Faculty of Education
Journal of Education

***

The impact of Flipped Classroom Strategy of Teaching Mathematics on Students' Achievements at Umm Al-Qura University

BY

Ali Abdalrhman Al Zebidi, Ph.D

Assistant professor -Department of Education

Al-Qunfudah University College- Umm Al-Qura University

Receipt date: 22 September 2020 - Date of acceptance: 14 October 2020

DOI: 10.12816/EDUSOHAG. 2021.

Abstract

This study aimed to explore the impact of using flipped classroom strategies of teaching mathematics (Calculus course) at Umm Al-Qura University on students' achievements. A final test was used for this study to identify the differences between two groups of students, experimental group that were taught by using flipped classroom strategies and control group that was taught by traditional teaching methods such as the lecture. Fifty university male students from Umm Al-Qura University were involved for the study and their performances evaluated after the implementation of using flipped classroom strategies of teaching during the 1st semester of 2019. An independent T- test was used to identified the differences of mean scores of the two groups of students.The results indicated that there were statistical differences between experimental group and control group in the final test scores for experimental group that were taught by this strategy. The flipped classroom strategy marginally improved the scores those learners.

***Keywords**:* Flipped Classroom Strategy, Mathematics, higher education, Educational technology, Umm Al-Qura University, achievement.

أثر استخدام استراتيجية الفصل المقلوب في تدريس الرياضيات على تحصيل طلاب جامعة أم القرى

د. علي بن عبدالرحمن الزبيدي
أستاذ مساعد بقسم التربية بالكلية الجامعية
بالقنفذة فرع جامعة أم القرى– المملكة العربية السعودية

المستخلص باللغة العربية:

تهدف هذه الدراسة الى معرفة أثر استخدم استراتيجية الفصل المقلوب في تدريس الرياضيات (مقرر التفاضل والتكامل) على التحصيل الدراسي لطلاب جامعة أم القرى. اشملت عينة الدراسة على خمسين طالب جامعي من طلاب الجامعة خلال الفصل الدراسي الأول لعام ٢٠١٩ لتقييم مستوى أدائهم بعد تنفيذ استراتيجية التدريس بالفصل المقلوب حيث تم استخدام مجموعتين من الطلبة، المجموعة التجريبية تم تدريسها من خلال هذه الاستراتيجية والمجموعة الضابطة وتم تدريسها باستخدام الطريقة التقليدية المحاضرة واستخدام السبورة. لمقارنة درجات الاختبار النهائي للمجموعتين في التحصيل الدراسي استخدم الباحث اختبار ت للمجموعات المستقلة. اسفرت النتائج عن وجود فروق ذات دلالة إحصائية بين المجموعتين الضابطة والتجريبية في متوسطات الدرجات للاختبار النهائي لصالح المجموعة التجريبية التي تم تدريسها باستخدام استراتيجية الفصل المقلوب. كما اكدت الدراسة على الدور الفاعل لمثل هذه الاستراتيجية على تحصيل الطلبة.

الكلمات المفتاحية: الفصول المقلوبة، الرياضيات، التعليم العالي، تقنيات التعليم، جامعة أم القرى، التحصيل الدراسي

Introduction

The advances in technology are revolutionizing various aspects of core daily activities and education is one of them. In the education sector, there has been an increased interest in utilizing a strategy called the flipped classroom (Johnson, 2013). Various institutions are leveraging technology to provide a form of blended learning where some part of the educational process is undertaken face-to-face with the remaining part conducted through the internet. This strategy herein forms the basis of the concept of the flipped classroom strategy. The traditional teaching strategy is where students and the instructor congregate in a singular location and the instructor has to teach and interact with the students at the same time. There is less use of technology, if any, in the traditional education (Berrett, 2012).

There has been an increased adoption in flipped classroom strategy in higher institutions of learning, especially universities and colleges. The strategy began in the US and has seen adoption all over the world. The flipped classroom strategy's basic idea is the replacement of the teacher-student in-person interaction time and an increase in individualized or collective homework for the learners (Cabı, 2018). The introduction of technology in the classroom frees up the time spent lecturing and increases the teacher's time to ensure that each student is at pace with the concepts being taught. The origin of the name "flipped" is because the traditional classroom paradigm has been shifted (Cabı, 2018).

