

## Effects of Flipped Classroom on Creativity, Accountability, and Math Anxiety of Female Elementary Students

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### ABSTRACT

The current study aimed to investigate the impact of the flipped classroom on creativity, accountability, and math anxiety among female elementary students. This quasi-experimental research employed a pretest-posttest control group design. The statistical population for this study encompassed all female elementary students in Isfahan, Iran, during the first semester of the academic year 2021-2022. The convenience sampling method was utilized to select 30 students who were then divided into experimental and control groups ( $n = 15$  per group). The experimental group received 16 online sessions using the flipped classroom approach while the control group continued with regular educational practices at the same time. The research instruments consisted of the Home-School Accountability Questionnaire, Standard Creativity Scale, and Math Anxiety Scale. Analysis of covariance was employed to analyze the data. The results revealed that the flipped classroom approach yielded positive effects on creativity ( $F = 6.15, p < 0.05, \eta^2 = 0.18$ ), accountability ( $F = 6.75, p < 0.05, \eta^2 = 0.20$ ), and math anxiety ( $F = 4.74, p < 0.05, \eta^2 = 0.15$ ).

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## Introduction

Students represent a nation's most valuable human capital. Through proper and effective education, they can contribute significantly to societal growth and prosperity (Ilanloo et al., 2022). On the other hand, the educational system requires innovative teaching methods that align with societal changes. By embracing information and communication advancements in the teaching process, education can offer diverse opportunities across various fields and levels. Accountability, recognized as a dimension of strong character, holds vital importance both in the classroom and daily life (Mohammadi et al., 2020). Javadi Nejad et al. (2019) affirmed that accountability entails a personal commitment made by an individual for themselves or by others on their behalf. Parents, counselors, and educators play pivotal roles in fostering students' accountability within schools, families, and communities (Jerrim & Sims, 2022; Ordofa & Asgedom, 2022).

In addition to nurturing accountability, enhancing creativity among students has been a constant concern of educational science researchers (Khoshnood et al., 2020; Saemi et al., 2014). Creative thinking involves problem-solving, addressing information gaps, proposing solutions to problems, evaluating and testing hypotheses, refining and retesting hypotheses, and ultimately sharing findings with others (Fan & Cai, 2022).

Moreover, numerous scholars in education and psychology have examined the influence of anxiety on mathematics education, consistently finding that a certain type of anxiety hinders mathematical learning (Naderi Dehsheykh et al., 2021). Math anxiety constitutes a psychological state experienced by individuals when encountering mathematical content in teaching, learning, problem-solving, or assessing mathematical tasks (Niyai et al., 2021). Daches Cohen et al. (2021) observed that this condition often manifests as excessive worry, cognitive disturbance, distress, obsessive thoughts, and psychological tension, consequently impeding the thought process. As a result, it becomes imperative to adopt approaches that integrate direct, participatory, and online teaching techniques to extend students' learning duration.

The evolving educational landscape demands novel teaching methods that align with societal shifts (Mili & Winch, 2019; Frick, 2020). Consequently, information and communication advancements can be integrated into teaching processes to offer myriad educational opportunities across all domains and grade levels (Shirani Bidabadi et al., 2016). Presently, a revolution in education involves the utilization of innovative communication technologies, facilitating remote

information exchange and communication within traditional in-person education systems (Howard et al., 2022; Johnson & Barrett, 2017). Teaching comprises a series of teacher-designed activities aimed at facilitating learners' comprehension and experience of learning (Nguyen et al., 2022). With the shift from behaviorism to constructivism in recent decades, student-centered classrooms have gradually supplanted teacher-centered ones. In essence, teachers assist students in assuming responsibility for their learning comprehension (Sadeghi & Heshmati, 2019). The flipped classroom technique constitutes a relatively novel approach in this context (Persky & McLaughlin, 2017).

In a flipped classroom, a teacher provides the lesson for students in advance, allowing them to engage in discussions on various topics, address problems, ask and respond to questions, and undertake drills during the classroom session (Hew & Lo, 2018). Essentially, lessons are conveyed directly outside the classroom in this methodology while pertinent activities and drills occur within the classroom under the guidance of a teacher acting as a facilitator (Han, 2022). Furthermore, class time within a flipped classroom encompasses more than just individual learning. It encompasses diverse teaching and learning methodologies, fostering interactions, urging learners to take ownership of their learning, and enabling them to master the subject matter (Fallah et al., 2020; Oudbier et al., 2022).

