

Promoting students' interest and achievement in mathematics through "King and Queen of Mathematics" initiative

Promote students' interest in maths using KQMI

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Abstract

Purpose – The study explored the impact of the King and Queen of Mathematics Initiative (KQMI) in promoting students' interest in learning mathematics and improving their achievement. The specific objectives of the study focused on the impact of the initiative in promoting interest in mathematics, assessing the contribution of the initiative to students' achievements and investigating challenges encountered by the initiative.

Design/methodology/approach – The study used a case study design with a mixed-method approach. One ward secondary school was involved. The sample size was $N = 79$, where 77 were grade three students in a science class and two teachers. Data collection involved documentary review, observation and interviews. Data analysis employed both content analysis and a dependent t -test to determine the effect size of the initiative.

Findings – The findings revealed that KQMI had a significant impact on improving performance in mathematics among students ($t(71) = -7.917, p < 0.05$). The study also showed that male students improved their performance more than their counterparts throughout the KQMI. The mathematics teacher revealed that students still need assistance to solve mathematical questions with different techniques to develop the expected competencies.

Research limitations/implications – The initiative was conducted only in one school, limiting the findings' generalization. Also, the innovation faced different challenges, such as accessing adequate resources and students with little knowledge of mathematics, which the initiative aimed to address.

Practical implications – Pedagogical innovations enhance the promotion of students' interest in learning mathematics and hence improve their performance. Also, through pedagogical innovations, teachers improve their teaching skills and practices from students' feedback.

Originality/value – The KQMI is a new pedagogical innovation modified from the existing innovations such as game-based method, task design, mobile learning and mathematics island.

Keywords Mathematics, Students' achievement, Students' interest, Pedagogical innovation

Paper type Case study

Introduction

Mathematics is an abstract subject; hence, it causes many students to lose interest, thus resulting in low achievement (Yeh *et al.*, 2019). Apart from an abstraction of mathematics

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causing low interest in students, experiencing anxiety about learning mathematics also has contributed to disliking the subject (Summer, 2020). This paper explores the contribution of pedagogical innovation in promoting students' interest in learning mathematics hence improving achievement.

Lack of interest in learning mathematics results in low achievement. Interest is one of the attitudinal and influential variables that are predictors of students' achievement in learning or avoidance of learning mathematics (Singh *et al.*, 2002). Studies have shown the trend of poor performance in mathematics in many parts of the world (Mazana *et al.*, 2020; Mbugua *et al.*, 2012; Ndume *et al.*, 2020; Sa'ad *et al.*, 2014). The trend of poor performance is associated with students' low interest in studying mathematics. Students feel the subject is boring. Factors such as teachers' lack of innovative pedagogies, the subject's broad content and students' inadequate practices amplify students' low interest in learning (Shoaib and Saeed, 2016). Pedagogical innovations in facilitating learning play a central role in addressing the challenges of students' low interest and achievement in the subject.

Peteros *et al.* (2020) assert that recognizing and awarding students for their improved performance helps them boost their confidence and interest in the subject. An enjoyable learning environment significantly impacts students' interest in studying mathematics and improves their performance (Mazana *et al.*, 2019). Despite the expected positive results from implementing the innovation to promote interest to learn mathematics and improve performance, Maass *et al.* (2019) warn that implementing innovation in the classroom is a challenging and demanding activity that requires teacher's commitment and motivation. The King and Queen of Mathematics Initiative (KQMI) adopted the awarding and recognition of students with improved achievement. The subject teacher crowned students the title of King or Queen to kindle students' interest and make mathematics learning more enjoyable.

The status of students' achievement in mathematics

Globally, students' performance in mathematics has been a challenging issue given its importance in this era of science and technology. In Nigeria, Sa'ad *et al.* (2014) report that students perform poorly in mathematics, citing students' negative attitudes and lack of innovative teaching methods as the cause. In Kenya, Mbugua *et al.* (2012) report similar factors for low achievement in mathematics. Peteros *et al.* (2020) report that, in the Philippines, the level of performance in mathematics in 2020 was low as the majority of students (53.01%) performed below the average. The implication is that many teachers fail to make the mathematics learning process enjoyable for students. Mazana *et al.* (2019) report that developing a positive attitude among students is when they enjoy the subject through various innovative and engaging methods. This positive attitude has a significant impact on improving achievement in the subject. Studies have revealed that apart from students struggling with mathematics achievements in Pakistan, female students have performed better than male students (Khan *et al.*, 2018). In the light of the above, it necessitates emphasizing pedagogical innovations to eliminate the challenges and enhance students' achievement in mathematics.

In Tanzania, the state of performance in mathematics subject is low. Ndume *et al.* (2020) show that the pass rate of mathematics in form four national examination is 16%. The trend of failure in the subject is high as research shows that in 2012 alone, 69% of form four students failed in the subject (Mazana *et al.*, 2020). Mazana *et al.* (2019) reported factors associated with low achievement in mathematics as (1) students' attitude towards mathematics, (2) the perception that the subject is complex, (3) low level of self-confidence, (4) bad grades attained in the classroom tests discourage students, (5) poor background and (6) irrelevance of the content to real-life situations.

As Mazana *et al.* (2019) posit, the persistence of the factors results in a small number of passing in form four national examination results. It implies that few students will continue in

science subjects in advanced secondary education and at the university level. Despite increasing students from 240,160 in 2014 to 435,345 in 2020, the pass rate has remained low, as shown in [Table 1](#). The pass rate had progressively decreased from 2.82% in 2015 to 0.09% in 2020. This performance decrease manifests the necessity of applying pedagogical innovations to promote interest and improve students' achievement in learning mathematics.

