

The Effect of the Flipped Classroom on the Nature of Science (NOS) and Students Achievement in Biology

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ABSTRACT

Background: Nowadays, new technologies as an integral part of the educational setting have created unique opportunities for teachers to apply various instructional and teaching methods to better educate students. This paper aimed at investigating the effect of the flipped classroom method on the nature of science (NOS) and achievement.

Methods: This was a pretest-posttest semi-experimental study with control group. The population included all tenth grade female students of Tabriz city in the 2017-2018. The sample size consisted of 45 students of tenth grade selected by cluster sampling method in which 23 of them were in the experimental group and 22 of them were in the control group. Data gathering tools in this study included the questionnaire of NOS (Liang et al, 2008) and an teacher made achievement exam in biology course. Data were analyzed using covariance analysis.

Results: Results showed that in the whole group comparison, the mean score of achievement in the experimental group was significantly higher than that in the control group ($P=0.02$). There was no significant difference on effect of flipped classroom on the NOS between two groups ($P=0.07$).

Conclusion: The Flipped Classroom has led to an increase in learning in students, thus it affects their academic development, but it did not affect students' nature of science.

Keywords: Flipped classroom, The nature of science, Biology course, Students achievement

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Introduction

Today our schools all over the country increasingly need to reform teaching methods. Little reforms in present teaching methods don't solve current problems and insufficiencies of school education. Accordingly, teaching methods are changing in schools. Along with these changes, teachers are looking for the best plan and action to present strong evidences of positive effects of new teaching methods on students' achievement (1). One of the strategic plans for improving teaching and learning process is using information and communication technology capabilities as an accessible and comprehensive knowledge source and teaching tools (2). One of the important and clear purposes in high school is reaching adequate perception of the NOS in high school periods. Right perception of NOS can develop the critical thinking in students and connect learned concepts to their daily life and future. Thus it can provoke the creativity and begin innovation and hereby scientific prosperity is provided (3). Karimi and Mehrmohammadi have stated hereupon that it is necessary for science educators to recognize scientific efforts and the quality of its connection to science. They can help their students only in case of complete perception of NOS. Adequate perception of NOS is one of main components of scientific literacy (4). Scientific literacy is closely related to NOS and NOS has an important role in the development scientific literacy. Based on the theory of scientific literacy, NOS is essential for learning lots of life skills such as problem solving, creativity, and critical thinking (5). Also there is a need for scientific skills to learn most of daily skills such as problem solving, creativity and critical thinking (6). The nature of science deals with the epistemology of science and considers the knowledge as a way of acquiring knowledge or a set of values and beliefs which are inseparable from growth and development of scientific knowledge (7-9).

Although the concept of science is defined in different forms but in general terms it refers to the value, methods and

ideas that are required in the growth of scientific knowledge. Therefore, the nature of science lies in methods and scientific approaches. One understands the nature of science properly who uses scientific methods to deal with phenomena and solve different scientific problems and has the right attitude to science such as variability, acquisition and experiment which is built and evaluated human thinking and non - deduction based on one or two observations (10). As an individual or a member of a society all of us, in one or another way, have a set of interests in the acquisition of scientific literacy. Adequate understanding of the nature of science is one of the main components of scientific literacy (9). Nevertheless, understanding NOS was the subject of researches for years and results show educators and students don't have adequate perception of NOS (2, 7, 11-18). It demonstrates that teaching efforts in the last years were not useful and effective in understanding NOS or teaching educators in this field (19). Education specialists perceived that in order to improvement of students' performance in Science lesson and also in attempt to profound understanding of students in this lesson, major changes should be done in current teaching methods (20). Liu et al stated that performance of the twelfth grade students at science lesson has decreased from 1995 – 2005 (21).

Also in our country there are some weaknesses at biology and the results of TIMSS study show that Iranian students have gotten very poor results in science lesson test and this indicates a low level of quality of Science education besides worldwide standards (22-26). At the recent decades, constructivist teaching methods are replaced with direct teaching method. Constructivism is a psychological and philosophical view that according to it, most people form what they learn and understand (27). The constructive learning emphasizes that the learner actively creates knowledge based on prior knowledge and experiences (28).

