Utilizing the Flipped Classroom Approach for the Teaching of Science at Elementary Level: An Experimental Study

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Abstract

This experimental study focused on investigating the effects of flipped classroom on student's science achievement at elementary school level in Pakistan. Quasi experimental research design was selected. Two sections of 8th grade students were chosen as experimental and control groups that comprised 60 students in total. They were taught in the flipped classroom and the traditional classroom respectively. Self-constructed Pre- and Post-test was used to collect data. t-test was applied keeping the nature of data in mind. Independent sample t-test showed that the difference was highly significant between the mean scores of experimental and control group after the experiment (p=0.00). Paired sample t-test showed that there was highly significant difference in the mean score of pre- and post-test of the experimental group (p=0.00). The effect size value (0.93), calculated through Pearson's correlation coefficient r, indicated a very large effect. Findings of this research will help to improve the situation of use of ICT for teaching and learning in Pakistan.

Keywords: Flipped classroom; Videos; e-book; Science achievement

Introduction

In the era of technology and web-based instruction, education sector has experienced a paradigm shift that has recently taken place (Lehtinen, 2002). It introduces a beginning of a new well-developed model known as the flipped classroom. It actually inverted and flipped the traditional classroom-homework paradigm(Bergmann & Sams, 2012).Transferring the lecture outside the classroom and taking homework inside the class via technology and learning activities are the basic steps in flipped classroom (Strayer, 2007).Main thought behind this transformation is to utilize the class time in application of the concepts under study, for getting better understanding instead of just delivering lecture. Instructional videos are the main tool that students watch at home while in class time there is more discussion and question answer

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sessions(Schwartz, 2015).Students are involved in different learning activities in groups (Schwartz, 2015).

Flipped classroom

Flipped classroom is an emerging concept that is implemented in different contexts at different levels. Bergmann and Sams taught chemistry in one of the high schools of Colorado in 2009. The thought behind the implementation of flipped classroom was that students reported difficulty in completing the daily home work. The teachers also reported that they find difficulty in revising the content for absent students in the next class. It was just the waste of time for them. In such a situation technology was utilized as a useful instructional material. Results were positive in a sense that it gave an opportunity to students, who missed their classes, to watch the lecture again(Bergmann & Sams, 2009).

Flipped classroom is widely used at higher education level now (Ruffini, 2014).The opinions about the flipped environment can vary. Some take it simply as another way of implementing student-centered approach and others view it as a cutting-edge approach in the field of education (Honeycutt, 2013). In the flipped classroom the sequence of class work and homework is flipped or switched (Honeycutt & Garrett, 2013). It is considered as a synonym of using educational videos specifically and technology in general for improving learning (Overmyer, 2014). It introduces learning flexibility and blends both the traditional and online world, while focusing on the improvement of instructional contact (Gunyou, 2015).

The concept of Flipped classroom model is now gaining popularity as:

- In 2012, 48% teachers flip one of their lesson, in 2014 the percentage grew up to 78%
- Upto 80 % teachers in 2012, reported positive change in the students learning after working in flipped classroom
- 71% teachers noticed improvement in the students' grades after the implementation of flipped classroom model (Bright, 2015).

Purpose of the research

In the developed or even developing countries the flipped classroom is now widely implemented at all level. The increased utilization of flipped classroom concept in the education sector all over the world has encouraged finding it out in the Pakistani context as well. But it seems alarming that no research has been found about flipped classroom in Pakistan to the best of my knowledge. Keeping the entire situation in mind current study was planned.

The main objectives of the study were to apply the concept of flipped classroom and to find out its effectiveness for the teaching of science at elementary school level. For this purpose an experimental study was planned, in which instructional method was independent variable that includes teaching in a flipped classroom setting. While science achievement of students was the dependent variable that was assessed through pre- and post-science test score.

Research questions

1. Is there any difference in the level of student's science achievement after working in flipped classroom?
2. What is the difference in the level of student's science achievement, taught through flipped classroom and the traditional way?

Literature review

Working in flipped classroom

In flipped classroom the teacher leads from behind(Marshall, 2013). She observes the students, gives guidance, provides timely feedback and assesses them in the classroom (Marshall, 2013). Instructors prepare videos related to specific subject or selected content and then upload those videos online so every student could have access to that video (Schwartz, 2015).Students' task is to watch those videos at home as homework (Schwartz, 2015). Next day, the class time is utilized for conducting discussion on these videos. First ten minutes of the class are fixed for giving lecture about those points that remained un-understandable. Mostly class time is used for dealing with the questions and implementation of the abstract concepts of a subject (Simkins, Maier, &Rhem, 2009).