Traditionally, teachers are meant to spend most of their time lecturing and dictating notes in some cases. Assignments are given to test concepts learned in class. However, the new strategy reverses the time spent on each and these assignments become the main aspect of the teaching strategy. One of the common strategies through which a flipped classroom strategy is implemented is by a teacher creating video content that is then shared by the students for them to consume outside the classroom (Cheng et al. 2019). The problems that would have been the key component of the homework given to students to undertake at their discretion is now conducted in class. Numerous benefits accrue to both the learners and instructors while utilizing this strategy (Berrett, 2012).

Literature Review

The flipped classroom strategy's origin can be traced back to the need by two instructors, Aaron Sams and Bergman (2012), to avail their lectures for college students who missed them due to engagements in athletics and other college sports. Various reputable institutions and

newspapers have published information on the flipped classroom, including The Washington Post (Strauss, 2012), The Economist (Flipping the Classroom, 2011), and the New York Times (Rosenberg, 2013). Each of these articles has reviewed the flipped classroom strategy in its unique way and reached different conclusions. Educators have reviewed the strategy on various platform and the overwhelming majority of them have expressed support and approval of this paradigm-shifting strategy.

One of the principal beneficiaries of the flipped classroom strategy is The Open University. This institution is purely based on online learning and utilizing technology to meet its students' evolving needs. Hundreds of thousands of students enroll in this university and content is provided to access the device of their choosing. In 2013, the Pre-Vodcasting Network was created for teachers interested in utilizing flipped technology in their teaching. Overmyer (2013) argues that this network has been at the core of the spread of flipped classrooms in the US and across the world. More instructors have joined and gained the skills required to make them successful in delivering content and increasing the performance of students.

As with any strategy, there are criticisms leveled against flipped technology, with Nochese (2011) arguing that the strategy's main premise is to replace teachers. Waddell (2012) amplified the concerns raised by Nochese (2011) by arguing that the more instructional videos are available to guide students, the fewer teachers will be required in classrooms. One of the significant players in the flipped classroom strategy, Salman Khan of the Khan Academy, endorsed the strategy and argued that while there are fears that teachers will be replaced, that is not the case. Khan, who has thousands of instructional videos on his platform, argued that flipped classroom frees up the teachers and enables them to focus on higher-level educational needs as highlighted in Bloom's taxonomy. Gojack (2012) also argued that there are benefits that accrue to learners using this strategy as peer-to-peer collaboration is increased and understanding is shared.

Lai & Hwang (2016) investigated how the application of flipped strategy in learning mathematics impacted the performance of learners. They relied on learners applying a self-regulated strategy to learning mathematics with teacher management incorporated in Taiwanese schools. Before applying this system, students were asked to clearly outline their goals, against which the performance changes will be measured and evaluated. As part of the evaluation process, students watched instructional videos and took quizzes independently, with their results being documented

in a database. The teacher management aspect came in with regards to evaluating the learning log and database management of the results scored in each test.

In their findings, Lai & Hwang (2016) confirmed results obtained by McNamara (2011), which argued that flipped classrooms and self-regulated learning improve learners' level of understanding. Drawing on the foundations laid by Zimmerman et al. (1996) on the need and importance of self-regulated learning, Lai & Hwang (2016) concluded that self-paced learning is a fundamental core in achieving educational success through the utilization of active learning.

Freeman et al. (2014) conducted a meta-analysis that sought to investigate the efficiency of applying traditional and constructivist strategies to teaching STEM courses. The unifying factors among the courses considered in this study were the presence of active learning, peer instructions, use of personal response time, and the presence of tasks completed by each individual. The study measured how students' performance varied with the use of active learning strategies such as flipped classrooms and compared it to performance under traditional forms of lecturing. The result indicated a 0.47 increase in performance when active learning strategies were used to replace traditional lecturing. The result was a huge outcome for advocates of adopting a flipped classroom strategy in STEM courses.

Pierce & Fox (2012) argued that the main reason for increased performance in students when the flipped classroom was implemented was due to increased contact time between the instructor and the learners. Lopes & Soares (2018) investigated how a flipped classroom impacted the perception of learners in financial mathematics courses. The study's overwhelming result indicated that students preferred using the flipped classroom as it allowed them to better understand various concepts of the class and mathematics was no longer as challenging as it seemed when the traditional lecture strategy was implemented.

