Integrate Technology into Secondary Mathematics Flipped Classroom

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Abstract. Innovative strategies have the potential to change the framework of mathematics education and learning. Therefore, it is essential to encourage educators to be receptive to new techniques and engage in novel activities. The flipped classroom is a novel and growing mode of instruction. This method of teaching has the potential to significantly improve mathematics education. This article examines strategies that include mathematics and technology in flipped classrooms as well as the roles teachers and students play in flipped classrooms from both the teachers' and students' perspectives. The study also shows some problems with putting technology into a flipped secondary math classroom, such as technical issues and teachers being too busy, and suggests ways to deal with these problems.

Keywords: Secondary mathematics; Flipped classroom; Technology; Education.

1. Introduction

Mathematics is a very important subject in the curriculum of secondary schools. It tests students' mathematical skills, logical thinking, and other skills. Both the instructors and the parents place high importance on it. The level of difficulty of mathematics as a topic rises over one's time spent studying it in secondary school. Many children who are excellent at mathematics in primary school struggle with mathematics in secondary school. This is because the traditional teaching method tends to offer students content and lead them in exercises that do not allow them to broaden their thinking. Because of this, educators will need to abandon their conventional teaching strategies and develop innovative educational concepts. Because of its beneficial impacts on learning and comprehension of mathematical concepts, many scholars believe that the use of technology should be integrated into all aspects of the mathematics curriculum. This is due to the rapid growth of educational technology. There is a possibility that the curriculum of school mathematics may be altered, and that the growth of mathematical knowledge and comprehension could be facilitated by the use of digital technology. New technologies encourage strong linkages between mathematical knowledge and practice and provide novel methods of explaining communication, collaboration, and social interaction. The purpose of this study is to investigate how technology can be included in a mathematical teaching classroom, as well as the appropriate procedures that teachers should follow and the roles that students and teachers should play in the process. The flipped classroom model, on the other hand, places significant demands on both the instructor and the whole learning environment, and as a result, it can be followed by a wide variety of challenges. Based on what several researchers have found, this essay will look at possible solutions to the problems that have been brought up.

2. The Application of Integrating Technology in Mathematics Flipped Classrooms

2.1 The Versions of Flipped Classroom

Cockrum presents a variety of different versions of the flipped classroom. He categorizes them as follows into the three different forms of iteration: first iteration, second iteration, and third iteration. The first and most common model is the traditional flipped classroom. With this technique, most

teachers begin to flip their classrooms. Firstly, teachers post videos for students to view at home. After that, they return to the classroom with the information and do classroom exercises. The second iteration focuses on the Explore-Flip-Apply model, which differs from the traditional flip classroom in that students are given a task at the beginning. They need to view a video to complete the work, and the video is key to their problem-solving. The second iteration requires students to investigate and assist one another in discovering relevant knowledge without the teacher's intervention. If students are unable to finish the job through the video, the teacher will continue to provide content and correct mistakes within the video to aid student comprehension. The third iteration encourages students to apply higher-order thinking skills. They will produce items such as innovations, student-made movies, blogs, collaborative papers, and presentations. Students must use what they have learned and apply it to their projects to complete them. If students successfully finish their projects, they will demonstrate profound learning and long-term retention.

In the educational setting for math flipped classrooms, the use of technology will play an essential role. Technology can be implemented into all three versions of the model that have been developed. The objectives of the class should guide the instructor's selection of a suitable technological tool. For instance, when students learn how to add and subtract fractions, the instructor can use visual technology tools to allow students to explore the concepts as they learn them.