One of the methods of teaching and learning which can be effective in students'

learning and improve that is the idea of flipped classroom. Activeness of learner is the other important component of this teaching method. Flipped teaching is also known by other names such as substitute class, reverse instruction, reverse teaching and blended learning (29).

Ng and Butt have defined the flipped classroom as follows ' Flipped courses require students to come to the class after viewing the required materials so that they can participate in the class activities. These learning materials such as video recorded lectures, PowerPoint presentations are delivered to students through an alternate medium such as podcasts or video-on-demand services (30, 31). Toto and Maher have also described this method' component of this teaching method. Students spend time in the classroom working on activities, such as solving problems, writing code, or discussing concepts with their peers. This creates a learning environment where students learn by collaborating with their peers. Many studies have shown that working with peers in class activities such as programming exercises improves overall learning, increases confidence in students and makes coding fun. Students generally find the flipped model to be a more enjoyable learning experience. (32, 33).

Many studies have shown that working with peers in class activities such as programming exercises improves learning and increases self confidence in students (34-36). The results of Herreid research indicate that flipped classroom has a positive effect on students' learning; because they found this method more effective than giving lecture by the teacher (37). Wang in his research in which he investigated the effect of flipped Classroom on students' achievement, showed that this new method can increase the students' motivation and their achievement (38). The results and findings of Mohanty&Parida (2016), Nwosisi et al. (2016), Guy & Marquis (2016), Tanner & Scott (2015), and Strayer (2012) indicated that flipped Classroom teaching enriches students' achievement (39-43).

According to the mentioned contents and

importance of NOS and the importance of learning and flipped classroom teaching method have positive impact on students' independency, development of knowledge, skills, attitudes, and retention? Moreover, by considering the features of current age, human being is facing by explosion of information and development of technology, the system of education has the obligation to organize the Biology curriculum in a way that attends all students' cognitive and personality abilities and to reach necessary abilities to face with super complexity and overcharging. Using the advantages of science and technology and new teaching methods, they have the capability to face new developments.

1-Flipped classroom has a positive effect on the students' attitude to NOS.

2-Flipped classroom has a positive effect on the students' achievement in Biology.

Methods

A pretest-posttest quasi-experimental design with control group has been used in this research. study population consisted of secondary school girls in the fourth region of Tabriz (300 students), which is in the academic year is 2017-2018 and the criterion for entering a statistical sample consists of the tenth grade students possessing the gender of female. The sample size in experimental studies is recommended to be at least 20 in each group (44). With due attention to this citation, the whole class was selected as the sample for each of the sample groups which according to Tabriz Education organization, this number is 20 or more for each class. Students of tenth grade were selected to be in the sample using cluster random sampling. First, the fourth region of Tabriz was chosen as a sample in random cluster manner. At the next stage, one of the high schools was taken from within the region chosen in the first stage and then at the third stage two Biology classes in tenth grade were chosen as a sample and randomly divided into experimental and control groups. Data were analyzed using one way variable covariance analysis (ANCOVA) in SPSS version 19.0.

Tools

Nature of science (NOS) Questionnaire:

NOS questionnaire was used to measure students' NOS beliefs. This 5 point Likert scale consisted of 24 questions with 6 subscales including observation and inference, Change in scientific theories, change in Scientific rules (for) theories, cultural and social impact on science, imagination and creativity in scientific investigations and scientific research methodology. Liang et al. have measured the reliability of this instrument by calculating Cronbach's alpha at three countries including United States of America (0.67), China (0.61) and Turkey (0.67) (45). At current research Cronbach's Alpha of 0.74 is reported. This questionnaire is also valid and reliable in Iran, so that it is known as the most cited, strongest and most influential tool and it has different forms in many countries (45). In the process of face and content validation, after translation, the questionnaire was given to 5 educational specialists and after remarks and making corrections in that, the questionnaire was confirmed in terms of face and content validity.

