the poor academic achievement in national examinations. This qualitative case study investigates the impact of practical instruction on the mathematics achievement of secondary school students in Uganda. The research involved interviews with sixteen teachers from selected secondary schools in the Kigezi and Ankole regions to gain insights into their perspectives on the utilization and advantages of practical instruction in mathematics. Thematic analysis was employed to analyze the data. Regarding assessment strategies, the study found that there is a need to incorporate alternative assessment methods that can effectively assess the range of learners' mathematics abilities. The study's findings highlight that teachers view practical instruction as a valuable approach that enhances students' mathematics achievement by involving them in hands-on experience with real objects and learner-centered activities. Based on these results, the study recommends the widespread adoption of practical instruction as a means to elevate the quality of mathematics education in Uganda, ultimately addressing the prevalent challenges in mathematics achievement at the secondary school level.

Contribution/Originality: The study explores the effectiveness of practical instruction in teaching mathematics and how it can help to boost the academic achievement of learners. It promotes creativity and innovativeness among teachers of mathematics and science to always improvise real objects that facilitate teaching and learning in the classroom.

1. INTRODUCTION

1.1. Background to the Study

Practical instructional work is a vital medium for building scientific skills. The more learners do practical work in mathematics, the more they will gain and understand the world around them (Kolucki & Lemish, 2011; Mbwile & Ntivuguruzwa, 2023). It has been established that learners' academic achievement and relevant skills improve

greatly when they are taught sciences using practical work (Watts, 2013). Learners in study institutions can engage more in mathematics concepts with practical work if the instructional approach is made via "interactions, hands-on activities, and applications" (Hampden-Thompson & Bennett, 2013).

Practical instruction can be understood as "learning experiences in which students interact with materials or secondary sources of data to understand the natural world" (Lunetta, Hofstein, & Clough, 2007). Practical instruction in teaching mathematics (science) is of great importance (Hodson, 1990; Vilaythong, 2011). One example is Watts (2013) who identifies some of its purposes, including "motivation for students – excitement of discovery, development of manipulative skills, knowledge of standard techniques, general understanding of data handling, consolidation of theory, and understanding of how science works" (p. 4). Also to improve learners' competences in mastering mathematics, the teacher must teach while relating mathematics to real-life situations (Syafriafdi, Fauzan, Arnawa, Anwar, & Widada, 2019).

According to Nizoloman (2013) teaching mathematics to learners plays a vital role in a country's education system because interdisciplinary core values and culture are instilled in the learner. Mathematics is taught to learners from lower levels of education and is now "recognized universally and taken as indispensable to self-reliance and sustainable development of any nation because of the perceived functional utility" (as cited in Nizoloman (2013)). There is a strong belief that any nation that seeks to grow and develop science and its technological levels must pay attention to, and invest heavily in, the teaching and learning of mathematics (Odunnuga, 2007). This argument is further supported by Ramdhani, Usodo, and Subanti (2017) who argue that mathematics as a science helps to develop the nation scientifically, is a model for scientific thinking in many relevant situations, and helps to draw logical conclusions and solve problems. This therefore stresses that mathematics trains the learner's mind on how to be attentive and concentrate throughout life and promotes the habit of accuracy and being orderly and systematic.

Korau (2006) provides his opinion about students' poor academic achievement in mathematics. He states that variables including the students themselves, teachers, curriculum, study environment, instructional materials such as textbooks, and instructors all influence the outcome. Academic achievement is the act of attaining an educational goal successfully (Steinmayr, Meiŋer, Weideinger, & Wirthwein, 2014) and the authors also assert that it is an outcome of performance indicating the level to which a person has accomplished various academic goals in training institutions such as secondary school. Nizoloman (2013) states that it is the end outcome of the learning experience, what learners have gained as a result of thorough teaching instruction. He further stresses that academic achievement in mathematics "primarily deals with the performance of students either in their teacher-made test or standardized achievement test administered by examining bodies" (p. 2231).

Looking at the academic achievement of learners in mathematics in Uganda, the level of poor achievement becomes more and more striking (Uganda National Examinations Board (UNEB), 2021, 2022). It is, therefore, crucial to understand the causes of this poor academic achievement despite its importance and recognition in society and various efforts by the government of Uganda.

Different scholars have cited a number of reasons for the poor academic achievement of learners in mathematics. Factors such as the interest of learners in mathematics, which, according to Aremu (1998) is related to the volume of work completed; nervousness (Odunnuga, 2007) problem-solving skills (Özreçberoğlu & Çağanağa, 2018) and a phobia of mathematics (Bature, 2006) among others.

Additionally, other studies found that learning environment, learners' misconceptions and errors, and teachers' instructional and assessment practices all contribute to learners' difficulties in studying specific mathematics content. In Uganda, the situation is more or less the same. There has been a continuous low level of academic achievement in mathematics compared to other examinable subjects at O-Level secondary schools for many years in spite of its usefulness, applicability and relevance in realizing the aspirations and goals of any nation (Uganda National Examinations Board (UNEB), 2016, 2018, 2019, 2021, 2022).

For the last three decades, and in every academic year, the UNEB has highlighted students' strengths and weaknesses in examinations. Specifically, students have had challenges in Trigonometry, Statistics, and Linear Programming, among other topics, in their effort to achieve the Uganda Certificate of Education (UCE) (Uganda National Examinations Board (UNEB), 2018, 2019, 2021, 2022). The reports on previous candidates' examinations consistently show that their performance in mathematics is not satisfactory, especially at the distinction level.

In particular, previous examiners' reports show learners' poor performance in mathematics problems that require hands-on skills. Examples are cited in areas such as trigonometry and statistics, where learners don't know how to use graph paper accurately or estimate the actual scales when drawing graphs. This poor academic achievement has therefore assumed an alarming proportion and caused a lot of concern for many years.

Research has shown that practical instruction has the potential to improve the learning of mathematics as it helps learners understand abstract mathematical concepts as well as solving real-life problems (Syafriafdi et al., 2019; Ulandari, Amry, & Saragih, 2019). However, there is lack of literature describing teachers' perceptions of the use of practical instruction in mathematics lessons and how the discipline can be handled practically. Therefore, this study seeks to close this knowledge gap by investigating the extent to which teachers teach mathematics using a practical instruction approach in O-Level secondary schools in Uganda. By adopting a practical instruction method and its experimentation techniques, the present study argues that secondary school mathematics and science teachers can enhance their professional growth and development. Additionally, the creativity and innovativeness of the ideas contained in this research might spark interest among Ugandan teachers and in the wider research community. These ideas may intrinsically motivate curious teachers to embrace practical instruction as a new approach to teaching mathematics since it lays out possible and improved ways that can help transform teaching strategies, enhancing learners' participation and academic achievement in mathematics and science in general.

