

THE IMPACT OF FLIPPED CLASSROOM INSTRUCTION ON ACHIEVEMENT IN MATHEMATICS IN RELATION TO SELF-REGULATED LEARNING

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Abstract

This study explores the impact of flipped classroom instruction on students' achievement in mathematics in diverse classroom settings in relation to self-regulated learning of students. The research utilizes both qualitative and quantitative methods including classroom observations, student assessments and students' interview to evaluate the effectiveness of flipped classroom instruction in promoting a deeper understanding of mathematical concepts on 164 students of class IX. Results revealed that the high self-regulated learners achieved significantly higher in flipped classroom-based instruction as compared to low self-regulated learners. Findings of the study suggest that flipped classroom instruction not only supports high self-regulated learners but also foster a more inclusive and dynamic learning environment resulting in a positive correlation between flipped classroom instruction and achievement in mathematics.

Keywords: *Flipped classroom, Academic Achievement, Mathematics, Self-Regulated Learning*

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INTRODUCTION

Education aims to introduce students to diverse sources of knowledge and skills. With the upsurge of cutting-edge technological innovations, it's time to familiarize students with the latest tools and resources of acquiring knowledge. Educational institutions, all over the world, are increasingly leveraging the internet, email, web-based technologies, e-learning platforms, and other online educational resources to enhance learning engagement and foster a dynamic learning environment. Students should actively gather, examine, present, and communicate

knowledge and information in an environment where teachers can serve as facilitators or guides. By using different teaching techniques and methods, teachers can revitalize the teaching-learning process, thus providing students meaningful learning experiences that not only enhances acquisition of knowledge but also promotes the development of higher order thinking skills and critical thinking.

Mathematics is one such subject that cultivates both lateral and quantitative thinking which are so essential for the development of 21st competencies and skills. Mathematics should be taught in a way that may encourage students to think and analyse the problems rationally. Learning for the students should be supervised in a manner so that the students may interact with concepts and expand their intellectual capacity (NCF, 2005). Technology has a substantial impact on the education industry and raise the need for more digitally-specific teaching methods.

The combination of audiovisual gadgets, presentations, and animations with educational materials results in a pleasant and productive learning experience. As a result of eliminating typical classroom learning activities, students' learning experiences may become more fun and intriguing. Technological advancements result in new paradigms of teaching and learning.

Also, Policy-makers and researchers urge teachers to embrace diversity and to adapt their instruction to the diverse learning needs of students in their classrooms (Schleicher, 2016). Using new technology in education provides opportunities for students to collaborate on relevant tasks with their peers. Flipped classrooms are considered as an effective mode for engaging students in active learning as well as in meaningful peer-to-peer and peer-to-teacher interactions during the in-class learning process (Chen, Chen & Chen, 2015). Flipped classroom is an instructional strategy that reverses standard teaching methods by offering instructional information outside of class and bringing assignments and homework inside the classroom. The most powerful aspect of this paradigm is the increased processing time for new content. It is a type of blended learning that offers students the opportunity to access content from anywhere and anytime via the online environment (Gunduz & Akkoyunlu, 2020). The acronym FLIP stands for Flexible Environment, Learning Culture, Intentional Content, and Professional Educator as suggested by Hamdan, McKnight, McKnight, and Arfstrom (2013) wherein teachers are expected to build suitable evaluation methods, establishing

objective criteria that are clear, and can be well understood by both the teachers and the students. According to Songhao, Saito, Maeda, and Kubo (2011), removing direct instruction in class allows teachers to supervise collaborative learning, provide individual remediation, and foster meta-cognitive ability through communication among diverse. In this process, the students are actively involved in handling the information through involvement opportunities and self-evaluation in a significant way. But for the whole task, it's only the teachers who can motivate the students but also the students themselves need to identify and regulate intrinsic learning strengths so that they may have a positive disposition towards their studies. Self-Regulated learning is learning that is markedly predisposed by students' self-generated ideas, emotions, methods and actions that are geared toward goal completion (Zimmerman and Schunk, 2011). Students' motivation and comprehension of mathematics are vital for analysis and problem-solving. The achievement of students in mathematics depends on their capacity to self-regulate their learning (Fisher & Baird, 2005). Students should be able to address the challenges with self-reflection and self-monitoring, which can be done only by self-regulated learning.