Achievement test: It was a teacher-made test with 16 items which was used in both Pre – test and Post – test. The test questions included four extensive answers questions, four short answers, four blank questions, four multi-choice questions. The test was graded by adding one score to every correct answers and zero to incorrect ones. The validity of the test was confirmed by specialists. In the process of checking the validity of content, after preparing the test, it was given to several educational specialists, biology specialists and biology teachers. After their review and making reforms in the test, face validity and content validity of that was approved and its reliability in pre/posttest has been verify edas 0.72 and 0.74 by Kuder – Richardson.

Procedure

In this study at first, the NOS questionnaire has been implemented for two groups of experimental and control in Biology. In order to implement this intervention, the

teacher of the flipped classroom was taught by the researcher about the details of flipped classroom and the process and procedure of this style. Experimental group was taught by flipped classroom method for ten sessions of one-hour (each session 50 minutes), the content of the textbook was designated in the form of power point and animation and it was given to the students before teaching and they were requested to watch CDs before coming to the class and study their textbooks while watching them and wherever they had faced a problem, take notes and bring them to the class to ask for solution and discuss about them. In fact, there was no teaching in the classroom and all was about asking questions and solving problems, while the control group followed their routine instruction. After teaching sessions, teacher made Post – test achievement and the NOS were implemented in Biology course. During its implementing by the teacher, the researcher was present as a supervisor at the school.

Results

Students participating in this study with an average age of 16.6 were in tenth grade of experimental science field, and both groups were at middle level in terms of academic achievement.

The results of descriptive data of NOS variables in Pre – test and Post – test of groups are shown in Table 1.

1-Flipped classroom has not affected the students' attitude to NOS.

Table 1 shows the descriptive statistics of the NOS in pre - test and post-test in the case study (flipped experiment group and control group).

2-Flipped classroom has a positive effect on the students' achievement in Biology.

In Table 2, shows descriptive data represented students' achievement scores in biology at Pre – test and Post – test in control and experimental groups.

1: flipped classroom has a positive effect on the NOS.

For testing the hypothesis that flipped classroom has a positive effect on the

Table 1: Descriptive data of the NOS variables in Pre – test and Post – test in control and experimental groups

Variable	Group	N	Pre – test		Post – test	
			Mean	STD	Mean	STD
Observation and inference	Experimental	23	12.35	1.22	14.35	1.58
	Control	22	12.77	1.51	14.20	1.71
Change in scientific theories	Experimental	23	13.43	2.04	15.91	1.90
	Control	22	13.77	1.63	14.68	2.19
Change in Scientific rules(for) theories	Experimental	23	13.17	1.96	15.13	2
	Control	22	13.14	1.32	14.68	2.37
Social and cultural impact on science	Experimental	23	9.39	0.98	10.52	1.37
	Control	22	9.44	1.04	9.85	0.87
Imagination and Creativity in scientific investigation	Experimental	23	12.30	1.55	14.57	1.70
	Control	22	12.86	1.42	14.33	1.49
Scientific research methodology	Experimental	23	13.83	2.48	16.17	1.72
	Control	22	13.73	1.60	15.09	1.54

Table 2: Descriptive data of achievement scores in Biology at Pre – test in groups

Variable	Group	N	Mean	Std	Mean	Std
Achievement	Experimental	23	13.48	1.72	17.56	2.05
	Control	22	13.95	1.43	16.39	2.61

acattitude towards NOS, analysis of covariance (ANCOVA) has been used. The results of analysis of covariance (ANCOVA) with regard to the effect of flipped classroom on attitude towards NOS in the control and experimental groups are shown in Table 3.

As the results of Table 4, there is no significance difference between groups at attitude towards NOS ($P=0.07 >0.05$). Therefore, the research’s hypothesis has rejected and null hypothesis has accepted.

2: Flipped Classroom has a positive

effect on the achievement in Biology course.

