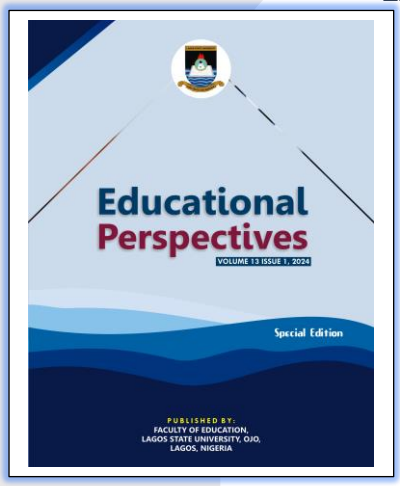

Effect of Flipped Classroom Strategy on Academic Achievement of Selected Senior Secondary School Students in Computer Studies

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ABSTRACT

Improving the learning effectiveness of students and reduce the frustration learning has always been a goal that teachers desire to achieve. In recent years, there are many approaches to improve the learning outcome of the student through active learning methods. One of the methods is the flipped classroom method. Therefore, this study examined the effect of using flipped classroom teaching strategy on the academic achievement of selected private senior secondary school students in Computer Studies. The study adopted pre-test post-test control group quasi experimental design. Two private secondary schools were purposively selected from the sixteen (16) private secondary schools in Mushin Local Government Area of Lagos State. A Computer Studies Achievement Test (CSAT) validated by three experts and with reliability estimate of 0.89 was used for data collection. Samples of eighty (80) SSS2 students offering Computer Studies from two senior secondary schools in Mushin Local Government of Lagos State were used for the study. Two instruments used were; teacher instructional guide for the treatment and control groups and Computer Studies Achievement Test (CSAT) (r=0.89) which contain 20 multiple choice questions with four options (A-D). Four research questions and four hypotheses were formulated to guide the study. Four null hypotheses were tested at 0.05level of significance. Data were analyzed using frequency, percentage, mean, standard deviation and T-test. The results show that there was a significant main effect on the students' achievement in computer studies when flipped classroom teaching strategy is used. Hence it is recommended that that both the government and the private school owners should provide ICT facilities and equipment for both the teachers and students for effective teaching and learning of computer studies and other subjects.

HOW TO CITE

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Background to the Study

Remarkable innovations and advances have been made in the field of information technology over the past decade, as such technology, as a valuable part, is intertwined with the education process. In this new millennium, students are more dependent on information technology and less tolerant of conventional educational patterns. In other words, students' needs and expectations from educational systems have changed (Hanimoglu, 2018). Conventional teaching strategy is a method that depicts an instructional situation where a teacher dishes out facts, ideas or contents to students (Ezeudu & Gbendu, 2020). It encourages passive learning and memorization of abstract phenomena (Bliss, 2016).It discourages active learning or students' involvement in the learning process (Asogwa & Echemazu, 2015). Though the teacher-dominated teaching methods like lecture method could be suitable for large class sizes and content coverage, it is rather found inefficient in improving students' attitude towards computer studies (Zakirman, 2019). To reverse these ugly trends, there is need for teachers to utilize innovative strategies such as flipped classroom.

A flipped classroom is an instructional strategy and a type of blended learning that reverses the conventional learning environment by delivering instructional content, often online, outside of the classroom. It is one such learning strategy that creates learning through technology, especially online video media, which helps reduce lecture time and increase the time for in-class activities where learners can learn cooperatively through practice (DeLozier & Rhodes, 2017). Technology can support flipped classrooms by letting students gain first by exposure to new material outside of class, usually via reading or lecture videos and then using class time to do the harder work of assimilating that knowledge, perhaps through problem solving, discussion, or debates. The growing accessibility and sophistication of educational technologies opens up increasing possibilities for students to explore and share, and create content (Bergmann & Sams, 2017). In addition, a flipped classroom has also been shown to promote not only students' sense of responsibility for their own work and self-regulation in assignment submission, but also their responsibility toward group assignments and classroom activities. (Yilmaz, 2017).

Flipped classroom instructional practice, is a new model for effective teaching. Leo and Puzio (2016) referred to it as a form of Blended Learning in which learners learn contents online by listening to audio lectures or watching the video lectures, mostly at their various home, and assignment is done together in the class with teachers and students discussing and solving questions. Students can work together on a task, exchange their opinion, experiences, views, discuss and negotiate strategies, actions and results through flipped classroom. These actions can provide students with opportunity to help, discuss, review, teach, influence each other and thereby enhance a motivational situation for developing a learning community.