1.2. Research Question

The following research question guided the study:

What practical instructional strategies do teachers employ in teaching mathematics?

2. REVIEW OF LITERATURE

2.1. Introduction and the Role of Practical Instruction in Mathematics

Abrahams (2011) suggests the concept of practical instruction (work) as the basic modus that includes laboratory activities and teachers' demonstrations. Millar (2004) and Abrahams (2009) recognize the role of practical instruction as it helps learners discover the linkage between the domain of objects and observation features and events as well as ideas. Therefore, it should be noted that practical instructional experiences can make mathematics more real and illustrate how mathematicians work in order to gain answers and offer strong insights into the mathematical world.

Practical instruction can be understood as "any teaching and learning activity that involves at some point the students in observing or manipulating real objects and materials" (Vilaythong, 2011). Such understanding calls upon teachers of mathematics to handle equipment and materials while teaching mathematical concepts and later involve their learners to embrace the same. This definitely enhances learners' study experiences since they can interact with the materials to check and observe the phenomenon under investigation. In practical instructional procedures, learners' participation (performing an experiment) is often guided by the teacher, who first performs a similar experiment to guide the learning session (Abrahams & Millar, 2008; Millar, 2004). This implies that the instructor should know of how to conduct an experiment with expertise. Mathematics, like any other science subject, by nature should be a hands-on and minds-on inquiry-based discipline (Mbwile & Ntivuguruzwa, 2023; Vilaythong, 2011). A discovery by prominent researchers was made in 2008 involving university students in Scotland. They found that students feel that laboratory work improves their practical skills and their ability to

understand theories (Hanif, Sneddon, Al-Ahmadi, & Reid, 2008). This means that a lot of mathematical laboratory work in secondary schools should be embraced to improve the skills of learners in various mathematical concepts.

Despite the fact that laboratory activities in mathematics are widely recognized as being fundamental in the teaching and learning of mathematics, many mathematics teachers in secondary schools have limited knowledge of how to design and perform practicals effectively (Sweeney & Paradis, 2004). Other researchers have expressed concern that students in higher institutions finish their degree programmes and become complete teachers in secondary schools and begin teaching mathematics when they lack a firm foundation on how to teach various mathematics concepts practically.

In accordance with the research findings of many science educators, practical instruction plays a vital role in the efficient teaching and learning of science. In the studies carried out by Abrahams and Millar (2008) and Mbwile and Ntivuguruzwa (2023) they discuss practical instructional work as an important area of concentration in science education. They further discuss that learners develop their knowledge in mathematics (science) and appreciate how hands-on skills can be essential for the learners to progress in mathematics. Therefore, learners should be given enough time and guidance on how to progress in mathematics practically. Additionally, secondary school teachers need to be creative and employ appropriate practical skills while teaching mathematics.

In spite of the recognized role of mathematical practical instructions cited by many scholars, it is argued that it is challenging to effectively organize, and instructors do not have sufficient skills and knowledge of conducting practical work in mathematics (Ndihokubwayo, Uwamahoro, & Ndayambaje, 2020). This means that mathematics teaching is primarily theoretical, hence encouraging memorization habits in learners. Accordingly, this further predicts teachers' lack of confidence in teaching using hands-on activities, resulting in a lack of pedagogical foundation in practical works. Onwu and Stoffels (2005) reveal that some teachers are poorly qualified and have less experience in handling practical work, leading them to feel pressure whenever they are required to teach such material.

Literature has also revealed that, due to secondary schools' curricula demands, teachers lack enough time to devise relevant experiments in mathematics since they have curriculum content demands and other content in textbooks to complete by the end of the year which is assessed by national examination bodies such as the UNEB in the case of Uganda. Due to a lack of practical teaching in mathematics, the Uganda National Examinations Board (UNEB) (2016, 2019, & 2021) cite learners' poor academic achievement in mathematics. Therefore, learning mathematics should involve seeing, observing, manipulating and handling real objects and materials, and mathematics teachers need to offer practical demonstrations, as this can boost learners' academic achievement. Academic achievement in mathematics has not been good for a number of years despite the government's attention to the discipline (Uganda National Examinations Board (UNEB), 2016, 2017, 2018, 2019, 2021, 2022). This level of performance is similar to that of other countries (Mukuka, Mutarutinya, & Balimuttajjo, 2019; National Examination Council of Tanzania, 2021).

The Uganda Certificate of Education (UCE) examination reports in 2018, 2019, 2021 and 2022 suggest that mathematics teachers should use practical instructional approaches due to the nature of how candidates were giving solutions to questions that required practical reasoning and problem-solving skills. Hence there is a need to critically expand teachers' knowledge and address these issues.

2.2. Theoretical Perspectives of the Study

The study adopted the constructivist learning theory as its paradigm. This learning theory was developed based on the work of psychologists such as Jerome Bruner (1915–2016), John Dewey (1859–1952), Jean Piaget (1896–1980) and Levy Vygotsky (1896–1943). The theory explains knowledge acquisition and how it can be learnt. It is a teaching/learning approach based on the premise that learning results from mental construction (Bada & Olusegun, 2015). It states that learners can learn and understand the content being taught through associating

what they know already with the new information given. Constructivism as a paradigm focuses on discovery constructivism, social constructivism and cognitive constructivism learning theories.

Piaget's cognitive constructivism maintains that cognitive development stems largely from independent explorations in which children construct facts and knowledge of their own (Piaget, 1976). Vygotsky (1976) argues that children learn through social interactions, building knowledge by learning from more knowledgeable adults and peers.

In other words, Vygotsky believed that cognitive development is affected by culture. Bruner (1966) attributes this to discovery constructivism and asserts that learners should construct their own facts and knowledge. Bruner further proposes that a teacher's task should be to interpret the learners' environment and encourage them to actively participate in learning via discovery learning. The theory played a significant role in assessing learners' academic achievement.

3. METHODOLOGY

3.1. Approach and Design

A case study design was adopted as the qualitative research approach due to its rigor and flexibility (Baxter & Jack, 2008; Creswell, 2014). Secondary school mathematics teachers were interviewed on several issues related to learners' academic achievement in mathematics and whether teaching mathematics practically can enhance their performance.