For testing the hypothesis that flipped classroom has a positive effect on the achievement in Biology course, analysis of covariance (ANCOVA) has been used. The results of analysis of covariance (ANCOVA) with regard to the effect of flipped classroom on the achievement in Biology course in the control and experimental groups are shown in Table 3.

The results of Table 3 showed that there is a significant difference in achievement between

Table 3: The results of ANCOVA of the effect of flipped classroom on attitude towards NOS

Model	The dependent variables	Type III Sum of Squares	Df	Mean of squares	F	Sig.	Eta
Group	attitude towards NOS	886.83	21	42.23	1.75	0.07	0.51
Error	attitude towards NOS	845.65	35	24.16			
Total	attitude towards NOS	319996.0	58				

Table 4: The results of ANCOVA of the effect of flipped classroom on the achievement in Biology course

Model	The dependent variables	Type III Sum of Squares	Df	Mean of squares	F	Sig.	Eta
Group	Achievement in Biology	24.45	1	24.45	5.34	0.02	0.11
Error	Achievement in Biology	192.06	42	4.57			
Total	Achievement in Biology	13242.62	45				

experimental group and control group ($P=0.02$, $f. 5.34$). Therefore, the research's hypothesis based on the positive effect of flipped classroom on the achievement in Biology course is being confirmed.

Discussion

The aim of the current paper was to investigate the effect of the flipped classroom method on the NOS and achievement of the tenth grade students in Biology. Results indicated that flipped classroom has not been able to affect the aspects of NOS including observation and inference, change in scientific theories, change in scientific rules (for) theories, social and cultural impact on science, imagination and creativity in scientific investigations and scientific research methodology. The results of this research are in line with the findings of Leader man (2007), Kang et al. (2005), Dagan & Abd-El-Khalick (2007), Bektas & Geban (2010), Fathiazar (1998), Saeedi et al. (2011), and Liaghat et al. (2011) (2, 7, 11-17).

On specifying these results, it can be said that different factors can be effective on students' perception towards NOS, which one of them are educators. If the purpose of education is to train students with scientific literacy and high perception from the NOS, so first of all it is necessary to develop these features in the teachers. Forming and development of adequate perception of NOS is one of the significant and prominent goals of science education in high schools. Science educators also need to correct perception of the NOS. One of the responsibilities of teachers is to transfer correct perception of NOS to students. Such a scientific perception in science educators is important in this regard that it affects teaching method and presentation manner of scientific content. Mentality of educator about NOS, consciously or unconsciously, will have effect on his teaching and also in inspiration of his viewpoint to students (17). Another factor that can affect the inadequate understanding of NOS, is the condition of textbooks. It should be mentioned that,

unfortunately many researches indicate that the curriculum element especially content in regard to components of NOS are in undesirable situation. Considering the aim of education is developing scientific literacy and enhancing perception of the NOS in students, components of NOS should be taken into account in designing and developing the curriculum and be used in quadrant elements of curriculum; because one of the most important and major resources of education for students are textbooks (content). Gallager has noticed in his findings that the science courses are more looking for the terminology of knowledge in science than NOS. Henry et al. stated that there is a little connection between the content of scientific books and NOS. The content of these books represent the science as an invariable fact (46). The factors that have caused the inverted method to affect the understanding of the NOS was the lack of the number of training sessions in the flipped method. Since with twelve training sessions, students cannot be expected to gain complete understanding of NOS.

In explaining this research finding, it can be said that in flipped classrooms students can have group activity in the classroom to solve problems and collaborate in learning. Also the flipped classrooms increase the interaction between the students and teachers and students participate in classroom activities. The student is responsible for his own learning and the motivation of the student and teacher is high.

Another factor affecting this finding is that there is emphasis on more interaction between students-students and students-teacher, flexibility and adaption with learner's condition, enhancement of the motivation in students, and paying attention to individual differences in flipped classrooms. Moreover, teachers create an attractive learning environment by integrating the technology in their teaching method. Students use technology for learning.

