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ORIGINAL RESEARCH ARTICLE

The Effects of Flipped Classroom on Students' Academic Performance Based on a Comparison of Merrill's Model with Conventional Teaching Methods

Parisa Alinejad Mehrban[1*], Zohreh Khoshneshin[2], Yousef Mahdavinasab[3], Javad Hatami[4]

[1] Math Teacher at Marafet High School, Tehran, Iran. (Corresponding Author). Email: palinejad67@gmail.com
[2] Assistant Professor of Educational technology. Faculty of Psychology and Education, Kharazmi University, Tehran, Iran. khoshneshin@khu.ac.ir
[3] Assistant Professor of Educational technology. Faculty of Psychology and Education, Kharazmi University, Tehran, Iran. ORCID: 0000-0003-0812-1467, yousef.m @khu.ac.ir
[4] Professor in Educational Technology, Tarbiat Modares University, Tehran, Iran. ORCID: 0000-0002-4517-2039, j.hatami@modares.ac.ir

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ABSTRACT

Purpose: This research aims to compare the effects of the flipped learning method based on Merrill's model with the conventional teaching methods on the academic performance of fifth-grade students in mathematics education.

Method: The statistical population of the research is all the fifth-grade students of the primary school in Islamshahr, Tehran, during the academic year 2018-2019. The data were through convenient sampling from students. The research method is quasi-experimental with a pre-test and post-test design. Pham and Taylor's standard academic performance questionnaire (1999) was used as a measurement tool. The face validity of the tool was confirmed by experts in educational sciences and specialized teachers of mathematics, and its impact score was reported as 2.3, and the reliability of 0.72 was obtained using Cronbach's alpha. The data were analyzed using one-way ANCOVA and paired t-tests.

Findings: The results showed that the flipped method designed based on Merrill's educational model had a greater impact on students' academic performance than its reported results in the literature. The implemented flipped method also affected students' academic performance greater than the general conventional methods. In general, the findings indicate that teaching in the flipped method according to Merrill's design has a greater impact on the academic performance of students in mathematics than its traditional versions as well as the regular lecturing methods of teaching.

Conclusion: It is argued that teachers and educational designers can enhance the effects of Merrill's model by integrating it into the flipped method classrooms. **©authors**

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1. Introduction

Nowadays, one of the revolutions in the field of education is deemed to be the use of new information and communication technologies (ICTs), which have revolutionized learning and have made it possible to exchange information and communicate remotely. Using technology, this approach has encouraged educational systems to revert to new methods of teaching and learning in independent and different ways and the form of face-to-face classes combined with distance education systems. Technology experts predicted that in a few years, tablets, laptops, and cellphones with wireless internet will be available to all students (Ahmed, 2016). Therefore, it is important to consider how these technologies can be employed in education to adopt the most suitable methods for teaching and learning activities.

One of the subjects that need adequate research attention, and our country has ranked lower in the international exams, is mathematics. Mathematics education is one of the important issues in the school curriculum. In today's modern world, applied mathematical knowledge helps people to make informed decisions as citizens of society. Tan and Tan (2015) believe that even though students try hard to understand the practical concepts of mathematics in schools, they do not get satisfactory results in practice. Math teachers always face challenges in improving students' performance in math lessons.

As such, mathematics education requires using new and appropriate educational methods as conventional and teacher-oriented methods do not meet the needs of all students. In teacher-centered and traditional style education, the teacher is more involved in teaching and educational activities and is considered to be a know-it-all in the scene, in this case, his communication and interaction with students are at a low level, and this is one of the important factors that affect students' school performance. Hence, only through deeper and multilateral interaction in the classroom, can the students apply the concepts to real situations and as a result, practical learning can happen at high cognitive levels.

Educational methods are among the skills that teachers are characterized by, and a teacher's art become evident in the quality of selection and correct implementation of these methods. The world of education today has shifted its focus from teaching to learning. This approach considers learning as the center and basis of all programs and educational policies. It is necessary to realize the goals of such an approach, taking advantage of all the rich facilities and technologies available along with modern educational models. Flipped learning is one of the methods of teaching and learning that uses technology to transfer education and facilitate learning (Bagheri and Joshghan Nejad, 2015) and is a student-oriented strategy that, in addition to solving the basic problems and issues of the subject matter, it strengthens and improves the quality of communication between teachers and students. This method can be a suitable answer to the problem of many teachers in teaching mathematics who are faced with a large volume of mathematics textbooks in each grade and insufficient time to bring learners to a high level of problem-solving ability and contribute to classroom time management.

