International Journal of Evaluation and Research in Education (IJERE)
Vol. 11, No. 2, June 2022, pp. 507~515
ISSN: 2252-8822, DOI: 10.11591/ijere.v11i2.22152

Teacher-student interactions for enhanced learning in upper secondary mathematics classroom

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Article Info

Article history:

Received May 17, 2021
Revised Feb 25, 2022
Accepted Apr 4, 2022

Keywords:

Interactive teaching
Problem-solving
Students' learning
Teacher-student interaction

ABSTRACT

Interactive teaching practices in mathematics classrooms are encouraged to meet the learning potential. However, how it is applied in the classroom is still challenging. This paper uses evidence gathered from a large research project to contribute to the understanding of teacher-student interactions. It followed an interventional approach with two teachers and 82 students of two grade 11 classes from one school of Kayonza District in Rwanda. Data were collected through observations, video recordings, and field notes. Results revealed that there is a variety of ways to facilitate and keep interactive learning. These include asking purposeful questions and giving feedback. The quality of teacher facilitation (52%) and students' engagement (60%) were moderately high. However, there was little guidance from teachers in the problem-solving process and the classroom discourse. It is argued that the role of instructional language in communication hinders the quality of teacher-student interactions. This leads us to advise an exploration of language supportive pedagogy in the Rwandan context.

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1. INTRODUCTION

A focus on interactive teaching practice has been there for a long time ago. It is seen to raise the quality of learning mathematics in terms of performance and a trend for its modern instruction in elementary and secondary schools [1], [2]. Interactive teaching has the potential to offer a learning environment that optimizes the exploitation of improving conceptual understanding and fostering problem-solving skills [3]. Interactive teaching involves learners in the learning process where their own experience and contributions are encouraged to be brought into learning to promote attention, participation, interest, and funs [1]. In this learning process, learners are expected to participate by responding to questions, providing contributions, interpreting, and showing their solutions to other students in the classroom. The primary role of applying interactive teaching is to encourage learning [3]. However, the application of interactive teaching is still challenging. Thus, this study contributes to the understanding of interactive teaching where teacher-student interaction is investigated to enhance learning.

Various types of interactive teaching in mathematics classrooms were applied for different purposes. The most used interactions include interactions between teacher and students and interactions between students and learning technology. For this study's purpose and context, the interaction between teachers and students was the focus. It was highlighted that the discourse and the causal relationship between teacher, the mathematics content, and participation of students in the environment defines teaching. The environment is referred to us as the classroom [4]. The classroom is where students meet to share ideas, agree or disagree, reason or solve problems, and opportunity to speak to one another to construct knowledge. Classroom interactions should therefore focus on students' collaborative learning.

In order to maintain active classroom interactions, teachers and students are encouraged to engage in productive talk, tasks, and reasoning [1]. The teacher talk should focus on posing questions that probe understanding and is followed by a reflection and a refinement of the work, which cause students to make further investigations. Thus, teachers are encouraged to use wait time and varied open questions and comment to monitor the talk. According to Schoenfeld [5], open questions offer multiple justifiable solutions while closed questions do not. However, in providing the lesson structure and guiding the problem-solving process and classroom discourse [4], teachers still use whole classroom talk for teaching rather than talking for learning. A common mode of teaching practice has been teachers presenting information with closed questions and students giving short answers.

Productive interactions between teacher and students and with the content have been proved to contribute to the learning potentials. For example, the study conducted by Kent [6] revealed positive results after an intervention of interactive teaching. The author used responsive teaching through the problem-posing (RTPP) model that positioned students as experts in mathematics. The author observed two teachers who implemented RTPP in their mathematics classroom once a month for two years. The study found an improvement in students' participation in learning and talking related to mathematics. Also, Hurst, Wallace, and Nixon [7] conducted a study to examine the impact of social interaction on student learning. The authors structured a course to create high-quality interaction between students with facilitation from their teachers. The study found that social interaction made learning fun, get students interested and engaged, allowed students to talk in the classroom, and helped them learn from others. More importantly, social interaction helped them learn huge content quickly and with improved comprehension [7]. Furthermore, The study conducted by Cobb, Yackel, and Wood [8] on three girls of elementary seven years old learners revealed that the sequence of interactions that occurred within 10 minutes under a "taken-as-shared" model helped students to develop an understanding of the place value numeration concepts. Quality interaction support understanding as well as engagement in the learning process.