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Authors' contributions

This paper is from the Ph.D. thesis and the name of the supervisor and counselors is also mentioned

Ethical Considerations

The proposal, the questionnaire, and the participant consent form were sent to the Research Committee of the Department of Education. All participants were fully aware of the nature and confidentiality of the study and were told in advance that the information provided by them would be kept confidential.

Conflict of Interest

None declared.

References

- 1 MehrMohammadi M. Reflection of the Teaching Process - Learning and Teaching, First Printing. Tehran: School Publications. 2000.Persian.
- 2 Chun DM, Plass JL. Networked multimedia environments for second language acquisition. Warschauer M, Kern R, editors. Network-based Language Teaching 2009.Cambridge University Press; 15170-<http://dx.doi.org/10.1017/cbo9781139524735>.
- 3 Fathiazar E. A Survey on Understanding the Nature of Science in Learners, Academicians, Students and Academicians of East Azarbaijan. Tabriz: Research Institute of Education of the Directorate General of Education and Training.1998. Persian.
- 4 .Karimi M. H, Mazidi, M. Mehrmohammadi, M. The first science of science is a guide to the philosophy of science. Journal of Social Sciences and Human Sciences University of Shiraz.2007 52(3). Persian.
- 5 Holbrook J, Rannikmae M. The Nature of Science Education for Enhancing Scientific Literacy. International Journal of Science Education. Informa UK Limited; 2007 Sep 3; 29(11):1347–62. Available from: <http://dx.doi.org/10.1080/09500690601007549>.
- 6 SadrEshrafi M. Application of Science Education Standards for Iran. Journal of Technology and Education, 2007; 1(4).236-217.Persian.
- 7 Lederman NG. Students and teachers conceptions of the nature of science: A review of the research. Journal of Research in Science Teaching, z 1992.29(4), 331-359. <https://doi.org/10.1002/tea.3660290404>
- 8 Lederman NG, Lederman JS. Research on Teaching and Learning of Nature of Science. Handbook of Research on Science Education, Volume II [Internet]. Routledge, <http://dx.doi.org/10.4324/9780203097267.ch30>
- 9 Lederman NG. Syntax of Nature of Science within Inquiry and Science Instruction. Science & Technology Education Library [Internet]. Springer Netherlands; 301–17. Available from: http://dx.doi.org/10.1007/1-4020-2672-2_14
- 10 Mola S. Examination of the experience of high school science teachers from the nature of science and how it reflects in textbooks. Tabriz University, Faculty of Psychology and Education.2010. Persian
- 11 Schwartz R, Lederman N. What Scientists Say: Scientists' views of nature of science and relation to science context. International Journal of Science Education [Internet]. Informa UK Limited; 2008. 18; 30(6):727–71. <http://dx.doi.org/10.1080/09500690701225801>
- 12 Laugksch R. C. Scientific literacy: A conceptual overview. Science education. 84:(1), 71-94.2000.[https://doi.org/10.1002/\(sici\)1098-237x\(200001\)84:1<71::aid-sce6>3.0.co;2-c](https://doi.org/10.1002/(sici)1098-237x(200001)84:1<71::aid-sce6>3.0.co;2-c).
- 13 Kang S. Scharmann, L. C, Noh, T. Examining students' views on the nature of science: Results from Korean 6th, 8th, and 10th graders. Science Education.2005;89(2), 314–334 <https://doi.org/10.1002/sce.20053>
- 14 Abd-El-Khalick F, Dogan N. Turkish