The interview questions were constructed basing on reports from the Uganda National Examinations Board (UNEB) (2016); Uganda National Examinations Board (UNEB) (2018); Uganda National Examinations Board (UNEB) (2019); Uganda National Examinations Board (UNEB) (2021) and Uganda National Examinations Board (UNEB) (2022) on previous examinations of the work of candidates which show that students' performance in mathematics is not satisfactory, especially at the distinction level.

Before interviewing the respondents, the interview items were critically reviewed by two senior teachers of O-Level mathematics, two senior mathematics education lecturers and one English teacher, who were purposively selected based on their vast experience in research, teaching, their knowledge of the Uganda mathematics curriculum for secondary schools, and exposure to other education systems with similar curricula. They offered suggestions that were incorporated into some statements to provide clarity and assisted in validating the items. After incorporating the experts' comments and suggestions, the initial 35 interview items were reduced to 17 and were moderated and sent back to the experts for a final review. The data collection tool was thereafter compiled and distributed to the participants.

3.2. Research Participants

The study included eight secondary schools in southwestern Uganda, four schools from Kabale district and four schools from Ntungamo district. A total of 16 (14 males and 2 females) mathematics teachers participated in the study.

Two respondents from each school were purposively selected to participate in in-depth interviews and had at least five years' teaching experience.

3.3. Demographic Characteristics of the Participants

Table 1 displays the participants' information regarding age range, teaching experience, gender, highest qualification level, and the class level they teach.

Table 1. Participants' information.

Respondent ID	Age range (Years)	Teaching experience (Years)	Gender	Highest academic qualification	Class/Classes taught
R_1	38–43	16	Male	BSc. in Education	S.3 & S.4
R_2	26–31	6	Female	BSc. in Education	S.3
R_3	32–37	8	Male	Diploma in Secondary Education	S.3 & S.4
R_4	38–43	15	Male	BSc. in Education	S.3 & S.6
R_5	32–37	10	Male	Diploma in Secondary Education	S.3
R_6	32–37	12	Male	BSc. in Education	S.3
R_7	38–43	19	Male	BSc. in Education	S.3 & S.4
R_8	32–37	12	Male	BSc. in Education	S.1 & S.3
R_9	32–37	11	Male	BSc. in Education	S.2, S.3 & S.4
R_{10}	44–49	24	Male	BSc. in Education	S.3
R_{11}	26–31	8	Male	BSc. in Education	S.3 & S.4
R_{12}	32–37	11	Female	BSc. in Education	S.2 & S.3
R_{13}	32–37	9	Male	BSc. in Education	S.2, S.3 & S.4
R_{14}	38–43	14	Male	BSc. in Education	S.3
R_{15}	32–37	10	Male	BSc. in Education	S.3
R_{16}	38–43	20	Male	BSc. in Education	S.3 & S.5
Total Rs = 16			14 males 2 females		

3.4. Ethical Considerations

Before the data collection exercise from the intended participants (mathematics teachers), permission from the relevant authority was sought and granted. Consent forms were presented to all respondents to confirm their willingness to participate in the study and informed them that ethical approval for the study had been received from the Research and Innovations Directorate of the College of Education, University of Rwanda (first author's institution). Additionally, where existing ideas from different scholars were used, references have been cited.

3.5. Data Collection Procedure

The participants received a document containing the consent form and a demographic form to complete a week before the face-to-face interview. It outlined the research purpose, the nature of their participation, how their data might be used and how they can withdraw from the study should they wish to do so. Nonetheless, confidentiality was assured, and they were requested not to withdraw. The interviewer visited each respondent in their school at the agreed appointment time, and each interview lasted between 20 and 25 minutes. Data were collected in February 2023.

3.6. Analysis Procedure

The responses from the interviews were critically analyzed using the thematic analysis guidelines of Braun and Clarke (2006) and Hayes (2000) which emphasize reading and re-reading the entire data set to become familiar with it so that precise and concise themes can be extracted and corresponding examples of extracts can be reported. The replicability and coherence of the generated themes were established during the rigorous re-reading of the data after transcription of the verbal data. At first, each data transcript was read by the first author from beginning to end. Then, the transcripts were re-read, highlighting text that appeared to be related. After coding six transcripts, preliminary codes were identified, which were then used to code all the remaining transcripts, including re-coding the six transcripts used to generate the initial codes. The initial codes were then reviewed to ascertain the relationship with the original data while allowing new ones to emerge. The final codes were used to describe major issues related to students' academic achievement in mathematics. Finally, quotations/excerpts from 16 different respondents were obtained from the manuscripts. Teachers' names were coded as R with a corresponding number.

The validity of the data was assured since the respondents were purposively selected from both private and public secondary schools. Furthermore, the findings from the teachers were constantly triangulated for emerging patterns. Following established good practice in traditional qualitative research, after obtaining themes from the data, example quotes must be offered to illustrate the themes (Denscombe, 2017). The second and third authors checked the analysis and conclusions drawn from them. In the analysis of the transcripts, the researchers aimed to identify themes that describe teachers' teaching skills, practicality and evaluation, and learners' engagement and assessment approaches. The findings were used to answer the research question.

4. RESULTS

The analysis aimed to investigate teachers' instructional strategies while teaching mathematics in O-Level secondary schools and explore their perceptions of the factors that influence learners' academic achievement. The teachers raised several issues that contribute to students' low grades and avoidance of the subject. Their responses revealed two major themes: (a) General performance and learners' attitudes toward mathematics, and (b) instructional materials and teaching.

4.1. General Performance and Learners' Attitudes Toward Mathematics

Teachers described their learners' attitudes and how they generally impact achievement in mathematics. Many teachers said that some learners have a positive attitude, but many have negative attitude toward the subject. Ten teachers stated that even for those with a positive attitude, teachers play a vital role in first convincing them that they can cope and will like the subject. They emphasized that some learners are interested while others are not interested at all. However, five teachers argued that most learners have a negative attitude, but performance in their schools is not bad, saying that it is average. They added that they understand slowly but the attitude is good. Another teacher reported that "performance is currently fair, and although it is not the best, we have registered a great improvement year after year."

One of the teachers put attitude at 80%, stating that "there is this idea that people taking science subjects see it as hard. But with the current teaching process that involves learners, at least now they have come to understand that our environment contains materials that we can use to teach mathematics and use in daily, real-life situations. So, they are not finding mathematics hard as such".