In flipped classroom, teacher's role is of a mentor or facilitator of the learning process. The achievements of individual member within the group are shared among the group members (Zhonggen & Guifang, 2016).

There are a lot of studies on learning styles that encourage presenting student-based activities and participation in discussion allowing students to effectively control the content, organize effective experiences, think creatively, reinforce cognitive development and improve their academic performance. In addition, the heavy theoretical and applied support for knowledge benefits and motivation for cooperation is increasing unlike the competitive and individual learning activities irrespective of gender (Jarvenoja, 2010). Cooperative learning encourages students to divide teamwork, employ individual contributions and reinforce meta-cognition by providing several chances of communication between learners (Songhao, 2015). Therefore, the developed

countries adopt new learning and teaching strategies supported by the rapid development of information and communication technology and the students' spreading use of electronic devices by spending a lot of time on electronic games, e-mails, internet and cell phones. All these devices became an integral part of students' lives and hence it is important to find evidences on how to make electronic learning a strong motivator for change, how to redesign the educational systems, and how to depend on the internet to reinforce the classroom experience. The model of student-centered flipped classroom leads to digesting the curricula and mastering the skills according to the lower level of the cognitive domain in Bloom's Taxonomy (Knowledge and Comprehension) at home. It also leads to focusing on the higher level of cognitive domain (Application, Analysis, Synthesis and Evaluation) in the classroom time (Songhao, 2015). This model of flipped classroom is designed to improve students' motivation since it promotes competence, independence and self-motivations. The flipped classroom strategy is probably designed to address the students' needs of self-efficacy and competence through an integrated system. According to studies conducted in the last two decades, students feel self-effective when they participate actively in spreading knowledge unlike what they have previously been when receiving knowledge from the instructor through traditional teaching (Abey, 2015).

In addition, flipped classrooms contribute to encouraging and improving skills in the domains of application, analysis, synthesis and evaluation which are all mental skills and processes not covered by the traditional curricula (Aidoo, 2022).

Statement of problem

One of the primary challenges of conventional teaching strategies is the passive learning environment they create. Students are often expected to absorb information passively without actively participating in the learning process. This can lead to reduced student engagement, limited opportunities for critical thinking, and a lack of motivation to explore topics independently.

Additionally, conventional teaching strategies may struggle to cater to the diverse learning styles and paces of students. Students have different strengths, weaknesses, and preferences when it comes to acquiring knowledge. Conventional methods may not adequately address these individual differences, leading to a one-size-fits-all approach that may not meet the needs of all students.

These challenges and limitations of conventional teaching strategies have prompted educators to explore alternative approaches such as the flipped classroom strategy. The flipped classroom model aims to address these issues by reversing the traditional instructional approach. In a flipped classroom, students are exposed to instructional materials, such as pre-recorded lectures or readings, outside of class time. This allows for individualized, self-paced learning. Class time is then used for active engagement, collaborative activities, and discussions facilitated by the teacher. This approach promotes student-centered learning, encourages critical thinking skills, and provides opportunities for personalized instruction and feedback.

Research Questions

The following research questions were formulated to guide the conduct of the study.

i. What is the difference in the mean score of computer studies students taught with flipped classroom strategy and those taught with conventional teaching strategy?
ii. What is the difference between the mean score of male and female students exposed to flipped classroom teaching strategy?
iii. What is the difference between the mean scores of male students exposed to flipped classroom strategy and male students exposed to conventional strategy in Computer studies?

iv. What is the difference between the mean scores of female students exposed to flipped classroom strategy and females students exposed to conventional strategy in Computer studies?

Research Hypotheses

The following null hypotheses were generated and tested at 0.05 level of significance:

i. H01: There will be no significant difference between the mean scores of students exposed to the flipped classroom strategy and conventional strategy of teaching in Computer Studies.
ii. H02: There will be no significant difference between the mean scores of male and female students exposed to flipped classroom strategy of teaching in Computer Studies.
iii. H03: There will be no significant difference between the mean scores of male students exposed to flipped classroom strategy and males students exposed to conventional strategy in Computer Studies.
iv. H04: There will be no significant difference between the mean scores of female students exposed to flipped classroom strategy and females students exposed to conventional strategy in Computer Studies.

METHODOLOGY

Research Design

Quasi-experimental design is suitable for this study as it involves comparing the academic achievements of two groups (control and experimental) without random assignment.

