Original Research Article

Investigating the Impacts of Flipped Classroom Approach on Class Nine Students Learning of Physics Concepts

ABSTRACT

The flipped classroom is an emerging pedagogical model characterized by shifting teacher-oriented to student-oriented learning. This study aimed to investigate the impacts of flipped classroom approach on academic success of class nine students learning thermal energy in one of the Middle Secondary Schools in Bhutan. A convergent parallel mixed method was employed in this research. The quantitative data were collected from the physics learning achievement test and survey questionnaire while the semi-structured interview is used for qualitative data. A total of 50 students participatedin the true-experiment with 25 each in the control group and experimental group. The Statistical Package for Social Sciences version 22 used to analyze the quantitative data and thematic analysis were done for qualitative data. The results of the study indicated a statistically significant difference (t (48) = 2.526, P = .05) in physics achievement test between control and experimental groups with a medium effect size (d = 0.68), signifying implementation of flipped classroom has positive effect on learning thermal energy. Moreover, flipped classroom approach brought positive impacts toward students' learning such as achievement, motivation, engagement, interaction and higher order thinking skills. The high positive correlation (r =0.828) between flipped classroom approach and higher order thinking skills confirmed that flipped classroom improves higher order thinking skills. Somechallenges found in applying the flipped classroom approach are poor internet connectivity and lack of resources. This study was limited to short duration and small sample size. Further studies are recommended for longer duration of observation with more coverage of physics topics and more sampled schools spread across the country.

Keywords:Flipped classroom, Control group, Experimental group, Achievement, Active learning, Higher order thinking skills, Motivation

1. INTRODUCTION

Quality-teaching arises from classroom practices and child centeredness. This indicates that today's classroom environment should be student-centered where students take an active role in learning and exploring deeper. The seven standards of Bhutan Professional Standards for Teachers are elaborated with 37 focus areas by incorporating content and pedagogical knowledge. Teachers are able to use appropriate pedagogy based on the content knowledge and evolving ideas of the subject [1]. Moreover, the National School Curriculum, Instructional Guide for class IX and X physics emphasizes transforming textbook-based knowledge to competency-based learning and experiential learning [2]. Further, it adopts the flipped classroom methods of learning where teachers act as guide and facilitator in the classroom. Therefore, the flipped classroom approach as a new pedagogy becomes an important aspect of the teaching-learning process to enhance students' learning. Jonathan Bergmann and Aaron Sams, high school chemistry teachers of Colorado develop a video lesson thereby flipped classroom approach (FCA) was introduced in 2007.

Despite the FCA being an exciting new topic in educational research, there is a lack of agreement on what exactly is flipped learning, and there is also limited scholarly research on its effectiveness [3]. However, [4] stated that learning is not limited to the classroom where students can learn at their own pace based on individual needs, thus switching to flipped classroom instruction. [3] define flipped classroom as an educational practice in two different ways such as interactive learning activities that happen inside the classroom and direct computer-based individual instruction outside the classroom. FCA allows students to learn and engage in interactive activities [5]. Furthermore, researchers highlighted that FCA utilizes technology to introduce learning materials to students outside the classroom [6]. As a result, it leads learners to fully engage in watching the videos and reading the learning materials on thermal energy. The learners learn the concept of wave motion independently at their own pace at home. However, learners become more active in the classroom enabling them to think deeper on thermal energy and learners get equal opportunities to participate in the learning process. According to Islam and slam [7] FCA makes learners to become more active and teachers as facilitator instead of active role in lecturing. Flipped Classroom has a positive effect on the engagement and learning experience of the students and enables an active teaching-learning process [9,10], allowing students to experience a friendly and collaborative learning environment [11]. Teachers assist learners and enable them to participate actively in the learning process.

However, in the Bhutanese classroom, students are passive listeners. Therefore, this study focuses on FCA and finding its impact in learning the class nine physics concept on thermal energy.

1.1 Aim and Objectives

The main **objectives** of this study was to investigate the impacts of a flipped classroom approach on class nine students' learning of physics concept. Specifically, it aimed to

- To compare physics learning achievement of experimental group and control group.
- To study the impacts of a flipped classroom approach on students' learning of thermal energy.
- To investigate the learning experience of thermal energy using flipped classroom approach.
- To explore the opportunities and challenges of using the flipped classroom approach in learning thermal energy.