Another admitted that sometimes they contribute to the negativity of their learners toward the subject. He said that "sometimes time limits them, and they fail to have enough time to teach and finish what they are supposed to cover, which results in learners not fully understanding the content, hence making them hate mathematics." Relatedly, another teacher from another school made a similar point and said, "There are some concepts that teachers don't explain to the students. They rush through and don't give their learners enough time to see what they are doing, and many of the teachers are money-oriented." When these teachers were asked about teaching strategies that can help elevate the process, they proposed that teaching mathematics using practical instructional approaches would be best because students would know how to deal with them more easily than using the framework and memorizing a lot of things that they will later forget.

When the teachers were asked if there was any notable difference between boys' and girls' performance in their schools, this is what they had to say:

R_1: "In the two classes I teach, they have an equal attitude toward the subject. Some boys perform well, and some girls also perform well, but there are girls who perform poorly and the same also applies to some boys, but we try our best to bring them up to the same level."

R_5: "Boys have a higher percentage in the subject than the girls."

R_6: "Girls perform at around 70%, but boys find it somewhat easier than girls."

R₇: "For the past two years to three years, both boys and girls have tried to develop a positive attitude toward the subject. Maybe now what they lack is practice and getting involved in doing the work so that they understand the concepts in the easiest way."

R₉: "Girls are still very far behind. Some perform very well, but the figure is still below 50%".

R₈: "Both boys and girls have positive attitudes toward the subject. However, sometimes the subject betrays them as much as they love it." This teacher argued that in his school, performance is average, but boys perform better in mathematics than girls, and he articulated three reasons why boys perform better than girls:

- Girls think that boys should perform better than them.
- Boys concentrate more than girls.
- There are more male mathematics teachers than female mathematics teachers, and this motivates boys to perform better than girls in mathematics and other science subjects.

R₁₀: "In my school, both girls and boys like mathematics, between 70% and 80%, because they perform better in mathematics these days than in other subjects."

Almost all the interviewed teachers reported that the general performance in their respective schools is average, and they attributed this to fact that some of the students have a negative mindset depending on their geographical location and their previous performance. Learners develop a negative attitude and believe that mathematics is unpassable, hard, and is for boys, which implies the need for more effort to encourage them to like the subject and get involved in calculations so that they find it easier and improve the performance. Relatedly, one teacher said that, in his school, academic achievement in terms of performance is only fair because students still believe that mathematics is hard and that they do not have enough time to concentrate.

4.2. Instructional Materials and Teaching

These were guided by the following sub-themes:

4.2.1. Teaching Approaches/Strategies

Some teachers defined practical instruction as the application of mathematics in the classroom where a learner is given hands-on experience while the teacher observes what the learner is doing and provides guidance accordingly. Others defined it as applying mathematics in real life through studying it practically using the available resources, or teaching by showing learners the application of what you are teaching using relevant examples. Teachers were examined about the teaching approaches/strategies they usually employ while delivering mathematics lessons. The following table shows the teachers' methods and the frequency of each approach.

Table 2. Teaching approaches and frequency of usage.

Approach/Strategy	Number of teachers who mentioned it
Group discussion and presentations	7
Question-and-answer	5
Guided discovery	5
Problem solving	1
Brain storming	2
Story telling	1
Demonstration	1
Observation	1
Chalk and talk	1
Lecture	5

Table 2 presents the various teaching strategies that teachers used in lesson delivery. The frequency of the teachers' use of each approach was also captured, with those using group discussion and presentations dominating followed by those using lectures.

Below is how some teachers described the applicability of the approaches:

- One teacher said that he uses chalk and talk as his instructional approach. "Chalk and talk is the method I use whereby I calculate some of the questions so that the learners can look at them on board." This leaves the question of whether the learners should calculate the answer or just look at what the teachers are doing.
- "This one depends on the topic; I have to first to make sure that I have the concept and content about what I am going to teach and relate it to a certain story."
- "Of course, most of the methods we use are learner-based. We look for the full participation of learners, and a teacher comes in just for guidance and the practical bit of the lesson. For example, if I use the question-and-answer method; I ask a question that triggers learners to answer/provide different answers and they discuss and choose the best."
- "I can also use the problem-solving approach where you give a problem, and learners try to solve it on their own. As there are different ways to solve it, they choose how to do it. This is strictly learner-centered and then I try to polish their solutions."
- "I normally use discussions in mathematics. We put learners in groups of four or five and give them some work to discuss. Each group has a discussion and then presents their work."

4.2.2. Assessment Approaches/Strategies

Teachers discussed various assessment strategies that they use to develop learners' skills, values, attitudes and understanding of mathematics concepts; these are summarized below, and the following assessment approaches were highlighted: individual classroom exercises, weekly tests, homework, topical tests, beginning of term, mid-term, end of term, end of year, and activities of integration. The respondents explained that the assessment strategies aim to prepare learners for the national examination at the end of their fourth year, organized by the Uganda National Examinations Board (UNEB). The teachers asserted that after assessing their learners, marking is done, the scripts or books returned, and they do any corrections with the learners. This helps the teachers discover their learners' weaknesses and address them quickly.

4.2.3. Evaluation

The teachers' self-evaluation was not clear as many of them were not specific on how they do it or how they should do it. Self-evaluation in teaching is an important aspect since it acts as a check-up tool for the teachers. Nine teachers were able to comment about their self-evaluation but seven did not express any interest in speaking about the concept. The following are some teachers' comments:

- Sometimes I ask the learners how the lesson was. They give me feedback, stating whether it was enjoyable and if the content was taught very well, or if they had problems understanding or if something wasn't clear. This helps me know how to evaluate myself as a teacher and to know the weaknesses of the learners and myself so that I can continue improving.
- I also ask some of my colleagues to come to my class and check my capabilities and methods of teaching so that they can help me in my self-evaluation.
- I assess my learners by giving exercises. If they perform badly then my objectives have not been met, but when the performance is generally good, then my conclusion is that my objectives have been met.
- I normally do my self-evaluation at the end of a cycle or topic. I give them a test and evaluate the answers to see whether my learners have understood. If they perform well, I can conclude that the concept was understood.