Roshan (2015) conducted a study that aimed to document how student performance in AP calculus varied with the intensity of application of flipped strategy. The result is as documented below:

Table 1*:*
Comparison between performance in the flipped classroom and traditional education

Year	n	5	4	3	2	1	Averag
2009-10 Traditional	**10**	**23.53%**	**35.29%**	**23.53%**	**11.76%**	**5.88%**	**3.59**
2010-11 (Flippe)	**17**	**33.33%**	**44.44%**	**22.22%**	**0**	**0**	**4.11**

The scoring of AP calculus is on a scale of 1-5, with 5 being the highest. The data from the research by Roshan (2015) shown above indicated that flipped classroom technology has a positive impact on students' performance in AP calculus, one of the aspects of mathematics that trouble many learners. Chen et al. (2015) evaluated how students' perceptions and gender impacted the outcomes of flipped learning. They concluded that the level of interest shown by students in a course is a predictor of the potential outcome of the learning experience. Gender was linked to interest in this study and it concluded that females performed poorly compared to males because of a reduced level of interest in mathematics.

Deviating from the role of flipped classrooms in mathematics, Moravec et al. (2010) investigated the applicability of the strategy in teaching biology. Citing various subjects taught using flipped strategy in this learning is fundamental to acknowledge that flipped educational strategy applies to all fields of education. Their strategy did not fully utilize the flipped classroom strategy but revised the teaching strategy to include instructional videos. The results showed a 21% increase in student performance during exams (Moravec et al., 2010).

Theoretical Framework

History of Flipped Classroom

Education has long been delivered using one primary strategy: a teacher stands in front of the learners and lectures them on a certain topic or concept. The students are then given homework that is meant to evaluate how well they have understood various topics or how well they can research. The strategy has been unchanged for many years as it was perceived to be effective. The majority of the homework was based on solving problems and the class lectures covered the key topic areas. While this strategy survived years, there has been disruption to how education is delivered due to increasing reliance on technology. In modern-day, both students' and teachers' lives revolve around technology to the extent that

ignoring the benefits it brings to the educational sector became impossible (Johnson, 2013).

The increasing distraction brought about technology makes it hard to maintain students' attention span in lecture halls for two hours, even four hours, as it used to be in what is now referred to as a traditional strategy of education. The rate at which technology has become an integral part of life demands that it be used for the betterment of both the educational process and the educational outcomes. The increasing flexibility brought about by the advancements in communications technology and the internet, in general, means that the interaction between learners and their instructors is no longer confined within a classroom or lecture hall walls (Jovanović et al. 2017). There has been a sustained rise in cloud computing options that make it easier to share video content where demonstrations can be made for increased learner understanding. Some of the commonly-used platforms include YouTube, Screencast, and Teacher Tube, among others.

One of the reasons the use of the internet in classrooms has increased in recent years is because of increased internet penetration and access to devices. The platforms mentioned above can be accessed from various devices, including but not limited to smartphones, tablets, desktops, personal computers, and smart TVs, among other internet-enabled devices. As time goes by, these devices become cheaper and more available, which will imply that flipped classroom technology can be implemented even in third world countries. At the moment, there are various developing countries implementing the strategy under different project names.

Bergmann and Sams (2012) pioneered using online videos to deliver content to learners. It was the first adoption of videos to flip the learning process that had been unchanged for ages. The key motivation for these two innovators was a method of delivering content taught in class to students who had missed the in-person lecture due to other commitments. The invention saw the creation of a new category in education catering to the needs that had been unsatisfied previously. At the time of invention, this strategy was viewed as a backup to the traditional education delivery system. However, with time, it has grown to become a key strategy to educating learners across the world.

Features of Flipped Classrooms

The schools that have adopted the strategy across the US and globally have introduced new aspects that differentiate them from others. These customizations are made to address the specific needs of a particular

institution. While the different locations customize their strategy, there are underlying similarities that define the flipped classroom learning as a strategy in the educational arena. The first feature is an active transfer of information from the traditional classroom lecture system to the outside for consumption (Albalawi, 2018). The key metric in this transfer is that it should be intentional by the instructor. There is an inherent difference between this learning strategy and online learning, where online learning is done purely via electronic media. At the same time, flipped classrooms are intended to free up time for a teacher to attend to the students' needs during face-to-face interactions. While online education eliminates in-person contact between instructor and learners, flipped classrooms complement the experience of in-person contact. This is a key difference that needs to be noted to understand the strategy of a flipped classroom (Freeman & Schiller, 2013).