Population of the Study

The population for this study comprised of all SSS2 students offering Computer Studies in two (2) out of sixteen (16) Senior secondary schools in Mushin Local Government Area of Lagos State. There are four (4) arms of SSS2 in each of the two schools out of which only one arm is offering Computer Studies. Each of the four arms is made up of an average class size of about 41 students. Therefore, the total population of students for this study is about 355 SSS2 students with 176 in school A and 179 in School B.

Sample and Sampling Technique

The study sample comprised only 80 SSS2 students offering Computer Studies in the two senior secondary schools. They were selected with the use of purposive sampling technique. This sampling technique was adopted because the two school selected use this flipped teaching strategy to teach their students. However, the two classes selected are the SSS2 students offering Computer studies.
The school A which was the e*xperimental group (EG)* consist of forty (40) SS2 students and school B:which is the *control group (CG)* consist of forty (40) students.

The population of the students, the total sample size and sample based on gender are shown in Table.1.

Table 1: Population, Sample Size, Sampling Techniques and Gender of Students Used for the Study

School	Group Status	SS2 Population per School	Arms Judgmentally Sampled	Sample per School	Gender		Total
					Males	Females	
School A	Experimental	176	Computer Studies	40	26	14	**40**
School B	Control	179	Computer Studies	40	22	18	**40**
TOTAL		**355**			**48**	**32**	**80**

Research Instrument

A Computer Studies Achievement Test (CSAT) was used to collect the data for this study. It was personally prepared by the researcher to cover the aspects of computer studies taught both the experimental and control groups with the Flipped and the Conventional methods respectively. The two groups from the two schools were taught Basic Programming Language as the specific aspects of Computer Studies recommended by the syllabus with the two methods. The same topics were treated in both groups. The researcher adopted the Flipped instructional method for teaching the Experimental group in School A while the Conventional method was adopted for teaching the same Computer Studies in School B. The CSAT research instrument consisted of 20 multiple choice items. It was personally constructed by the researcher based on the course contents taught. Each of the question items consisted of four (4) options and the respondents were instructed to circle their chosen options on the question paper.

Validation of the Instrument

The instrument (tests) for data collection in this study was validated by the project supervisor and experts in Measurement and Evaluation. They eliminated irrelevant items from the questions. They also suggested areas of modifications and their comments were used to improve the quality and high content validity of the instrument before administration.

Reliability of the Instrument

Twenty (20) copies of the validated draft copies of the Computer Studies Achievement Test were pilot-tested on students offering Computer Studies in one of the schools from the same study population who were not among those that participated in the main study. Data generated were divided into two (2) equal halves and correlated statistically with the use of split-half method of estimating reliability. The reliability coefficient was estimated and the result was above 0.89. Based on this, the test instrument was accepted as good and reliable for the study.

Method of Data Collection

The CSAT was personally administered as a pretest to all students by the researcher and the two Computer Studies teachers who were the regular teachers in the same schools, as research assistants. This is to determine the similarity of the two groups before the commencement of the study.

In School A which is the Experimental Group, the students were taught with Flipped method. This was done by:

1. providing a detailed guide of the course contents to be covered;
2. providing a detailed guide of how to read and cover the instructional contents;
3. providing textbook examples to guide on what to do and how it would be done;

4. organize classroom sessions with the students to attend to their personal and group questions and assignments.

On the other hand, the students in the control group were taught with the conventional method by taking them through different classroom sessions in their school's computer studies classroom.

The data collected with the research instrument was analyzed with both descriptive and inferential statistics. The data collected to answer the research questions was analyzed with statistics which include:

- Percentage (%),
- frequency (f),
- Mean (X) and;
- Standard Deviation (SD).

On the other hand, the hypotheses formulated were tested with t-test at 0.05 level of significance.

RESULTS

Hypothesis One

The first hypothesis formulated for this study states that:

H_{01}: There will be no significant difference between the mean scores of students exposed to the flipped classroom strategy (FCS) and conventional teaching strategy (CTS) in Computer Studies.

Table 2: T-test of significance of difference between the mean scores of students exposed to the flipped classroom strategy (FCS) and conventional teaching strategy (CTS) in Computer Studies.