4.2.4. Materials

The teachers stated that there are materials that they can use when teaching mathematics so that students can understand the topics well. Instructional materials are those used to aid the teaching and learning process of mathematics. Therefore, according to this explanation, a practical instructional teaching strategy includes the use of learning aids in the teaching and learning of mathematics. Teachers were asked how they can practically teach some of the topics (statistics and trigonometry in senior three) and which real objects they can apply. They highlighted several real objects which included charts, graph paper, mathematical instruments and tables, calculators, sticks when tallying so that we count and group in statistics, a box, a pen and a pencil, place cards, buildings, bottle tops and books. Below is how some teachers explained how they can apply/use these objects:

- Statistics: "At O-Level in senior three, it is all about charts. Learner need graph paper to draw graphs, and they need mathematical instruments such as compasses to draw pie charts and rulers to draw tables since data should be put in tables. Learners should have the necessary equipment, and teachers should have charts on the board to demonstrate to learners what to do so that they can do the practical work on their own."
- Trigonometry: "Trigonometry is a bit of a challenge because some of its teaching materials are limited. Most of the time, learners are given mathematical tables or calculators by the school, which help us to teach trigonometry."
- Statistics: "I get some sticks which we can count, especially when I am teaching about the mean, so that we can count how many sticks there are, and which sticks are tall or short."
- Trigonometry: "When dealing with circles, items that can be brought in are things that can help you identify angles in a circle. You can even come with place cards when you have drawn circles and then you can also look at angles in different shapes, such as rectangles and triangles. We can also look at the angles in buildings, such as the angle between walls so that we can explain the adjacent sides and the opposite sides to a different angle. For example, I must make sure that the opposite and adjacent walls meet at angle of 90 degrees if I am to make a straight wall when making a corner."
- Statistics: "As a maths teacher, I may not use correct data. I may decide to use data that my students have, or I may decide to ask my students to collect data by themselves, for example, their ages or their heights, or if we had done a previous test in a certain subject, we may use the data collected, present it, analyze it, and eventually we use it as statistical data that can help me teach them statistics."
- Trigonometry: "I may choose rulers that we normally use, or I may choose different types of rulers so that when I am making diagonals or squares, they can help me to describe the names of the shapes."
- Statistics: "We go to the school farm and count the different colors of the cows that we have. We note the number of brown cows, black cows, and black and white cows. Then we see how we can present it on a graph and represent these numbers on either a pie chart or a bar graph."

4.2.5. Learners' Engagement

Teachers were asked about their learners' engagement in the learning process, especially when handling some of the mathematics topics practically and when teaching using conventional methods such as lectures. Most of the teachers expressed positive responses. They reported that their learners feel excited and motivated when they take real objects into class for observation and use in the teaching/learning process. The lesson becomes livelier and helps the learners better understand the concept. The teachers also said that when they just go with notes for a lecture approach and use the board to make calculations, the learners' face the dilemma of wanting to know what it actually was and what it could look like, which can lead to the learners being not active at all, and instead bores them and won't bring good result at the end. Teachers were asked whether they have brilliant students in their classes who do not care about whether you have brought objects or not, can they still perform better? On this, learners were described as being slow and quick learners in different categories. The teachers said that there are

even those who read ahead of others and those who don't bother. However, although these scenarios happen, they don't occur regularly. It is true that some quick learners can discover a lot, even when the teacher has not brought in real objects/materials. Let's take a look at certain teachers' scenarios:

- "I have always had a problem with that comparison until I understood how I could compare them. When I had a math's lesson in the morning, it was the hard learners who were always there. However, when I had a lesson in the afternoon using aids, it involves more interaction. When there are no aids, some learners are disinterested and that shows; with real objects learners are more motivated."
- "If I go into a lesson without teaching materials (real objects), then it seems as if I am trying to talk alone, and even when you ask learners, it becomes difficult for them to answer the questions."
- "When I use these objects in my class, learners' motivation is very high. They are more motivated when I use these objects than when I just talk and give them work, they don't get it. Actually, when I use real objects in class, the lesson is exciting, and the students feel motivated."

From speaking with the teachers, it was realized that their perceptions and attitudes toward practical instructional was very positive. One of the teachers said, "We have been doing things in a particular way that has not had the desired outcome, but with practical instruction, we deliver something real and, as teachers, we feel like we have taught well."

5. DISCUSSION

The discussion is based on the sub-headings identified under the results section.

5.1. General Performance and Learners' Attitude Toward Mathematics

The study explored the general academic achievement, attitude, instructional materials and mathematics teaching in selected O-Level secondary schools in Uganda. The implications of the findings are discussed in light of the related literature. The findings indicate that many students have a negative attitude toward studying mathematics. These results are consistent with previous studies (e.g., Mata, Monteiro, & Peixoto, 2012). Also, Ganley and Vasilyeva (2011) and Mata et al. (2012) found that girls showed a declining attitude toward mathematics as they progressed. This result is close to what teachers said on the differences in performance between girls and boys in science subjects, especially mathematics. Other related studies also report that mathematics is often considered a subject in which male students perform better than female students in terms of both self-concept and attitude (Lindberg, Hyde, Petersen, & Linn, 2010). Teachers stated that students see mathematics as complicated and can not be passed as easily as other subjects. This result was compared with Ignacio, Nieto, and Barona (2006) who reported that despite the usefulness and utility of mathematics, it is perceived by many learners as very difficult, boring, not practical, and abstract. Therefore, teachers find that many students have a negative attitude toward mathematics. According to this assertion, teaching mathematics practically can convert negative attitudes toward the subject and learners will start to enjoy academic achievement in the subject.

Teachers also expressed that learners should be confident using mathematics to analyse and solve practical problems in real-life situations. This is believed to be the main contributing factor to academic achievement according to Mazana, Montero, and Casmir (2020) and Mbwile and Ntivuguruzwa (2023). Their studies also revealed gender differences mentioned by the respondents. It was reported that girls underperform in learning institutions and that some cultural factors impact females students' learning. Improving learners' academic achievement in Science, Technology, Engineering, and Mathematics (STEM) is said to have been a matter of concern for very many years (Tugirinshuti, Mugabo, & Alexis, 2021). Due to this, Uganda has shifted from content-based curricula to competence-based curricula (CBC) (Ndihokubwayo et al., 2020). From the findings, teachers support CBC due to its emphasis on the usage of student-centered teaching and learning approaches where practical

instruction is employed. The teachers reported bias among learners toward the subject, and this contributes greatly to poor academic achievement, predominantly due to classes being teacher-centered and controlled. The results were consistent with studies conducted previously by Makhechane and Qhobela (2019) and Poti, Dudu, and Sebatana (2022).