Traditional education strategies have been hinged on a system where instructors' main functionality is to dispense facts in the classroom. The lectures were to be done per the lesson plans and fit within the required timeframe. It was a race to cover the entire content in often a short span, translating to teachers skimming through facts without proper emphasis. However, the flipped classroom eliminates the need to hurry as students will do the majority of learning independently. Teachers now have more time to guide these learners on approaching various types of issues that arise in the course under consideration. The ability to solve problems or evaluate the thought process that goes into approaching certain types of problems enhances learners' understanding more than giving them a lot of facts they are supposed to remember or write down (Berrett, 2012). Flipped classroom changes the setup from lecture-oriented to a problem-solving approach.

According to Alsowat (2016), the key problem of the traditional lecture delivery system is that once the teacher-student interaction ends, there is no way the experience can be re-lived in the same manner. While the teacher may lecture on the same topic multiple times, there is no way students can re-experience it away from class. The flipped classroom, as a result, creates an archive of the content and lectures delivered. Students understand concepts at varying speeds. Some will understand something from the first time they are educated on it and those who need more time. Therefore, the archive provides a method through which some students may repeatedly experience the lecture until they grasp the content being

discussed. As a result, learners can instantly access the topic discussion anywhere without attending another similar lecture.

While it may be changing the dynamic of educational content delivery to a tech-based approach, the flipped classroom's primary goal is freeing up more time between the instructor and learners. This time can then be redirected towards increasing face-to-face instructor-learner or learner-learner interaction. Instructors, upon adopting this strategy, will have more one-on-one contact with each student in their class. A teacher's ability to cater to the needs of each student in a large classroom has been a key criticism of the traditional educational system. However, the problem is being solved by the adoption of a flipped educational strategy (Overmyer, 2013).

While this method has gained substantial popularity over the years, there still exist misconceptions surrounding it and often prevent the effective use of the strategy. The major misconception is that the flipped classroom is replacing teachers. This misconception is not only false, but it lacks merit on several grounds. First, these teachers create the instructional videos, and without them, the flipped strategy would not work. Secondly, it is not eliminating in-person teaching and learning experience, but rather making it more effective. Therefore, the instructional videos enable teachers to utilize their time in high-level learning as opposed to spending it instilling concepts into students, concepts that can be grasped independently (Alsowat, 2016).

One key criticism of the flipped classroom strategy is that it takes the in-class ineffective educational delivery system and integrates technology without actually solving the problem. This criticism has been addressed by proponents of the system, arguing that there is an introduction of free time that an instructor can utilize differently to improve the learners' educational experience (Bergmann & Sams, 2012). The strategy was not inherently designed to change education strategy in its entirety, but rather give instructors the ability to improve the learners' understanding by reducing the time spent lecturing them on various aspects that can be covered independently. There is an introduction of more time where learners can correspond with peers on the contents of their lectures and receive instant feedback from the instructor.

One of the upsides of this strategy is that it enables the instructors to use the strategy to tweak, accept, or reject aspects of the strategy and change the strategy to the specific needs of their learners. It is essential to

appreciate the fact that a flipped classroom is not merely an instructor recording their lecture and they are done with the process (Sun. et al. 2016). The flipped classroom can be viewed as a comprehensive strategy that incorporates inquiry, summative and formative assessments, and direct instruction, among other elements. The biggest aspect upside of this strategy is that it allows the instructor to customize the experience of the learners by designing the learning experience to best address weaknesses identified in learners.

Many students in the world have an issue with mathematics. Many fail and change majors, or some do all it takes to avoid math-related classes (Overmyer, 2013). Part of the reason why mathematics is among the most failed courses is that covering the entire curriculum while ensuring that each student is apace with the rest is a significant problem. The result is that while the teacher may be moving from one concept to the next, most students skim through without adequately understanding the underlying concepts. It results in learners who have deficiencies in several aspects of the curriculum they covered (Overmyer, 2013).