REVIEW OF LITERATURE

Bhagat, Chang & Chang (2016) examined the effectiveness of the flipped classroom learning environment on learner's learning achievement and motivation, as well as to investigate the effects of flipped classrooms on learners with different achievement levels in learning mathematics concepts. A total of 82 high-school students participated in this study and divided into experimental and control groups. Findings indicated a significant difference in the learning achievement and motivation between the two groups with students performed better using the flipped classroom. Further analysis showed a significant difference in the performance of low achievers in the experimental and control groups.

Talan and Gulsecen (2019) compared a flipped classroom with blended learning and face-to-face learning environments. The aim was to identify the effect of these learning environments on students' achievements, academic engagement and satisfaction levels by forming one control and two experimental groups I and II. The students in Experimental group -I learned the theoretical aspect of the course through the materials in the online learning environment i.e. flipped classroom whereas the students in Experiment-II learned the theoretical aspect of the course in the classroom in accordance with the blended learning model and fulfilled

active learning activities out of class study time. The study revealed that the scores for the students in the experimental groups with regard to academic achievement and engagement were higher than the scores for those in the control group and the differences between the groups were statistically significant. Students were generally found to be satisfied with the flipped classroom.

Wei et.al. (2020) explored approaches to manage the flipped classroom in a Chinese context and designed an approach to improve the mathematical learning performance of middle school students. The results showed that the proposed flipped classroom approach significantly improved the students' mathematical learning performance.

Shao and Liu (2021) studied the effect of flipped classrooms on student learning performance compared to traditional classrooms via meta-analysis. The results indicated that the flipped classroom can improve students' academic performance. These findings provide a broad perspective for educators to implement flipped classrooms in the future.

Diningrat, Setyosari, Ulfa&Widiati, (2024) in their study found that students perceived a positive experience within the Online Flipped classroom while the regulation of goal setting, environment structure, and help seeking were developed.

Sun (2015) investigated the role of self-regulation on students' learning in an undergraduate flipped math class. The study found that all domains, specifically self-efficacy had a positive effect on math achievement, especially math self-efficacy.

Similar studies carried out in the subjects of English (Boyraz,2014) and Physics (Atwa, Din & Hussain,2016) also revealed the positive impact of flipped classroom on academic achievement of students.

NEED OF THE STUDY

Although the conventional approach to teaching and learning was sufficient in pre-digital times, the abrupt explosion of technology has had a substantial impact on the education process. It has raised the necessity for more digitally-specific teaching methods. Mathematics is an important subject which instils in students the capability of analysis, logic and critical thinking. So, there is an utmost requisite of emphasis on concept acquisition and modification in teaching methods and techniques in mathematics learning. According to Bloom's revised

taxonomy (Anderson & Krathwohl 2001), students should engage in lower-level cognitive work (gaining knowledge and comprehension) outside of class and focus on higher-level cognitive work (application, analysis, synthesis, and/or evaluation) in class with peer support and instruction. In a flipped classroom, students receive direct teaching, such as watching a lecture online, before discussing the content in class. This allows students to focus on participating in class and receiving feedback on their efforts during the course, rather than afterward (Akçayır, 2018). In a flipped classroom, educators serve as guides, arranging class time and clearing up any misconceptions over the topic. Students participate considerably more actively in a flipped classroom than in a standard classroom. In this, the traditional routine of spending class time occupied with coordinate guidelines and completing content-related exercises for homework is flipped. When teachers deliberately plan and execute these adaptations during their lessons to facilitate learning, students get more time to internalize the material through critical thinking and skill development. Over the last two decades, educational scholars have been investigating different methods and techniques of teaching mathematics. To succeed in mathematics classes, students must overcome their fear of the subject. The combination of audiovisual gadgets, presentations, and animations with educational materials results in a pleasant and productive learning experience. Mathematics classroom should feel like a community where ideas can be discussed, developed, debated, and understood (Bruce, 2007). Students should feel that all ideas are welcome in the classroom, even those that are unconventional (Nickerson, 1999). Thus, by eliminating typical classroom learning activities, students' learning experiences may become more fun and intriguing. For the success of the teaching-learning process, it is not only the teacher but the student whose self-belief, self-efficacy, motivation towards the goals and regulation of work matters. Students should be able to analyse their own weaknesses and strengths through the use of self-regulated learning. Therefore, it becomes imperative to find the connection between self-regulated learning and achievement in mathematics which led the researcher to investigate the impact of flipped classroom on achievement in mathematics in relation to self-regulated learning.