However, despite the existence of new methods such as the flipped method, learning takes place at low cognitive levels in our schools and most students cannot relate education to their previous learning or real situations in their lives. Whereas, if the teachers are able to make learning a meaningful and in-depth activity, they will be able to achieve high levels of education and it will lead to their achievements (Fardanesh, 2010). But according to researchers and scientific documents, the use of new educational innovations and technologies is not enough, because, despite the importance of new educational technologies, these technologies alone cannot make fundamental changes in education and require appropriate education and learning design. Considering the limitation to conduct the study at schools such as set curriculum activities and the lack of facilities and time necessary for hands-on activities to engage students in mathematics lessons, it was necessary to conduct the present research outside the classroom using teacher-centered activities designed based on Merrill's model so that adequate time and

planning could be allocated for practical activities and deepening of student learning, and at the same time, the teacher could accurately evaluate the students' performance and behaviors.

In this regard, despite the use of the flipped classroom method, there are misconceptions in this field, and sometimes it is thought that the flipped classroom is just changing the role of the student at home and school by using educational videos. Hence, the educational design of this process and how to produce educational videos are not considered. In addition, few studies have addressed the role of educational design in the flipped classroom, which requires further research attention. Therefore, considering the fact that, to the author's knowledge, no research has been done in Iran regarding the flipped model, the current research tries to answer the question of whether the implementation of the flipped classroom and its integration with the educational design models can improve learning and affect the academic performance of students.

1.1. Research Hypotheses:

Hypothesis # 1: The flipped teaching method designed based on Merrill's educational model affects the academic performance of students greater than the conventional flipped classroom method.

Hypothesis # 2: The flipped teaching method designed based on Merrill's educational model affects the academic performance of students greater than the regular lecturing method.

Hypothesis # 3: The flipped teaching method affects the academic performance of students greater than the regular lecturing method.

2. Literature Review

The advancement of technology has changed teaching-learning activities from traditional and passive to active and integrated learning (Nazarizadeh Dehkordi, Babaei Farsani, Ardakani, 2015). Flipped learning is one type of blended learning. In the flipped classroom, students view the educational content before coming to the classroom through videos recorded by the teacher and come to the classroom with relative preparation and familiarity with the subject, as a result, the classroom time is spent on activities, used to be known as "homework". Here, the teacher has the possibility to devote limited classroom time to interacting with students and solving cooperative and interactive activities, especially at the upper levels of the learning pyramid, instead of giving lectures and teaching content. With this method, instead of an all-knowing person who stands in the classroom and is engaged in delivering lectures and speeches, the teacher becomes a helper, guide, and facilitator of the education process alongside the students, who move around in the classroom environment and has better opportunities for individual and group interaction with students (McNally et al., 2016). In this regard and for a better understanding of the flipped classroom. Table 1 below compares the flipped classroom and direct education methods.

Table 1. A comparison of direct learning and flipped learning methods (Alvand, 2016)

	Direct Learning	Flipped learning
1	A hard task (class work)	An enjoyable task (class work)
2	Lesson plan with teaching design approach	Lesson plan with learning design approach
3	Teacher as a lecturer	Teacher as a facilitator and designer
4	Everything is taught	Everything is learned
5	Lesson in class	Lesson everywhere
6	Passive student (teacher-centered)	Active student (student-centered)
7	Attention to low cognitive levels	Attention to high cognitive levels
8	Uniform and universal education	Attention to individual differences and personalization of education
9	Paying attention to the presentation of materials in the form of a lecture	Opportunity to pay attention to group work
10	Emphasis on presenting content and not paying attention to curiosity and relationship	Balanced emphasis on content, curiosity and relationship