Flipped Classroom and Educational Strategies

One main educational strategy will be considered in this research regarding its applicability to the flipped classroom strategy and how it affects the teaching of mathematics. It is the constructivism model, also known as an inquiry-based strategy to education. The main argument of this model is that the use of interactive teaching strategies, which allows the learners to play a part in the process, is motivating and improves the ability of these learners to grasp the concepts being taught (Reyes-Lozano et al. 2015). The adoption of a flipped strategy advances the arguments of the constructivist approach as it creates more time for there to be an interaction between the instructor and the learner. It allows learners to interact with both the instructor and each other and collaborate among themselves to increase their understanding of the key concepts in their relevant courses.

Criticism has been leveled against the flipped strategy's applicability with regards to its ability to properly teach mathematical concepts to students. Often the argument is that it is hard for a video-based educational system to properly teach core mathematical content. It creates room for the development of manipulative skills as opposed to the understanding of core concepts. To this criticism, it is essential to understand the strategy behind the flipped classroom because it is not replacing teachers but rather expounding on topics covered in class (Freeman & Schiller, 2013). Once

students learn a topic, the instructional videos are meant to guide them to further understanding. It is a constructivist strategy because it gives the student the ability to digest the contents learned and maybe look outside for further guidance. They can pause the lesson until they understand one concept, for example.

Bloom's Taxonomy offers six main goals of education, knowledge, application, comprehension, evaluation, synthesis, and analysis (Reyes-Lozano et al. 2015). This model can be revised to fit the exact needs of a specific group of learners. For college mathematics, the revised model is as shown below.

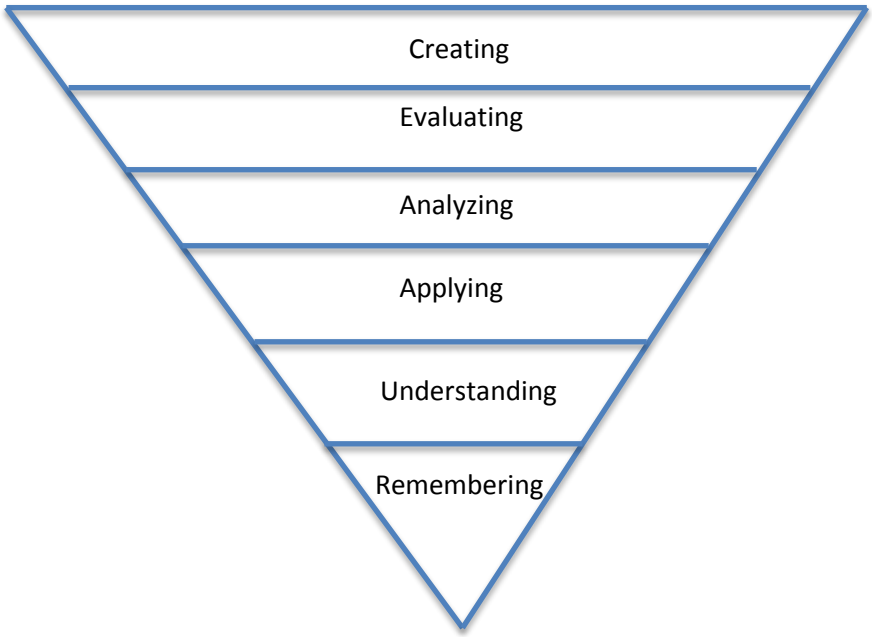

Figure1: A revised model of Bloom's Taxonomy as applied to flipped classroom strategy. (Reyes Lozano et al., 2015)

When the flipped strategy is applied to this revised Bloom's Taxonomy, it enables students to undertake the two lower-level tasks, understanding and remembering. As the two lower parts of the taxonomy can be performed outside the classroom is the crated for the rest of the high-level learning goals to be performed inside the classroom. The result is that higher-level learning goals, according to Bloom's Taxonomy, are achieved with the guidance and instruction of the instructor in charge (Bhagat et al., 2016). The benefits of any education are realized when learners gain and apply high-level goals of education, according to Bloom's taxonomy and

flipped educational strategy when applied to mathematics, creates room for that to be accomplished.

Statement of The Study Problem

It has been observed and documented in some studies that mathematics in KSA is a stumbling block for many learners and a majority of them will do all it takes to avoid majors that involve mathematics. The rate of failure has become a point of concern to educators and instructors alike as they attempt to find the root cause for poor performance and how it can be rescued. The application of mathematics in real life is enormous and all must be done to improve the literacy rates in this core subject.

