A STUDY OF EMERGING LEARNING ENVIRONMENT IN AN ACTIVITY DRIVEN CHEMISTRY FLIPPED CLASSROOM

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ABSTRACT

Digital simulations, computer assisted instructions, videos etc. to enhance learning have limited effects unless the traditional teaching model is transformed. Flipped learning is an innovative model of a classroom structure where the coverage of content occurs outside of the classroom learning space using video/podcasts and class time is made available for students to engage in hands-on collaborative learning. This study traces the evolution of student engagement in a activity oriented chemistry flipped classroom in comparison to a traditional class XI Chemistry course. The lecture content of the flipped class was delivered online via videos. Class time was utilized for problem solving and active student-centered learning. The content in traditional class was taught using lecture method. The learning environment and activity in both the classrooms were investigated using the WIHIC [What is happening in this class] inventory. Results of the quantitative data analysis support the efficacy of the instructional activities on the learning environment of the flipped classroom.

Key words: Innovative model, flipped learning, Active student-centered learning, Learning environment

1. INTRODUCTION

Smart education demands more student-oriented classes instead of teacher-oriented classes. Many school and college educators have shown eagerness to innovate their instructional style from traditional lecture to a more active, student centered style using collaborative projects, class presentations and discovery activities (Baker, 2000). Salomon Gavriel describes technology as a great tool to access information and to connect students to experts along with other students all over the world. However, technology alone is unable to transform the new information into knowledge. Instead, the active process must occur within the learner themselves. He also suggests that while a more traditional classroom is conducive to memorization of content, technology rich classrooms using a constructivist approach improve students' real-world skills including composing questions, producing hypothesis and tackling new problems intelligently. Frailich et al. (2009) were able to conclude that the web-based learning activities which integrated visualization tools with active cooperative learning strategies provided students with opportunities to construct their knowledge regarding the abstract concepts in chemistry. Progressive teachers and administrators must understand the reality and the pervasiveness of information technology in the lives of students (Gerald Robert Overmyer, 2014). Advances in Internet and communication technologies like Cloud computing and services such as YouTube, Teacher Tube, and Screencast.com have made it favorable for teachers to deliver content with dynamic multi-media educational resources and for students to access information digitally thus bridging the space between instructors and learners.

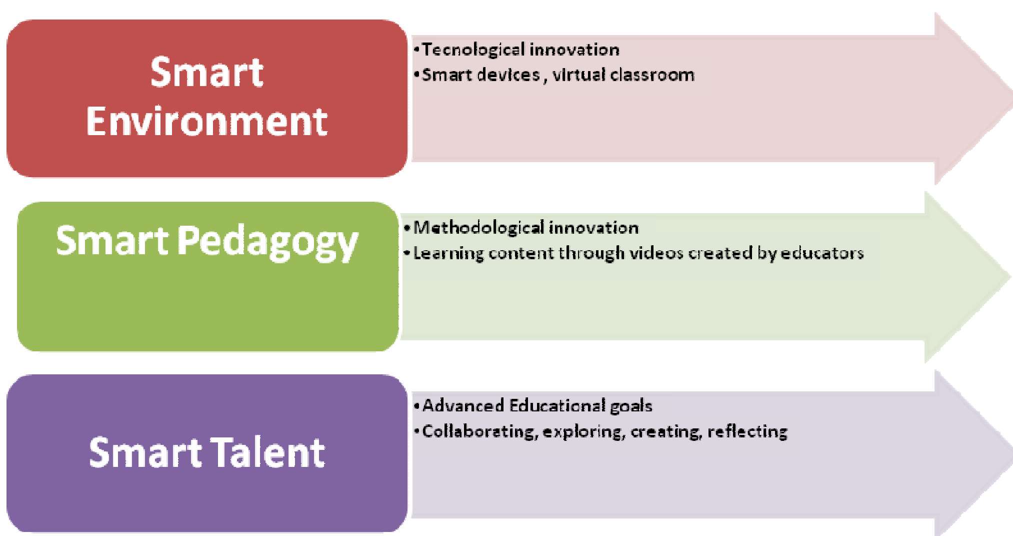
This study has stemmed out of a desire to explore a learning based educational model that can transform class time into a workshop where students can inquire about lecture content, test their skills in applying knowledge and interact with one another in hands-on activities facilitated by the instructor. This study aimed to investigate its outcome on the students' collaborative ability, self-directed learning ability and its effect on the learning environment of a classroom. The experimental study is based on an alternative model of instruction called Flipped Learning Model (FLM), where teacher shifts direct learning out of classroom space and moves it to the individual learner space with the help of one of several technologies and focuses on active, face-to-face learning in the classroom.