3. Method

The current research was conducted through a quasi-experimental method with a pre-test and post-test design and a control group. The statistical population included 180 students in Javadalameh school located in Islamshahr city. The students were in the fifth grade of an elementary school in the academic year 2018-2019. Considering the research conditions, available and purposive sampling was used. Among the fifth-grade students, considering the time and versatile schedule of the classes and the fact that the subjects were taught by the same teacher, 45 students were purposefully selected and tested. The selected subjects were randomly divided into three classes of 15 students, making two experimental and one comparison group. The first class received flipped instruction, where all course content was based on Merrill's design pattern. The second class was subjected to flipped training, but the design of the training files did not follow a specific pattern. The third group was kept as a comparison group, where they received the regular conventional training conducted by lecturing. After determining the sample groups, the mathematics lessons entitled “volume” and “capacity” from the fifth math textbook were taught and filmed by the relevant teacher and compiled into 10 separate files. The content was presented to the students through virtual media, and along with additional files, explanations, and assignments were presented to the students in the virtual space outside the classroom. The treatment lasted for 10 sessions, and after the completion of the training sessions, the academic performance test was also conducted. In this study, descriptive and inferential statistics were used to analyze the research data. In the descriptive part, the mean scores, and central and dispersion indices were reported. In the inferential part, covariance analysis and t-tests were used in order to eliminate the possible effects of the pre-test.

The instrument used to collect the data included Pham and Taylor's standardized academic performance questionnaire. The questionnaire contains 48 questions in five areas: self-efficacy, emotional effects, planning, and lack of outcome control and motivation, which measures the subject's performance using a five-point Likert scale. To obtain the validity of the tools, the test was given to educational science experts and was evaluated using the opinions of three professors in this field. It was also examined by four elementary and secondary school mathematics teachers. After applying the changes in the title of the three questions and modification of some statements, the experts confirmed the validity of the questionnaire in terms of clarity, comprehensibility, and relevance to the research objectives. Also, Cronbach's alpha test was used to check the reliability of internal consistency which yielded a reliability score of 0.72. In previous research by Alvand (2015), Kirzami (2013), and Dertaj et al. (2015), Cronbach's alpha coefficient of 0.75, 0.71, and 0.68, had been obtained respectively for the academic performance questionnaire used in this study.

4. Findings

Examining research hypotheses:

Hypothesis #1*: the flipped teaching method based on Merrill's educational design has a greater positive effect on the academic performance of students compared to the conventional flipped classroom method.*

Table 2. Examining the normality of academic performance of experimental group 1 and 2 students in pre-test and post-test

Variable	Number	Significance level
Pre-test	30	0.200
Post-test	30	0.001

In order to use the information in table 2, the condition of normality of the data is rejected, and due to the non-normality of the distribution of the data in experimental group 1 and 2, the Kruskal-Wallis non-parametric statistical test was used.

Table 3. Kruskal-Wallis statistical test

H	7.030
Standard deviation	1
Significance level	0.019

As shown in Table 3, the P-value is 0.019 and because it is smaller than 0.05, we conclude that there is a significant relationship between flipped training with Merrill's design and conventional flipped training, as a result, we can say that flipped training corresponding to Merrill's design has had a greater impact on academic performance of students in comparison to the conventional flipped method.

Hypothesis # 2*: The flipped teaching method based on Merrill's educational design has a greater positive effect on the academic performance of students compared to the regular lecturing method.*

Table 4. Kolmogorov Smirnov one-sample

Test	Number	Mean	SD	Sig. level
pretest	30	171.57	6.595	**0.144**
posttest	30	184.70	7.415	**0.087**

As shown in table 4, the p-value is >0.05, hence, the data distribution is normal. Therefore, the first condition of covariance analysis, i.e. the normal distribution of the data, is confirmed. However, in examining the other conditions of covariance analysis, the homogeneity of the regression slope is not confirmed and it is not possible to use covariance analysis, so the paired t- test is used.

Table 5. Paired t-test to check the difference between pre-test and post-test in experimental group 1 and the control group

Test	Mean	SD	T	Sig. level
pretest	171.57	6.595	-18.354	**0.000**
posttest	184.70	7.415		

As it can be seen in table 5, the mean score of the students in the pre-test was 171.57, which increased to 184.70 in the post-test, which is statistically significant. Since the P-value is <0.05, it can be concluded that the academic performance of the students who received the flipped education with the Merrill design has grown significantly compared to the students who received the education in the regular teaching method.

