Impact of Flipped Classroom in teaching Computer Graphics

Dr. M. Anita Indu
Head of the Department,
Department of Computer Applications,
Shri Shankarlal Sundarbai Shasun Jain College for women,
T.Nagar, Chennai.
ORCID ID: https://orcid.org/0000-0001-8141-4157

Abstract

Due to increase in pressure to undergo transformation, the higher education is now stepping towards flipped classroom technology. Research shows that emergence of flipped classroom has linked the pedagogy and educational outcomes, thereby identifying the gaps in the literature which could modify the future design and evaluation.

The current study introduced the flipped classroom concept in the Computer Graphics course in Arts and Science Colleges. In this course, visualization is essential for better understanding the concept of 2D and 3D objects with their projection. Thus flipped classroom was introduced and the performance of students was observed. Pre test and Post test was done in the control and treatment group. The result showed a significant increase in the performance in the treatment group. The perception of the students who used the flipped classroom was recorded through the questionnaire. The results demonstrated that usage of flipped classroom in Computer Graphics course enhanced the student learning in an interesting way.

Keywords: *Pedagogy, Teaching Methods, Bloom's Taxonomy, Flipped Classroom, Computer Graphics, Visualization.*

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1. INTRODUCTION

Flipped classroom is a pedagogical approach focused on student engagement, in which the faculty guides the students as they apply concepts and engage creatively in the subject matter. The traditional learning is reversed by the flipped classroom, which is an instructional strategy and a type of blended learning, that is used to deliver instructional content (online) outside of the classroom. It is one such learning strategy that creates learning through online video content created by the faculty or taken from any media, which helps reduce lecture time and increase the time for in-class activities. This will help the learners to learn cooperatively through practice (DeLozier & Rhodes, 2017; Jovanovi.C, Gasevi .C, Dawson S., Pardo A., & Mirriahi N.,2017). Technology can support flipped classrooms by letting students to exposure to new material outside of class, usually via lecture videos and then using class time to do the harder work of assimilating that knowledge, perhaps through problem solving, group discussion, or debates. The growing accessibility and sophistication of educational technologies opens up increasing possibilities for students to explore, share, and create content (Bergmann & Sams, 2012).

The four pillars of flipped classroom(FLIP) are

1. Flexible Environment : The learning environment is created among students so that they are flexible enough to choose when and where they learn.

2. Learning Culture: In the student-centered approach, the flipped learning model helps in-class time in exploring topics to greater

depth and creating rich learning opportunities. Thus the students can actively involve in knowledge construction.

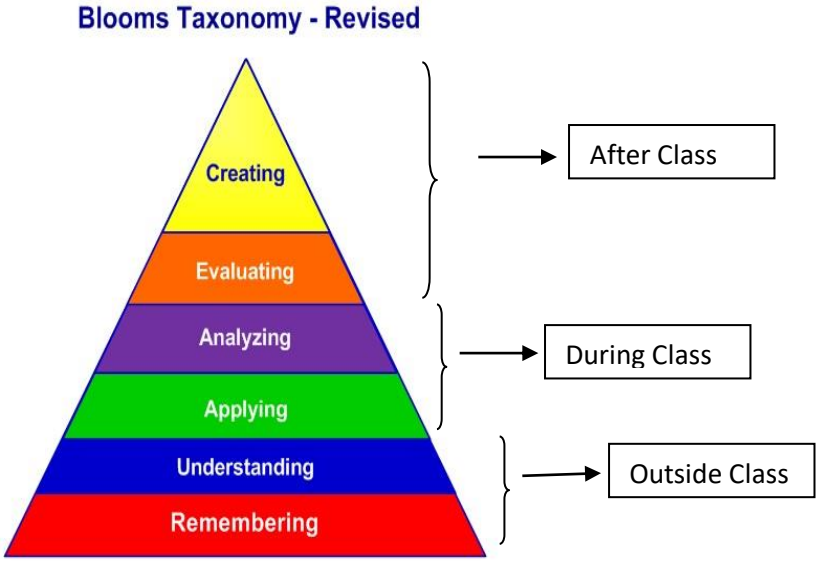
3. Intentional Content : To maximize classroom time in order to adopt methods of student-centered, active learning strategies, depending on grade level and subject matter, Intentional Content were used by the educators.