5.2. Teaching Approaches/Strategies

The teachers' definition of practical instruction is similar to other scholars' definitions (e.g., Hampden-Thompson & Bennett, 2013; Kolucki & Lemish, 2011; and Lunetta et al., 2007). It has been established through the findings that learners' academic achievement and relevant skills improve greatly when they are taught science and mathematics using practical work (Mbwile & Ntivuguruzwa, 2023; Vilaythong, 2011; Watts, 2013). Therefore, practical instruction has been emphasized as a better method than other teaching strategies mentioned in the analysis, such as the lecture approach. The lecture method has been decribed by many researchers as a traditional approach that doesn't promotes learners' skills (Mbwile & Ntivuguruzwa, 2023). In addition, the use of practical instruction in teaching mathematics has a positive impact on improving learners' academic achievement and, in particular, learners' conceptual understanding. Despite the practical instructional approach being considered as a better approach, many teachers are reluctant to use the learner-centered teaching/learning approach (Ndihokubwayo et al., 2020; Mukuka et al., 2019).

5.3. Assessment Approaches/Strategies

Despite teachers highliting a number of assessment approaches, this has not improved learners' academic achievement, according to Uganda National Examinations Board (UNEB) (2016); Uganda National Examinations Board (UNEB) (2018); Uganda National Examinations Board (UNEB) (2019) and Uganda National Examinations Board (UNEB) (2022). There is a need to incorporate alternative assessment methods that can effectively assess the range of learners' mathematics abilities. This can be achieved by the use of learner-centered teaching approaches, according to Watt (2005) and Mukuka et al. (2019). Watt (2005) advocates for more practical work in mathematics and changes to teaching methods to help develop asssessment tasks to suit the syllabus. According to these analyses, secondary school teachers should plan extra time for teaching and assessing their subject in a manner that can improve their students' results.

Assessment should be seen as a learning process in which learners are active in their own assessment and self-learning with respect to understanding and performing better. It requires techniques that focus on assessing what learners know as well as the concepts that they don't know (Dandis, 2013). From the analysis, teachers were using a variety of assessment tools but have not grounded the learners to excel in the national examinations (Uganda National Examinations Board (UNEB), 2016, 2019, 2021). This highlights a need to incorporate alternative assessment methods to effectively assess the range of students' mathematical abilities.

5.4. Evaluation

Teachers' self-evaluation was unclear, as seven teachers did not express any academic interest in it. Teacher self-evaluation encourages teachers to examine their teaching activities in order to understand and improve their practices. If teachers do not evaluate the teaching process, they can't adapt and improve their teaching methodology, which can change learners' academic achievement.

Self-evaluation is a powerful technique for improving academic achievement as well as the professional growth of teachers (Ross & Bruce, 2007). Therefore, it is directly linked to learners' academic achievement. Previous studies by Arter (1994) and McDonald and Boud (2003) stress that teaching learners how to assess themselves can contribute to a more accurate self-evaluation and to a better academic achievement. From this perspective, self-

evaluation is realized as a mechanism that facilitates both learners' academic achievement and teachers' professional growth.

5.5. Materials

Some scholars have discussed the importance of teaching mathematics using real objects (concrete materials). They argue that it is easy to apply concrete objects while teaching, but it can also be easy to misuse them. Concrete objects can effectively teach mathematics to stimulate both learners' thinking and teachers' teaching (Ahmed, Clark-Jeavons, & Oldknow, 2004; Thompson & Lambdin, 1994). During the interviews, the teachers exposed the knowledge they have regarding the application of teaching objects and how innovative they can be in modeling these objects. However, some teachers expressed that it is hard for them to get teaching materials for topics such as trigonometry. This partly explains why learners have been performing poorly in the national examinations (Uganda National Examinations Board (UNEB), 2016, 2017, 2018, 2019, 2021, 2022). Ben-Hur (2006); Deogratias (2022) and Gainsburg (2008) stress the importance of teaching and learning mathematics with the application of real objects.

There are challenges associated with teaching mathematical concepts using real objects. One of these is that teachers are not taught that a real object can be used for the conceptual development and understanding of a mathematical concept. There is a belief among university instructors that students are competent enough to learn and understand mathematical concepts without real objects. Also, instructors say that it is time-consuming to design and implement instructional activities using real objects for teaching and learning mathematics (Deogratias, 2019, 2020). Due to teachers' inability to teach mathematics without real objects to explain it in real life, learners see the subject as abstract, resulting in poor academic achievement in the national examinations.

5.6. Learners' Engagement

In teaching mathematics as one of the core STEM (science, technology, engineering, and mathematics) subjects, teachers need to engage their learners in the teaching/learning process of the subject, as this contributes to the sustainable development of society (Lo & Hew, 2021). This assertion is supports total learner engagement when teachers teach the subject using practical instruction. They are better motivated than when teachers use chalk and talk or lecture methods. Other scholars (e.g., Dove & Dove, 2015; Konstantinidou & Kyriakides, 2022) also support the view that learners' engagement is high when teachers use real objects to teach and that it has a direct effect on the learners' outcomes. Therefore, it is evident that learners' mathematics engagement greatly affects their learning outcomes.

6. CONCLUSION

The study examined the teaching strategies that secondary teachers employ in teaching mathematics and how they impact learners' academic achievement. The respondents revealed that strategies involving hands-on activities can significantly promote academic achievement compared to traditional methods, such as lectures or the chalk and talk approach. Therefore, practical involvement while teaching mathematics is encouraged to boost academic achievement. Respondents further revealed that teachers need to be more creative and innovative while teaching topics such as trigonometry where teachers were reporting a shortage of enough real objects to use while teaching. Additionally, mathematics teachers should strive to improve their learners' engagement in the subject. This can be achieved by making their lessons lively and involving practical instruction.

7. RECOMMENDATIONS

The following recommendations are based on the study's findings:

1. The use of models (people who have excelled in mathematics, particularly females). They should be invited to talk to students, particularly female students, as this improves their attitude through expressing how they made it to where they are and elaborate more on how either gender can pass mathematics.
2. Teaching should be learner-centered rather than teacher-centered; learners are capable of discovering many things, even without guidance from the teacher.
3. Another recommendation is that emphasis should be put on how to handle mathematics using practical methodologies, i.e., using different materials in real life that can help improve students' academic achievement.
4. There is a need to always give immediate feedback to learners to improve their attitude toward the subject.
5. The school administration should provide teachers with resources that can help them improvise and use more real objects while teaching mathematics practically, as this will reduce the use of the lecture method.
6. Teacher training courses for those in service should be established and encouraged to help change teachers' negative attitudes to teaching the subject since it was reported that many have become money-minded in schools.