Due to poor performance in mathematics and the associated factors, teachers have been innovating and experimenting with various initiatives to promote students' interest in learning the subject to improve achievement. Some of the pedagogical innovations include mobile learning in mathematics ([Ndume et al., 2020](#)), mathematics island ([Yeh et al., 2019](#)) and task design ([Coles and Brown, 2016](#)).

Therefore, this study explores the KQMI in promoting students' interest and achievement in mathematics. The initiative intends to create an enjoyable learning environment while focusing on recognizing and awarding students to promote interest and improve achievements in mathematics.

The genesis of KQMI

The KQMI is a pedagogical innovation of mathematics teachers at the school. The KQMI primarily was adopted from a nearby primary school called Tuishime, where higher achievers were crowned the titles of King for a male and Queen for a female student at the end of the academic year, i.e. November each year. The event took place on Parents' Day at the school to inspire students to work hard and improve their achievements.

The KQMI started in a new academic year in January 2020 at Lemara Secondary School, where this study was conducted. A mathematics teacher called Jamila adopted the initiative, and she was committed to seeing students' mathematics achievement improve in the school where she taught. Mostly, ward secondary schools (secondary schools built in each ward in Tanzania are classified by a generic name as ward secondary school) are regarded as low-quality schools because they are newly established, under-resourced and located in catchment areas, i.e. the villages in the vicinity, affecting classroom attendance due to dropouts. Notably, the enrolled students always have an average or low performance in Primary School Leaving Examination. For example, in many ward secondary schools, the pass rate in mathematics is between 5 and 8% lower than that of well-established public and private schools. As a result, students will achieve low in mathematics in national examinations.

Interestingly, most students in many ward secondary schools fail in mathematics while passing other science subjects such as biology, chemistry and physics. According to [Mazana et al. \(2019\)](#), mathematics is a compulsory subject at the lower secondary level; hence, students who aspire to continue with any science or business combinations at the upper

Year	Total no. of students	No. of pass	% of pass	+/- from previous year (%)
2020	435,345	87,582	20.12	+0.09
2019	422,332	84,578	20.03	+0.02
2018	360,225	71,703	20.02	+0.83
2017	317,444	60,621	19.19	+1.07
2016	349,202	62,990	18.12	+1.36
2015	383,851	64,332	16.76	+2.82
2014	240,160	47,001	19.58	N/A

Source(s): Subject performance analysis from NECTA* Website

*NECTA = National Examination Council of Tanzania

Table 1.
Form four national examination mathematics pass rate in seven consecutive years

secondary level must have a pass in mathematics. This requirement hinders their dream as they cannot join science subjects in advanced levels of learning as they did not pass mathematics.

The teacher at Lemara Secondary School was motivated to adopt and implement the KQMI to address the challenge of massive failure in mathematics and the need to help these students to reach their dreams of continuing in higher levels of education in mathematics, science and business subjects. The implementation of KQMI involved the third-grade science class where the teacher was assigned to teach. Since the class expected to sit for the grade four national examination the following year, the initiative gave the teachers and students more time to learn.

The KQMI involved a weekly mathematics test competition where it crowned one male and female student who emerged with the highest score as King and Queen of Mathematics for one week. Every Friday, the teacher administered a test and could ask for help from other teachers in administering and invigilating the test. After every three months, students sat for comprehensive tests. The mathematics teacher who implemented the KQMI dedicated her time to helping students as she had to work extra hours to make the initiative realistic, attainable and sustainable. The extra work included marking students' tests during the weekend and spending hours for remedial classes on the weekdays. In some cases, the teacher had to incur costs for printing tests which is rare for many teachers. The King and Queen received a special badge to identify them and recognize their efforts and achievement, and they had to strive hard to retain their titles.

Problem statement

Studies have shown that students' performance in mathematics is poor, and the data have confirmed this poor performance trend (Mazana *et al.*, 2019, 2020). The crucial factors include the perception that mathematics is a complex subject and the lack of self-confidence among students due to their low grades. Despite students' poor background in mathematics, the mentioned factors have resulted in a negative attitude towards the subject, which has affected their interest, thus, leading to poor performance in the subject. The introduction of KQMI focused on promoting students' interest in the subject to attract self-confidence and improve mathematics achievement. The study then focused on exploring whether the KQMI has a significant impact on promoting students' interest in learning mathematics and improving their performance.

Research questions

The key questions that guided the study were the following:

- RQ1. How has KQMI promoted students' interest in learning mathematics?
- RQ2. To what extent the KQMI has succeeded in improving students' achievement in mathematics?
- RQ3. What challenges affect the implementation of the KQMI?

Research hypotheses

- H1. The KQMI has a significant impact on improving students' achievement in mathematics.
- H2. After implementing the KQMI, female students will achieve better mathematics than male students.

Literature review

Pedagogical innovations are inevitable towards achieving the fourth goal of Sustainable Development Goals (SDG4) concerning quality and equitable education. The quality and value of education require learners to be taught through innovative pedagogies and inculcate a sense of innovation to explore the world and develop new knowledge applicable to solving various problems. Bodinet asserts,

Focusing on an educational paradigm rooted in critical pedagogy, the Socratic method, futures studies, and peace education, this essay takes the position that classrooms of the future should be transformed into safe harbours where students are afforded the opportunity to explore, deconstruct and share knowledge of themselves, their experiences, and the world in which they live. (2016, p. 1)

Based on the above call for pedagogical innovations to enhance learning, promoting students' interest to learn mathematics and improving their achievement in the subject is the central focus. The following section presents a review of these aspects.

Interest

Harackiewicz *et al.* (2016) define interest as “an individual’s momentary experience of being captivated by an object and more lasting feelings that the object is enjoyable and worth further exploration”. In the context of learning, Wong and Wong (2019) define interest as the state of engaging students in learning mathematics while enjoying the learning process. This study considers interest as the state of students being confident and free in interacting with teachers and colleagues in learning mathematics while showing they like and enjoy the learning process. Emefa *et al.* (2020) define interest as a psychological state occurring during the interaction between a person and a specific subject or activity, including the process of willingness, attention, concentration and positive feeling towards that particular subject or activity.