Probably a factor as to why interaction is explored so poorly. Historically, classroom interaction was less valued in mathematics education as compared to other disciplines [9]. It was valued after realizing that interaction in the classroom shapes learning. Classroom interaction existed in ways that were specific to the role of language in communication, relationships between individuals, and collective reflections, forms of mathematical argumentation [9]. Classroom interaction attracted much attention, mainly in transforming the education system to accommodate 21st-century skills. Classroom interaction turns out to be the key to starting a conversation. Nizeyimana and Osman [10] noted "students' – teacher interactions constitute a crucial indicator of student engagement."

According to Cohen, Raudenbush, and Ball [4], classroom interaction refers to any form of conversation that enables teachers and students to stay connected during learning and is extended over some time. It entails a relationship between teachers and students around the mathematical content being learned. Teachers are regarded as facilitators of learning and influence students' engagement on the content in the classroom. Indeed, the current effort for teaching and learning mathematics focus on lesson implementation that include peer engagement [11]. Thus, teachers and students in the classroom play different roles that target common goals. Teachers' role is to structure the lesson content and set tasks that enable students to discuss, choose the mode of delivery, guide students to complete the task, and monitor the classroom positive talk [4]. On top of that, teachers provide the necessary support and information about the lesson content or task to one or a group of students to promote learning. Students' role is to be engaged in the learning process. This engagement is due to teachers' work on the content, how teachers understand their work, see and use learners' errors, and how skillful teachers respond. Also, what teachers do, think, and say with students maintain them in the process. Although both roles of teachers and students are essential to learning with understanding or deep learning effectively, the learning framework requires committed teachers who understand the subject and know how to make it accessible for learning [4].

Different programs, projects, interventions, continuous professional development (CPD), and initiatives were implemented worldwide and in Rwanda to support the teacher's change from talking and listening to students' active involvement in the learning process. For example, after implementing a competence-based curriculum in Rwanda in 2015, projects such as VVOB, in partnership with the University of Rwanda, facilitate in-service STEM teachers to achieve their teaching potential. However, despite efforts, the patterns of teacher-student interaction in mathematics remain unchanged [12]. Teachers still present information and pose closed questions with a total lack of feedback on students' responses apart from "not correct" and yes, is correct. Consequently, the achievement of the national priority of quality education [13] will be difficult. Several factors were identified to cause this [7]. It is expected that teachers do not understand the points of focus and their practicability and the role of students and teachers to maintain a productive classroom interaction and language of instruction. These aspects have drawn attention towards conducting this study.

Various studies [7], [14]–[16] explored the patterns of interactions between teachers and students in elementary and lower secondary schools in mathematics. They focused on the qualities of teaching. The interaction between teachers and students around the content should characterize the mathematics instruction [4]. To our knowledge, few studies were conducted in upper secondary schools. Consequently, little is known about the qualities of teaching through interactions in upper secondary schools to support the construction of mathematical understanding. This study builds more knowledge on the qualities of teaching through interactions. It examines actions of teachers and students around the content, particularly the extent to which teacher facilitates active learning and students' engagement during mathematics teaching. We also hope that building knowledge about the actions of teachers and students in the classroom could inform interactions on what to improve in the professional development to enhance students learning. The article highlights effective practices and processes of teaching and learning mathematics in upper secondary schools.