Chou et al. (2021) believed that flipped teaching could prompt underachieving learners' active learning and thereby enhance learning effectiveness. Nouri (2019) reported that students had a positive attitude towards flipped classroom and that a positive attitude towards flipped classroom was strongly correlated to perceptions of increased motivation, engagement, increased learning, and effective learning. Campillo-Ferrer and Miralles-Martínez, (2021) reported that most students had a positive perception of flipped classroom, noting the advantage of practical in-class activities, as well as increased self-autonomy in learning. Khayat et al. (2021) showed that the flipped teaching method had greater impacts on the components of self-determination and class perception in students, compared to the traditional method. Razm et al. (2021) reported that flipped classroom increased the sense of responsibility in the students, compared to the traditional method. Liu (2022) stated that the potential affordances of the flipped classroom environment might place learners in more positive states of control and value appraisals than the environment of conventional classes, which can lead to the removal of negative emotions such as anxiety. Also, Parvaneh et al. (2020) showed that flipped classroom had a positive effect on the improvement of learner autonomy and reducing language anxiety. Zhao and

Yang (2023) reported that flipped classroom substantially reduced participants' writing anxiety while Fallah et al. (2022) indicated that flipped classroom enhanced the creativity of senior high school students. Tien et al. (2020) in a study showed that in terms of creativity, the group participating in flipped classroom learning significantly outperformed the group using traditional learning strategies. Moreover, flipped classroom learning promoted students' motivation and satisfaction (Tien et al., 2020).

A review of the background reveals that the flipped classroom approach, besides gaining popularity among students, offers numerous opportunities for information dissemination and feedback gathering for both teachers and students. This approach transcends temporal and spatial confines of the traditional classroom, augmenting students' creativity and academic performance. Given that social networks have entered the educational realm as novel educational tools and have significantly influenced the teaching-learning process in the current decade, these avenues warrant focused investigation. Nonetheless, the potential correlation between the flipped classroom approach and math anxiety remains an unexplored empirical domain. Broadly speaking, the flipped classroom strives to cultivate a student-centered environment, employing techniques such as group activities and leveraging emerging technologies. It enhances teacher-student rapport and moves away from conventional methods and lectures, thereby potentially enhancing and fortifying students' academic prowess. Given the pertinence of the flipped classroom to student education and the need to facilitate its integration within the Iranian educational landscape, it becomes imperative to address this research gap. Accordingly, the present study aimed to investigate the effects of flipped classroom on creativity, accountability, and math anxiety in female elementary students. As a result, by emphasizing the problems in the field of mathematics education and the effect of the reverse learning method in the world of education, the current research sought to find a suitable answer to the following questions:

1. Does the flipped classroom have an effect on improving the creativity of elementary school students?
2. Does the flipped classroom affect the students' accountability?
3. Can the flipped classroom reduce math anxiety in the students?

## Methods

### Design

This quasi-experimental research adopted a pretest-posttest control group design. The purpose of a quasi-experimental design is to identify the cause-and-effect relationship between two independent and dependent variables. Quasi-experimental studies encompass a broad range of nonrandomized intervention studies. These designs are frequently used when it is not logistically feasible to conduct a randomized controlled trial (Harris et al., 2006).

### Participants

The statistical population comprised all female third-grade elementary students in Isfahan, Iran, during the first semester of the academic year 2021-2022. The inclusion criteria encompassed ages 8 to 9, enrollment in the third grade, absence of psychiatric treatment, and expressed willingness (from both parents and children) to partake in the training sessions. Exclusion criteria involved psychological disorders, non-participation in training sessions, failure to complete assignments, and unwillingness to engage in the study. Thirty students were selected and divided into an experimental group ( $n = 15$ ) and a control group ( $n = 15$ ). Informed consent was acquired from both students and parents, assuring them of data confidentiality. The study protocol was approved by the Ethics Committee of Payame Noor University. (Code: IR.PNU.REC.1401.127)