8. LIMITATION(S)

The number of female teachers was low, with only 2 out 16 participants being female. The authors had hoped to interview more female teachers but could only access two in the schools selected for the study.

Funding: This research is supported by the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science based at the University of Rwanda-College of Education (Grant number: ACE II(P151847)).
Institutional Review Board Statement: The Ethical Committee of the University of Rwanda-College of Education, Rwanda has granted approval for this study on 18 December 2019 (Ref. No. 01/P-CE/001/EN/gi/2019).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Abrahams, I. (2009). Does practical work really motivate? A study of the affective value of practical work in secondary school science. *International Journal of Science Education, 31*(17), 2335-2353. https://doi.org/10.1080/09500690802342836

Abrahams, I. (2011). *Practical work in secondary science: A minds-on approach.* London: A&C Black.

Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education, 30*(14), 1945-1969. https://doi.org/10.1080/09500690701749305

Ahmed, A., Clark-Jeavons, A., & Oldknow, A. (2004). How can teaching aids improve the quality of mathematics education. *Educational Studies in Mathematics, 56*, 313-328. https://doi.org/10.1023/b:educ.0000040412.39121.e0

Aremu, A. (1998). Motivating learners for more effective achievement in mathematics. *Nigerian Journal of Applied Psychology, 4*(1), 27-34.

Arter, J. A. (1994). *The impact of training students to be self-assessors of writing.* Paper presented at the The Annual Meeting of the American Educational Research Association.

Bada, S. O., & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education, 5*(6), 66-70.

Bature, I. J. (2006). Survey of causes of maths-phobia among secondary school students in Ogun State. *Journal of Education Studies, University of Jos, 12*(1), 7–12.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544-559.

Ben-Hur, M. (2006). *Concept-rich mathematics instruction: Building a strong foundation for reasoning and problem solving*. United States of America: ASCD.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bruner, J. S. (1966). *Toward a theory of instruction*. Cambridge: Harvard University Press.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage Publications.

Dandis, M. A. I. (2013). The assessment methods that are used in a secondary mathematics class. *Journal for Educators, Teachers and Trainers, 4*(2), 133–143.

Denscombe, M. (2017). *The good research guide: For small-scale social research projects* (3rd ed.). Maidenhead: Open University Press.

Deogratias, E. (2019). The efficacy of concept-rich instruction with university preservice teachers in a Tanzanian context using Vygotskian perspective. *World Journal of Educational Research, 6*(3), 373–385. https://doi.org/10.22158/wjer.v6n3p373

Deogratias, E. (2020). *Exploring the implementation of concept-rich instruction with university mathematics pre- service teachers. A Tanzanian case*. Doctoral Dissertation, University of Alberta.

Deogratias, E. (2022). The importance of using real objects for teaching and learning a mathematical concepts with pre-service teachers of mathematics: Using real objects for teaching and learning a mathematical concepts. *International Journal of Curriculum and Instruction, 14*(1), 24-36.

Dove, A., & Dove, E. (2015). Examining the influence of a flipped mathematics course on preservice elementary teachers' mathematics anxiety and achievement. *Electronic Journal of Mathematics & Technology, 9*(2), 166–179.

Gainsburg, J. (2008). Real-world connections in secondary mathematics teaching. *Journal of Mathematics Teacher Education, 11*, 199-219. https://doi.org/10.1007/s10857-007-9070-8

Ganley, C. M., & Vasilyeva, M. (2011). Sex differences in the relation between math performance, spatial skills, and attitudes. *Journal of Applied Developmental Psychology, 32*(4), 235-242. https://doi.org/10.1016/j.appdev.2011.04.001

Hampden-Thompson, G., & Bennett, J. (2013). Science teaching and learning activities and students' engagement in science. *International Journal of Science Education, 35*(8), 1325-1343. https://doi.org/10.1080/09500693.2011.608093

Hanif, M., Sneddon, P. H., Al-Ahmadi, F. M., & Reid, N. (2008). The perceptions, views and opinions of university students about physics learning during undergraduate laboratory work. *European Journal of Physics, 30*(1), 85. https://doi.org/10.1088/0143-0807/30/1/009

Hayes, N. (2000). *Framework for qualitative analysis in doing psychological research*. Buckingham, UK: Open University Press.

Hodson, D. (1990). A critical look at practical work in school science. *School Science Review, 71*(256), 33–40.

Ignacio, N. G., Nieto, L. J. B., & Barona, E. G. (2006). The affective domain in mathematics learning. *International Electronic Journal of Mathematics Education, 1*(1), 16-32. https://doi.org/10.29333/iejme/169

Kolucki, B., & Lemish, D. (2011). *Communicating with children: Principles and practices to nurture, inspire, excite, educate and heal*. New York: United Nations Children's Fund (UNICEF).

Konstantinidou, E., & Kyriakides, L. (2022). Instructional engagement and student learning outcomes: Direct and indirect effects based on country-specific contingencies. *Studies in Educational Evaluation, 73*, 101144. https://doi.org/10.1016/j.stueduc.2022.101144

Korau, Y. K. (2006). *A systematic attempt to establish the fear and poor performance of senior secondary school students in geometry and trigonometric concepts, a case study of waec candidates*. Paper presented at the The 43rd Annual Conference of Mathematical Associaation of Nigeria Held at ATBU Bauchi.

Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychological Bulletin, 136*(6), 1123–1135.

Lo, C. K., & Hew, K. F. (2021). Student engagement in mathematics flipped classrooms: Implications of journal publications from 2011 to 2020. *Frontiers in Psychology, 12*, 672610. https://doi.org/10.3389/fpsyg.2021.672610

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In N. Lederman, & S. Abel (Eds,), Handbook of research on science education. In (pp. 393-441). Mahwah, NJ: Lawrence Erlbaum.

Makhechane, M., & Qhobela, M. (2019). Understanding how chemistry teachers transform stoichiometry concepts at secondary level in Lesotho. *South African Journal of Chemistry, 72*, 59-66.