4. Professional Educator : Professional Educators create their own video with the help of video recording softwares, which are now available in open source, and connect with each other to improve their instruction. The Professional Educators remain the essential ingredient during in-class activity among the students.

2. FITTING OF FLIPPED CLASSROOM IN REVISED BLOOMS TAXONOMY

Bloom's Taxonomy by educational psychologist Dr. Benjamin Bloom in 1956, was created in order to promote higher forms of thinking in education. This taxonomy aims at analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts.

In traditional learning, remembering and understanding (lower level of learning – Revised Blooms Taxonomy) is happening in class, while students are usually left to work on activities that involve higher level of learning outside the classroom. In the flipped classroom model, learning is flipped. Students are made to finish the lower level of cognitive work before class. When they come to class, they are engaged with higher cognitive levels of learning with peers and faculty in their class.



3. IMPLEMENTATION OF FLIPPED CLASSROOM

According to Jeff Dunn (2014), the six easy steps for implementing flipped classroom are Plan, Record, Share, Change, Group, Regroup.

1. Plan : Plan your lesson which you want to use in flipped classroom

2. Record : Use open source video recording softwares like Screen O Cast, OBS, ShareX to record your content. The video must not be more than 10 mins. Then only it will be easy for the students to listen and understand the concept.

3. Share : Send the video to the students before the session. They must watch the video before they come to class.

4. Change : The students now know the content before they come to class.

5. Group : An effective way to discuss the topic is to separate into groups where students are given a task to perform.

6. Regroup : Share the group work with everyone and ask questions to know in depth about the topic.

After these six steps, Review, Revise, and Repeat should be done.

Some strategies that can be used during in-class activities are:

- Active learning. Allow students to apply concepts in class where they can ask peers or instructors for feedback and clarification.
- Peer instruction. Students can teach each other by explaining concepts or working on small problems.
- Collaborative learning. Collaborative learning activities could increase student engagement, enhance student understanding, and promote collective intelligence.
- Problem-based learning. Class time can be spent working on problems that can last for the duration of a semester.
- Discussions or debate. Give students the opportunity to articulate their thoughts on the spot and to develop their arguments in support of their opinions or claims.

4. OBJECTIVE OF THE STUDY

Computer Graphics is a very active field with new knowledge being updated each and every time. There will be a pressure to regularly review our teaching contents and adjust accordingly. Among the students, Computer Graphics is an exciting course with new animation techniques, Geometric Modeling, Clipping and Visualization in 2D and 3D form and Projections. The students find it difficult when the subject is taught in a traditional way.

The aim of this study is to apply an innovative pedagogy, called a flipped classroom, to conduct a learner-centered learning environment in a computer graphics course. An experiment was conducted on a computer graphics course in an arts and science college under University of Madras to investigate the effectiveness of the proposed approach.

5. THEORETICAL BACKGROUND

According to Thomas Suselo(2017), teaching computer graphics can be challenging due to the requirement of a diverse range of skills such as mathematics, physics, programming, spatial reasoning, problem solving, and art and design. This issue was addressed by conducting a systematic literature review identifying reported challenges, methodologies, and approaches for teaching computer graphics. The issues listed are : Insufficient knowledge of mathematics (Glvez et al., 2008; Hui et al., 2012; Zhou et al., 2010) and basic programming (Lowther et al., 2000; Papagiannakis et al., 2014), Difficulties in understanding transformations, projections and 3D geometric modelling (Elyan. 2012), Difficulties in solving logical problems (Hitchner and Sowizral, 2000; Talton and Fitzpatrick, 2007) and making the connection between theory, programming, application and the visual effects (Stephenson and Taube-Schock. 2009). Students have become passive learners and don't interact much with peers and teaching staff (Peternier et al., 2010, Marti et al. 2006).