The KERIS" Smart Education Global Trend Vol. 2013 no. 17 defined flipped learning as follows " Flipped learning refers to flip around the conventional ways of education for students to listen to their teacher-generated lectures at home and participate in learning activities in class such as discussion, quiz, project, etc., to solve their tasks"(KERIS, 2013a). This educational method transforms teachers from a knowledge messenger to facilitator and is based on the rationale that students' learning takes place through their classroom activities as well as discussions and debates with their teachers and fellow classmates. With increasing availability of smart devices and their penetration in the smart education field, more smart devices can be applied to enrich teaching-learning process.

Flipped learning as a smart education model:

Heeseok Lim (2011) stated that smart education was "an overall approach to improve learning effectiveness by changing the vertical and unilateral way of conventional teaching and learning methods into horizontal, bilateral, participatory, intellectual and interactive manner". Flipped learning includes the basic ideal of Smart education as it has many similarities with mobile learning for its use of smart devices with mobility. In flipped learning, students are instructed to watch videos produced by their teachers through their own smart devices for on the go watching and learning.

Figure 1: Flipped learning as a smart education model:



The research study explored the Flipped learning model [FLM] as a pedagogical approach that integrated content, media and technology to meet the goals of enjoying the learning of chemistry as well as the objective of creating a rich learning environment by actively involving the students in the learning process. Moreover, the need of the study is justified by the review of literature, which clearly shows a lack of research studies in India, on new approaches of teaching and learning chemistry at all levels of science education.

2. REVIEW OF RELATED LITERATURE

Research provides evidence that the infusion of technology into teaching and learning has a remarkable influence on the instructional strategies of the educational institutions. A teacher who is adept at creating a course that raises the pedagogical benefits of that technology such as online quizzes, blogs and discussion boards can facilitate students to meet the desired learning outcomes (Heather Glynn Crawford-Ferre, Lynda R. Wiest, 2012, George R. Bradford, 2011, Wen-Shan Lin, Chun-Hsien Wang, 2011, HyeRan Park, et al, Andrina Granić, 2009).

The review of literature on flipped classroom approach brings to light the fact that there are no studies conducted on this topic in India. The literature reviewed included a wide variety of publication types including, books, blog postings, newspaper and magazine articles, theses, white papers, as well as conference papers and peer reviewed journal articles. Most of these articles were published in the 2000s with a few number published in the late 1990s signifying the contemporary status of the concept.

