Exploring usefulness of video-based instruction as a pedagogical tool in learning of Mathematics

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Abstract: In this study, we examined the use of videos as a pedagogical tool in mathematics lessons at O-level (age 15-16 years). A case study of a class of 29 students from a low-performing school was considered. The content of the videos were leaned on the prior knowledge of the students and we provide a study of a set of five videos prepared on the topic Locus which embodied progressive and interlinking quizzes, worked examples and class activities. Each lesson was video recorded for grasping the classroom dynamism. We found that constructive classroom interaction hinged on the videos encouraged the low-performing students to participate thereby enhancing socio-pedagogical interactions in the class. Carefully chosen stop points of the videos greatly enhanced students’ attention and focus. Moreover, small-group questioning and discussion strategies maintained students’ interest, enthusiasm and motivation. The majority of the students found the videos interesting and helpful in retaining more information and improving their understanding of Loci. Assessment worksheets and quizzes evidenced an improvement in their performances. The study establishes that carefully created educational videos in mathematics can provide better learning opportunities and can mediate gainful knowledge construction among students.

Keywords: video, pedagogical tool, teaching and learning

I. Introduction

Difficulties encountered by secondary school students in the learning of mathematics are well documented [1, 2 & 3]. As students make the transit from one class level to another, the mathematical topics they encounter snowball on previous knowledge and become increasingly challenging. This often actuates difficulties among students in mastering the concepts and ensuingly a number of them lose interest for the subject. Under the circumstances, they stop thinking mathematically and rely mostly on memorizing programs. Such situations are also expedited when students are not provided with the proper guidance in classes [4]. Guiding students in the mathematics classroom requires recognizing their understanding of mathematical concepts and using an appropriate method to direct their progress from conceptual to procedural understanding, which can be ultimately assessed. Instructing for conceptual understanding necessitates suitable teaching approaches.

The advances of technology have the potentiality to create opportunities for improving mathematics education. The use of technology is valued in its ability to diversify the learning process and make learning of mathematics accessible to all type of learners. Audio-visual materials, for instance videos, have the power to capture the attention of learners, increase their motivation and enhance their learning experience [5]. Many studies focused on using videos available on the Internet as pedagogical tools in the mathematics classroom. Adams and Hayes [6] argued that the mathematics teacher can make his/her own video, each tailored to the individual needs of the student. In this fashion, flexibility in teaching and learning are increased [7]. Teachers can spawn a bank of useful videos [8], which can be used for revision or in situations where a student had missed a key lesson in mathematics.

Demonstration of how to solve simple routine and non-routine problems is at the heart of most mathematics-teaching styles. Merely listening to the teacher solving mathematical problems is not always useful for consolidating mathematical concepts. In most cases it leads to boredom, lack of motivation and interest for the subject thereof resulting in inadequate conceptual understanding and mastery of the topic. On this matter, videos help in the study of mathematical concepts, which are expressly difficult to understand without a graphical representation [9]. Greenberg and Zanetis [10] mentioned that videos in the mathematics classroom allow students to expand their understanding of complex concepts by strengthening the links between abstract ideas and practical applications.

We provide a case study of using videos in a class of Geometry. The learning of Geometry is generally considered difficult for many students and the components of Geometry are more prevalent (about 25%) in
mathematics examinations at O-level [11]. Since the concepts associated with Geometry’s syllabus at O-level is quite wide-ranging, this study is restricted to the topic Locus. It encompasses almost all essential geometrical skills such as reasoning, problem solving, communication, critical thinking and psychomotor skills. Another motivation to create videos for the topic Locus is that students generally have difficulties to manipulate their geometrical tools following teacher’s demonstration of loci construction on the whiteboard.

In this work, we investigate students’ perceptions of videos and to what extent do these affect classroom dynamism and students’ performance. This study is significant since, like Mauritius, in many countries, the conventional chalk-and-talk method perpetuates and there is an increasing demand for innovative teaching to provide flexible learning opportunities for secondary school mathematics students. The Government of Mauritius is actively promoting ICT in schools with the primary aim of diversifying the teaching and learning tuned in with the demand of the 21st century skills. However, research has shown that the effective use of technology in classroom is not a well-established practice among educators [12 & 13].

II. Methods

The video contents on the topic Locus were created based on the prior knowledge of the students and their abilities using the concept proposed by [14] and they were embedded in a series of five lessons. Each lesson progressively developed the video contents as per the sequence (see Figure 1): (1) a real life example, (2) testing of prior knowledge activities, (3) introduction of new content and worked examples, and (4) formative assessments in the form of cumulative quizzes were also included. The particularity of these videos is that, they not only serve for explanation and introducing the concepts, but also to demonstrate pencil-and-paper exercises (see Figure 2) that students are required to carry out in classes and examinations. The exercises are concordant with past examination questions.