Students work in groups in flipped classroom. Mostly they work in groups consisting of six or seven members each where they can discuss with each other and use their previous knowledge for understanding new concepts (Restad, 2013) Video watching is an essential element of a flipped classroom but still it is much more than just watching videos. Main goal of flipped classroom is to introduce something new other than the traditional lecture method that is considered to be the only way of delivering information (McEvoy et al., 2016).

Role of ICT in flipped classroom

Incorporation of videos in classroom helps in the comprehension of the concepts, understanding of the material faster and providing equal learning experiences for all the students (Fulton, 2012). Information and communication technology (ICT) facilitates social interaction between students and their peers and among the teachers as well(Koschmann,

2002). ICT creates a better learning environment in all ways that support higher order thinking and helps in developing meta-cognitive skills. It creates an environment that engages students in problem solving activities and provides a large variety of tools that support the learners in solving those tasks(Steinkuehler, Derry, Hmelo-Silver, & Delmarcelle, 2002).Technology is not limited to some specific tools. It has a wide variety. Video watching is an essential part of the flipped classroom but still it is not more important than the student. Focus should be on the learner and then the tools should be used accordingly. Wide variety of different softwares can help the students in fostering their skills that lead to better student performance (Nouri & Shahid, 2005). In the era of technology, teacher not only transmits new knowledge to students but gives students responsibility to search for the knowledge and recognize the value of learning (Lim & Chai, 2008).Incorporation of videos in classroom helps in comprehension of the concepts, understanding of the material faster and providing equal learning experiences for all the students(Fulton, 2012).

Research on flipped classroom model

Flipped classroom has raised its popularity at its highest. It persistently calls for research with its implementation in the field(Berrett, 2012). It demands to focus on finding the effects of flipped classroom on student's achievement (Bishop & Verleger, 2013).Following are some research examples conducted about the implementation of the flipped classroom approach.

A study examined the use of flipped classroom, for enhancing student's engagement that promotes active learning, in Malaysia at university level in 2014. Results showed that students were motivated and they felt encouraged being part of flipped classroom (Jamaludin & Osman, 2014). A survey was conducted by the Center for digital education in 2013, to get an understanding about the adoption of flipped classroom. Results indicated that 75% teachers agreed that a flipped classroom takes more time in preparation phase than the traditional one, and 85% strongly agree that their attitude towards teaching and students attitude towards learning has positively changed after working in flipped classroom. The subjects of Economics and Science were considered most suitable that need flipped classroom model (Bart, 2013).

In University of British Colombia, Louis Deslauriers in 2011 selected 850 science students from undergraduate level. Students were divided in two groups. Results showed that group 1 scored an average 74% and group 2 scored an average 41% (The Economist Newspaper, 2011). Flipped classroom model was introduced for university students for the subject of science in 2014. This concept was introduced for the first time and showed positive results among students. Seventy percent

students reported that in a flipped classroom, group discussions and problem solving activities contributed to their learning. Flipped classroom provided them an opportunity to play an active role instead of the traditional classroom where they just sit passively (Bart, 2013).Flipped classroom was implemented in Singapore at university level. Study was conducted in 2014. Focus was on getting students' views after working in flipped classroom model. Results showed that students approved flipped classroom model because it positively influenced their learning and enhanced achievement level (Linga & Wang, 2014).

Need and ICT situation in Pakistani schools

ICT (Information and Communication Technology) tools assist in enhancing the Pakistani students' academic performance(Aftab, 2012). With the advancement of ICT facilities, the use of computer has also increased. Computer is one of the most famous ICT tools that is extensively used in Pakistan (Aftab, 2012).Pakistan needs serious attention for the integration of ICT into curriculum that will enable us to be vigilant in the educational era. In 2004, Medium Term Development Framework (MTDF) admitted several steps taken by the Pakistani government for introducing ICT in the education system. I.T labs are present in 5000 higher secondary schools. It was planned under MTDF, 2014 that ICT labs will be provided to 600 schools. The government of Pakistan has developed National Information and Communication Technology (NICT) strategy that includes six elements. It focuses on the application or utilization of ICT in the educational process to increase its quality.