Hypothesis # 3*: The conventional flipped teaching method has a greater positive effect on the academic performance of students compared to the regular lecturing method in the classrooms.*

Table 6. Examining the normality of academic performance of experimental group 2 and control group in pre-test and post-test

Variable	Number	Significance level
Pre-test	30	0.200
Post-test	30	0.200

As shown in Table 6, the p-value is greater 0.05, and as a result, the distribution of the data is normal. However, due to the heterogeneity of the slope of the regression line, covariance analysis cannot be used, so the T test was used.

Table 7. Paired T-test to check the difference between pre-test and post-test in the experimental group

Test	Mean	SD	T	Sig. level
pretest	171.38	8.004	9.052	0.000
posttest	181.70	8.683		

As it can be seen in table 7, the mean score of the students in the pre-test was 172.38, which increased to 181.75 in the post-test, which is statistically significant. Since the P-value is <0.05, it can be concluded that the academic performance of the students who received the traditional flipped education has grown significantly compared to the students who received the education in the regular classrooms.

5. Discussion

This research aimed at examining the effect of the flipped classroom designed according to Merrill's educational design model on the academic performance of fifth-grade students in mathematics classes. The results showed that when the pre-test effect is removed from the post-test results of the groups, the difference between the groups with 95% confidence is meaningful. Based on the calculations and presentation of the results after removing the effect of the pre-test, there is a significant difference between the mean scores of the groups. It can be concluded that the flipped classroom based on the Merrill model in comparison with the conventional flipped method and the regular lecturing method has greater positive effects on the academic performance of the students.

The results are in line with the studies by Bahmani et al.'s (2016), Gholami et al. (2017), Ektefaeenejad et al. (2017), Morouse et al (2010), Leech and Plot (2000). To further explain these findings, it can be said that considering that the flipped method and Merrill's model are more flexible, it activates and creates pleasure and motivation toward learning in students.

In the flipped learning method or the flipped class, which is one of the new teaching methods implemented during the last decade and has received much attention, the teacher provides the students with educational slides, videos, and other lesson content that he has prepared in advance, so that they get to know the content of the new lesson before the class and practice it using the provided resources. In explaining the findings of the research, it can be said that the goal of all educational strategies and methods is the academic success of students. The flipped classroom has been introduced as an effective method in strengthening students' academic skills, considering the effective components in academic performance as well as emphasizing educational technology and individual skills in the fast-paced world of the information age. During the implementation of this method, students' motivational activities and spontaneous planning on their learning process are developed and students participate in the classroom environment with a program and rich knowledge about the upcoming issues. In Merrill's model, according to the detailed view and examination of all the components of the subject in the lesson plan, the learner prepares with enthusiasm and high self-confidence to participate in face-to-face activities and also class tests, and controls the anxiety and excitement caused by presenting assignments and participating in the school tests.

In addition to influencing academic motivation and desire, the flipped classroom with Merrill's educational model can become a collaborative environment with the previous preparation of students and create an optimal atmosphere in the classroom. In this research, it was revealed that the flipped class based on Merrill's model can complement the conventional flipped classes and effective steps should be taken to improve them because it can affect the academic performance of students. Most of the students planned their learning and carried out the learning activities with self-confidence and self-regulation. In the face-to-face classroom, they seek to fix their learning deficiencies and also learn at a higher level. In the classroom, the teacher has the role of providing the primary content of education for virtual education, and in the continuation of the education process in face-to-face classes, he plays the role of a facilitator

and educational guide so that the learning path is followed correctly and the learners achieve the overall goals of the lesson.

6. Conclusion

In the continuation of this research, considering the gap between educational models and their integration with the flipped classroom method, researchers in this field are suggested to integrate other educational models with this learning method and examine their results.

It is believed that training with careful designing and planning can yield better results. Also, considering that the present research was done in the field of geometry, researchers are suggested to employ this method in other areas of mathematics, such as number theory, statistics, logic, and algebra, and analyze the results.

Declaration of Competing Interest

The author declares that he has no competing financial interests or known personal relationships that would influence the report presented in this article.

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