To change the traditional learning patterns and teacher-centered learning modes, the concept of the flipped classroom originated with Bergmann and Sams in 2007 (Bergmann & Sams, 2012). The flipped classroom is a learner-centered pedagogy that reverses the in-class and out-of-class learning activities in traditional classrooms (Chen, Wang, Kinshuk, & Chen, 2014). In the flipped classroom, the in-class lecture is transformed to before-class learning through videos or other forms of media to free up more in-class time for opportunities to discuss the issues, practice, or apply knowledge (Bergmann & Sams, 2014). Therefore, the flipped classroom can increase the interaction between teachers and students in class, give teachers the opportunity to address the problems of individual students, and enable students to have more successful experiences in knowledge application (Lin & Hwang, 2018b). To date, the flipped classroom has been applied to various educational degrees and courses (Slomanson, 2014; Teo, Tan, Yan, Teo, & Yeo, 2014).

6. NEED OF THE STUDY

The main aim of this study is to apply the flipped-classroom pedagogy to conduct a learner-centered learning environment in a computer graphics course. This study developed a smart learning diagnosis system to support the flipped classroom to assist students in learning and diagnosing the concepts of computer graphics and assist instructors in managing the students' learning status.

To evaluate the effectiveness of the proposed approach, an experiment was conducted on a computer graphics course to investigate the following research questions.

(1) Do the students who learn computer graphics with the flipped classroom learning and diagnosis approach show better learning achievement than those who learn with the traditional-classroom learning approach?

(2) Do the students show better problem solving ability when they learn using flipped classroom method?

(3) What are the students' perceptions of the proposed system in terms of perceived usefulness?

7. SMART FLIPPED MANAGEMENT SYSTEM(SFMS)

In this study, a smart flipped management system was developed to assist instructors and students in conducting learning and diagnostic activities in the learning mode. The instructor had used Google Classroom(LMS) to add the instructor and the students for computer graphics course. The videos required for the flipped classroom were uploaded in the Google Classroom.

The flipped classroom which reverses the in-class and out-of-class learning activities was introduced in SFMS.

Out class Activity : The instructor would load the video and tell the students to go through it before coming to the class.

In Class Activity : During the class, the instructor will conduct some activities based on the topic like think-pair-share, think-aloud pair problem solving, fish bowl discussion and so on. This will help students to clarify their doubts and to gain more knowledge on the subject. In this Learner-centric method, the students share their knowledge and clear their doubts with their peers.

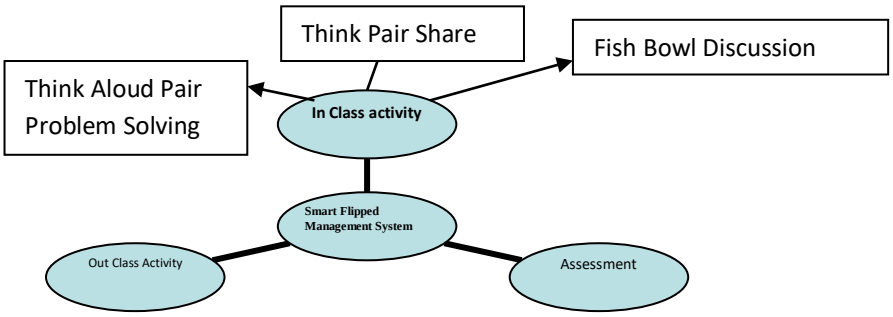


Fig : **Smart Flipped Management System**

1) Think-Pair-Share

- Take a central concept presented in the out-of-class material, or a particularly controversial quiz question from a prior assessment, and have students reflect on it individually and then discuss it further.
- Think phase: students work independently and flesh out their thoughts/arguments and may write their thoughts down.
- Pair phase: students discuss their response with a partner.
- Share phase: the instructor elicits responses from all members of the class and begins to engage students in a wider

discussion demonstrating the many different perspectives.

2) Think-aloud pair problem solving

- Present students with a set of complex problems that require multiple steps to solve.
- Pair up students and ask one student to be the problem solver, who explains their thought process in developing a solution based on what was learned out of class.
- The partners listen to this process and offer suggestions if there are difficulties, or expresses confusion should there be parts that are difficult to understand.
- After the first problem has been solved, ask the students to switch roles and begin again.