2.2 The Characteristics of Technology

Students are encouraged to collaborate on their learning through the use of group projects in flipped classrooms. The practice of working in groups is an instructional method that aims to consciously generate a social context for learning to facilitate increased levels of comprehension. Students are required to collaborate in small groups that have been formed by the instructor to complete group work, in which each student is given a distinct function to fulfill. To cultivate higher level thinking in the pupils, they engage in conversation with one another and share the thoughts that have occurred to them. Students will experience a greater sense of calm and self-assurance when working on group assignments because they will be able to assist one another and work together to find solutions to challenges. The process of designing assessments is among the most essential elements of an educational program. Learning outcomes and assessments must be in sync with one another. Better evaluation is possible when the flipped classroom model is combined with technological tools. Technology, in contrast to manual work, possesses high levels of accuracy and speed. It can identify very fast whether a student is correct or incorrect (via the use of multiple-choice questions), and the student then obtains immediate information.

In today's classrooms devoted to the study of mathematics, the application of digital technologies is becoming an increasingly common practice. Researchers have been interested in methods for maximizing the possibilities of digital technology for more than three decades. And the first step for educators is to make efficient use of internet resources. Users of various STEM-related platforms have access to programs built for a variety of topics, and educators can fully utilize the platform's resources to meet the needs of their students in the classroom. Second, integrating various forms of technology should receive considerable attention. Often, a single piece of software cannot address all of a user's problems. Excel, for example, can be used for the derivation and computation of formulas, whilst Scratch can provide animation; hence, a teacher could mix the two applets to aid student learning. Only by integrating the various software components can maximize their utility.

2.3 Connect Mathematics Topics

According to technology functions, there are three basic forms of technology implemented in flipped secondary mathematics classrooms.: delivery, exploration, and feedback. Students learn at their own pace when videos or Nearpod are used to deliver content, typically knowledge-delivery technology. Video is commonly regarded as an effective medium. The second component is exploration, which enables students to conduct independent research or consolidate their knowledge. This is an important aspect of secondary school mathematics that requires a strong connection

between technology and the subject matter and is related to the properties of technology itself. Students can use the sliders and movable points in GeoGebra to observe changes in the graph and enhance their ability to combine numbers and shapes. This type of software is more suitable for chapters discussing graphs, such as function graphs. Students can use coggle to complete concepts in mind when understanding object relationships, for instance, the axis of symmetry and values in quadratic functions.

3. Different Roles of Using Technology in Mathematics Flipped Classroom

3.1 The Role of Students

In a flipped classroom, students no longer receive instruction directly from the teacher. They are knowledge explorers and testers. They will polish their knowledge systems through the use of technology, get experience in the problem-solving process, and, during group discussions, gain peer support to solve the problem. And students could also do the self-checking by using technology. For instance, after the students have finished their computations on the function problem, they can use software like GeoGebra to examine the function image and determine whether or not it corresponds to their computations. In contrast, students are frequently given the answers to questions and guided to solve problems in a traditional classroom.

3.2 The Role of Teachers

The role of the teacher is very important in a flipped classroom, particularly in situations where students lack the ability to self-regulate and the motivation to learn. In a classroom that follows the traditional model, the role of the teacher is frequently that of a knowledge-giver. On the other hand, in a classroom that follows the flipped model, the role of the teacher is that of a guide who directs students to investigate knowledge on their own. At the same time, educators need to make certain that students in flipped classrooms continue to use the flipped method outside of school hours. A traditional classroom is one in which the teacher spends the majority of their time lecturing and only a small portion of their time discussing topics with the students. The majority of a teacher's time should be spent not lecturing but rather facilitating interactive learning activities. Because of this, educators can make effective use of flipped classrooms to distribute learning resources to students, while students have the opportunity to watch videos outside of the classroom. Despite this, teachers only occasionally have enough time to respond to every one of our inquiries. Teachers should record two or three additional videos to support the success of a particular learning resource. These videos should match different levels of students, with special attention paid to students who are at risk, among other considerations. Teachers should plan questions ahead of time, organize students into groups for discussion, and encourage students to engage in conversation with one another to successfully facilitate classroom discussions