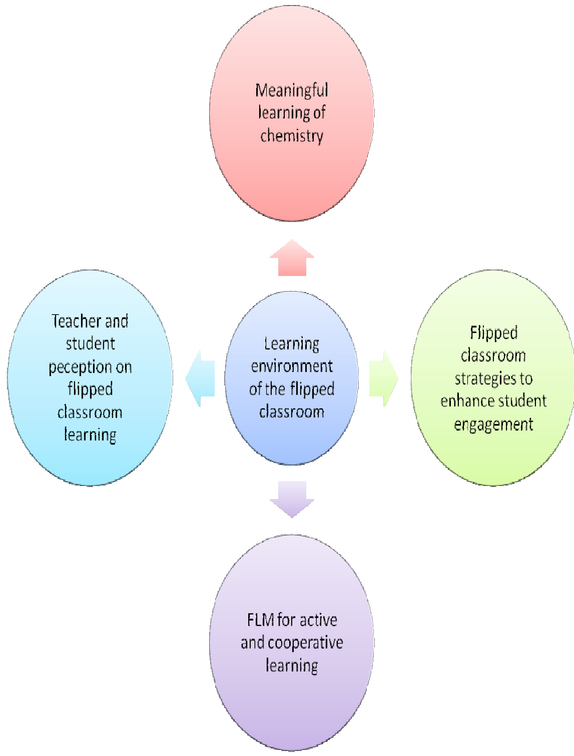
Almost every publication made some reference to increasing active learning. Active learning is about involving students in doing things and thinking about what they are doing and is superior to lecture in developing thinking and content skills; that active learning improves student attitudes and achievement; and that active learning better serves learning styles (Bonwell & Eison, 1991). The pre-class component of learning content via an online lecture can be considered as one more form of scaffolding for active learning in the classroom (Strayer, 2007). Virtually 80% of the selected publications referred to collaborative learning activities as part of their implementation (Brenton McNally, et al, 2016, Cha J, et al, 2013, Eichler J.F, et al,2015; Hughes, 2012; Johnson & Renner, 2012; Lage et al., 2000; Lara & Okhuysen, 2012; Lazareva V, 2015, McLaughlin J.E, et al, 2012, Michael K. Seery, 2015, Sang-Hong Kim, et al 2014 ; Strayer, 2007; Strayer, 2012;,Toto & Nguen, 2009; Travis Roach, 2014, Zappe et al., 2009), suggesting that collaborative learning is a key component to the classroom flip. There is strong theoretical and empirical support that collaborative learning activities have cognitive and motivational benefits (as cited in Johnson & Renner, 2012, p. 2).

Most of the publications identified skills such as creativity, innovation, critical thinking , problem solving ability and communication skills developed through active and collaborative learning activities as contributors to a rich learning environment (Houston & Lin, 2012; Hughes, 2012; Johnson & Renner, 2012; Lage et al., 2000; Moravek et al., 2010; Padadopoulos, 2010; Ronchetti, 2010; Strayer, 2007; Strayer, 2012;; Toto & Nguen, 2009; Warter-Perez & Dong, 2012; Zappe et al., 2009). Strayer observed that students in the classroom flip preferred and experienced more innovation and collaboration (2007, p. 103) and that they were more willing to work together than traditional students (2007, p. 160).

Johnson and Renner, however observed that not all students prefer collaborative work and that not all students inherently possessed the skills required to be effective at collaborative work (2012, p. 74). Generally, the literature supported the view that with adequate teacher preparation, flip learning model is an effective approach to enrich the learning environment of the classroom Many teachers reported that student interaction and engagement increased in class with the classroom flip (Franciszowicz, 2008; Gannod et al., 2008; Houston & Lin, 2012; Hughes, 2012; Lage et al., 2000; Padadopoulos, 2010; Ronchetti, 2010). With greater collaboration both in and out of classroom, students felt they received more personal attention, had more control over their learning, and were able to engage in critical thinking (Baker, 2000, Eichler J.F, et al, 2015, Hodge A , 2013, Kelly E. Snowden 2012, Lazareva V, 2015 Mazur A. D, et al, 2015, Mooring S.R, et al, 2016, Weaver G.C, et al, 2015, Zainuddin Z, et al,2016).

3. CONCEPTUAL FRAMEWORK OF THE STUDY:

The conceptual framework to inform this study on the FLM as a catalyst in enhancing learning efficacy in chemistry was derived from an analysis and synthesis of the research literature from the following fields:



4. RESEARCH METHOD

Research design: The researcher used Embedded mixed method research design to include qualitative data to answer a research question within a large quantitative study.

The research questions for the present study were as follows:

<u>For Quantitative Data :-</u>

Does the pedagogical strategy based on flipped learning approach to teaching chemistry have a positive effect on the learning environment in the classroom?

<u>For Qualitative Data: -</u>

What factors do the students perceive, that have influenced the learning environment of a flipped chemistry classroom?

<u>For Mixed Methods Component: -</u>

To what extent and in what ways do observations and qualitative interviews with students serve to contribute to a more comprehensive understanding of the learning environment of a flipped chemistry classroom, via embedded mixed methods analysis?

Participants: The experimental group (EG) and control group (CG) were intact classes comprising of 100 students each of the science stream of FYJC. In this study the researcher followed the convenience sampling procedure defined by McMilan (2000), where a group of participants is selected because of availability.