3) Fishbowl discussion

- A small group of students sit in a circle and engage in a peer-mediated discussion (with instructor intervention if necessary).
- Remaining students sit in a larger circle and watch the discussion, taking notes and critiquing the content and logic of the discussion.
- The outer circle can then discuss the interaction that occurred and provide additional insight into the topic and provide constructive feedback.

7. RESEARCH INSTRUMENTS

To evaluate the effect of the proposed approach on student learning performance, various data sources were analyzed, including a prior knowledge test, a learning achievement test and questionnaire results. The prior knowledge test was designed to assess the students' knowledge level with regard to computer graphics before participating in the course. The learning achievement test was designed to evaluate the students' learning results after the conclusion of the course. In this study, these two tests included 10 multiple-choice test items, and the maximum score of the tests was 100 points. Moreover, one questionnaire was designed to capture the perceptions of the treatment group with regard to the usefulness of the proposed system.

In this study, the treatment group consists of 20 students. Pre test was conducted with the multiple choice questions. The data was collected with the help of questionnaire to capture the perceptions of the students in this group with regard to the usefulness of the proposed system. The Post test was an assessment, which is done through the Google Form.

8. EXPERIMENTAL PROCEDURE

Students in the treatment group and control group were asked to take pretest before undergoing the computer graphics course. This is used to capture the initial learning motivation, learning attitude, and problem solving ability of the two groups.

The control group students were taught computer graphics in traditional way with chalk and board strategy. With regard to the treatment group, the students were asked to engage in the flipped classroom. Out of class, the students were asked to engage in self-learning to learn the theoretical concepts of computer graphics by watching the video clips sent by the instructor through the Google Classroom. The students can watch the video any time and as many times they want. Moreover, the students made specific diagnosis assessments to evaluate their level of understanding through the proposed system. In class, the instructor facilitated the students' engagement with the activities.

After going through all of the learning activities, all the students from the two groups were given post test. The post test was 20 multiple choice question to know the knowledge level of the students about the topics: animation techniques, Geometric Modeling, Clipping and Visualization in 2D and 3D form and Projections.

9. RESULTS

The statistical software was used to analyze the performance of the students in the experiment, including the results of the prior knowledge test, learning achievement test and usefulness of the proposed system questionnaire.

a) Analyses of prior knowledge and learning achievement

To measure the students' prior knowledge and learning achievement, two tests were conducted before and after the software engineering learning activities. With regard to the prior knowledge test(pre-test), the mean value and standard deviation of the test scores were 4.4 and 2.83 for the control group and 5 and 2.26 for the experimental group. The test scores for the post-test were 5.8 and 3.614 for the control group and 16.2 and 2.66 for the experimental group.

Table : Mean and Standard Deviation for the students' learning achievement(Pre –Test).

Group	Number of Students	Mean	S.D.*
Control Group	10	4.4	2.83
Experimental Group	10	5	2.26

* SD = Standard Deviation

Table : Mean and Standard Deviation for the students' learning achievement(Post –Test).

Group	Number of Students	Mean	S.D.
Control Group	10	5.8	3.61
Experimental Group	10	16.2	2.66

To investigate the effectiveness of the proposed approach for improving the learning achievement of the students in the computer graphics course, t –Test was done to exclude the difference between the prior knowledge of the two groups.