Constructivism learning theory guided this study. Constructivists state that learning occurs within meaningful and integrated contexts with the mind engaged and is built over a while [17]. Constructivists emphasize that new knowledge is acquired when the old one is challenged to attain a desired understanding of concepts. This learning is socially constructed, which is why constructivist theory could not be enough to support this study. The social constructivism theory of learning was considered in the study to support the claim. This theory state that students construct knowledge when other voices, thinking, and meaning are merging socially. The theory further states that learning is the interaction that happens between teachers and students while making interpretations and constructing new knowledge. These statements support the framework described by Cohen, Raudenbush, and Ball [4], which states that students interact with each other, with the teacher, and with the content in the classroom. Therefore, teacher facilitation should optimize learning and develop students' engagement in the learning process.

2. RESEARCH METHOD

2.1. Research design and participants

The study examined the pattern of interactions between teachers and students around the mathematical content for enhanced learning. The research question was how much the teacher's actions (in their role to provide the lesson structure, guides the problem-solving process, and classroom discourse) facilitated students' participation in the learning process. To answer this question, we used mixed methods as the research design. The qualitative part provided us a detailed description of classroom interactions, while the quantitative served us to collect reliable and consistent data [18].

The participants were involved in intervention over four months, emphasizing the value of learner-centeredness, self-directedness, and efficacy for enhanced student engagement and problem-solving abilities in mathematics. The participating teachers have attended a two-day workshop on an intervention model at the beginning of June 2019 to have very knowledgeable teachers promote students' abilities in solving mathematical problems and beyond. These teachers were assisted over 14 weeks. In addition, participating teachers have also been introduced to teaching mathematics aligned with the competence-based curriculum in Rwanda [19] on top of being qualified for teaching mathematics for secondary schools. The participating teachers' backgrounds served us to validate the observations made.

Classroom observations served as the basis for this study. The study involved two male teachers and 82 students (45 females and 37 males) of grade 11. The age of students varies between 16 and 19 years old. These students are from one secondary school selected from five government/ boarding schools in Kayonza District of Rwanda, 2019. The selection was made based on the performance of these schools in the national examination of grade 12. The selected school was the best and has science combinations. The class of Mathematics-Economics-Geography (MEG) with 35 students and Physics-Chemistry-Biology (PCB) with 47 students were considered. The two classes were considered because we wanted to understand students who take subsidiary mathematics (PCB) and core mathematics (MEG). Core mathematics refers to the principal subject, while subsidiary mathematics refers to compulsory subjects for science or economics [19]. Core mathematics is taken seven periods per week, while subsidiary mathematics takes three periods per week (in Rwanda, a period corresponds to 40 minutes). This indicates that there was a chance to make more observations in MEG than in PCB.

2.2. Research instrument

The study used the Mathematical Classroom Observation Protocol for Practices (MCOP^2) as a framework to describe teacher-students' interaction. The framework supports the development of conceptual understanding with two factors of teacher facilitation (0.850 of Cronbach alpha coefficient) and students' engagement with their respective 0.850 and 0.897 of Cronbach alpha coefficients [20]. It is grounded in models of effective teaching. While the instrument was designed for American students, it was deemed relevant to the Rwandan context. MCOP^2 was applied to secondary school students at the level at which it was originally designed. Validity and reliability were checked before its use. They can be used for a live classroom or a complete videotaped lesson episode more than three times in each class as per recommendation by the originator [21].

The use of MCOP^2 does not require any extensive training or professional development other than reviewing the detailed user guide and understanding the terminologies used in the rubrics [20]. However, to ensure the reliability of the MCOP^2 ratings in our context, interrater reliability was checked. Before comparison, this was done by watching and rating three videos independently from senior five MEG and PCB classes. Each item scored 0 (not at all) to 3 (extremely well) based on the item description in the rubric [21]. An agreement of 88% was met after comparison. We revised the user guidelines and watched the video again several times after discussing what we rated in the previous video. Finally, an agreement of 94% was met. In addition, the Cronbach alpha coefficient for the two factors in the MCOP^2 indicated better results for internal consistency (student engagement, $\alpha = 0.942$; and teacher facilitation, $\alpha = 0.864$).