- grade 10 students and science teachers' conceptions of nature of science: a national study. *Journal of Research in Science Teaching*. 2007;45 (10), 1083–1112. <https://doi.org/10.1002/tea.20243>
- 15 Bektas O, Geban O. Turkish high school students' conceptions of the nature of science. *Procedia - Social and Behavioral Sciences*. Elsevier BV; 2010; 2(2):1982–6. [dx.doi.org/10.1016/j.sbspro.2010.03.268](https://doi.org/10.1016/j.sbspro.2010.03.268)
 - 16 Saeedi M, Ardestani T, Rahmani S. Some false beliefs about the nature of science in the Guidebook. Union of Scientific Societies of Teachers of Physics of Iran, Parsi Teacher of Physics magazine. 2011. Persian.
 - 17 Liaqat S, Niknam Z. Analysis of content of educational texts of guidance courses based on the nature of science: the case of third-grade empirical science textbooks. Abstract articles of the International Conference on Science and Technology with an emphasis on the Islamic world. 2011. Persian.
 - 18 Ibrahim B, Buffler A, Lubben F. Profiles of Freshman Physics Students' Views on the Nature of Science. *Journal of Research in Science Teaching*, 2009. 46(3), 248-264 <https://doi.org/10.1002/tea.20219>.
 - 19 Tao P. Eliciting and developing junior secondary students understanding of the nature of science through a peer collaboration instruction in science stories. *Journal of science education*. 2003;25 (2), 147-171. <https://doi.org/10.1080/09500690210126748>
 - 20 Yousefi A, Yousefi R. Teaching science and the changing world (goals, benchmarks and perspectives), The first national education conference in Iran 1404, Tehran, Research Institute of Science, Technology and Industry. 2011. Persian.
 - 21 Liu OL, Lee H-S, Linn MC. Multifaceted Assessment of Inquiry-Based Science Learning. *Educational Assessment*. Informa UK Limited; 2010 .28;15(2):69–86. <http://dx.doi.org/10.1080/10627197.2010.491067>.
 - 22 Mohammad Esmail.A. National reports on the internal and external outcomes of science and mathematics education. In the 2003 TIMS (two separate reports), the Education Research Institute of the Ministry of Education. 2005. Persian.
 - 23 Khayamanesh A, Charity M. The trend of changes in inputs and outcomes of science education based on the findings of TIMSS-R and. TIMSS Tehran: Research Institute of Education. 2002. Persian.
 - 24 Rahiminejad A. A report on the study of the mathematical and population science practice of 1 Iranian student in the fourth grade of the primary school in the 2003 TIMS and its comparison with the 1999 Education Ministry Education Ministry. 2005. Persian.
 - 25 The National Center for International Studies of Themes and Pearls. Brief Report of the Most Important Findings of the TIMSS, Tehran: Research Institute of Education, Ministry of Education. (1995, 1999, 2003, 2007, 2011, 2015). Persian.
 - 26 LashkarBlokhi, G. R. Iranian Student Persia's in the Mirror of Thais 2011. *Growth in Educational guidance*. 2013: Volume 18. Number 8. Persian.
 - 27 Gholami M. Introduction on constructivism theory in learning and its application in education. Third International Conference on Psychology. Educational Sciences and Lifestyle. TorbateHeydariyeh. University of TorbateHeydariyeh 2016. Persian.
 - 28 Mehrmohammadi M, Mahmoodi F. Upside downness: A New Approach to Curriculum Design in Professional Fields (with emphasis on Education). *Journal of Higher Education Curriculum Studies*. 2013; 3(6):141-177. Persian.
 - 29 Najafzadeh A. Comparison of the Effect of a Flipped Classroom Method with the Traditional Method on the Level of Academic Achievement and Learning Level of the 9th Grade Student in Tabriz. University of Tabriz. Faculty of Psychology and Education, Master's Thesis. 2017. Persian.