### Instruments

**Home-School Accountability Questionnaire:** This 56-item questionnaire was designed by Kordlou (2011), and is scored based on a four-point Likert scale from 1 = I am fully satisfied to 4 = I am not at all satisfied. It consists of five subscales: the first of which addresses a student's activities outside the school (at the gym, the park, etc.). The second subscale pertains to the responsibilities of students at home, whereas the third subscale measures a participant's absenteeism and tardiness. The fourth subscale evaluates feelings of security, self-esteem, and attachment, whereas the fifth subscale assesses accountability. In this study, the subscale of accountability was used. Questions 22, 23, 25, 26, 27, 28, 31, 32, 33, and 37 are for measuring accountability. Javadi Nejad et al. (2019) reported an alpha Cronbach coefficient of 0.88 for the Home-School Accountability Questionnaire. For measuring the validity of the Home-School Accountability Questionnaire, nine specialists in psychology and educational sciences were asked to evaluate the items of

the questionnaire. The Cronbach's alpha coefficient was 0.89 in the present study.

**Creativity Questionnaire:** This questionnaire was designed by Abedi (2002), and consists of 30 three-choice items. The questionnaire was scored on a three-point Likert scale. In fact, this questionnaire evaluates four constituent factors of creativity, i.e., fluidity, innovation, flexibility, and expansion. Cronbach's alphas of fluidity, innovation, flexibility, and expansion were 0.75, 0.67, 0.61, and 0.61, respectively (Daemi & Moghimi Barforoosh, 2004). In the present study, Cronbach's alpha coefficient was 0.78.

**Math Anxiety Scale:** The Math Anxiety Scale was designed by Chiu and Henry (1990) and consists of 22 items that explain math-related activities. This scale is scored based on a four-point Likert scale. This scale has four dimensions: anxiety in learning math, anxiety in solving math problems, math teacher's anxiety, and mathematical evaluation anxiety. Arji et al. (2019) reported an alpha Cronbach coefficient of 0.77 for the Math Anxiety Scale. Moreover, Cronbach's alpha coefficient was 0.81 in our research.

## Procedure

During the pre-test phase, students completed the research questionnaires under the guidance of the first author. The educational content for each session was curated by the teacher (first author) and delivered in the form of instructional videos, clips, images, and podcasts

on the Shad Application for the experimental group. Students were tasked with viewing these materials at home and completing class activities from their math textbooks to prepare for the upcoming session. In the physical classroom, students participated actively in groups of three, engaging in lesson analysis and problem-solving. They reinforced the pre-studied educational content through crafts, educational games, and group exercises. In each session, one student from each group explained the problems. Adequate time was allocated for task completion, with any difficulties addressed in the classroom setting. The final session encompassed a post-test, where participants responded to the research questionnaires once more. Ultimately, the collected data from the pre-test and post-test stages underwent analysis.

## Data Analysis

The Shapiro–Wilk test and Levene's test were employed to analyze the normal distribution of data and equality of variances. The mean and standard deviation and analysis of covariance (ANCOVA) were used for data analyze data via SPSS 23.

## Findings

Table 1 reports the means and standard deviations of creativity, accountability, and math anxiety in the experimental group and the control group.

**Table 1.**

*Mean and Standard Deviation (SD) of Creativity, Accountability, and Math Anxiety in Experimental and Control Groups*

Variables	Phase	Experimental group	Control group
		Mean $\pm$ SD	Mean $\pm$ SD
Creativity	Pretest	60.93 $\pm$ 6.00	61.20 $\pm$ 3.56
	Posttest	64.80 $\pm$ 3.74	61.60 $\pm$ 3.15
Accountability	Pretest	37.46 $\pm$ 4.29	36.60 $\pm$ 2.32
	Posttest	40.53 $\pm$ 3.37	37.13 $\pm$ 3.62
Math anxiety	Pretest	53.33 $\pm$ 4.38	53.66 $\pm$ 5.44
	Posttest	49.06 $\pm$ 3.95	53.06 $\pm$ 5.73

The normal distribution of the data was checked using the Shapiro-Wilk test. According to the results, the normal distribution of scores in experimental group was confirmed for creativity ( $W= 0.891$ ,  $p> 0.05$ ), accountability ( $W= 0.860$ ,  $p> 0.05$ ), and math anxiety ( $W= 0.938$ ,  $p> 0.05$ ). Moreover, the distribution of data in variables of creativity ( $W= 0.915$ ,  $p> 0.05$ ), accountability ( $W= 0.933$ ,  $p> 0.05$ ), and math anxiety ( $W= 0.928$ ,  $p> 0.05$ ). in the control group was normal.