Interest is a construct of motivation and other constructs like perceived control, collaboration involvement and efficacy (Ahmed, 2016). Also, Järvelä and Renninger (2014) concur that the concept of motivation is broader than interest, implying that interest, together with other factors, results in motivation. Knoll (2000) added that interest is a significant initiator of motivated behaviour; hence, before a student is motivated in learning, one must be interested first. Järvelä and Renninger further assert that interest is a cognitive and affective motivational variable that advances through four phases: (1) triggering of interest, (2) sustained, (3) emerging interest and (4) extending to a more well-developed individual interest.

In their study, Toli and Kallery (2021) provided the characteristics of interest that include increased attention, efforts, effects and experience. They used a situational interest development model to enhance students' interest in learning science. The findings revealed a significant positive correlation between students' learning outcomes and interest in the subject.

The study focused on interest as a single construct without relating to other aspects of motivation. It explored students' psychological state towards their willingness to participate, learn attentively and concentrate on the subject happily. As Harackiewicz *et al.* (2016) presented, all the four interest-enhancing initiatives, attention-getting settings, contexts evoking prior individual interest, problem-based learning and enhancing utility value, were considered in the KQMI. Again, Singh *et al.* (2002) reveal that motivation and interests serve the goal of enhancing students' achievement in mathematics.

Pedagogical innovations to promote interest in learning mathematics

Improved students' performance in mathematics begins with students' interest in liking the subject. Students' interest is an internal aspect that develops in a given environmental setting

(Azmidar *et al.*, 2017). These traits manifest students' interest in learning mathematics. In their research, Wong and Wong (2019) found no significant correlation between students' interest in the subject and performance. Their study further revealed that being interested in learning mathematics includes liking the subject, answering questions in mathematics class, desire to learn more about the subject and anxiety to know all about how to do mathematics problems. However, Frenzel *et al.* (2010) found that promoting students' interest in learning mathematics was more beneficial to low achievers as they improve their performances over time. This finding contradicts Wong and Wong's (2019) reports, however, they gave the factors concerned with the insignificance of interest and achievement.

Motivation has also been considered an essential factor in promoting students' interest in learning mathematics. Yeh *et al.* (2019) assert that a low level of motivation results in low interest in learning mathematics and hence low achievement. This assertion indicates a correlation between students' interest and their academic achievements. They further argue that game-based teaching methods engage learners, encourage critical thinking and construct motivation. Although Otoo *et al.* (2018) opine that motivation has no significant impact on promoting interest, such assertion has received little support from scholars.

Again, studies have uncovered various aspects of improving students' interest in mathematics. According to Yeh *et al.* (2019), three aspects indicate students' interest in the subject: attitude, initiative and confidence. They further describe that students' liking of the subject significantly influences their attitudes. The initiative is from participating voluntarily in mathematics activities even beyond class hours. Confidence is the ability to ask questions or request the teacher to re-explain concepts during the lesson. Hackett and Betz (1989) also confirm that confidence is central to enhancing students' interest in learning and improving the subject's achievement. Self-confidence enhances students' interest, whereby self-confidence depends on the perceived usefulness of the content, background knowledge and the level of anxiety among students (Otoo *et al.*, 2018). In this regard, promoting students' interest in learning mathematics depends on students' internal factors.

Teachers use motivation strategies such as rewards, recognition, encouragement and praise to boost students' interest in learning mathematics (Kashefi *et al.*, 2017). Another pedagogical innovation used was the Concrete-Pictorial-Abstract approach to raise students' interest in studying mathematics (Azmidar *et al.*, 2017). The approach starts with concrete objects to perform mathematical operations, followed by pictorial and the last move to abstraction. This process implies that interest also depends on external factors from students learning environment.

Therefore, developing students' interest in learning mathematics depends on internal and external factors. Counselling, consultations and assessment results identify students with challenges and take time to understand them to help identify internal factors and use them in assisting. The external factors may include rewards, recognitions, remedial classes and praise. Teachers need to be aware of this and design pedagogical approaches that consider both factors. Combining these strategies bears a solid contribution to promoting students' studying interests.

Pedagogical innovation in improving students' achievement in mathematics

Without suitable teaching methods and effective use of time allocated for teaching, many students will fail to improve their academic achievements (Moshah, 2018). Students have struggled to develop mathematical skills, which probably implies that the teaching methods used were less effective and impactful. The struggle has led to various pedagogical innovations to promote students' achievement in the subject.

Innovative teaching methods significantly improve students' achievement in mathematics (Abd-Algani, 2019). Such teaching methods include evaluation for learning,

digital tools and applications, constructive learning principles and differential teaching. [Yeh et al. \(2019\)](#) developed a game-based method to enhance students' learning environment. Their innovation found that the teaching method increased students' mathematics achievement ([Abd-Algani, 2019](#)). Task design is also considered a pedagogical innovation that intends to enhance students' learning, understanding and achievement in tests ([Coles and Brown, 2016](#)). Coles and Brown further mention the principles of implementing task design: (1) lesson delivery beginning with contrasting examples to spark curiosity among students, (2) students showing similarities and differences and (3) students naming the differences are directly linked and results in learning.

Despite the efforts to implement pedagogical innovations to improve students' achievement, teachers and students encounter some challenges. Teachers fail to implement innovative approaches in schools due to limited material and time resources and huge workloads ([Abd-Algani, 2019](#); [Kashefi et al., 2017](#)). Apart from the challenges that teachers face, on the side of students, the readiness to learn, the level of motivation and background issues act as challenges ([Wang et al., 2018](#)). Wang *et al.* further reveal that ability of teachers to apply pedagogical innovations in classroom settings depends on the methodological resources they have at their disposal. The resources are necessary to support and ensure the effectiveness of innovative pedagogies used in teaching and learning.