Students Taught	N	%	$\bar{X}$	SD	Mean Difference	Df.	t-calc.	t-crit.	Remark
With FCS	40	50.00	72.38	3.22	11.88	78	7.14	1.98	H_{01} Rejected
With CTS	40	50.00	60.50	9.62					
Total/Mean	80	100	66.44	6.42					

**Level of Significance=0.05*

The analysis presented in the above shows the statistical test of the observed difference in the mean achievement scores of students taught computer studies with flipped classroom strategy (FCS) and conventional teaching strategy (CTS). It also shows that the difference between the two mean scores is 11.88. It shows further that t-test statistic was used as the test statistic and the t-test calculated value of the difference is 7.14 On the other hand; the corresponding t-calculated value at 0.05 level of significance and 78 degrees of freedom is 1.98. It shows that the t-calculated value is higher than the critical value and therefore, the null hypothesis was rejected. This implies that the students taught with the flipped classroom strategy performed significantly better than their mates taught computer studies with conventional teaching strategy.

Hypothesis Two

H_{02}: There will be no significant difference between the mean scores of male and female students exposed to flipped classroom strategy of teaching in Computer Studies.

Table 3: T-test of significance of difference between the mean scores of male and female students exposed to flipped classroom strategy of teaching in Computer Studies.

Male and Female Students Taught with FCS	N	%	$\bar{X}$	SD	Mean Difference	Df.	t-calc.	t-crit.	Remark
Male	26	65.00	75.39	2.72	8.60	38	7.56	2.02	H_{02} Rejected
Female	14	35.00	66.79	3.75					
Total/Mean	40	100	71.09	3.24					

**Level of Significance=0.05*

The data analyzed and presented in the above table represents the statistical test of the observed difference in the mean achievement scores of male and female students taught computer studies with flipped classroom strategy (FCS).It shows that the difference between the two mean scores is 8.60. It also shows that t-test statistic was used as the test statistic and the t-test calculated value of the difference is 7.56. On the other hand, the corresponding t-calculated value at 0.05 level of significance and 38 degrees of freedom is 2.02. It shows that the t-calculated value is obviously higher than the critical value and therefore, the null hypothesis was rejected. This implies that the male students performed significantly better than their female counterpart when they were both taught computer studies with the flipped classroom strategy.

Hypothesis Three

H_{03}: There will be no significant difference between the mean scores of male students exposed to flipped classroom strategy and males students exposed to conventional strategy in Computer Studies.

Table 4: T-test of significance of difference between the mean scores of male students exposed to flipped classroom strategy and male students exposed to conventional strategy in Computer Studies.

Male Students	N	%	$\bar{X}$	SD	Mean Difference	Df.	t-calc.	t-crit.	Remark
Taught with FCS	26	54.20	75.39	2.72	12.89	46	12.86	9.32	H_{03} Rejected
Taught with CTS	22	45.80	62.50	3.98					
Total/Mean	48	100	68.95	3.35					

**Level of Significance=0.05*

The analysis presented in the above table shows the statistical test of the observed difference in the mean achievement scores of male students taught computer studies with flipped classroom strategy (FCS) and that of male students taught computer studies with conventional teaching strategy (CTS). It also shows that the difference between the two mean scores is 12.89. It shows further that the t-test statistic was used as test statistic and the t-test calculated value of the difference is 12.86. On the other hand, the corresponding t-calculated value at 0.05 level of significance and 46 degrees of freedom is 9.32. This reveals that the t-calculated value is significantly higher than the critical value

and therefore, the null hypothesis was rejected. This implies that the male students taught with the flipped classroom strategy performed significantly better than their male classmates taught computer studies with the conventional teaching strategy.

Hypothesis Four

H_{04}: There will be no significant difference between the mean scores of female students' exposed to flipped classroom strategy and females students exposed to conventional strategy in Computer Studies.

Table 5: T-test of significance of difference between the mean scores of female students exposed to flipped classroom strategy and female students exposed to conventional strategy in Computer Studies.

Female Students Taught with	N	%	X-bar	SD	Mean Difference	Df.	t-calc.	t-crit.	Remark
FCS	14	43.75	66.79	3.75	8.69	30	6.12	4.34	H_{04} Accepted
CTS	18	56.25	58.10	4.31					
Total/Mean	32	100	62.45	4.03					

The analysis presented in the above table shows the statistical test of the observed difference in the mean achievement scores of female students taught computer studies with flipped classroom strategy and that of female students taught computer studies with conventional teaching strategy. It also shows that the difference between the two mean scores is 8.69 in favour of female students taught computer studies with FCS. It shows further that t-test statistic was used as the test statistic and the t-test calculated value of the difference is 6.12. On the other hand, the corresponding t-critical value at 0.05 level of significance and 30 degrees of freedom is 4.34. This reveals that the t-calculated value is higher than the critical value and therefore, the null hypothesis was rejected. This implies that female students taught with flipped classroom strategy performed better than their female classmates taught computer studies with conventional teaching strategy and the observed difference is statistically significant.