OBJECTIVES OF THE STUDY

1. To study the effect of Instructional Strategies on Achievement in Mathematics of grade IX students.

2. To study the effect of high and low levels of Self-Regulated Learning on Achievement of grade IX students in Mathematics.

3. To study the interaction effect of Instruction Strategies and Self-Regulated Learning on Achievement of grade IX students in Mathematics.

HYPOTHESES

The present study was conducted to test the following hypotheses:

Ho1: There is no significant effect of Instructional Strategies i.e., Flipped classroom Instruction and Conventional mode of Instruction on Achievement of grade IX students in Mathematics.

Ho2: There is no significant effect of high and low levels of Self-Regulated Learning on Achievement of grade IX students in Mathematics.

Ho3: There is no significant interaction effect of Instructional Strategies and Self-Regulated Learning on Achievement in Mathematics of grade IX students.

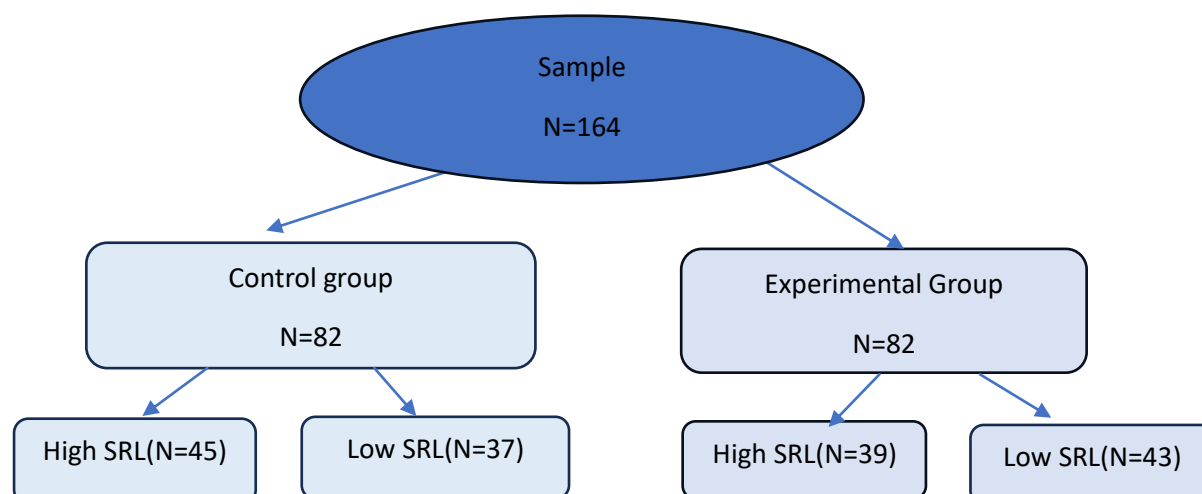
SAMPLE OF THE STUDY

The population consisted of both male and female students of class IX within the age group of 13-15 years. For the purpose of the study, a sample of 164 students from two randomly chosen senior secondary private schools of Chandigarh affiliated to CBSE.

RESEARCH DESIGN

In this study, a pre-test, post-test 2x2 factorial design was employed. The two groups, taught through instructional strategy based on Conventional instruction method and Flipped classroom instruction respectively formed the Control group (C) and experimental group (E). Self-Regulated Learning was taken as classifying variable. Self-Regulated Learning inventory by Gupta and Mehtani (2017) was administered to measure the self-regulated learning and thus classifying the learners into high and low self-regulated learners. To measure the achievement scores in mathematics, the Mathematical Achievement Test (MAT) for class-IX was designed and developed by the investigator herself.

Schematic representation of the Factorial Design: A 2x2 factorial design was employed to study the effect of two independent variables on one dependent variable, as well as the interaction effects of these variables on the dependent variable.