MCOP^2 has 16 statements that measure both teacher facilitation and student engagement. Items 1-5 and 12-15 for student engagement measure the role of students in the classroom and their engagement in learning, and items 4, 6-11, 13, and 16 for teacher facilitation measures the role of the teacher as the one who provides the lesson structure and guidance for problem-solving process and classroom discourse [21]. The instrument was complemented by video recordings, field notes, and our own experience.

2.3. Data collection process

Before undertaking this study, an introductory letter was requested and obtained from the University of Rwanda-College of Education from the directorate of the research and innovation unit for ethical clearance purposes. The letter was then taken to the deputy director of education of the district where the study was conducted. This was to ensure that researchers had all documents that the school administration could ask. After explaining the purpose of the study, participating teachers and students have all signed the consent forms for voluntary participation in the study.

To gather information about the actions of teachers and students in the classroom, two raters (one researcher and research assistant) went into the class with the teacher and were given a seat at the back of the classroom. Raters recorded a live classroom on a recording sheet for MCOP^2 within the allotted time for a lesson per day, i.e., 40 or 80 minutes of the single or double period. Comments were also added to each item scored in the MCOP^2 to justify the reason for the score. We have also taken 10 videos (six from MEG and four from PCB). The camera was placed at the back of the classroom to capture the behavior of the whole classroom, and three audio recorders were placed in groups during the meeting to capture the voices of students and that of the teacher when supporting.

Algebraic topics, including exponential and logarithmic equations, and solving equations using numerical methods were targeted to be observed. These topics encompass many fundamental concepts in the learning of mathematics and are very useful in real life. We wanted to observe these lessons because they are flexible to set open tasks and design problem-solving activities at a high level. However, due to the course structure and the scheme of work, other units, such as vector space of actual number; matrices and determinants of order 3; points, straight lines, planes, and sphere in 3D; and bivariate statistics were observed. Altogether, 70% of observed lessons were algebra, and 30% were geometry and numbers. We have done 37 observations during 14 weeks.

2.4. Data analysis

Microsoft Excel was used to analyses data collected through MCOP^2. Scores of each lesson sheet were recorded in an MS Excel sheet in the range from zero to three, and then the average scores were computed horizontally. These means were computed to get the overall teacher-student interaction in the classes involved in the study.

To complement data from MCOP^2, a sample of 12-minute videos was extracted from videos taken from MEG. The video was used to explain the construction of knowledge due to interactions between students engaged in a collaborative small group activity from which the teacher facilitated the learning process. The groups were working on logarithmic and exponential equations. The teacher had not taught the standard notations or formulas either the real-life applications of logarithmic and exponential functions or how they look graphically and their domain of definition. The teacher had instead attempted to let students discover the topic of the lesson and, more importantly, to guide their sense-making in mathematics that reflected the development of understanding the relationship between exponential and logarithmic functions. These students had been working together as partners in the classroom. However, it was their first time to discuss a situation that required them to exhibit, generate and demonstrate their mathematical understanding without being introduced to the subject as usual. Table 1 shows the descriptive statistics for each item in the MCOP^2. Items 1-5 and 12-15 represent students' engagement and, items 4, 6-11, 13, and 16 represent teacher facilitation.

In addition, both teacher's and students' conversations and prior classroom observations indicated that students experienced the traditional way of learning mathematics. In other words, students were familiar with the chalk and talk strategy. They were accustomed to the teacher giving them what they need to know about a particular topic such as formulas, notations, standard computations, and so on and then providing students with exercises that help them to repeat and memorize the learned material/content. Although the learning method may not be deficient in some circumstances, it is often seen as limiting students' learning and developing a total lack of interest instead of opening rooms that assist them in exploring the beauty and power of mathematics. Therefore, the analysis of the lesson episode shows how the changed role of the teacher supported students' learning.