Recent initiatives were taken in (2002-2006) the Education Sector Reforms (ESR) and in (2001-2015) the Education for All National Plan of Action (NPA). Ten national professional standards were set in 2009 by the ministry of education and the policy and planning wing for giving proper training to the teachers. One of the most important strands was giving importance to the use of Information and Communication Technology. Government of the Punjab has taken several steps for highlighting the importance of integration of ICT into curriculum. elearn.punjab (2014)program has provided all the textbooks till secondary level on the online website. Both teachers and students can use these books. Some extra information has also been made available in the form of videos. It provided different animations, assessment sheets, simulations audios and videos.

Keeping in view the existing situation regarding the implementation of the flipped classroom all over the world successfully, this intervention study was planned to implement the concept of flipped classroom in

Pakistan. The current situation of ICT in Pakistan also provided some base for designing a study regarding the implementation of the flipped classroom concept at school level.

Methodology

Participants of the study

This experimental study was conducted at one of the public secondary schools for girls. Two sections of grade 8th were selected as a sample for this study. One section was taken as experimental and other was the control group of the study. The number of students in both sections was equal i.e.30 students each, making 60 students in total.

Quasi-experimental research design

This study adopted quasi experimental research design. It is known for non-randomized intervention study that prevents the researcher from creating artificial setting by randomly assigning participants to different groups when dealing with humans (Chen, 2010). Instead of random assignment, matching technique was used. The same pre-test was taken from both groups before the intervention. The pre-test score showed equal level of understanding in both groups as the test scores of both groups were almost same (m=6.07 and 6.23). The research questions of the study called for two groups in which comparison could be made so Non-equivalent control group pre-and post-test design was used.

Instrument of data collection

To assess students' level of science learning,a science test was constructed in consultation with the subject teacher, which was used as pre- and post-test. Pre- and post-test was same; nevertheless, the order of items was changed to reduce the chance of familiarity. It was developed on the concepts that were taught during experiment. It was an objective type test that included both open and close-ended questions. Total marks were 30. It was developed keeping in view the Bloom's taxonomy. Questions were formulated that covered all domains of Bloom's taxonomy like knowledge, comprehension, application, analysis, synthesis and evaluation. The pre- and post-test was formed from two chapters of science. It comprised different topics like introduction to science and different scientists, different periods of science, photosynthesis and respiration, allotropic forms of carbon: diamond and graphite, uses of science in daily life, scientific developments in today's world, density of water and ice, water as universal solvent, uses of different gases, the ozone and UV (Ultra-violet) rays, carbon dioxide and it's uses etc. Then it was validated from different experts and changes were made accordingly.

Procedure of the study

The study was conducted for one month. The students of both experimental and control groups were pre-tested before the intervention. An e-book was developed using Flipped PDF Professional Software that involved all the related content which was selected in consultation with the subject teacher. But majority of the students have no access to internet or to run the software (Flipped Pdf Professional Software) at home. So, it was decided to prepare all the selected subject related material on CDs and then provide those CDs to the students of experimental group. Demo was given to all the students on how to save the videos on their computers in the computer lab. The set schedule for both sections by the institute was followed.

Students watched video related to the topic before the class at home and wrote down the questions that were discussed in the class next day. All students were encouraged to take part in the discussion on the video in the class. Then some questions were asked from the students to know their level of understanding. After classroom discussion a short lecture of five to 10 minutes was given to the students by using power point presentation in the class before performing relevant learning activities. Then groups were formed randomly. In group formation focus was given on grouping of mixed ability students. Randomly numbers were assigned to the students and then groups of 5 to 6 members were formed. Total strength was 30 students. Guidelines were given before assigning the tasks.

Focus was on co-operative learning in the beginning. Then gradually it was shifted towards more collaborative learning. Students were assessed during the activities and feedback was provided. The strong points of the group were appreciated and guidance was provided for more improvement. One concept was completed in two days. First day was for question/answers session, PowerPoint presentation and discussion. On the second day, the hands-on activities were performed. After one month a same post-test was given to both experimental and control group to find out any improvement in students' level of understanding science concepts. Only the sequence of the items was changed.

Results and findings

The first research question focused on finding out the difference in pre- and post-test scores of students within group. To find out the significant difference between the pre- and post-test scores of the experimental group, a paired sample t-test was calculated.

Table 1: ***Results of the Paired sample t-test***

Experimental group	Mean (SD)	T	Df	Sig
Pre-test	-10.56(3.93)	-14.70	29	0.00
Post-test				

It was hypothesized that there is no significant difference in the students' science learning before and after working in the flipped classroom. For this, paired sample t-test was calculated for pre- and post-test scores of experimental group. Results showed that there was highly significant difference in the mean score (see Table 1) of pre- and post-test of the experimental group (p=0.00). Results didn't support the first hypothesis because a student-centered flipped classroom results in higher level of student's science learning before and after working in the flipped classroom.