At Umm Al-Qura University, most of teaching methods depend on the lecture and the use of whiteboard in mathematics. Based on the observation of the researcher and according to the department of mathematics, students who fail these courses repeatedly end up dropping out of college. It is becoming apparent that technology has to be infused into the learning process to some extent to improve the outcomes of the educational process, specifically in mathematics. With flipped classroom strategy gaining popularity and the volume of instructional videos available always expanding, there is a need for learners and educators to tap into this section for their benefit.

The problem of the current study is determined as to what extent could applying flipped classroom strategy in teaching mathematics (Calculous course) promote students' achievement At Umm Al-Qura University compared to the use of current traditional teaching methods.

The Study Questions

This study seeks to answer the main question as following:

- What is the impact of using flipped classroom strategy for teaching mathematics at Umm Al-Qura University on students' achievement?

To answer this main study question, the researcher should to accept or reject the null hypothesis:

there are no statistical differences in the scores mean between control group and experimental group regarding the teaching strategies.

Purpose of The Study

The study aims to examine the differences in students' achievement of mathematics when flipped classroom strategy is applied compared to when traditional strategies to teaching are applied. Moreover, this study introduces the role of using this strategy as a new teaching method that

could promote the achievement of mathematics and enhance the learning environment.

Significance of The Study

The study contributes to the ever-increasing volume of literature exploring how technology can be leveraged to improve in students' achievement at various institutional levels. The study draws conclusions based on a mathematical environment to provide insights into the benefits of shifting the current strategy of education to a technology-intensive strategy, flipped classroom as an example.

Delimitations of The Study

This study intended to highlight the impact of using flipped classroom strategy of students' achievement compared to the traditional teaching methods. The target audience were students at Umm Al-Qura University from its Al-Qunfudah University College branch. Students were from Department of Mathematics who took the cause called Calculous in the first term of the year 2019. The time of the experiment was the first 4 weeks of the term. Two groups of them were selected randomly to apply the intervention which represent the other Calculous course groups at this institution.

Definition of terms

Flipped classroom strategy: it is a teaching strategy that integrating the video technology into the learning of courses (Cheng et al. 2019). in this case, instructors provide students with videos as an additional material and let them learn and discuss based on their individual differences so students can lead the lecture.

Students' achievement: it is basically the level of getting a particular learning goals that is represented by scores (Alamri, 2019).

Methodology

Participants

The study leveraged data obtained from students in their study of calculus course for the first term in 2019 at Umm Al-Quraa University. A total of 50 students were employed to compare the two strategies of teaching two groups of students. All students were males and between 18-25 years old. Those two groups were chosen randomly from 12 groups of students that took the Calculous course in the first semester of 2019 and all students, in this study, have not had this course before so the equality

between the two group is probably assumed. Flipped strategy, in this case, denotes all forms of study that entailed the use of technology in delivering content to students while maintaining the face-to-face interaction between instructors and learners. In the flipped classrooms, teachers created content that was to be consumed by students both before the class and after the mathematics class..

Research Design

The study adopted the experimental design and a Semi-experimental Method was used here for the experiment that took about four weeks during the 1st term of 2019. The learning environment (teaching strategy)was considered an independent variable and the students' achievement of mathematics was the dependent variable.

The control group for this study was college students who learn mathematics using traditional strategies to education. They were 25 students in number. The intervention group was comprise of students learning via flipped technology and for uniformity of results, 25 of them were considered. In both of these scenarios, the dependent variable will be their mathematical achievement.

The study tool here is a final test that has 23 valid questions. This test was reviewed by three of associate professors in math field so they made some notes and became in its final version with 20 questions. Data was collected from students scores in the final test and an independent sample *t*-test was used to identified the differences between the control group and experimental group in the mean of test scores .