Table : t-Test: Paired Two Sample for Means

	Control	*Treatment*
Mean	1.4	5.9
Variance	4.266666667	4.544444444
Observations	10	10
Pearson Correlation	0.16149263	
Hypothesized Mean Difference	0	
Df	9	
t Stat	-5.235075457	
P(T<=t) one-tail	0.000269139	
t Critical one-tail	1.833112923	
P(T<=t) two-tail	0.000538278	
t Critical two-tail	2.262157158	

There was a statistically significant difference between the adjusted means (p = 0.0002 < 0.05). This shows that the learning achievement of the experimental group was significantly higher than that of the control group. The result reveals that computer graphics course with the proposed system benefits students more than the traditional classroom in terms of learning achievement.

b) Analysis of perception of students using flipped Classroom

The researcher used a 4-point Likert-type scale (i.e. Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1) to rate the perception of the students towards the usage of flipped classroom in computer graphics course. The above table shows that the perception of the students was high towards the usage of flipped classroom. The graphical representation of perception among the students were shown below:

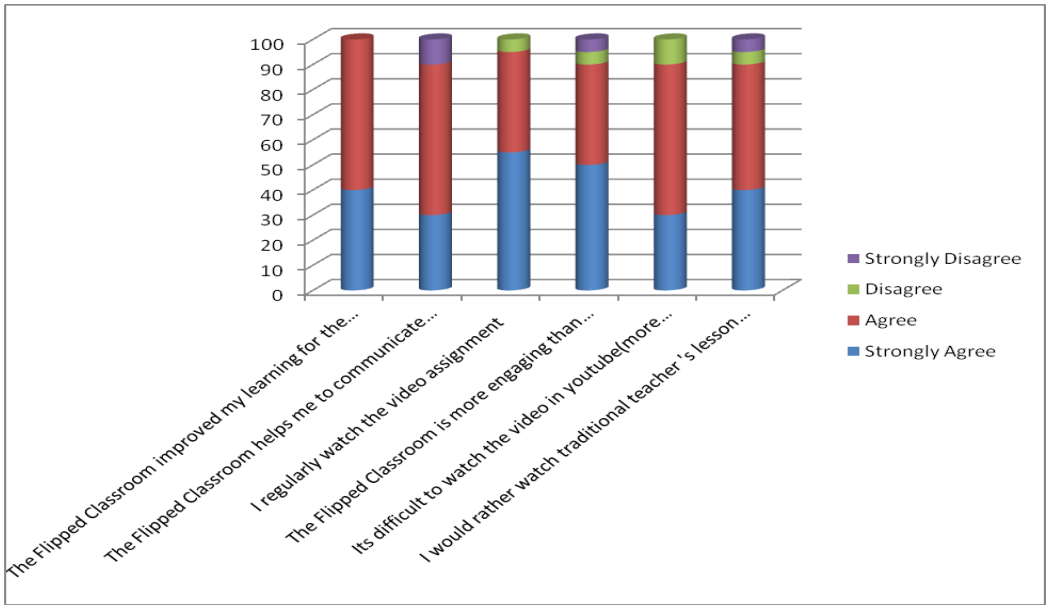


Figure : Perception of the students towards flipped classroom

10.CONCLUSION

This study proposed the flipped classroom through Smart Flipped Management System(SFMS) to support the computer graphics course in the higher education. An experimental study was done to evaluate the effectiveness of the proposed study. The result revealed that computer graphics course with the proposed system benefitted the students more than the traditional classroom in terms of learning achievement. The perception of the students in experimental group was also high towards the usage of flipped classroom in computer graphics.

REFERENCES

1. Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Eugene, Or: International Society for Technology in Education.
2. Bergmann, J., & Sams, A. (2014). *Flipped Learning: Gateway to student engagement*. Washington, DC: International Society for Technology in Education.
3. Chen, F., Lui, A. M., & Martinelli, S. M. (2017). A systematic review of the effectiveness of flipped classrooms in medical education. *Medical Education, 51*(6), 585–597. https://doi.org/10.1111/medu.13272
4. DeLozier, S.J., Rhodes, M.G.(2017), Flipped Classrooms: a Review of Key Ideas and Recommendations for Practice. *Educ Psychol Rev* 29, 141–151 (2017). https://doi.org/10.1007/s10648-015-9356-9.
5. Dennis G.Balreira,MarceloWalter,Dieter W.Fellner ,"A survey of the contents in introductory Computer Graphics courses", Computers & Graphics, Volume 77, December 2018, Pages 88-96
6. Dunn, J. (2014). The 6-step guide to flipping your classroom. Retrieved from http://dailygenius.com/flipped.
7. Elyan, E. (2012). Enhanced interactivity and engagement: Learning by doing to simplify mathematical concepts in computer graphics and animation. Proceedings of the 2012 IEEE Global Engineering Education Conference (EDUCON), 1-8. doi:10.1109/EDUCON.2012.6201073
8. Glvez, A., Iglesias, A., & Corcuera, P. (2008). An introductory computer graphics course in the context of the European space of higher education: A curricular approach. International Conference on Computational

Science, 5102, 715-724. doi:10.1007/978-3-540-69387-1_83.