![Figure 1: Sequence of video contents](image1.png)

The lessons spanned over a two-week period and each one consisted of a duration of 70 minutes. A girl’s class, comprising chiefly of 29 low performing students, was selected for convenience. These girls never experienced video-based instructions in their teaching and learning of mathematics. During the lessons, the students were arranged in groups allowing for interaction and encouraging the low performing students to participate in class activities. In consonance with Denning’s views [15], stop points in the videos were carefully chosen during the lessons so as to engage the students into discussion through oral questioning. The approach reflected the premise of assessment for learning. Data was collected chiefly through video recorded (i) focus group interviews and (ii) classrooms sessions so as to gauge holistically the changes in the classroom dynamics. Along with the quizzes, assessment worksheets given to students, were designed abreast with the NCTM strands for assessing mathematical proficiency [16], to attest the changes in their understanding of Locus. Cognisant of the sensitive issues of interviewing students and video, necessary ethical approval was obtained from the school authority and informed consent from parents was sought prior to the start of the study. In addition, both confidentiality and anonymity were maintained to protect the right of the participants.

III. Findings and Discussions

Students’ perception of videos

Students were given the opportunity to comment on the usefulness of the videos in focus group discussions. They were positive about the videos as illustrated by some of these comments:

- **Teacher:** What changes have the videos brought in your class?
- **Student 1:** It was easier to understand
- **Student 2:** The class was better. It was different from our normal class. The videos contained more
details about the topic; there were more examples.

Student 3: It showed each part of the topic in details and with examples.
Student 4: It was less boring.
Student 5: It was more fun.

The bar chart in Figure 3 shows the feedback obtained from the students on the first video presented to them. All of the 29 students found the videos appealing and easy to understand. Out of 29 responses 25 reported to have an increased understanding of the topic. The majority claimed that videos helped to remember the concepts and encouraged focusing on the task. During the focus groups most of them made reference to the ability to pause and rewind the videos whenever required. They preferred working in groups and asserted to have benefitted from the embedded quizzes.

Classroom Dynamism

In order to capture changes in the class dynamics the class sessions were video recorded. The recordings evidenced improved class dynamics. Research states that positive classroom dynamics entails establishing and maintaining environments that allow students to engage in meaningful learning [17]. Discussions and cooperative learning were encouraged and the videos enhanced the interaction in the class consequently reducing significantly the face-to-face tutoring. Group discussion around the content of the videos considerably boosted students’ confidence and performance. Students who described themselves as quiet before had become active participants in class corroborating Reba and Weaver’s [18] research findings on promoting active learning in technology enhanced mathematics classroom.

Students’ performance

Students were assessed on quizzes incorporated in the videos. The quizzes (see Figure 4) also contributed as diagnostic assessment for improving the next lesson. The quizzes comprised of questions based on concepts taught during previous sessions as well. The students mostly argued that the videos aided them in remembering facts and understanding concepts and they could correctly answer questions on topics of previous sessions. Figure 5 shows the marks obtained by the groups for two consecutive quizzes.

![Figure 4: A sample quiz in the videos](image-url)
Students were also able to attempt correctly past examination questions on the topic *Locus*. Figure 6 is an example of the answer provided by a student to a particular question. Inspired from the colourful representations in the videos, the student’s creativity was seen in the different coloured pencils used to make the drawings and measurement were often precise. Neatness in the workings can also be discerned from the Figure 6. In addition, sessions of oral discussions also took place during the lessons and the students’ enthusiasm to answer oral questions could be seen from video recordings. Students’ persistence and level of engagement on the task at hand revealed their motivation to work in groups, discuss and share their results.

![Figure 5: Comparison between marks in quizzes obtained by each group in two consecutive lessons](image)

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![Figure 6: A sample of student work](image)

**Figure 6: A sample of student work**

### IV. Conclusions

This study set out with the aim of exploring the usefulness of videos in the teaching and learning of Mathematics among low performing students. In particular, the topic *Locus* was considered and we investigated the students’ perception of the videos and the effect of the video-based contents on classroom dynamism and students’ performance. This study produced results which corroborate the findings of a great deal of the previous work in this field [5 & 19]. It was noted that the audiovisual contents promoted dynamism in class, facilitating comprehension and making contents more attractive. First and foremost, the videos were used with low performing students. Albeit, only girls were involved, we firmly believe that the findings of this study can be used to inform the benefits of adopting alternative methods to teaching mathematics in comparison to the traditional expository ones favored by many mathematics teachers. The use of videos is one of the various means of technology integration in mathematics classes but we found out that students particularly liked the pencil-and-paper exercises being modeled in the videos. Even if, the project addresses only one mathematical topic, *Locus*, the philosophical perspectives of the videos can be easily be extended to other subject areas as well. It is nonetheless encouraging enough to believe that more videos of this nature can bring meaningful classroom transaction between the teacher and the students. In summary, from this project, we have found enough evidence that the following can be actualized: increased students’ disposition towards mathematics,
improved mathematical problem solving skills and discourse in class.

References