- 30 Ng W. Technology Integration and the Flipped Classroom. *New Digital Technology in Education*. Springer International Publishing; 2015; 149–69. http://dx.doi.org/10.1007/978-3-319-05822-1_7
- 31 Butt A. Student Views on the Use of Lecture Time and their Experience with a Flipped Classroom Approach. *SSRN Electronic Journal* [Internet]. Elsevier BV; 2012. <http://dx.doi.org/10.2139/ssrn.2195398>.
- 32 Toto R, Hein Nguyen. Flipping the Work Design in an industrial engineering course. 2009 39th IEEE Frontiers in Education Conference. IEEE; 2009. <http://dx.doi.org/10.1109/fie.2009.5350529>.
- 33 Maher ML, Latulipe C, Lipford H, Rorrer A. Flipped Classroom Strategies for CS Education. *Proceedings of the 46th ACM Technical Symposium on Computer Science Education - SIGCSE '15*. ACM Press; 2015; <http://dx.doi.org/10.1145/2676723.2677252>.
- 34 Gehringer EF, Peddycord BW. The inverted-lecture model. *Proceeding of the 44th ACM technical symposium on Computer science education - SIGCSE '13*. ACM Press; 2013 <http://dx.doi.org/10.1145/2445196.2445343>.
- 35 Gariou-Papalexioiu A, Papadakis S, Manousou E (Gelly), Georgiadu I. Implementing A Flipped Classroom: A Case Study of Biology Teaching in A Greek High School. *Turkish Online Journal of Distance Education* [Internet]. Turkish Online Journal of Distance Education; 2017 Jul 1; 47–47. <http://dx.doi.org/10.17718/tojde.328932>
- 36 Capone R, De Caterina P, Mazza GAG. Blended learning, flipped classroom and virtual environment: challenges and opportunities for the 21st century students. *Edulearn17 Proceedings .IATED*; 2017; <http://dx.doi.org/10.21125/edulearn.2017.0985>.
- 37 Herreid C, Schiller N, Herreid K, Wright C. Case Study: A Chat with the Survey Monkey: Case Studies and the Flipped Classroom. *Journal of College Science Teaching* [Internet]. National Science Teachers Association (NSTA); 2014; 044(01). http://dx.doi.org/10.2505/4/jcst14_044_01_75.
- 38 Zhang H, Wang X. Design and Research on the Application of Flipped Classroom in Business English Teaching in Higher Vocational Education. *DEStech Transactions on Social Science, Education and Human Science* [Internet]. DEStech Publications; 2017 Oct 10;(eemt): <http://dx.doi.org/10.12783/dtssehs/eemt2017/14528>
- 39 Mohanty A, Parida D. Exploring the Efficacy & Suitability of Flipped Classroom Instruction at School Level in India: A Pilot Study. *Creative Education* [Internet]. Scientific Research Publishing, Inc.; 2016;07(05):768–76. <http://dx.doi.org/10.4236/ce.2016.75079>.
- 40 Nwosisi C, Ferreira A, Rosenberg W, Walsh K, I. A Study of the Flipped Classroom and Its Effectiveness in Flipping Thirty Percent of the Course Content. *International Journal of Information and Education Technology .EJournal Publishing*; 2016;6(5):348–51. <http://dx.doi.org/10.7763/ijiet.2016.v6.712>.
- 41 Guy R, Marquis G. Flipped Classroom: A Comparison of Student Performance Using Instructional Videos and Podcasts versus the Lecture-Based Model Of Instruction. *Proceedings of the 2016 InSITE Conference*. Informing Science Institute; 2016; <http://dx.doi.org/10.28945/3458>.
- 42 Tanner M, Scott E. A Flipped Classroom Approach to Teaching Systems Analysis, Design and Implementation to Second Year Information Systems University Students. *Proceedings of the 2015 in SITE Conference*. Informing Science Institute; 2015; dx.doi.org/10.28945/2117.
- 43 Strayer JF. How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*. Springer Nature;

- 2012; 15(2):171–93. [dx.doi.org/10.1007/s10984-012-9108-4](https://doi.org/10.1007/s10984-012-9108-4).
- 44 .Gal, M. Borg, W. Gall , J. Quantitative and qualitative research methods in education and psychology, A group of authors (translators).2008. Persian.
- 45 Liang, L.L., Chen, S., Chen, X. et al. An international collaborative study nature of science nature of scientific knowledge development pre-service science teacher education. *Int J of Sci and Math Educ* (2009) 7: 987. <https://doi.org/10.1007/s10763-008-9140-0>
- 46 Gallagher J.J. Prospective and Practicing Secondary School Science Teachers Knowledge and Beliefs about the Philosophy of Science. *Science Education*.1991; 75, 121-133.<https://doi.org/10.1002/sce.3730750111>