Statistical Analysis of Data

Descriptive and Inferential statistics were calculated through the use of SPSS software and MS Excel. Descriptive statistics such as measures of central tendency i.e., Mean, Median, Mode, and dispersion i.e., Range and Standard Deviation were calculated to study the nature of distribution of the data. Kurtosis and Skewness were calculated to check the normal distribution. t-ratios as well as f-ratios were computed to find out the significance of difference between means of pre-test scores and post-test scores. To find the main and interaction effect between the independent variables, ANOVA (Analysis of Variance) was calculated.

Table1:
Descriptive statistics for Pre and Post Tests

Statistics					
		Pre-test (control)	Post- test(control)	Pre- test(Experime ntal Group)	Post- test(Experimen tal Group)
N	Valid	82	82	82	82
	Missing	0	0	0	0
Mean		20.9390	26.8780	20.5488	31.0244

Std. Error of Mean	.88198	.82865	.81375	.87213
Median	20.0000	26.0000	20.0000	30.0000
Mode	15.00	23.00	15.00	20.00
Std. Deviation	7.98664	7.50373	7.36886	7.89745
Skewness	.422	.182	.367	.005
Std. Error of Skewness	.266	.266	.266	.266
Kurtosis	-.476	-.394	-.497	-1.116
Std. Error of Kurtosis	.526	.526	.526	.526
Range	34.00	33.00	32.00	30.00

Table2:

Mean Gain Scores of Two Groups (Experimental and Control Group)

Instructional Strategy	Conventional	Flipped Classroom
Mean Gain Scores	5.93	10.47

Figure 1: Comparison of Mean Gain Scores of the Two Groups based on Conventional and Flipped Classroom Instructional Strategy

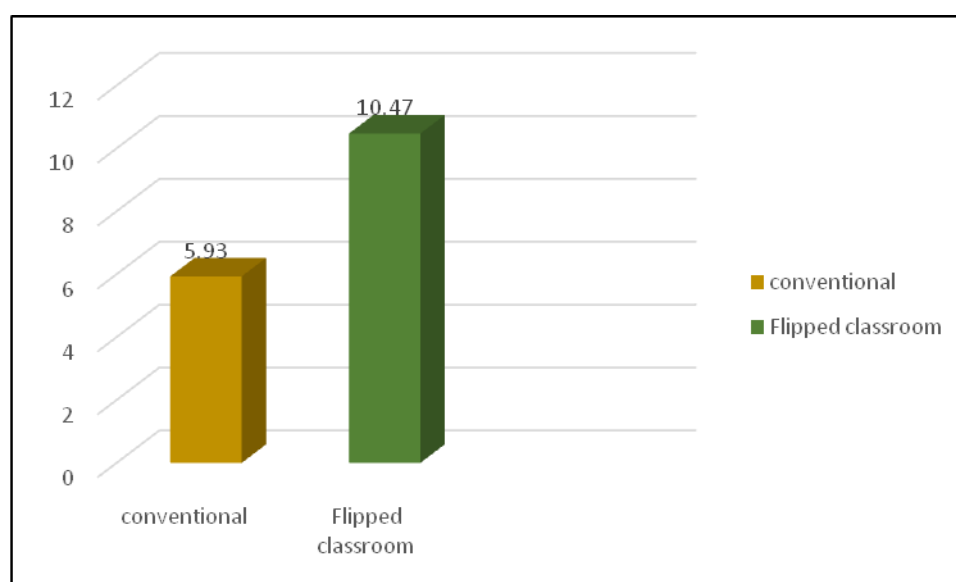


Table 3
Anova (Analysis of Variance 2X2) on the Pre and post-test scores of Mathematical Achievement Test (For Control Group)

ANOVA						
Pre-test		Sum of Squares	df	Mean Square	F	Sig.
Pre-test (control)	Between Groups	604.003	1	604.003	10.590	.002
	Within Groups	4562.692	80	57.034		
	Total	5166.695	81			
Posttest(control)	Between Groups	751.014	1	751.014	15.770	.000
	Within Groups	3809.767	80	47.622		
	Total	4560.780	81			

Table 4
One Way ANOVA between Groups with Differential Self-Regulated Learning Exposed to Conventional and Flipped classroom Instructionalstrategy(Post-Test)
ANOVA