However, the innovations implemented might enhance students' interest and hence achievement in the subjects, but several other factors also significantly contribute to students' learning and achievement. Students' ability, attitudes and perceptions, socio-economic variables, parent and peer influences, school-related variables, family and home environment, motivational variables and instructional time affect students' achievement ([Singh et al., 2002](#)). This study also compared students' performance before, during and after the KQMI. The purpose of the comparison focused on understanding the consistent influence of other factors apart from the KQMI on students' achievements in mathematics.

Theoretical framework

Several studies have shown the application of the Interest-Driven Creator (IDC) theory in promoting students' interest in learning mathematics ([Wong et al., 2020](#); [Wong and Wong, 2019](#)). The theory shows the issues that contribute to creating and sustaining students' interest in learning. From the IDC theory, [Wong et al. \(2020\)](#) came up with a model that involves three stages and focuses on developing and maintaining interest in learning. The model stages are Triggering, Immersing and Extending. According to [Harackiewicz et al. \(2016\)](#), triggering implies catching students' interest through attention-catching situations or environmental stimuli that ignite a reaction or response, while immersing means a maintained response to engage in learning activities/tasks. Harackiewicz *et al.* further reveal that extending means internalized behaviour of re-engaging in particular learning activities and tasks as the outcome of the former two stages (see [Figure 1](#)).

Methodology

Design of the study

A case study design was adopted to understand the effectiveness of the innovative initiative that aimed at promoting students' interest in learning mathematics and improving their performance. A case study was appropriate because the design involved intensive analysis of individual units within a case. A researcher focuses on the process of tracing and allows multiple ways of collecting information ([Creswell, 2014](#); [Denzin and Lincoln, 2018](#)). In this case, the unit was a specific class, grade three, in a school. The design was flexible enough to allow multiple data collection methods, i.e. interviews, observation and documentary review.

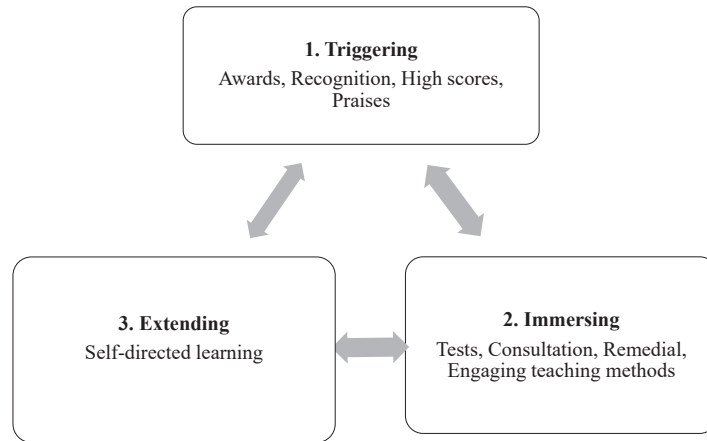


Figure 1.
Interest development
model modified from
Wong *et al.* (2020)

Study area

Lemara Secondary School was the area of study. It is one of the ward secondary schools within Arusha Municipality in Arusha region, located in the northern part of Tanzania. Historically, ward secondary schools were introduced in 2004 when Tanzania implemented the Secondary Education Development Programme phase two (SEDP II). SEDP II aimed to expand the enrolment rate in secondary schools since many students failed to proceed with education after completing the primary level. Ward schools mushroomed quickly, and they started operating while under-resourced with both teaching and learning materials and the number of teachers. These challenges persisted for a long time – the poor performance in form four national examinations among ward secondary schools confirms this (see [Table 1](#)).

Lemara Secondary School, established in 2005, is a co-education school. Currently, the school has grade one up to grade form four students. Mathematics is one of the compulsory subjects for all students, whether they specialize in science, business or arts subjects.

Participants and the KQMI context

The study involved form third grade (form three) science class in 2020. The class fits in the study because science class requires a good command of mathematical skills; hence, promoting their interest and performance in mathematics could significantly impact their science subjects. The participants in the study were 77 students (40 females and 37 males) and two teachers (a mathematics teacher and the head of the school).

Despite the KQMI involving weekly tests to find the King and Queen of another week, it involved teachers' use of participatory teaching methods and remedial sessions to help the low achievers who were willing to be assisted. The study did not focus on the weekly scores but on the examinations stipulated on the school calendar; midterm, terminal and annual examinations. These tests gave a clear understanding of the performance trend during the implementation of the KQMI. The winners each week were crowned and given a special badge to wear for the whole week while exempted from all school activities outside the classroom. Wearing the special badge and the exemption from activities meant recognizing their weekly achievement, thus attracting many students to compete for such respectful recognition.

Data collection methods

Data collection methods involved documentary review, classroom observation and interviews. The data collection process considered teaching, learning and assessment practices conducted from January 2020 to November 2020. These data collection methods allowed researchers to interact with practitioners involved in action research within their contexts. Through interacting with the practitioners, the researcher obtained adequate and rich information concerning the implementation of KQMI. The methods ensured that appropriate data were collected to provide evidence for evaluating the implementation of KQMI. Qualitative data analysis employed content and narrative analysis. Quantitative data analysis employed a *t*-test calculation to find whether the initiative had a significant impact on improving students' mathematics performance.

Interviews: The mathematics teacher who implemented KQMI, the head of the school, and six selected students participated in the interview. The mathematics teacher was purposively selected because she was the one implementing the KQMI at school. The head of the school has vital information concerning supporting and monitoring the initiative. Further, the head of the school occasionally observed the teaching and learning process in mathematics class to improve students' interest in learning the subject. Students were selected from each test, the highest and lowest achiever, making six students from four tests administered. Two students won the crowns twice, making six students participate in the interview instead of eight.