In addition, Levene's test was conducted to analyze the equality of variances. The results indicated that the hypothesis of equal variances was confirmed for creativity ( $F= 1.54$ ,  $p> 0.05$ ), accountability ( $F= 2.21$ ,  $p> 0.05$ ), and math anxiety ( $F= 2.56$ ,  $p> 0.05$ ) in the pretest and posttest. The significance level of between-group interaction and pretests were employed to analyze the regression slope homogeneity. The results indicated that the hypotheses of the regression slope homogeneity



were not rejected. Based on the results of Box's M statistic, the assumption of homogeneity of the variance-covariance matrix was respected (Box's M= 5.59, F= 0.84,  $p > 0.05$ ). The confirmation of the foregoing hypotheses made the ANCOVA possible.

Table 2 reports the ANCOVA results regarding the effects of flipped classroom on creativity, accountability, and math anxiety in the posttest. According to the results, there were significant differences between the pretest and posttest scores of creativity, something which indicated the significant effectiveness of flipped classroom in improving creativity in the posttest of the experimental group ( $p <$

0.05). The results also indicated that there were significant differences between the pretest and posttest scores of accountability, something which proved the significant effectiveness of flipped classroom in enhancing the accountability of students in the posttest of the experimental group ( $p < 0.05$ ). The separate analysis of dependent variables indicated that the resultant F-value was significant in differences between the two groups (by controlling the pretest effect) for math anxiety ( $p < 0.05$ ). Given the decreased score of math anxiety in the experimental group, it is concluded that flipped classroom alleviated the math anxiety of students.

**Table 2.**

*The Results of Analysis of Covariance on Research Variable*

Variables	Sources	SS	df	MS	F	P	$\eta^2$	Power
<b>Creativity</b>	Pretest	0.17	1	0.17	0.01	0.901	0.001	0.05
	Group	76.53	1	76.53	6.15	0.020	0.18	0.66
<b>Accountability</b>	Pretest	0.07	1	0.07	0.06	0.942	0.001	0.05
	Group	85.90	1	85.90	6.75	0.015	0.20	0.70
<b>Math anxiety</b>	Pretest	0.17	1	0.017	0.007	0.933	0.001	0.05
	Group	119.53	1	119.53	4.74	0.030	0.15	0.65

## Discussion

The present study examined the effects of flipped classroom on creativity, accountability, and math anxiety in female elementary students. The research results indicated that flipped classroom improved creativity and accountability in addition to mitigating math anxiety of students. In line with the results of the present study, Fallah et al. (2022) reported that flipped classroom increased creativity in high school students. Moreover, Hew & Lo (2018) showed that the flipped classroom approach in professional education yields a significant improvement in student learning compared with traditional teaching methods. Urquiza-Fuentes (2020) reported that students in the flipped classroom group were more responsible of their learning process.

Apparently, the flipped classroom approach has the potential to enhance students' creativity due to its incorporation of strategies that activate creative thinking. These strategies encompass fostering a creativity-inspiring environment, minimizing excessive control in the classroom, cultivating intrinsic motivation, and nurturing practical and adaptable thinking (Tsai et al., 2020). Flipped classrooms seem to naturally facilitate such conditions (Tien et al., 2020). A classroom, viewed as a dynamic and flexible environment, can play a pivotal role in nurturing creative

thinking and fostering creativity among students. This enables them to apply acquired knowledge in novel ways across various contexts beyond the classroom setting (Adams, 2015; Fan & Cai, 2022). Owing to its inherent flexibility, the flipped classroom lacks rigid frameworks, affording students the autonomy to tailor their learning experiences based on their interests (Fallah et al., 2022). Consequently, instructional plans are customized to accommodate learners' individual interests and characteristics, a factor that enhances their motivation and creativity.

Conversely, the implementation of the flipped classroom method involves significant student engagement within the learning process. In their quest for answers, students explore various avenues and ideas, fostering an environment conducive to their creative development. Students are required to review instructional materials (comprising teacher-recorded videos) independently to comprehend the subject matter outside of class. Utilizing supplementary exercises and educational resources in the materials enhances their comprehension. Given that students acquire foundational knowledge beyond the classroom, their classroom engagement occurs at a higher cognitive level under the guidance of the teacher. This elevated engagement serves as a catalyst for nurturing students' creativity.