3.3 The Interaction Between Students and Teachers Through Integrating Technology

In a flipped classroom, the roles of the teacher and the students are reversed, and there is a shift in the way in which they communicate with one another. In a traditional classroom, the teacher interacts with students mainly face-to-face, whereas, in a technology-applied math reversal classroom, the teacher communicates with students primarily through the use of science and technology, and the communication is primarily non-verbal. For instance, the responses that students provide to questions are transferred to the instructor via the platform, and the instructor then provides feedback on the student’s work. Flipped learning in mathematics is learner-centric, with students completing assignments at their own pace. Enhanced teacher-student and student-student cooperation and communication during lesson time is the most important aspect of the flipped classroom. Students identify these connections as emotional bonds that can be interpersonal, rather than passively collecting knowledge in a boring style, they engage in creative problem-solving by sharing their findings through practice. One of the basic reasons for the success of flipped learning is the emergence

of student-teacher interaction, as students have acquired the skills to participate in discussions and share their knowledge borrowings. In flipped learning, students can also work together in small groups to do projects with the teacher, and the roles of the students become more complicated.

4. The Effects of Integrating Technology on Secondary Mathematics Flipped Classroom

4.1 Advantages of Technology Using in Flipped Classroom

4.1.1 Student engagement

The participation level of a student is composed of three main components: behavioral engagement, emotional engagement, and cognitive engagement. Behavioral engagement mainly focuses on students' participation, effort and attention. Using technology in a flipped secondary mathematics classroom encourages greater interaction and engagement on the part of the students. The students cannot only study mathematical principles in the classroom but can also use related applets to prepare for activities that take place outside of the classroom. During group discussions, students can talk about their thoughts and collaborate with others in their groups to find solutions to problems, which raises the level of interactivity in the classroom. In an inverted classroom, teachers can make better use of the allotted class time to foster a more interactive learning environment than they would be able to in a traditional classroom. Furthermore, emotional engagement is linked to the affective reactions of students (such as interest, fulfillment, emotions, and nervousness), as well as their attitudes toward or the value they place on learning. Applying technology in a mathematics flipped classroom could reduce students' math anxiety and give them a sense of accomplishment, for instance, by allowing them to watch the video multiple times before class to better comprehend the new material before going to class. And interesting online learning games or videos could also arouse students' interest. Thirdly, cognitive engagement is concerned with the level of investment and self-regulation in learning by students. However, to the best of our knowledge, there has not yet been a research synthesis published that investigates how the flipped classroom way influences the cognitive engagement of students in comparison to the traditional method of lecturing.

4.1.2 Incorporates different learning styles

Since each student comes from a unique mathematical background, it can be challenging to cater to the specific needs of all of them within the confines of a single lesson. The implementation of appropriate technological tools within educational settings represents one viable approach to addressing this issue. The instructor can record videos with varying degrees of challenge, and the students have access to a variety of resources to help them solve the problems. The students are free to study the material at their own pace.

4.1.3 Prepare students for future

The development of STEM student education can be facilitated by the implementation of technology in the classroom setting. Students gain the ability to think independently as well as develop a sense of teamwork when they use technology in the classroom. They can use math and computers together to solve problems, which not only broadens the students' horizons but also gives them new ways to look at technology, which helps them plan their careers in the long run.

4.2 Challenges of Technology Used in Mathematics Flipped Classrooms

Even though flipped classrooms offer various advantages in educational settings, this model also has many challenges. There are several challenging aspects of flipped classroom implementation, such as technical issues and time commitment, as follows:

4.2.1 Students' limited preparation

One of the most crucial parts of seamless flipped learning is getting students to learn on their own at home. They need to preview the knowledge at home before taking the flipped classroom. As a result, the advantages of the flipped classroom may be diminished. The flipped classroom has become an alternative to the traditional classroom in the past few years. Although pre-review is also required in traditional classrooms, pre-review plays a more significant role in flipped classrooms. Before attending the class, students not only prepare for the mathematics knowledge test but also become accustomed to using the appropriate applet in class. Some students with a poor mathematics foundation may face some challenges, like not understanding how to preview effectively. Another issue is that because students do the preview at home, teachers are unable to provide immediate feedback to meet the diverse needs of their students. Students need to take notes during preparation and write down questions to be addressed in class. This may decrease students' motivation to solve math problems. Also, over time, they may forget the specifics of the problem and become dissatisfied with it.