Mata, M. d. L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research, 2012*, 1-10. https://doi.org/10.1155/2012/876028

Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2020). Assessing students' performance in mathematics in Tanzania: The teacher's perspective. *International Electronic Journal of Mathematics Education, 15*(3), em0589. https://doi.org/10.29333/iejme/7994

Mbwile, B., & Ntivuguruzwa, C. (2023). Impact of practical work in promoting learning of kinematics graphs in Tanzanian teachers' training colleges. *International Journal of Education and Practice, 11*(3), 320-338. https://doi.org/10.18488/61.v11i3.3343

McDonald, B., & Boud, D. (2003). The impact of self-assessment on achievement: The effects of self-assessment training on performance in external examinations. *Assessment in Education: Principles, Policy & Practice, 10*(2), 209-220. https://doi.org/10.1080/0969594032000121289

Millar, R. (2004). *The role of practical work in the teaching and learning of science*. Paper presented at the Commissioned Paper-Committee on High School Science Laboratories: Role and Vision, Washington DC: National Academy of Sciences.

Mukuka, A., Mutarutinya, V., & Balimuttajjo, S. (2019). Exploring the barriers to effective cooperative learning implementation in school mathematics classrooms. *Problems of Education in the 21st Century, 77*(6), 745. https://doi.org/10.33225/pec/19.77.745

National Examination Council of Tanzania. (2021). *Candidates' response item analysis report for form four national examination in mathematics*. Tanzania: Dar es Salaam.

Ndihokubwayo, K., Uwamahoro, J., & Ndayambaje, I. (2020). Effectiveness of PhET simulations and YouTube videos to improve the learning of optics in Rwandan secondary schools. *African Journal of Research in Mathematics, Science and Technology Education, 24*(2), 253-265. https://doi.org/10.1080/18117295.2020.1818042

Nizoloman, O. N. (2013). Relationship between mathematical ability and achievement in mathematics among female secondary school students in Bayelsa State Nigeria. *Procedia-Social and Behavioral Sciences, 106*, 2230-2240. https://doi.org/10.1016/j.sbspro.2013.12.254

Odunnuga, J. B. (2007). *Understanding primary mathematics methods and curriculum*. Abeukouta, Nigeria: Satellite Publication.

Onwu, G., & Stoffels, N. (2005). Instructional functions in large, under-resourced science classes: Perspectives of South African teachers. *Perspectives in Education, 23*(1), 79-91.

Özreçberoğlu, N., & Çağanağa, Ç. K. (2018). Making it count: Strategies for improving problem-solving skills in mathematics for students and teachers' classroom management. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(4), 1253-1261. https://doi.org/10.29333/ejmste/82536

Piaget, J. (1976). Piaget's theory. In B. Inhelder, H. H. Chipman, & C. Zwingmann (Eds.), Piaget and his school. In (pp. 11-23). Berlin, Heidelberg: Springer.

Poti, J. G., Dudu, W. T., & Sebatana, M. J. (2022). A South African beginner natural sciences teacher's articulated PCK-in-practice with respect to electric circuits: A case study. *EURASIA Journal of Mathematics, Science and Technology Education, 18*(10), 1–16. https://doi.org/10.29333/ejmste/12426

Ramdhani, M. R., Usodo, B., & Subanti, S. (2017). Student's mathematical understanding ability based on self-efficacy. *Journal of Physics: Conference Series, 909*(1), 12065. https://doi.org/10.1088/1742-6596/909/1/012065

Ross, J. A., & Bruce, C. D. (2007). Teacher self-assessment: A mechanism for facilitating professional growth. *Teaching and Teacher Education, 23*(2), 146-159. https://doi.org/10.1016/j.tate.2006.04.035

Steinmayr, R., Meiŋer, A., Weideinger, A. F., & Wirthwein, L. (2014). *Academic achievement*. Oxford, UK: Oxford University Press.

Sweeney, A. E., & Paradis, J. A. (2004). Developing a laboratory model for the professional preparation of future science teachers: A situated cognition perspective. *Research in Science Education, 34*, 195-219. https://doi.org/10.1023/b:rise.0000033765.64271.12

Syafriafdi, N., Fauzan, A., Arnawa, I. M., Anwar, S., & Widada, W. (2019). The tools of mathematics learning based on realistic mathematics education approach in elementary school to improve math abilities. *Universal Journal of Educational Research, 7*(7), 1532-1536. https://doi.org/10.13189/ujer.2019.070707

Thompson, P. W., & Lambdin, D. (1994). Research into practice: Concrete materials and teaching for mathematical understanding. *The Arithmetic Teacher, 41*(9), 556-558. https://doi.org/10.5951/at.41.9.0556

Tugirinshuti, G. J., Mugabo, L. R., & Alexis, B. (2021). Effectiveness of video-based multimedia to enhance the learning of astrophysics in Rwandan secondary schools. *Available at SSRN 3990199*. https://doi.org/10.2139/ssrn.3990199

Uganda National Examinations Board (UNEB). (2016). *Report on work of candidates*. Kampala, Uganda: UNEB.

Uganda National Examinations Board (UNEB). (2017). *Report on work of candidates*. Kampala, Uganda: UNEB.

Uganda National Examinations Board (UNEB). (2018). *Report on work of candidates*. Kampala, Uganda: UNEB.

Uganda National Examinations Board (UNEB). (2019). *Report on work of candidates*. Kampala, Uganda: UNEB.

Uganda National Examinations Board (UNEB). (2021). *Report on work of candidates*. Kampala, Uganda: UNEB.

Uganda National Examinations Board (UNEB). (2022). *Report on work of candidates*. Kampala, Uganda: UNEB.

Ulandari, L., Amry, Z., & Saragih, S. (2019). Development of learning materials based on realistic mathematics education approach to improve students' mathematical problem solving ability and self-efficacy. *International Electronic Journal of Mathematics Education, 14*(2), 375-383. https://doi.org/10.29333/iejme/5721

Vilaythong, T. (2011). *The role of practical work in physics education in Lao PDR*. Sweden: Umea University of Sweden.

Vygotsky, L. (1976). *Play and its role in the mental development of the child*. New York: Routledge.

Watt, H. M. (2005). Attitudes to the use of alternative assessment methods in mathematics: A study with secondary mathematics teachers in Sydney, Australia. *Educational Studies in Mathematics, 58*, 21-44. https://doi.org/10.1007/s10649-005-3228-z

Watts, A. (2013). *The assessment of practical science: A literature review*. Cambridge: Cambridge Assessment.