Results

Table 2.
Means and Standard Deviations of two groups of students in their final test scores

	Groups	N	Mean	Std. Deviation
Achievement	**Control group**	**25**	**11.3200**	**2.19317**
	Experimental group	**25**	**18.0000**	**1.55456**

Table 3.
Results of an independent sample t-test to compare the two groups means of scores for students in their achievement.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Achievement	Equal variances assumed	2.214	.143	-12.424	48	.000	-6.68000	.53765	-7.76102	-5.59898
	Equal variances not assumed			-12.424	43.256	.000	-6.68000	.53765	-7.76409	-5.59591

In this study, two groups of students, the control group which was taught by traditional teaching methods and the experimental group which was taught by the flipped classroom strategy, were compared in the final test of Calculous course to explore the differences in their academic achievement. The final test score is 20 so students can reach this score as a full mark. According to the data in Table 2., the mean score of students' achievements of experimental group (18.00, *SD* =1.55) is higher than the man scores of the control group (11.32, *SD* = 2.19). Here, the interval of the mean score between the groups is 6.68. Consequently, there is actually differences in the means scores of the two groups that effect the results of comparing groups in means.

In addition to that, the *SD* of the experimental group is 1.55 whereas the SD of the control group is 2.19 which indicated that the experimental group has lower Standard Deviation than the other group; therefore, that the mean of final test score of the group taught by flipped classroom strategy is better in defining all test scores.

An independent sample t-test was administered to test the Hypothesis of this study question that whether there are statistical differences in the scores mean between control group and experimental group or not. So, the results were tested at the significant level of 5%. Based on Table 3., the Sig value is 0.001 (2-tailed). This is less that alpha (a= 0.05) which means the null hypothesis is rejected so there are

definitely statistical differences in mean scores of students' achievements between experimental group and control group. Accordingly, the researcher concluded that there is a positive impact of employing flipped classroom strategy for teaching mathematics on students' achievement at Umm Al-Qura University.

Discussion and Conclusion

This study contributes to the ever-increasing body of literature exploring the topic of flipped classrooms and their impact on the achievement of learners. The study herein has indicated that flipped classroom strategy increases the achievement s of individuals when undertaking mathematics classes in universities. Internet is taking an integral part of daily lives and the advances in virtual communications open up channels that can be leveraged to make instruction and teaching an engaging affair, taking the low-level processes outside the class and leaving room for the instructor to focus on high-level educational needs (Lopes & Soares, 2018).

Due to advances in technology, producing online instructional videos is easier than ever. There is no unique set of skills required by the user to be able to grasp how to produce and make available instructional videos. The main problem to be navigated to the successful implementation of the flipped classroom strategy, as a result, is not necessarily the production of instructional videos, but rather the proper utilization of the freed class time. It enables the instructor to move from a group learning strategy and make use of an individual learning approach, thereby attending to the needs of each individual student in their classroom (Chen et al. 2016).

The consistent result from all studies that have been undertaken to prove the concept of flipped classroom have pointed towards it being better compared to the traditional education system (Chen et al. 2016, Taylor, 2007, Lai & Hwang, 2016). The advantage arises in the sense that it combines the best parts of online learning, where students study independently, and traditional strategy, where students are guided by their instructors. By enabling the successful merger of the two concepts, the advantages to be had from each form of instruction are combined. The result is that the flipped educational strategy is better than the traditional strategy in enabling the instructor to focus on high-level learning.

Recommendations

According to the results of the current study, the researcher recommends some points as following:

- Investigate the effectiveness of flipped classroom strategy on students' achievement and performance with large sample size.
- Investigate the effectiveness of flipped classroom strategy on students' achievement and performance with different subjects rather than mathematics.
- Investigate the effectiveness of flipped classroom strategy on students' achievement and performance with the female gender.
- Apply such strategy in different environmental context.
- Investigate students' attitudes towards the flipped classroom strategy.
- Investigate faculties' attitudes towards the flipped classroom strategy.
- Saudi universities ought to hold continuous workshops on how implementing flipped classroom strategy for teaching face-to-face or online classes because this study found the valuable use of this strategy that enhance the achievement of students.

References

Alamri, M. M. (2019). Students' academic achievement performance and satisfaction in a flipped classroom in Saudi Arabia. *International Journal of Technology Enhanced Learning, 11*(1), 103-119.

Alsowat, H. (2016). An EFL flipped classroom teaching model: Effects on English language higher-order thinking skills, student engagement and satisfaction. *Journal of Education and Practice, 7*(9), 108-121.

Albalawi, A. S. (2018). The Effect of Using Flipped Classroom in Teaching Calculus on Students' Achievements at the University of Tabuk. *International Journal of Research in Education and Science, 4*(1), 198-207.