Documentary review: The researcher reviewed several documents, such as students' score records, to gather relevant information. The score involved students from science class (KQMI class) and other students (non-KQMI class). The KQMI class scores were taken before, during and after the initiative. In the non-KQMI class, the researchers took the scores from examinations before and after the initiative. Also, the researcher reviewed the mathematics teacher's lesson plan to understand how the teacher planned the lessons and the kind of recommendations she gave for improvement.

Observation: Researchers conducted classroom observation to understand the noticeable changes in students' behaviours like participating in discussions, attendance and asking questions.

Data analysis plan

Data analysis involved statistical analysis and coding data into categories and themes based on the data type obtained. The scores obtained from the documentary review were analyzed using a *t*-test to determine whether the initiative significantly impacted students' performance. Again, the analysis involved Cohen's *D* statistical calculation to determine the effect size of the KQMI on students' performance. The study had two hypotheses: (1) showing that the initiative has a significant impact on students' performance and (2) showing that after implementing the initiative, female students would perform better than male students. Data from observation and interviews were coded and developed into themes – direct quotations from respondents supported the findings.

Dependability, trustworthiness and credibility

Multiple procedures ranging from the data collection to analysis ensured the research's dependability, trustworthiness and credibility (Creswell, 2012). The study employed a triangulation method involving multiple data collection methods such as interviews, observation and documentary review (see Table 2).

Ethical consideration. The researcher adhered to all research ethics. The researcher handled data confidentially while maintaining anonymity after obtaining participants' consent to participate in the study (Auerbach and Silverstein, 2003; Creswell, 2007). Respondents were informed about the purpose of the research. Participants granted their

Table 2.
Data collection
methods

Question Number	Type of data	Methods	Possible questions
QN1	Information regarding students' active participation and engagement in mathematics lessons	Interviews with teacher, students and classroom observations	How do students behave during mathematics lessons? What are their attitudes towards the subject?
QN2	Data involved the scores of students in mathematics: (1) the scores of the examinations before KQMI, (2) the scores of the tests during the KQMI and (3) the scores from standardized examinations after the implementation of KQMI. From the scores in the tests during KQMI, the analysis used <i>t</i> -tests calculations to determine the significance of KQMI	Documents review to obtain students' scores	How are students improving in performance? Are there any noticeable changes? If any, are they positive or negative?
QN3	Information regarding obstacles the teachers and students encountered and unexpected circumstances that interfered with the expected running of the initiative	Interviews	What obstacles/challenges do you frequently encounter? How does that affect the implementation of the initiative?

consent, and the researcher protected all respondents from physical, psychological and political harm or risk. The information collected and presented did not disclose participants' identities to maintain anonymity. Ensuring anonymity, the researcher used pseudo names during the data presentation.

Findings

The study intended to explore the impact of KQMI in promoting students' interest in learning mathematics and improving their achievement. Further, the study intended to uncover the challenges teachers and students faced during the initiative's implementation. The findings have revealed that students revived their learning interests as they engaged more in learning activities. Achievement gradually improved as the average increased from 17.6 to 29.8 in the first year of implementing the KQMI. Despite the promising results of the initiative, teachers' commitment and material and financial support emerged as threats to the KQMI's sustainability. The following sections present these findings in detail.

The KQMI in promoting interest in learning mathematics

In promoting students' interest in learning mathematics, the teacher employed teaching methods to make students like the subject and find it easy. The methods observed include mathematics clinic/consultation service, peer tutoring, demonstration and task-based. Mathematics clinic was a teaching method conducted under a tree outside the classroom when students were free. With this method, students consulted their teacher regarding their challenges in the subject. A teacher sat outside under the tree and asked students with difficulties in mathematics to go for advice and assistance. The method worked well as those students who lacked the confidence to speak in the classroom could now express their challenges and get assistance. On the other hand, the demonstration involved the teacher writing a mathematics problem on the board and solving it while showing students the

formula and procedures until they reached the answer. Then task-based followed up for students to solve, emulating what the teacher had demonstrated in the classroom. This observation is supported by what the mathematics teacher said,

In teaching, I mainly use demonstration and activity-based methods to show them how to solve various mathematical problems. Later, I give them questions that they must solve, as I had demonstrated. Also, I conduct remedial classes in the evening for those who wish to come and share their difficult areas. I also adopted a mathematics clinic strategy from one of my friends, though it was for all classes, not only the science class that I implemented the KQMI. I did this because students had varying levels of confidence as some could not speak in front of the class, but when they came alone, they shared the challenging part of their learning. (Mathematics teacher, 2021)

The findings again have revealed that students' classroom behaviours have changed positively as they actively participated in the learning activities. The findings revealed that students demonstrated passive learning behaviour before KQMI, but after the initiative, they showed interest in the subject as they actively engaged in learning activities. Now students asked questions, responded to the teacher's questions and assignments and participated in discussions, particularly trying to link concepts they have learned in the classroom. They tried to link what they have learned with its application in real-life situations. Further, students request the teacher repeat what they did not understand well, as shown in [Table 3](#). The act of students asking questions to the teacher, participating in discussion and requesting to reteach concepts they did not understand well implies that they have improved their confidence hence understanding the subject. The KQMI enhanced students' academic engagement since it increased the number of students attending remedial classes, unlike before. The academic engagement proved that students previously were afraid or disliked the subject due to low interest.