Table 1. Descriptive statistics for each item in the MCOP^2

	MCOP^2 statements	Scores	Mean
1	Students are engaged in exploration/investigation/problem solving	61	1.65
2	Students used a variety of means (models, drawings, graphs, concrete materials, and manipulative) to represents concepts	46	1.24
3	Students were engaged in mathematical activities	78	2.11
4	Students critically assessed the mathematical strategies	58	1.57
5	Students persevered in problem-solving	42	1.14
6	The lesson involved fundamental concepts of the subject in promoting relational/conceptual understanding	81	2.19
7	The lesson promoted modeling with mathematics	44	1.19
8	The lesson provided opportunities to examine the mathematical structure (symbolic notations, patterns, generalization, and conjectures)	61	1.65
9	The lesson included tasks that have multiple paths to a solution or multiple solutions	46	1.24
10	The lesson promoted precision of mathematical language	62	1.68
11	The teachers' talk encouraged student thinking	36	0.97
12	There were a high proportion of students talking related to mathematics	78	2.11
13	There was a climate of respect for what others had to say	76	2.05
14	In general, the teacher provided wait-time	79	2.14
15	Students were involved in the communication of their ideas to others (peer-to-peers)	81	2.19
16	The teachers use students questions/comments to enhance conceptual mathematical understanding	57	1.54
	Overall scores	986	1.67

3. RESULTS AND DISCUSSION

After summing scores of each statement of the overall 37 observations made in both PCB and MEG classes, we got 111 total scores in the range of 0 to 3. The descriptive statistics of mean and average scores of the overall 37 observations are displayed in Table 1. The description of each statement can be found in the reference [21].

Across the 16 statements of MCOP^2, the overall average scores were 1.67 (56%) out of three, indicating the moderate quality of interactive teaching. The lowest average score of 0.97 (32%) was found in statement 11 (teachers' talk encouraged students' thinking). The highest average scores of 2.19 were found at two statements; 6 (the lesson involved fundamental concepts of the subject to promote relational/ conceptual understanding) and 15 (students were involved in communicating their ideas to others-peer to peers). Statements 6 and 11 load under the factor that measure teachers' role in facilitating the learning process. Teachers facilitated students to interconnect concepts and construct mathematical understanding as recommended in the competence-based curriculum (CBC) [19]. For example, the teacher was introducing exponential and logarithmic functions. Students were encouraged to sketch graphs ($y = 2^x$) before being introduced to the concepts and then compare the function with properties of logarithms. This strategy made students discover the relationship between logarithmic and exponential functions themselves. This may be because teachers received intervention on top of the training received from Rwanda Basic Education Board and at the university that encouraged them to focus on the active participation of their students. But some weaknesses were also noted in statements 2, 5, 7, 9, and 11.

We noticed that the teacher did most of the representations and manipulations of concepts such as models, graphs, and drawings instead of allowing students to manipulate and explore concepts (statement 2). The teacher should guide students with guiding questions that encourage them to continue; what else do you know to do that, what could be this if you do that, can you try, and encourage others to intervene [6] to reach the destination. However, we found them making much effort to talk to teach instead of talking for learning. In this case, the teacher is expressing his/her cognitive processes while he/she is supposed to develop those of learners [7], [22]. Yet, most of the work teachers do on the chalkboard could be done by the students if they are supported. This teaching makes the lesson boring as we observed students falling asleep on the bench, uninteresting and even useless [7], because students could not construct the mathematical understanding.

The characteristics of most lessons excluded opportunities for students to apply the mathematical knowledge and skills they know to solve the issue in their context (statement 7). The exact methods for solving equations were encouraged than finding other techniques that can provide good approximations of the solutions. This act limits students from getting the learning potentials. Students will be limited to find the usefulness, beauty, and power of mathematics in their lives, thus get interested and motivated to do it. The act may also cause students to be less engaged in the learning process. For instance, we noticed a lack of tasks that invite many acceptable answers (statement 9). The lack of these tasks may cause students to make many unproductive talks (talk related to mathematics) and thus become a challenge for teachers to monitor the whole classroom or group talk. These are in line with the findings of Nizeyimana and Osman [10].