Instruments:

For Quantitative Data: - The inventory WIHIC [What Is Happening In This Class] designed by Fraser, Fisher, and Mcrobbie (1996) was adapted to measure the learning environment (LE) of the classrooms.

For Qualitative Data: - Observation schedule and Semi-Structured Focus Group Interview for assessing emerging and final learning environment of the flipped classroom

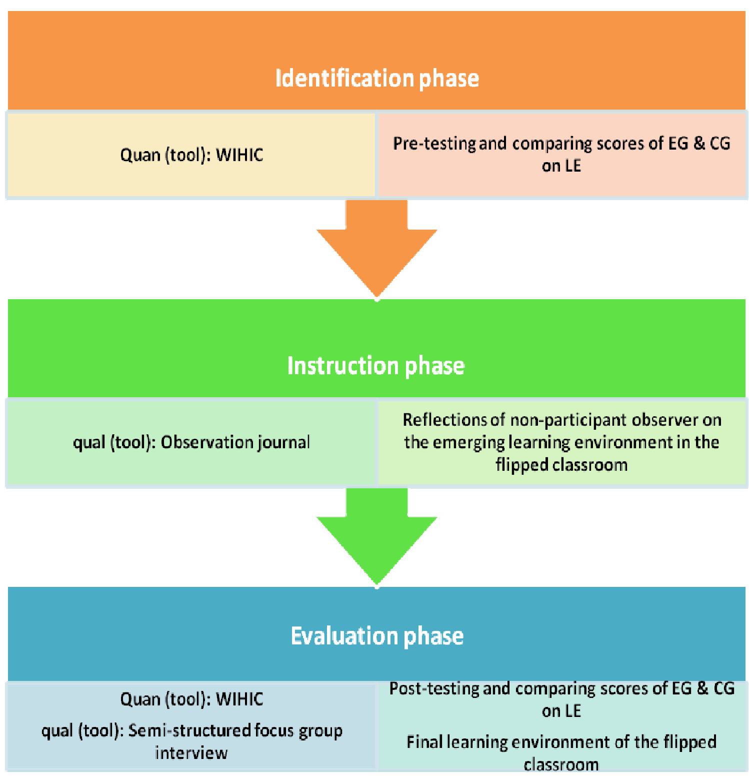
The development and theoretical underpinning each of these instruments and their purpose are discussed below:

Measuring learning environment: The scales of the WIHIC inventory used in this study included Student Cohesiveness (SC), Teacher Support (TS), Involvement (IN), Task Orientation (TO), Cooperation (CO). The students are asked to provide their responses on a five-point Likert scale of Almost Never, Seldom, Sometimes, Often and Almost Always. The total score for a scale is simply the sum of the circled numbers for the eight items belonging to that scale. Omitted or incorrectly answered items are given a score of 3. The higher the scale score, the more a classroom practice occurs in that dimension.

Observation schedule: Every cycle in the instructional phase was observed by an external non-participant observer. The observation tabulated the interactions occurring in the setting, researcher's behaviour, body language of the participants, culture of the classroom, comfortability of the students, classroom dynamics, unplanned events that may occur.

Semi-structured Focus Group Interview: The post-intervention interview of students of the experimental group formed the last leg of the qualitative data to be collected. The semi-structured focus group interview had questions developed by the researcher and was carried out with 15 students of the experimental group. The observer of the instructional phase was the moderator.

Procedure: Figure 3 illustrates the 3-phase design to investigate the effectiveness of the treatment based on FLM on the learning environment in classroom (LE).



5. INSTRUCTIONAL DESIGN

Flipped classroom instructional design used in this study:

The nerve-centre of successful flipped classroom learning is the instructional design. The researcher who is also the instructor analysed every step of the lesson planning and implementation activity to construct the Flipped Classroom Instructional design used in this study.

1. Scope of content: The goals for the pedagogy were determined in lieu of the scope of content and the learning objectives were listed in consonance with the Blooms' revised taxonomy.

2**. Pre-class content:** Videos of transcripts of the weekly content were created in Power point slides with the voice recorded by the researcher were posted for viewing in Google classroom, Edmodo, Whatsapp on mobiles and also as unlisted You-Tube video links.