Bergmann, J. & Sams, A. (2012). *Flip your classroom: Reach every student in every class everyday*. International Society for Technology in Education. Washington, D.C.

Berrett, D. (2012). How 'flipping' the classroom can improve the traditional lecture. *The Chronicle of Higher Education. 58* (21) 16-18.

Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The impact of the flipped classroom on mathematics concept learning in high school. *Journal of Educational Technology & Society, 19*(3), 134-142.

Cabı, E. (2018). The impact of the flipped classroom model on students' academic achievement. *International Review of Research in Open and Distributed Learning, 19*(3).

Chen, S. C., Yang, S. J., & Hsiao, C. C. (2016). Exploring student perceptions, learning outcome and gender differences in a flipped mathematics course. *British Journal of Educational Technology, 47*(6), 1096-1112.

Cheng, L., Ritzhaupt, A. D., & Antonenko, P. (2019). Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. *Educational Technology Research and Development, 67*(4), 793-824.

Clark, K. R. (2015). The effects of the flipped model of instruction on student engagement and performance in the secondary mathematics classroom. *Journal of Educators Online, 12*(1), 91-115.

Freeman, H., C. & Schiller, N. (2013). Case studies and the flipped classroom. *Journal of College Science Education. 42*(5) 62-66.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410-8415.

Gojak, L. (2012). To flip or not to flip: That is not the question! *National Council of Teachers of Mathematics.* Retrieved from http://www.nctm.org/about/content.aspx?id=34585

Johnson, G. B. (2013). *Student perceptions of the flipped classroom* (Doctoral dissertation, University of British Columbia).

Jovanović, J., Gašević, D., Dawson, S., Pardo, A., & Mirriahi, N. (2017). Learning analytics to unveil learning strategies in a flipped classroom. *The Internet and Higher Education*, *33*(4), 74-85.

Lai, C. L., & Hwang, G. J. (2016). A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers & Education*, *100*, 126-140.

Lopes, A. P., & Soares, F. (2018). Perception and performance in a flipped Financial Mathematics classroom. *The International Journal of Management Education*, *16*(1), 105-113.

Moravec, M., Williams, A., Aguilar-Roca, N., & O'Dowd, D. K. (2010) Learn before lecture: A strategy that improves learning outcomes in a large introductory biology class. *CBE Life Science Education*. *9*(4), 473-481.

Noschese, F. (2011). Khan Academy: My final remarks. *Action-Reaction: Reflections on the dynamics of teaching*. Retrieved from http://fnoschese.wordpress.com/2011/05/10/khan-academy-my-final-remarks/

Overmyer, J. (2013). Teacher vodcasting and flipped classroom network - A professional learning community for teachers using vodcasting in the classroom. *Teacher Vodcasting and Flipped Classroom Network.* Retrieved from http://flippedclassroom.org

Overmyer, G. R. (2014). *The flipped classroom model for college algebra: Effects on student achievement* (Doctoral dissertation, Colorado State University).

Pierce, R., & Fox, J. (2012). Vodcasts and active-learning exercises in a "flipped classroom" model of a renal pharmacotherapy module. *American Journal of Pharmaceutical Education*, *76*(10), article 196.

Reyes-Lozano, C. A., Meda-Campaña, M. E., & Morales Gamboa, R. (2015). Flipped classroom as educational technique to teach Math on a competencies-based Approach: Case study. *Conferencias LACLO*, *5*(1).

Rosenberg, T. (2013). In flipped classrooms, a method for mastery. *New York Times*. http://opinionator.blogs.nytimes.com/2013/10/23/in-flippedclassrooms-a-method-for-mastery

Roshan, S. (2015). The flipped classroom: touch enabled, academically proven. In *The Impact of Pen and Touch Technology on Education* (pp. 215-222). Springer, Cham.

Sun, Z., Lu, L., & Xie, K. (2016). The effects of self-regulated learning on students' performance trajectory in the flipped math classroom. Singapore: International Society of the Learning Sciences.

Strauss, V. (2012). The flip: Turning a classroom upside down. *Washington Post*, http://www.washingtonpost.com/pb/local/education/the-flip-turning-aclassroom-upside-down/2012/06/03/gJQAYk55BV_story.html

Waddell, D. (2012). Point/Counterpoint: To flip or not to flip? *Learning & Leading in Technology*, *39*, 7-8.