Discussion of Findings

The first research question of this study was to assess the difference between them mean scores of students exposed to the flipped classroom strategy and conventional strategy in Computer Studies. The first finding reveals the difference between the mean achievement scores of students taught with flipped teaching method results into better academic achievement among the students than the conventional teaching method. The observed difference in the mean achievement of students taught with flipped teaching method and students taught computer studies with conventional teaching method was also found to be statistically significant. This finding agree with of Adu and Adeyanju (2015) where applied flipped learning to determine senior secondary school students' achievement in Economics. They reported a statistical significant in performance of those taught with flipped learning method. Alzain,(2015) also applied flipped learning to teaching tertiary education students in the Faculty of Education, Abdul Rahman University Riyadh. He recorded a significant impact of the application of the concept of flipped learning style on the academic achievement of the students.

The second research question of the study was to determine the difference between the mean scores of male and female students exposed to flipped

classroom strategy of teaching in Computer Studies. The result shows that there is a difference in the academic achievement scores of male and female students taught computer studies with flipped classroom strategy in favour of male students. The implication of this is that male students taught with flipped classroom strategy performed better than their female counterpart taught with the same method. The observed difference in the mean achievement of male and female students when they were both taught with the flipped classroom strategy was found to be statistically significant. This implies that the male students performed significantly better than their female counterpart when they were both taught computer studies with the flipped classroom strategy. This finding agree with Halpern et al, (2017) in a study titled encouraging girls in math and science also recorded that though male performed better than females when they were both taught with flipped learning, the method helped to improve the performance both male and female students.

The third research question of the study was to establish the difference between the mean scores of male students exposed to flipped classroom strategy and male students exposed to conventional strategy in Computer Studies. According to the finding, male students taught with flipped classroom strategy performed better than their male mates taught with the conventional teaching strategy. It shows that male students taught with the flipped classroom strategy performed significantly better than their male classmates taught with the conventional teaching strategy. Similarly, Sheldon and Filak (2010) and Schultz, et al (2014) obtained similar results of male performing better when they were taught with flipped method than when taught with other conventional methods. The study of Schultz, et al was on the effects of the flipped classroom model on student performance for advanced placement high school chemistry students while that Sheldon and Filak (2016) was titled manipulating autonomy, competence and relatedness support in a game-learning context.

The last research question sought to find out the difference between the mean scores of female students exposed to flipped classroom strategy and female students exposed to conventional strategy in Computer Studies. Analysis of the mean achievement scores of the two groups of female students shows that female students taught computer studies with flipped classroom strategy and their female classmates taught computer studies with and conventional teaching strategy also shows that it is different. Also, a statistical test of the significance of the observed difference in the mean achievement scores revealed that it is significant.

The implication of this is that the female students taught with flipped classroom strategy performed better than their female classmates taught computer studies with conventional teaching strategy and the observed difference is statistically significant. In line with this finding, Abeysekera and Dawson (2016) in their report on a related study observed that with proper motivation and cognitive load in the flipped classroom, there was a significant difference between the achievement scores of females taught with flipped learning and females taught with conventional method.

Conclusion

The purpose of this study was to assess the effect of using flipped classroom teaching strategy on the academic achievement of selected senior secondary school Computer Studies. The study also intends to examine possible effects of flipped classroom on gender and their performance. Four specific research questions and four hypotheses were raised to guide the study. It was concluded based on the finding that students taught with flipped teaching method performed better and their performance was also found to be significant. This shows that the flipped classroom teaching strategy had impact on the students and improved their

academic achievement than conventional teaching strategy

It is also concluded based on the findings in this study that male students learnt significantly better when taught computer studies with flipped classroom strategy than when taught with conventional teaching strategy. Similarly, female students taught computer studies with flipped classroom strategy performed significantly better than when they were exposed to the conventional teaching strategy.