3. **Pre-class Assignments and In-class activity:** Assignments based on the weekly learning content were constructed formed on the learning objectives. The assignments were reviewed, graded and re-posted to the students' ahead of the in-class instruction day. Thus, gauging the level of assimilation of the content and detecting common errors among the students, the instructor was informed and geared to clarify the doubts before the commencement of the in-class activity. Announcements regarding the in-class activity were posted in the digital classrooms.

The **in-class** learning activities were conducted in consonance with the instructional design and in the presence of a non-participant External Observer. Students of the experimental group were randomly divided into 15 groups of 5-7 students each and were allotted topics for power point presentation and other team activities. The instructor reviewed the class progress at the end of every session to address common errors and doubts.

4. **Post-class activities:** The instructor engaged students in private conversation outside of class to make them feel comfortable in this innovative learning environment. Supplementary learning materials were posted to further augment the conceptual understanding of the topics. The students were encouraged to post private comments for the instructor to innovate and to seek timely redressal of their problems.

5. Evaluation and feedback: In addition to posting grades, the instructor posted additional resources and guidelines as private feedback to the students for raising their cognitive abilities. The instructor solicited consistent feedback from the students regarding the quality of the videos and its content, the mode of transmission of the lessons and the in-class active learning strategies.

6. DATA ANALYSIS

To analyse the quantitative data descriptively, the researcher used measures of central tendency, variability and divergence from normality. For inferential analysis't- test' was used.

Quantitative results and findings:

Based on the quantitative analysis of the WIHIC scores and the t-test results the researcher has tried to answer the following research questions: -

Does the pedagogical strategy based on flipped learning approach to teaching chemistry have a positive effect on the students 'learning environment in the classroom?

The findings of the analysed quantitative data are tabled as follows: -

Table 1 depicts the Pre-test Mean, Standard deviation & t-ratio of LE scores of EG & CG:

Variable	Scores	N	Mean	SD	t- ratio	Table value		l.o.s.
Learning environment in the classroom (LE)	Pre-test EG	78	102.64	11.30	1.39	0.05	1.98	Not significant
	Pre-test CG	78	100.15	11.11		0.01	2.61	Not significant

Table 2 depicts the Post-test Mean, Standard deviation & t-ratio of LE scores of EG & CG:

Variable	Scores	N	Mean	SD	t- ratio	Table value		l.o.s.
Learning environment in the classroom (LE)	Post-test EG	78	154.24	15.05	24.27	0.05	1.98	Significant
	Post-test CG	78	101.77	11.76		0.01	2.61	Significant

Table 3 depicts the Pre-test- Post-test Mean, Standard deviation & t-ratio of LE scores of EG:

Variable	Scores	N	Mean	SD	t- ratio	Table value		l.o.s.
Learning environment in the classroom (LE)	Post-test EG	78	154.24	15.05	24.50	0.05	1.99	Significant
	Pre-test EG	78	102.64	11.30		0.01	2.64	Significant

Table 4 depicts the Pre-test- Post-test Mean, Standard deviation & t-ratio of LE scores of CG :

Variable	Scores	N	Mean	SD	t- ratio	Table value		l.o.s.
Learning environment in the classroom (LE)	Post-test CG	78	101.77	11.76	1.75	0.05	1.99	Not Significant
	Pre-test CG	78	100.15	11.11		0.01	2.64	Not Significant

The column representation of the mean individual scale scores of WIHIC inventory, which is Student cohesiveness(SC), Teacher support(TS), Involvement(IN), Task orientation(TO) and Cooperation(CO) are presented in the figures given below:-