Self-regulated Learning	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Low	Corrected Model	849.776 ^a	1	849.776	44.563	.000
	Intercept	342.276	1	342.276	17.949	.000
	C+E	849.776	1	849.776	44.563	.000
	SRL	.000	0	.	.	.
	Error	667.413	35	19.069		
	Total	22021.000	37			
	Corrected Total	1517.189	36			
High	Corrected Model	1590.712 ^b	1	1590.712	97.455	.000
	Intercept	881.834	1	881.834	54.026	.000
	C+E	1590.712	1	1590.712	97.455	.000

SRL	.000	0	.	.	.
Error	701.865	43	16.322		
Total	41779.000	45			
Corrected Total	2292.578	44			

Table5:Paired Sample Test For Control and Experimental Groups with respect to Self-Regulated Learning

Paired Samples Test										
Self-Regulated Learning			Paired Differences					t	df	Sig. (2-tailed)
			Mean	Std. Dev iation	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Low	Pair 1	Pre-test(Exp) - Post- test(Exp.)	- 8.30	5.93	.904	-10.12	-6.47	-9.17	42	.000
High	Pair 1	Pre-test(Exp) - Post- test(Exp)	- 12.6 4	5.25	.842	-14.34	-10.93	-15.01	38	.000

low	Pair 3	Low Srl (post test control) - Low srl(post testexp)	-1.64	8.70	1.43	-4.55	1.25	-1.15	36	.257
	Pair 4	high Srl (post control) - high srl(post exp)	-8.32	8.65	1.42	-11.20	-5.44	-5.85	36	.000
High	Pair 5	high Srl (post control) - high srl(post exp)	-3.50	6.36	4.50	-60.67	53.67	-.778	1	.579

Figure 2:Graph showing Post-test mean scores of MAT (Control and Experimental Groups) with respect to Self-Regulated

Learning



RESULTS AND CONCLUSIONS

In the light of the analysis and interpretation of the data, the following conclusions are drawn. The achievement in mathematics of the experimental group taught through Flipped classroom instruction is significantly higher than the control group taught through conventional teaching. Hence, the null hypothesis Ho1: “There is no significant difference in achievement of grade IX students taught through different instructional strategy i.e., Flipped classroom instruction and conventional teaching” is rejected. It is concluded that Flipped classroom instruction yielded better achievement scores in mathematics than conventional teaching which is in consonance with the study by Josephine (2022).

The difference came out to be significant in mean gain scores in achievement of mathematics with high level of Self-Regulated Learning and low level of Self-Regulated Learning. Hence, the null hypothesis Ho2: “There is no significant effect of high and low level of Self-Regulated Learning on Achievement of grade IX students in Mathematics” is rejected. The mean gain scores of the groups with high level of intelligence and low level of Self-Regulated Learning on the achievement in mathematics are found to be significantly different.

The present study reveals that there exists a significant difference in gain scores in achievement of mathematics due to the interactional effect of instructional strategies and

Self-Regulated Learning. Hence, the null hypothesis Ho3: “There is no significant interaction effect of Instructional Strategies and Self-Regulated Learning on achievement in Mathematics of grade IX students” is accepted. High self-regulated learners in both control and experimental group are found to perform better as compared to low self-regulated learners.

EDUCATIONAL IMPLICATIONS

Results of the present study reveal that Flipped Classroom as an instructional strategy provides an interactive learning environment and enhances students’ achievement in mathematics. These findings have far-reaching implications for improving the effectiveness of instruction. Developments in flipped classroom learning have provided both teachers and students with a diverse range of teaching- learning processes, thus extending the educational boundaries beyond the traditional four walls of the classroom.

An inevitable aspect of Learning through flipped classroom instruction is not only to reduce the face-to-face classroom hours, but also on how existing resources can be manipulated with time devotion to a number of activities that can be completed in class. Flipped classroom learning when combined with self-regulated learning can help the students to identify their mistakes with adaptation to a better managed time schedule for a more engaging and enjoyable classroom setting.

Thus, in a nutshell, the results of this study can be highly beneficial for both teachers and parents. By understanding and addressing the specific needs of students, they can bring positive transformations in the teaching-learning process. Moreover, these insights can help in effectively channelling students’ potential which can enhance their overall academic and personal growth.