9. Hitchner, L. E., & Sowizral, H. A. (2000). Adapting computer graphics curricula to changes in graphics. Computers & Graphics, 24(2). doi:10.1016/S0097-8493(99)00162-4.
10. Hui, P., Shanmei, L., Xiu, J., & Ruifang, Z (2012). Ability-oriented teaching reform for computer graphics. 7th International Conference on Computer Science & Education, 1908-1911.
11. Jeff Dunn(2014). The 6-step guide to flipping your classroom. Retrieved from https://medium.com/@jdunns4/the-6-step-guide-to-flipping-your-classroom-d721878f85c1.
12. Jovanovi, C., Gasevi, C., Dawson, S., Pardo, A., & Mirriahi, N. (2017). Learning analytics to unveil learning strategies in aflipped classroom.The Internet and Higher Education, 33,74-85.https://doi.org/10.1016/j.iheduc.2017.02.001.
13. Lin, H. C., & Hwang, G. J. (2018a). Research trends of flipped classroom studies for medical courses: A review of journal publications from 2008 to 2017 based on the technology-enhanced learning model. Interactive Learning Environments.
14. Lowther, J. L., & Shene, C. (2000). Rendering + modeling + animation + postprocessing = computer graphics. Journal of Computing Sciences in Colleges, 16(1), 20-28.
15. Marti, E., Gil, D., & Julia, C. (2006). A PBL experience in the teaching of computer graphics. Computer Graphics Forum, 1(25). doi:10.1111/j.1467-8659.2006.00920.x
16. Papagiannakis, G., Papanikolaou, P., Greassidou, E., & Trahanias, P. (2014). glGA: An OpenGL geometric application framework for a modern, shader-based computer graphics curriculum. Eurographics - Education Papers. doi:10.2312/eged.20141026.
17. Peternier, A., Thalmann, D., & Vexo, F. (2006). Mental vision: A computer graphics teaching platform. International Conference on Technologies for E-Learning and Digital Entertainment, 3942, 223-232.
18. Stephenson, B., & Taube-Schock, C. (2009). QuickDraw: Bringing graphics into first year. SIGCSE Bull., 1(1). doi:10.1145/1539024.1508946.
19. Suselo, Thomas, et.al(2017),"The Journey to Improve Teaching Computer Graphics: A Systematic Review", Available at https://www.researchgate.net/publication/326147819.
20. Talton, J. O. & Fitzpatrick, D. (2007). Teaching graphics with the OpenGL shading language. SIGCSE Bull., 39(1). doi:10.1145/1227504.1227402.
21. Thomas Suselo & et. al.(2017). The Journey to Improve Teaching Computer Graphics : A Systematic Review. International Conference on Computers in Education, At New Zealand: Asia-Pacific Society for Computers in Education.
22. Zhou, J., Ye, M., & Huang, C. L. (2010). Reform of computer graphics teaching method. International Forum on Information Technology and Applications. doi:10.1109/IFITA.2010.192.
23. A.M. Barani, R.Latha, R.Manikandan, "Implementation of Artificial Fish Swarm Optimization for Cardiovascular Heart Disease" International Journal of Recent Technology and Engineering (IJRTE), Vol. 08, No. 4S5, 134-136, 2019.
24. Manikandan, R., Latha, R., & Ambethraj, C. (1). An Analysis of Map Matching Algorithm for Recent Intelligent Transport System. Asian Journal of Applied Sciences, 5(1). Retrieved from https://www.ajouronline.com/index.php/AJAS/article/view/4642