The findings obtained from the interview have indicated that the KQMI has elevated students' interest in learning mathematics. The observation noted students' behavioural change as they engaged more in mathematics-related activities such as attending lessons, asking questions and spending a significant amount of time practising and assisting each other. Such behaviour indicates the level of interest that students had developed in liking the subject. The teacher kept recognizing students who made significant improvements in mathematics achievement. Since the initiative recognized top achievers as Kings and Queens, those improving their scores also got a chance to have lunch with the teacher. Having lunch with the teacher was not only a way of motivating them but also implied that their improved achievement was recognized and valued, as the mathematics teacher claims,

Students started spending more time studying mathematics than in other subjects, which improved performance in mathematics and not in the other subjects. Students living in school hostels were found in the class around 10 pm, solving mathematics questions in groups. One of the teachers on duty observed this situation while walking around the school premises. (Mathematics teacher, 2021)

The KQMI not only raised students' interest in liking mathematics as they changed their behaviours positively but the teacher also learned and transformed her teaching practices. During the interview, the teacher admitted that the initiative had broadened her ability to understand and identify students struggling in the subject due to low achievement, hence designing appropriate methods such as mathematics clinics and remedial sessions to assist them. Also, since students started reading more and asking questions, this prompted the teacher to make thorough preparations in advance and start solving the examples she intended to use in the class in advance to have more confidence as she argues,

Previously [when] you enter the class knowing there will be no questions, so even the preparations were not intensive enough. Nevertheless, as they started asking many questions and asking to repeat or clarify using simple language, I started having intensive preparations for lessons so that

No.	Learning activities	Before KQMI	After KQMI
1	Responding to classroom assignments like doing tasks given in their exercise books	Rarely done, students had a low level of self-confidence	Frequently done and when one faces difficulties, seeks assistance from the teacher or colleagues
2	Responding to teachers' questions during the lesson	Few and almost the same students always	Most of the students respond to questions and spark discussions during the lesson
3	Asking questions to the teacher	Students hardly asked questions to the teacher	Students developed a tendency of asking questions to the teacher. Some asked during the classroom, while a few others went to the office after lessons for more clarification
4	Asking the teacher to repeat parts they did not understand during the lesson	When asked if they had understood the lesson, always students responded they had understood the lesson well	Frequently, students asked the teacher to repeat a section or provide more examples for them to understand the concept
5	Attending 1 h for remedial classes after school hours	Students remained behind for restorative sessions occasionally during the weeks near midterm, terminal or annual examinations	On average, 50% of students stayed behind to attend remedial classes, and each reported the area where they faced difficulties
6	Classroom attendance	Some students dodged mathematics lessons even when they were at the school premises	All students attended mathematics lessons and wrote all tests administered except when they were sick or had permission from the teacher
7	Students engage in mathematical practices in their free time	The teacher observed only a few students practising how to solve mathematics problems	More students in groups created similar questions as one given by teachers and applied the learned knowledge to solve them Students conducted peer tutoring in the evening during the preparation time as part of internalizing the learned concepts and preparation for tests
8	Enhanced students cooperation	Few students worked together in collaboration	Top achieving students assisted low achievers in the classroom during preparation time in the evening

Source(s): Data from mathematics teacher interview

Table 3.
Changes in students' behaviour during the implementation of KQMI

I may not seem less prepared or fail to respond to some questions. Also, I started taking a variety of books in classrooms. But most importantly, I used the feedback to identify and provide assistance to low achievers. (Mathematics teacher, 2021)

The trend of students' achievement in mathematics during the KQMI

In the second research question, the focus was to determine whether the initiative improved students' achievement and to what extent. The findings have revealed improvement in students' achievement in mathematics. The mean in test 1 was 17.6, increasing to 29.8 in test 4. The teacher administered test 1 in March 2020, where students learned and covered a few topics compared to test 4 at the end of November after covering all the topics required in form three class.

The study compared students' achievement through mathematics scores before and after implementing the KQMI. The scores before KQMI were taken from the form two standardized

examination, while after the initiative, the scores were from the national form four examinations. The findings revealed that the performance in form two examination before the initiative was 31.2% of the KQMI class achieved the pass grades while only 6.6% of the non-KQMI class achieved the pass grades. After the initiative, 35.1% of KQMI class achieved a passing grade, while only 1% of the non-KQMI class achieved a passing grade. The grading is classified in a range of scores as **A** = 75–100% (Excellent), **B** = 65–74% (Very good), **C** = 45–64% (Good), **D** = 30–44% (Satisfactory) and **F** = 0–29% (Fail). A grade from **A–D** is a pass and a grade of **F** is a fail.

The comparison of mathematics achievement, as shown in Table 4, reveals that, despite the increment in complexity and quality of the content covered, the KQMI class had a low doping rate compared to that of the non-KQMI class. Before the initiative, 46.75% of students in a KQMI class obtained a passing grade, while a non-KQMI class had 6.6%. After implementing the initiative, 35.1% of students in a KQMI class obtained a passing grade compared to 1% of students in a non-KQMI class. Although the achievement had dropped for both classes, the KQMI class did not have a sharp drop.

The findings have shown that the KQMI has improved students' achievement in mathematics. The study had two hypotheses for testing the significant impact of the initiative on students' performance. The first hypothesis stated that the KQMI has a substantial impact on promoting students' achievement in mathematics. The dependent *t*-test was employed to understand the effect of the KQMI in improving students' performance. The study found that the initiative was statistically significant as the *p*-value was 0.000 in all pairs tested; hence, it rejected the null hypothesis and supported the research hypothesis.