The flipped classroom, characterized as a learner-centered instructional approach, shifts the responsibility for learning from instructors to students (Akçayır & Akçayır, 2018). This method endows students with greater control over their learning experiences, both within and outside the classroom. Consequently, students develop an enhanced sense of ownership over their education (Nouri, 2016). A study investigating the role of the flipped classroom in augmenting student responsibility found that this pedagogical approach substantially increased students' accountability for their learning endeavors (Urquiza-Fuentes, 2020). The approach underscores the transformation of students from passive recipients of knowledge to active seekers of information, leading to the mastery of subjects (Fallah et al., 2020). As such, students shoulder the responsibility of engaging with lessons, monitoring their learning progress, identifying areas of weakness, formulating strategies to address these deficiencies, and ultimately applying and generalizing acquired knowledge to real-world scenarios (Persky & McLaughlin, 2017). The flipped classroom method prioritizes individual interests and disparities, deep learning, the utilization of diverse educational applications, collaborative learning, and the creation of optimal learning environments (Akçayır & Akçayır, 2018). In summation, this approach can serve to elevate students' creativity and accountability by influencing, generating, and enhancing self-directed learning skills, motivation, and self-regulation. Notably, flipped classrooms extend beyond individual learning during class time, incorporating a plethora of teaching and learning methodologies. This encompasses motivating learners to embrace learning responsibility and cultivating the skills necessary to master subject matter (Urquiza-Fuentes, 2020).

In flipped classrooms, students are exposed to a variety of skills, including engaging in discussions involving both open-ended and closed-ended questions, active listening, posing direct inquiries, addressing inconsistencies, and seeking additional support and guidance from teachers. As a consequence, their capacity to set objectives and tackle challenges becomes enhanced. This newfound empowerment has the potential to mitigate student anxiety (Lo & Hew, 2021; Staddon, 2022). Within the context of flipped classrooms, students prepare for lessons in advance, affording them the opportunity to revisit the instructional material multiple times, with a focused approach on specific subjects. Each student embarks on the journey of comprehending and internalizing lessons in alignment with their individual nuances. Essentially, learning becomes a self-directed endeavor for students, enabling them to pose more insightful questions during in-person

sessions and delve into lessons more profoundly. The outcome is a higher level of effectiveness and depth in the learning process (Tien et al., 2020). Flipped classrooms also underscore the importance of collaborative activities, where peer pressure transforms into peer cooperation to collectively attain goals and surmount challenges. In this dynamic, teachers transition from being the sole instructors and exclusive conductors of activities to facilitators and aides. Consequently, anxiety is notably alleviated, and students encounter enhanced opportunities for learning (Niyai et al., 2021).

## Conclusions

The research findings affirm the efficacy of the flipped classroom approach in fostering creativity, cultivating accountability, and mitigating math-related anxiety among third-grade students. Within the flipped classroom framework, instructional materials are presented through a combination of videos, images, and podcasts tailored for student consumption. Subsequently, the onus rests on the students to allocate time for viewing these resources, determine the frequency of content review to ensure comprehension, proactively raise questions to facilitate the application of acquired knowledge, and engage in real-world problem-solving. Moreover, students are encouraged to master the lessons and document challenging concepts for subsequent discussion during in-person sessions with teachers, where troubleshooting takes place. Consequently, teachers transition from a role of supervision and problem identification to facilitation and guidance, assisting learners in achieving a more profound understanding of the subject matter. Given the demonstrable effectiveness of this pedagogical approach, educators are advised to consider integrating the flipped classroom method into their teaching practices. It is further recommended that educational authorities provide the requisite infrastructure and resources to support the implementation of flipped classrooms for both students and teachers.

This study faced certain limitations, which made the generalization of results difficult. Firstly, the participants were the third-graders of Isfahan (Iran), who participated in a math class. Therefore, the results cannot be generalized to other students and other lessons. Secondly, self-reporting questionnaires were used for data collection. For future research, it is suggested to conduct flipped classroom approach for other lessons. It is also suggested that this approach be implemented for other educational levels as well as male students. Also, in future research, it is suggested to use interviews in addition to questionnaires to collect data.

## Conflicts of Interest

No conflicts of interest declared.

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