Figure 4 represents Mean pre individual scale WIHIC scores of EG & CG

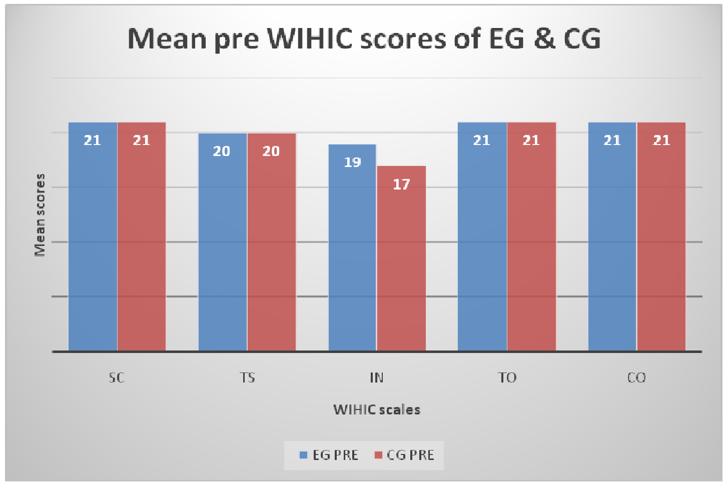


Figure 5 represents Mean post individual scale WIHIC scores of EG & CG

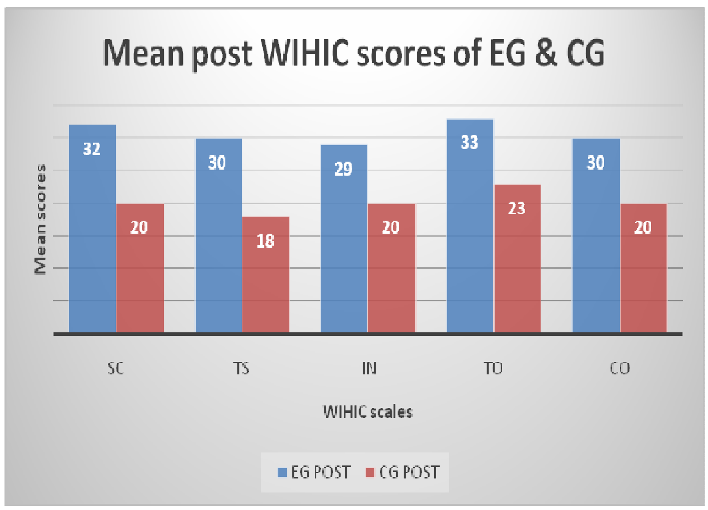


Figure 6 represents the Mean pre and post individual scale WIHIC scores of EG.

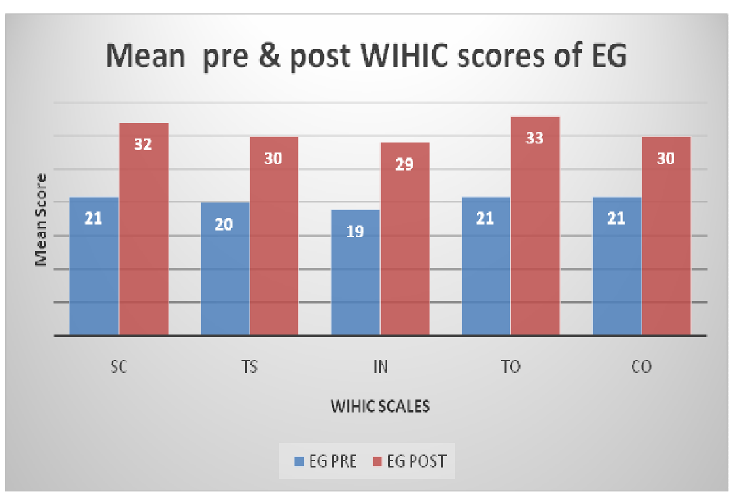
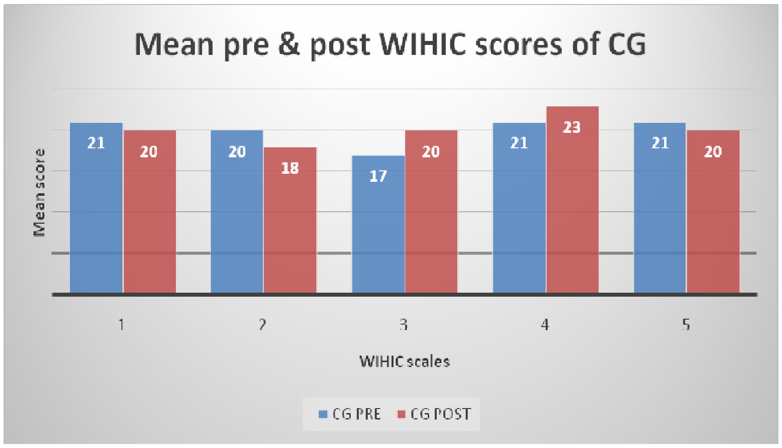


Figure 7 represents the Mean pre and post WIHIC scores of individual scales of CG.