The second research hypothesis stated that after implementing the KQMI, female students would perform better than male students. Despite the mathematics teacher and the head of the school being females, they have not inspired female students to improve their achievements. The study expected female students to have more self-confidence because of a female mathematics teacher. The findings contradict Khan *et al.*'s (2018) study that female students outperform male students when a female teacher instructs a subject. In test 1, as the initiative started, there was no significant difference in achievement between male and female students, $t(71) = 1.351, p > 0.05$. However, in test 4, it was found that there was a significant difference in achievement as males performed better than female students, $t(74) = 2.951, p < 0.05$. In this view, the research hypothesis, "After implementing the KQMI, female students will have higher achievement in mathematics than male students", was rejected, and the null hypothesis was accepted. Again, the descriptive statistics in Figure 2 reveal that in all tests except test 3, males had a higher average than female students. Therefore, the findings confirm that the initiative was less effective for female students than male students. This finding contradicts Khan *et al.*'s (2018) report that females perform better than males in mathematics (see Figure 3).

#	Grade	Before KQMI			After KQMI				
		KQMI class	Cumulative (%)	Non-KQMI class	Cumulative (%)	KQMI class	Cumulative (%)	Non-KQMI class	Cumulative (%)
1	A	2	2.59	0	0	1	1.3	0	0
2	B	6	10.39	0	0	2	3.9	0	0
3	C	14	28.57	4	1.9	12	19.5	0	0
4	D	14	46.75	10	6.6	12	35.1	2	1
5	F	41	100	199	100	50	100	198	100
<i>Total</i>		77	100	213**	100	77	100	200**	100

Note(s): ** The variation in total before and after KQMI is because of dropout, transfer to other schools and repeating classes.

Table 4. Performance comparison before and after the implementation of KQMI

Figure 2.
Mean comparison in
four administered tests

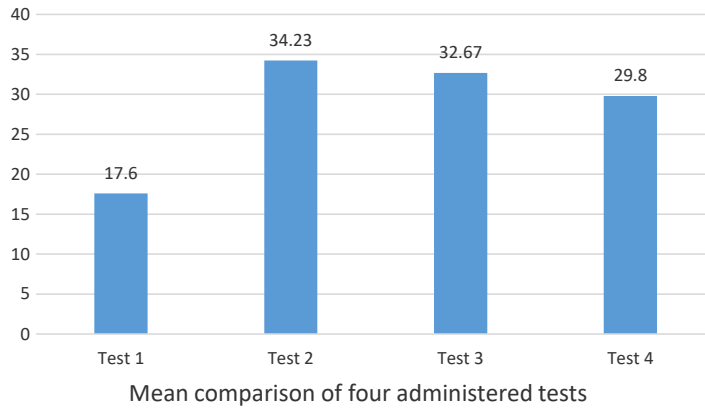
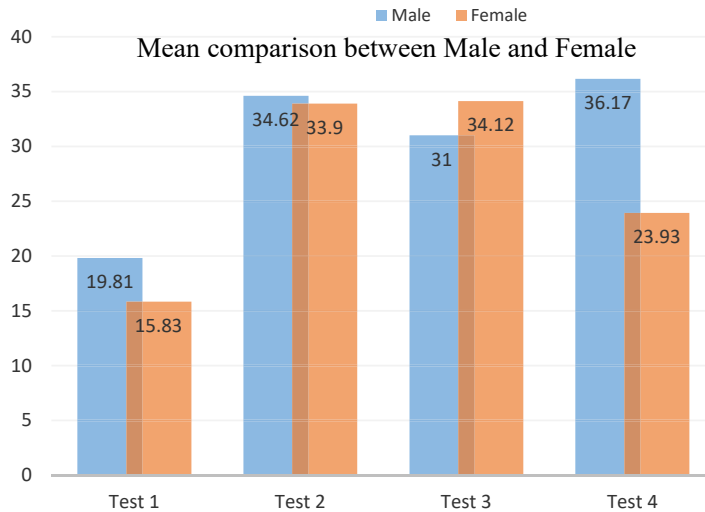


Figure 3.
Mean comparison
between male and
female students in
four tests



The researchers calculated the pair of tests to determine the effect size of the training programme. The findings revealed that the T1*T2, T1*T3 and T1*T4 pairs had Cohen's *D* greater than 0.8 hence implying the effect size of the training is as large as shown in Table 4. The effect size of tests (see Cohen's *D* in Table 4) revealed that as the number of topics increased and tests became comprehensive, the initiative's effect reduced; for example, T1*T2 Cohen's *D* is 1.55, wherein T1*T4 Cohen's *D* is 0.99. However, as calculated in the *t*-test, the later pairs found that there was no significant improvement from test 2 to test 3 and test 3 to test 4 ($p > 0.05$) (see Table 5).

Table 5.
Summary of dependent
t-test results on the
effect of KQMI

No.	Pair	M_1	M_2	Mean difference	SD	Cohen's <i>D</i>	<i>df</i>	<i>t</i> -value	<i>p</i> -value
1	T1*T2	17.80	34.70	-16.901	10.877	1.55	70	-13.093	0.000
2	T1*T3	17.69	33.12	-15.431	15.558	0.99	71	-8.416	0.000
3	T1*T4	17.69	29.39	-11.694	12.535	0.93	71	-7.917	0.000

Challenges encountered during the implementation of KQMI

The study found that the teacher spent her weekend marking the tests or assignments and recording the scores to announce winners every Monday morning. Further, the teacher designed special badges for winners as a sign of recognition to the entire school. Hence, the initiative required intrinsic motivation of individual teachers and commitment regardless of little assistance from school management. In this view, other mathematics teachers were hesitant to join the initiative citing it as it adds more responsibilities to the workload they already had. As a new initiative without any reference for its success, it received little assistance at the school level. The school did not provide the required resources and facilities. The teacher used her resources like money and time to manage the initiative. The head of the school confirmed the findings as she said, *“We do not have enough resources to support every new initiative. But some creativity means added responsibility, so many teachers are against it. It should come from within to be successful.”*

The teacher reported some discouragement from fellow teachers as they did not assist in administering tests or marking. In some cases, the mathematics teacher requested some students from higher classes to assist in administering and invigilating the test. The teacher wrote the test on the board, so it was tedious somehow and forced the teacher to have few questions than her prior expectations.