REFERENCES

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, 126, 334–18.
<https://doi.org/10.1016/j.compedu.2018.07.021>

Atwa, Z. M., Din, R., & Hussin, M. (2016). Effectiveness of Flipped Learning in Physics Education on Palestinian High School Students' Achievement. *Journal of Personalized Learning*, 2(1), 73-85.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman

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

Boyras, S. (2014). Evaluating flipped classroom/education method in English teaching. [İngilizce Öğretiminde Tersine Eğitim Uygulamasının Değerlendirilmesi.] *Unpublished Master Thesis*. Afyon Kocatepe University. [Afyon Kocatepe Üniversitesi.]

Bruce, C. D. (2007). Student interaction in the math classroom: Stealing ideas or building understanding. *What Works? Research into Practice*, 1–4.

Chen, L., Chen, T. L., & Chen, N. S. (2015). Students perspectives of using cooperative learning in a flipped statistics classroom. *Australasian Journal of Educational Technology*, 31(6), 621–640. <https://doi.org/10.14742/ajet.1876>

Diningrat, S. W. M., Setyosari, P., Ulfa, S., & Widiati, U. (2024). Integrating PBI in the flipped classroom: A framework for effective instruction. *World Journal on Educational Technology: Current Issues*, 12(2), 117–127. <https://doi.org/10.18844/wjet.v12i2.4662>

Fisher, M. and Baird, D.E. (2005), Online learning design that fosters student support, self-regulation, and retention. *Campus-Wide Information Systems*, 22(2), 88-107. <https://doi.org/10.1108/10650740510587100>

Gündüz, A.Y. and Akkoyunlu, B.(2020). Effectiveness of Gamification in Flipped Learning. *Sage Open*, 10(4).DOI:[10.1177/2158244020979837](https://doi.org/10.1177/2158244020979837)

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). A Review of Flipped Learning. Retrieved from; <http://www.flippedlearning.org/review> (24.12.2024)

Josephine S., Uy (2022). Flipped classroom and students academic achievement in mathematics. *International Journal of Scientific and Research Publications*, 12(10). doi: <http://dx.doi.org/10.29322/IJSRP.12.10.2022.p13057>

NCF(2005) National Curriculum Framework. <https://ncert.nic.in/nc-framework.php>

Nickerson, R. S. (1999). How We Know—And Sometimes Misjudge—What Others Know: Imputing One's Own Knowledge to Others. *Psychological Bulletin*, 125, 737-759. <http://dx.doi.org/10.1037/0033-2909.125.6.737>

Schleicher, A. (2016). Teaching Excellence through Professional Learning and Policy Reform: Lessons from Around the World. Paris: International Summit on the Teaching Profession; OECD Publishing. <https://doi.org/10.1787/9789264252059-en>

Shao, M. M. & Liu, X. H. (2021). Impact of the Flipped Classroom on students' Learning Performance via Meta-Analysis. *Open Journal of Social Sciences*, 9, 82-109. <https://doi.org/10.4236/jss.2021.99007>.

Songhao, H., Saito, K., Maeda, T., & Kubo, T. (2011). Evolution from collaborative learning to symbiotic E-learning: Creation of new E-learning environment for knowledge society. *US-China Education Review*, 8(1), 46-53.

Sun, J. C. Y., Wu, Y. T., & Lee, W. I. (2017). The effect of the flipped classroom approach to OpenCourseWare instruction on students self-regulation. *British Journal of Educational Technology*, 48(3), 713–729. <https://doi.org/10.1111/bjet.12444>

Talan, T., & Gulsecen, S. (2019). The Effect of A Flipped Classroom on Students' Achievements, Academic Engagement and Satisfaction Levels. *Turkish Online Journal of Distance Education*, 20(4), 31-60. <https://doi.org/10.17718/tojde.640503>

Wei, X., Cheng, I. L., Chen, N. S., Yang, X., Liu, Y., Dong, Y., & Zhai, X. & Kinshuk (2020). Effect of the flipped classroom on the mathematics performance of middle school

students. Educational Technology Research and Development, 68(3), 1461–1484.
<https://doi.org/10.1007/s11423-020-09752-x>

Zimmerman, B. J., & Schunk, D. H. (Eds). (2011). *Handbook of self-regulation of learning and performance*. Routledge