4.2.2 Extra workload

A flipped classroom imposes more work and time on students than a traditional classroom, and it is difficult for secondary school students to devote more time to math because they have more subjects to study. A study shows that students view studying outside of the classroom as an additional time burden. In the traditional classroom, where learning needs less time and effort, some learners may have established passive learning habits. Not only do students have an increased workload, but so do teachers, who need to record the videos and prepare the materials in advance. Additional time is required to prepare proper supporting quiz questions as well as certain out-of-class exercises. The amount of time that is actually required to prepare materials for flipped courses can be nearly six times longer than the time that is required for traditional course preparation. When it comes to their day-to-day lessons, many educators, particularly those who have been in the profession for an extended period, do not frequently use the inverted classroom strategy. This is due to the fact that the flipped classroom creates additional work for them.

4.2.3 Technology Issues

Technical and technological issues, such as the production of high-quality extracurricular materials and the availability of technological resources. Teachers must ensure that the technology used is functional (e.g., have computers that are bug-free and have user-friendly software), and they must be aware that anything that goes wrong during the process will affect the overall quality of the class. In addition, the instructor is responsible for ensuring that students can effectively utilize the software. The technical and pedagogical limitations of video lectures, such as poor audio quality, monotony, and boredom, may negatively influent the student's learning experience in a flipped classroom. In addition, the instructor must ensure the quality of the designed software. For instance, the poor audio quality of videos has negatively impacted student learning. There is a negative connection between the length of videos and the proportion of videos watched by the sample. What's more, many chapters in secondary school mathematics, such as graphs, functions, etc., place heavy emphasis on science and technology. It's hard for teachers to make relevant lesson plans, so many of them would rather use chalk and a blackboard in the classroom.

4.3 Suggestions for Optimizing Integrating Technology in the Flipped Classroom

To avoid students not knowing how to prepare for class by studying, educators need to provide proper guidance. The educator may employ technology, such as a post-video quiz, to collect data for a limited time. This allows the educator to track student progress and provide timely feedback, saving students' time. In addition, math teachers should obtain professional training to effectively implement technology in the classroom, such as students developing math technology groups with computer specialists teaching teachers how to use them to better implement the flipped classroom. Teachers should familiarize themselves with relevant technology platforms, such as PhET, where numerous

manipulable models already exist. This will lower the teacher's workload and increase the flipped classroom's efficacy.

5. Conclusion

Several research studies have shown that the implementation of technology in a flipped classroom is useful for boosting student learning, developing student thought, and producing students with a multifaceted perspective. To provide pupils with a more intuitive knowledge of mathematics and easy-to-follow directions, teachers must acquire the necessary computer skills and make full use of Internet resources containing appropriate tools. In addition, teachers can divide the burden to develop a variety of themes. In addition, the students will have access to all of the educational materials they will need to properly complete their work outside of the classroom. And schools must be fully equipped and connected to a stable network in order to provide students with superior educational approaches. In a successful flipped classroom, students will be given greater opportunities to explore new areas of knowledge independently and will be able to combine their previous computer and mathematics expertise more efficiently. Students will complete assignments at their own pace, which will stimulate their brains to seek out the essential concepts that underlie their existing knowledge. This will be superior to simply take assessments. This article analyzes the use of technology in flipped classrooms and provides teachers with suggestions for integrating technology into flipped classrooms. It is also beneficial for better promoting the development of secondary mathematics education.

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