On the side of challenges-facing students, the study revealed that they were inspired to work hard and win the title, hence placing more effort in learning mathematics than other subjects. During the interview, the teacher revealed, *“Some teachers complained that students are focusing on only one subject. This situation, to some extent, lowered their performance in other science subjects. However, I asked them to motivate them using different strategies. I could not change my initiative because I wanted my students to improve their achievement.”*

Some students were discouraged since recognition was for those who topped the test score while neglecting those not appearing at the top but significantly improved. A few students said that they never expected to win the title based on their abilities, so they were not motivated to work harder than before. This situation was associated with a lack of recognition whereby later in implementing KQMI, the teacher started considering their progress and recognized them. Again, students had to incur the costs of buying answer sheets which to some it appeared to be a burden due to the socio-economic status of their families. As a result, they started tearing plain pages from their exercise books which was also discouraged by some teachers, as reflected in the interview:

Apart from the King and Queen, I prepared badges for the most improved girls and most improved boys, who moved to one or more grades higher than the previous one. The challenge I faced was that some students scored very low and believed they would never improve, so they never put effort to improve no matter how the teacher assisted and motivated them. Also, I learned and changed how to recognize them due to some students' discouragement as they believed they would never win or be recognized. (Mathematics teacher, 2021)

Discussions

Pedagogical innovations have proved to effectively promote students' interests in learning mathematics (Mazana *et al.*, 2019). The innovations help students to discard their long-rooted beliefs that mathematics is complicated and they cannot perform well. The KQMI, as pedagogical innovation, has significantly improved students' interest in learning mathematics and improved performance through the designed teaching methods such as task-based (Coles and Brown, 2016) and mathematics clinic. These task-based teaching and mathematics clinics are in the immersing stage in the theoretical framework where students engage in learning activities that develop interests in learning (Wong and Wong, 2019).

The initiative's outcome saw students change their classroom behaviours where they became active in interacting and showing interest in the subject.

Through innovations, students activate their interests to participate in classroom activities and better use their private time to learn and solve mathematical problems. The findings have proved the improved achievement after the KQMI, as the first hypothesis has confirmed. However, the hypothesis predicted that female students would outperform male students because the mathematics teacher was female, but female students achieved lower than their counterparts. This finding led to the rejection of the second research hypothesis and accepted the null hypothesis. The findings resonate with [Hackett and Betz \(1989\)](#) and [Chouinard et al. \(2007\)](#), who found that sex difference in mathematics self-efficacy correlates with sex variation in mathematics achievement.

In a sustained context, [Wong et al. \(2020\)](#) term self-directed learning as extending interest as students make meaningful internalization of the learning behaviour. [Sa'ad et al. \(2014\)](#) support the finding as they reveal that a lack of pedagogical innovations harms students' academic achievement. Recognizing the achievement boosts students' self-confidence; hence, it makes them free to make trials in solving problems, asking questions and urging the teacher to reteach some concepts they have not well mastered. This finding resonates with [Peteros et al. \(2020\)](#) that recognition boosts students' confidence and interest in learning mathematics. Students with a high level of confidence are likelier to have high achievements in the subject ([Hackett and Betz, 1989](#)).

[Wong et al. \(2020\)](#) affirm that triggering interest involves facilitating an activity that elicits initial interest. In this study, award-winning and recognition triggered students' interests in participating actively in learning tasks and seeking assistance for improvement. The recognition, awards and good scores triggered students to engage in various activities. Students who developed an interest in learning mathematics have significantly improved the subject's achievement. This finding contradicts the findings of [Wong and Wong \(2019\)](#) that there is no significant correlation between students' interest and their performance. Since they spend more time learning and practising, it makes them more confident and internalizes the taught skills, making it easy to apply the learned skills even in tests and examinations ([Azmidar et al., 2017](#); [Frenzel et al., 2010](#)).

Implementing pedagogical innovations such as KQMI requires teachers' self-commitment and intrinsic motivation ([Maass et al., 2019](#)). There are a few obstacles that jeopardize the sustainability of the initiative. The teacher experienced a lack of recognition at the school level, and assistance from fellow teachers threatened pedagogical innovations' prosperity. The lack of cooperation is a challenge for mathematics teachers and the other teachers who may be motivated to try their innovative strategies in teaching their subjects. School management should motivate teachers and students to use pedagogical innovations by providing resources and facilities. Using personal resources among teachers and students demotivates them and obstructs the innovation to deliver the expected outcome.

Conclusions

The study intended to explore the impact of KQMI in promoting students' interest in learning mathematics and improving their achievement. The initiative has promoted interest as students actively participated in learning activities. Comparing the achievement before and after the initiative and with other non-KQMI classes, the KQMI has significantly improved students' achievement in mathematics. Pedagogical innovations such as KQMI have effectively promoted students' interest in learning mathematics at Lemara Secondary School which saw their interest revised and achievement improved. Apart from the promising results of the initiative, teachers' commitment and material and financial support emerged as threats to the sustainability of the pedagogical innovation. Supporting these pedagogical

innovations is vital for sustainability and achieving a maximum outcome in improving general performance among the students.

It is crucial to pilot the initiative in other schools to determine its contribution to promoting interest and achievement in mathematics. Teachers should be provided with motivation and capacity-building training to adopt and implement pedagogical innovations such as the KQMI. Teachers and students should get the necessary support to improve mathematics performance, especially in under-resourced ward schools that lag in national examination results. Future studies should first focus on implementing the initiative in more schools and assess its impact on promoting students' interests in learning mathematics and improving performance. Secondly, studies should aim at strategies to inspire more teachers to engage in pedagogical innovations and foster cooperation. The pedagogical innovation and collaboration will enhance teachers' continuous professional development to see them transform their classroom teaching practices.

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