Recommendations

The following are the recommendations for implementation proffered as the way forward

1. Effectiveness of flipped learning is majorly tied to availability and accessibility of information and communication devices for the teachers, students and the schools. It is therefore recommended that all tiers of school owners and government should ensure they provide ICT facilities and equipment to the schools for the use of staff and students in the schools under their respective control.
2. The study has proven that students learnt better when taught with the flipped classroom strategy than when taught with conventional teaching strategy.It is therefore recommended that the teachers should embrace teaching the students using the flipped method. This can be done by uploading different class assignments and instructional content through WhatsApp, blog platforms and other platforms.
3. The teachers should embrace teaching the students frequently using flipped learning. This will make students to be more aware of the impacts and gradually, the impacts will be felt and many more students will start to develop interest in the flipped learning method

References

Adu, E.O &Adeyanju,H.(2015): *Home and school factors as determinant of students' achievement in senior secondaryschooleconomicsinBotswanaARPN,JournalofScienceandTechnology,3(2):219-221.*

Alzain,H.(2015).Theimpactoftheapplicationofthec onceptoftheinvertedrowintheacademicachiev ementofstudentsintheFacultyofEducationPri ncessNorabint Abdul RahmanUniversity,Riyadh.TheInternational Journalof Educationalspecialist,4(1),171-186.

Abey,S.L.(2015).Motivationandcognitiveloadinflip pedclassroom:definition,rationalandacallfor research.HigherEducationResearch&develo pment,34(1),114.https://doi.org/10.1080/072 94360.2014.934336.

Aidoo,H.(2022).Theimpactoftheapplicationoftheco nceptoftheinvertedrowintheacademicachieve mentofstudentsintheFacultyofEducationPrin cessNorabint Abdul RahmanUniversity,Riyadh.TheInternational Journalof Educationalspecialist,4(1),171-186.

Asogwa, U.D., &Echemazu, R. (2015). Effect of power point presentation on secondary school students, achievement in Christian religious knowledge. *International Journal of Educational Research, 11(1), 22-32.*

Bergmann,J.,& Sams,A.(2017). *Flipyourclassroom:Reachevery studentinevery classevery day.*Eugene, OR:InternationalSocietyforTechnologyinEd ucation.

Bliss M.(2016).Successfulstoriesandconflicts:Al iteraturereviewon the effectiveness of flipped learning in higher education.*Journal of Computer AssistedLearning*,*34*(4),409-416.https://doi.org/10.1111/jcal.12250

DeLozier,S.J.,&Rhodes,M.G.(2017).Flippedclassr ooms:Areviewofkeyideasandrecommendatio nsforpractice.*EducationalPsychologyReview ,29(1),141e151*.https://doi.org/10.1007/s106 48-015-9356-9.

Ezeudu, S.A. &Gbendu, G.O. (2020). Effect of flipped classroom strategy on students' attitude towards Secondary School Geography: Implications for Entrepreneurship Education in Nigeria. International Journal of Studies in Education. 16(2), 38-51

Hanimoglu, E. (2018). The perceptions of students about the role of school counselors on career selection. European Journal of Educational Research, 7(4), 763-774. doi: 10.12973/eu-jer.7.4.763

Halpern, D.F., Aronson, J., Reimer, N., Simpkins,S., Star, J.R., &Wentzel,K. (2017). *Encouraging girls in math and science.*Washington, DC:InstituteforEducational Sciences, United StatesDepartment of Education.

Halpern, D.,Benbow, C., Geary,D., Gur, R., Hyde, J.S., &Gernsbacher,M.A. (2017). The scienceof sexdifferences in science and mathematics.*Psychological Sciencein the PublicInterest, 8*(1), 1–51.

Jarvenoja,H.(2010).Sociallysharedregulationofmotivationandemotionincollaborativelearning:Facultyof Education, University of OULU.

Leo, J., & Puzio, K.(2016). Flipped Instruction in a High School Science Classroom. *Journal of Science Education and Technology, 25*(5), 775–781. doi:10.1007/s10956-016-9634-4.

Sheldon, K. M., & Filak,V. (2010). Manipulating autonomy, competenceand relatedness support in a game-learningcontext:New evidencethatallthreeneeds matter.*British Journal of Social Psychology, 47*, 267–283.

Songhao.(2015).EvolutionfromCollaborativeLearningtoSymbioticE-Learning:CreativeofNewE-Learning EnvironmentforKnowledgesociety.*US-ChinaEducationReview,8*(1),46-53..

Yilmaz,R.(2017).Exploring the roleofe-elearningreadiness on student satisfaction and motivation in flipped classroom. Computersin Human Behavior, 70,251e260. https://doi.org/10.1016/j.chb.2016.12085.

Zakirman,Z., & Perera C. J. (2019).Exploring students' competence, autonomy and relatedness in the flipped classroom pedagogy cal model. *Journal of Further and Higher Education, 43*, 115–126.

Zhonggen,Y. and Guifang,W.(2016).Academicachievementsandsatisfactionoftheclicker-aidedflipped businessEnglishwritingclass.EducationalTechnology&Society,19(2):298-312.