Discussion: The findings of the 't' test statistics suggest a significant difference between the experimental and control group on the learning environment in the classroom, pre and post treatment. The students of the experimental group who were exposed to the flipped learning model experienced greater cohesion and cooperation and enjoyed working on various activities with the support of the teacher. They seemed to prefer the fertile learning environment and adopt this innovative teaching approach in the classroom that required working and collaborating with classmates when completing learning tasks. Many of the research studies reviewed showed that students learn in environments which provide them opportunities to participate in learning with hands-on activities and the opportunity to collaborate with students (Bryan et al., 2011). Doerr and English (2003), Lehrer and Schauble (2000) all concluded that activities which require students to develop their own approaches to representing and solving problems provide a rich learning environment. In Broad et al. study, evidence showed that students in a technologically rich learning environment shifted their focus from being engaged in completing assignments to discussions and exploring the concepts they were learning. Consequently, studies showed students are less motivated when a tremendous amount of contextual material is presented during traditional face-to-face instruction (Bryan et al., 2011). These findings were synchronous with the pre-post and post-post't' tests result findings of the control group.

Qualitative results and findings:

Based on the qualitative analysis of the observation journal and semi-structured interview the researcher has tried to answer the following research questions: -

1." What factors do students perceive, have influenced the learning environment of a flipped chemistry classroom?"

The following themes surface from the reflections of the non-participant observer which provide an insight to the perceptions of the students on the chemistry flipped classroom environment.

Innovative and Flexible learning: The chemistry flipped classroom teacher did not follow a fixed pattern for conducting class as observed in a traditional class. The flexibility of teaching content through videos prior to the class allowed the teacher to have doubt solving sessions at the beginning of each lecture the flipped classroom teacher provided the students with different ways of learning the content.

Constructive learning: The instructor allowed a variety of teaching –learning modes to establish the understanding of a concept or a theory in chemistry. The students were transformed into active members of the learning process building knowledge instead of passively receiving it from the teacher.

Student engagement: Task oriented activities engaged the students were engage in meaningful learning without the teacher being central. Students in the flip class were more willing to work together and engage activity in the classroom on some level than the students in the traditional classroom. The inputs by the teacher facilitated the students to be engaged at a deeper level by understanding the purpose behind their learning activity. Activities involved with each instructional strategy engaged the students in the learning process and made them responsible for their learning.

Student-teacher Dynamics: The flipped classroom teacher worked to create an environment where students had the flexibility to explore and get more meaningful experiences and felt comfortable asking questions at any point for clarification. The students felt less threatened to speak up and welcomed the teacher proximity and support.

Classroom culture: The structure of the classroom was loose as compared to any traditional classroom. The classroom proceedings did not follow any predictable structure, instead the environment metamorphosed into an active learning center.

2. "To what extent and in what ways do observations and qualitative interviews with students serve to contribute to a more comprehensive understanding of the learning environment of a flipped chemistry classroom, via embedded mixed methods analysis?

The themes that emerged from the observations made by the external non-participant observer were synchronous with those that emanated from the responses of the focus group participants.

These connections formed the basis for a theme analysis of the learning environment of the flipped classroom in this study.

Activity driven classroom: The students were unanimous in endorsing the flipped class as activity driven as it was peppered throughout by activities that scaffolded their understanding of chemistry. The active learning strategies like PPT presentations were effective in enhancing their knowledge in the field of chemistry while sharpening their communication skills and honing their leadership qualities. A student expressed this by saying, **"**Group presentation gave us confidence to speak before an audience. "It was stressed out sometimes, I have to do my part and get others to do their part. It brought out leadership qualities in me." The varied activity did not allow the student to predict a set pattern of learning culture of the flipped classroom. A student responded by saying, "The presentation included topics from SYJC which had to be read. It required probing and led to knowledge of new concepts."