Table 2: ***Results of the Independent sample t-test***

Groups	Mean (SD)	T	Df	Sig
Post-experimental	16.63(4.5)	8.50	58	0.00
Post-controlled	8.47(2.7)			

It was hypothesized that there was no significant difference in the students' science learning of experimental and control group students, after working in flipped classroom.For this, independent sample t-test was calculated for post-test scores of experimental and control group. Results showed that the difference was highly significant between the mean scores (see Table 2) of experimental and control group after the experiment (p=0.00). This indicated that students learn the science concepts better in the flipped classroom setting as compared to the students studied in a traditional classroom.

Effect size

After applying t-test, the effect size was calculated in order to find out the magnitude of the difference. For current study effect size was calculated with Pearson's correlation coefficient r that is one of the most common measure for calculating the effect size for a t-test. The effect size for a paired sample t-test was calculated. The value, 0.93 showed a very large effect, which indicates that studying in flipped class brought a large effect on the science achievement of students of experimental group.

Discussion and Conclusion

The study intended to investigate the effects of flipped classroom on student's science achievement in Pakistani context. One main

research question and two sub-questions were formulated. It intended to identify the difference in the level of students' science achievement between group and within group.

First research question addressed the difference between pre- and post-test scores of students in experimental group to identify the effects of flipped classroom on students' achievement. After analyzing the data, it was found that there was highly significant difference (p=0.00) in the mean score of the experimental group. Second research question was about finding the difference in post-test scores of control and experimental group after the experiment. Results showed that there was highly significant difference in the mean scores of experimental and control group after the experiment (p=0.00), where experimental group has mean value (16.63) and control group has (8.47).Effect size shows the magnitude of the difference. For current study effect size was determined through Pearson's correlation coefficient r. Pearson's correlation coefficient r value (0.93) for pre- and post-test scores of experimental group showed higher effect on students' performance after working in flipped classroom.

Results of research studies conducted byAmresh, Carberry, and Femiani (2013),Demetry (2010), Kong (2014), Mason, Shuman, and Cook (2013), Marlowe (2012), Lockwood and Esselstein (2013), Linga and Wang (2014), Fulton (2012), Bart (2013), Long (2012), Szoka (2013), Butt (2014)and Stone (2012)are akin to the result of current research and it was concluded that students remain motivated, take interest and showed higher scores and achievement level in flipped classroom than in traditional classroom.

It is concluded from the findings that flipped classroom has positive effects on students' learning of science topics. Both independent and paired sample t-test scores showed clear difference in the pre- and post-test results of experimental and control group. Value of Effect size indicated the higher impact of flipped classroom on students' learning after working in flipped classroom. The findings give rise to the idea of implementation of flipped classroom in teaching of science at school level in Pakistan.

Contributions of study

Main contribution of the study is that flipped classroom has been tried and implemented for the first time in Pakistani context therefore; it has contributed in the field of research. No research has been found about the flipped classroom implementation in Pakistani context to the best of my knowledge.

Another contribution is that in current research, after field visit it was found that some students didn't have access to the internet at home.

Keeping the situation in mind, it was planned to convert all the related videos on CDs. Then those CDs were provided to all the students. This is one of the biggest contributions of this research that would be helpful for developing and under developed countries especially. After studying the relevant literature, it was found (to the best of my knowledge) that whenever the flipped classroom was implemented, relevant lecture or videos were provided to the students through online means. Students used internet for getting access to that material.

The study has its scope in terms of the implications for the secondary school officials, teachers, students and creative thinkers or researchers regarding the effectiveness of the flipped classroom in Pakistani context.

Conclusion

This experimental research was planned to find out the effects of science flipped classroom on student's performance at school level. Although the flipped classroom is relatively a new concept as it was started in 2007 but it gained popularity in a very short time, all over the world. Keeping its effectiveness in mind a science flipped classroom was designed in Pakistani context. Its implications, contribution to the field and future research opportunities provided thought provoking results that will help to improve the situation of ICT in Pakistan. Facilities are there, however, what is needed is proper utilization and implementation. It is expected that this pioneer study will give rise to further implementation of the flipped classroom at all levels, which will help in making our education system more advanced and technology-driven.

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