In most of the lessons observed, the content inputted students to reason, think, argue, discuss and critic the mathematical concepts (statement 11). The rushing to cover the content was most apparent. Thus, questions like "why" and "what if" that help student to critic their thinking and that of others were used less in a small group meeting or the whole classroom. We noticed that more questions were asked during a small group meeting. This result is in contrast with the study conducted by Setianingsih [23]. This means that there are many skills such as problem-solving and reasoning that student would not develop if the probing questions are less used. Developing these skills through problem-solving investigations [23], [24] because the challenge causes students to think. The cognitive level should also be maintained at a high level to keep interactive teaching active [25]–[28]. Teachers should ask students questions that probe their understanding, that cause them to refine their work and extend thinking [26].

It was also noticed that students were accustomed to one unique solution with known steps no matter how hard the teacher tries otherwise. This is confirmed by the comments made at different times and on different topics. For instance, the asked question is to sketch the curve of the function $f(x) = 3^x$ for $-2 \leq x \leq 2$ and its inverse $f^{-1}(x)$ using a Cartesian plane with a table of coordinates to fill. This means that a student familiar with being given a table of coordinates is more likely to develop procedural knowledge with a total lack of understanding. Teachers are encouraged to ask productive questions [6], consider open-ended tasks, and give room to reasoning. Lai [29] emphasized the need for careful design, planning, and implementation of the lesson. The manner the teacher facilitates the learning process matters the most to engage students fully.

The 16 statements of the MCOP^2 represents the amount of teacher facilitation and student engagement. The average scores of the lesson under each statement are displayed in Table 1. To observe the specific model of the scores under each factor in the MCOP^2 for PCB and MEG, we grouped statements under their factors. The minimum, maximum, and mean values were displayed in Table 2. The analysis of the two factors is also displayed in Table 3.

Table 2. Descriptive statistics for each factor in the MCOP^2

Factors	MEG					PCB					Overall
	Min	Max	Mean	SD	%	Min	Max	Mean	SD	%	mean (%)
Students' engagement	0.96	1.96	1.46	0.70	48.7	1.2	2.72	2.00	1.02	66.6%	(59.96)
Teacher facilitation	0.88	2.3	1.46	0.81	48.7	1.4	2.72	2.08	0.90	69.5	(52.14)

Note: Number of observations=37; Min=minimum; Max=maximum

Table 2 shows the amount of teacher facilitation and students' engagement in PCB and MEG classes separately. We noticed that students in PCB showed more engagement than in MEG. PCB students are scientists compared to MEG students. Also, many mathematics concepts are applied in their major subjects. Besides, they received more teacher facilitation than in MEG. The motivation for many students to take MEG combination is Geography and Economics. They do mathematics as an obligation. It can be said that students in MEG are not intrinsically motivated to learn mathematics. In addition, from students' conversations with researchers, students often fail to care much about mathematics because even the more significant part of textbooks they use do not show the mathematics in their area of interest (Geography and Economics). For instance, the terminologies used in exercises 3.4 provided in unit 3 on the logarithmic and exponential function are in chemistry [30]. However, this should not be an excuse because the CBC encourages students to have and develop various knowledge in different subjects and do further research [19].

The overall student engagement was more visible (59.96%) than teacher facilitation (52.14%). Table 3 also shows that students played their role in the learning process (statements 3, 12, 14 and 15 scored high, 70% and above) that teacher role (only statement 6 scored 70% and above). Thus, there is a need to elevate students' roles in the learning process [6]. However, the lesson structure, guiding the problem-solving process, and classroom discourse should be at a high level to keep interactive learning between students, with the teacher, and with the content. Teachers should react positively to students' work and provide prompt feedback. This will allow learning to happen for students rather than their teacher as it was traditionally. Students will know how to apply mathematics to solve real-life, society and/or workplace problems.