Catalyzing student engagement: Students from the flipped classroom mentioned that the learning activities shaped them in ways more open to engaging them in varied aspects of learning chemistry. They were given opportunities to apply what they have learnt. The group agreed that they were involved in continuous learning through activity in the flipped chemistry class as compared to a traditional chemistry class. They opined that, "There was no active learning in a traditional class…just passive listening". Many among the group replied that the flipped class was more effective in generating interest and motivated them in the learning of chemistry. "It was interesting to watch the content in digital form".

Class and Group dynamics: The reflections and responses suggest that the students preferred group activities that involved collaborative participation. The instructor worked on creating a classroom atmosphere without boundaries of rigidity. The loose structure of the flipped classroom encouraged the students to move and express freely while engaging in the activities in the class. The student- teacher dynamics in the flipped classroom centered around the teacher being more of a facilitator than an instructor. The students responded by saying: "It was a complete different experience. We had to research on topics, coordinate with each other and build up the presentation. It brought about unity among the students". "There was lot of collaboration, team work, team spirit. In fact, we ended up making the PPT slides for those who did not have computers."

Teacher support: The student responses and reflections were positive on the support they experienced from the flipped class teacher at every stage of the instructional process. A student expressed, "In a traditional class we don't even ever get to talk to the teacher. We can always ask doubts but not the kind of interaction we had in flipped class." "We could approach you anytime, anywhere. You were just one touch away".

Learning environment of flipped classroom vs traditional classroom: Students in the focus group seem to appreciate the fragmented and unstructured learning environment of the flipped class. It kept their attention better as compared to a lecture centered traditional class. The noise and chaos in the activity driven flipped class did not have any detrimental effect on learning. Instead the students seem to enjoy constructing knowledge by working and collaborating in groups. This was evident in the reflections made by the observer and from the student responses. Students preferred more innovation in the classroom, and they said they experienced more innovation in the flipped classroom as compared to the traditional. Students from the flip classroom mentioned that a successful learning environment would include activities that help them to apply what they have learned.

"In traditional class when the teacher is teaching, some maybe sleepy, some in their own mind set, day dreaming…but not so in flipped class."

"In normal classroom, only self-motivated students can learn, whereas everyone loves to see videos and can learn." "The activities created a rapport among students. Everyone came together because of group activities"

When asked, to sum up, what is the best part of a flipped class?

The response was…Activities, Teacher interaction, Assignments, innovative videos…Each instructional strategy added value at every stage. Flipped learning is a comprehensive package of all instructional strategies put together.

7 CONCLUSIONS FROM THE STUDY

The present research study based embedded variant of mixed method design investigated the effect of FLM on a chemistry FYJC class, and could arrive at the following conclusions: -

1. The analyzed quantitative data on EG & CG on the learning environment in the classroom revealed significant increase in the scores of EG over the CG. Thus, it could be concluded that this new innovative digital learning approach of teaching content outside of classroom with videos benefitted the students in comprehending the concepts in chemistry thereby improving their interest in the subject which reflected in a vibrant learning environment in the classroom.

2. These findings were backed by the results that emanated from the qualitative data gathered through observations and focus group interview. Students responses seemed to welcome and prefer the new learning approach based on the FLM. Their appreciation of the varied learning activities promoting collaborative work reflected in the vibrancy of the flipped classroom. The students of EG fancied the chaos and noise of an activity driven flipped class to a monotonous passive traditional class.

Limitations

This study was limited by the short period of time allotted for this research study due to the course structure of FYJC class. The researcher followed the convenience sampling procedure thereby limiting the findings of the study.

Implications:

The result of this study implies that technology infused flipped learning model may result in enhancement in the chemistry learning efficacy of students and has several possible implications for teachers and students Teachers can simplify content in chemistry through illustrative videos and spend more time in class for doubt solving and activity-based learning, structure and catalyse interactive student-centered classroom through various activities making learning of chemistry enjoyable and interesting and boost student engagement in learning chemistry.

The flipped classroom approach is a relatively novel learning approach and need to pass the test of time. Although, it has been heralded as a unique and cutting-edge learning approach, it still lacks implementation in India. Clearly, there is need for further research and development of variants based on FLM to suit domestic learning classrooms and students.

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