Table 3. Analysis of statements under each factor in the MCOP^2

Factors in the MCOP^2	Low (below 45%)	Middle (between 45% and 70%)	High (70 % and above)
Student engagement	2, 5	1, 4, 13	3, 12, 14, 15
Teacher facilitation	7, 9, 11	4, 8, 10, 13, 16	6

Based on the observations made, it was noticed that various factors influence qualities of interactions between partners of the classroom and with the content and its maintenance. Factors include the quality of the task, the probing questions that challenge students' understanding, and how the teacher reacts to their students' work. For example, we observed a mathematical scenario presented to students in MEG. The scenario requested that students determine the amount of money that can be paid when a customer has delayed paying the loan at the bank for a month (31 days). The late payment rate was set to 150 Rwandan francs (FRW) on the first day of delay. The money was doubled on the second day of delay, and this pattern continues until the customer pays. This situation was presented to students to enable them to discover the lesson topic, attract their attention in the classroom, and motivate them in the learning process. Also, as indicated by both students and their teacher in conversations, the provided situation was related to economics. Many students pursue MEG simply because they are interested in Economics or Geography, as highlighted earlier.

During the discussion of the scenario, the appreciation of applying mathematics concepts to model the situation could be seen among students. Students showed interest and motivation as they raised voices discussing the appropriate concepts to apply; they asked questions to seek clarifications. They used multiple ways to achieve the solutions, and, more importantly, they asked questions in public. Teachers should pay attention to the task given to students during learning, the questions they pose, and how feedback is given. However, we noticed that teacher's feedback was "yes" and "no" types of reactions in line with previous studies [7], [26]. Also, setting this scene in the language of instruction (English) was difficult. This can be devoted to the barriers in the language of instruction in Rwanda where long sentences of explanations were avoided. Also, although students were from the best performing school in the district, they codeswitched into the local language (Kinyarwanda) when explaining something of more than three minutes. Teachers and students should make efforts to use English during small group meetings or whole-class discussions. These difficulties could be influenced by the shift from French as a medium of instruction to English in Rwanda.

4. CONCLUSION

Based on the findings of this study, many conclusions can be drawn to achieve the learning goal. The study indicated that the quality of the task, posing purposeful questions, and the way teachers react to students' work ais very significant to the quality of learning mathematics that put forth interaction between students and teachers and with the content for enhanced learning. Teachers should pose questions that engage students to think, make further investigations, and for themselves or key questions that reflect the lesson's objective to save time rather than intimidating them with short responses. Teachers also should allow a wait time to enable students to respond, reflect and critique their reasoning. More opportunities are to be given to students to manipulate and explore the learning materials and apply knowledge in various real contexts to develop problem-solving skills.

The study also indicated that the role of students in the learning process was more visible (60 %) than that of teachers (52%). Further research may look into factors that hinder teachers' capabilities in organizing such interactions, be language barrier be external such as syllabus constrained to be completed within a nationally predetermined time. Due to the small sample used in this study, the study results should not be generalized to other secondary schools with an upper level that accommodates mathematics in Kayonza District. The results only provide indications in the quality of actions for both teachers and students around the content in the classroom. Nevertheless, we believe that educators can use this paper as a reference to improve students' learning. Also, the results in this study are only applicable to the participants in this study. Large-scale research can be conducted to get more general knowledge on qualities of actions in mathematics classrooms for both teachers and students.

Furthermore, the study indicated a low level of English talking that limited teachers' reaction or feedback to students' work. Thus, the partners of the classroom (students and teachers) should make an effort to make use of instructional language. Therefore, we recommend continuous professional development (CPD) in instructional language use for teachers and encourage research projects on supporting both teachers' and students' proficiency in the medium of instruction.

ACKNOWLEDGEMENTS

The authors acknowledge the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science for funding this research and thank participant teachers and students from Kayonza district for making this research possible.

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