2. LITERATURE REVIEW

Flipped classroom is a new methodology that addresses the needs of different learners in the classroom [12]. In the flipped classroom, students watch the video lesson before attending the course, besides studying outside the class, and have hands-on activities in class [20]. The class becomes the place to work through problems, advanced concepts and engage in collaborative learning. According toHamdan, flipped classroom is defined as learning outside the class, in which students can access learning materials from anywhere, anytime, create the learner-centered activities of the lesson and provide individual support in the classroom [21]. In addition, the flipped classroom is referred to as a student-centered approach to learning, in which the learner is more active than the teacher in class learning [20]. A flipped classroom is an innovative learning instruction currently practiced by educators around the world. It is generally agreed that the flipped classroom creates an immersive learning culture that helps create collaborative learning among the students themselves, involving the teacher as facilitator and allowing learners to use the prior knowledge they had from the video instructor prior to class, participate well and foster communication skills.

The flipped learning has changed the culture of students' learning from teacher-centered to learner-centered, with emphasis on students' activities.Vimala (2012)claims that flipped classroom is a 21st century learning style that is learner-centered approach which focuses on use of technology in the learning process [22]. However, teachers are not replaced by flipped learning, rather professional teachers are more important in flipped

classrooms to guide and expand learning experience [23]. Such a classroom really expects a professional teacher to guide, provide insights, and facilitate learning for student's discovery. In addition, Chenet al (2014) claim that student-centered culture provides exploring topics in greater depth and creating richer learning opportunities [23]. The flipped learning approach allows us to use class time in progressive ways leading to learning by doing. This offers efficient methods of instruction for teachers and provides opportunity for students to experience hands-on learning with the given materials. Hence, self-learning promotes self-exploration and experiential learning.

Flipped classroom approach promotes active learning and enhances students' engagement. Active learning is defined as teaching and learning strategies that actively involve students in the learning process [12]

The flipped Classroom was also found to help students transfer their knowledge between contexts, thereby strengthening their conceptual understanding of thermal energy. Ankoraconcluded from the findings that the benefits of using the flipped classroom as it enhanced the students' interest and enriched theirlearning experience[15].

However, they also reported that engagement to learning will not be effective if students do not take responsibility in flipped learning. Islamet al (2018) mentioned that teachers use the lessons to involve students in activities such as small group discussions, problem solving, peer grading, and experiential learning activities[7]. This indicates the activity-oriented nature of flipped classrooms are progressive activities that engage students learning meaningfully.The study conducted in the Netherland on flipped classrooms showed that 75.5% of them were motivated to learn with flipped lessons [8].

A review of studies from different countries found that flipped classrooms bring significant learning outcomes. However, [14] argued that there is no significant difference in learners' learning outcomes but it has significant difference on student satisfaction, knowledge, skill and attitude. Moreover, the study indicated that students' interactions and engagement in flipped learning had no correlation on the levels of achievement.

3. METHODOLOGY

This study employs a convergent parallel mixed method which is the form of a mixed method that converges quantitative and qualitative data to get comprehensive analysis of the research problem. It involves both elements of qualitative (open-ended) and quantitative (closed-ended) data. The research design in this study was True-experimental design. Specifically, one group pretest posttest control group was employed in this study. The pretest was administered prior to the teaching-learning process to determine the learning outcomes of the students for two groups. The two groups of total 50 were

assigned randomly, the one group as experimental group and another group as control group. The experimental group was treated using intervention so called flipped classroom whilst the control group was taught using the lecture method. After three weeks of implementation of flipped classroom approach and lecture method for experiment and control group respectively, the posttest was conducted for both the groups. Moreover, a survey design was also adopted in this study as it provides a quantitative description of the flipped classroom on participants' attitudes and opinions. The qualitative method explores the subjective views with regard to challenges, opportunities and learning experiences of flipped classroom through semi-structured interview whilst a quantitative methodcollects objective views on impacts of flipped classroom approach, and students' opinions of learning experience of using flipped classroom through survey questionnaires. The questionnaire was made up five level Likert scale item of "strongly agree" to "strongly disagree". The items on the questionnaire were scored as follows: Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). The study was conducted in one of the Middle Secondary Schools under Chhukha district. The convenience probability sampling was used to select the school because of the researcher's convenience and its geographical location. The purposive sampling method was used to select student interviewee from the experimental group as they are experts in the field of intervention. Moreover, it is purely based on researcher knowledge and judgement. Likewise, a purposive sampling technique was used for survey questionnaires. As they are treated with intervention, they are purposely selected to be participants.

4. RESULT

This section presents the key findings of the study on "Investigating the impacts of a flipped classroom approach (FCA) on class nine students learning of thermal energy in Physics**".**

3.1 Comparison of pre-posttest for EG and CG

The physics learning achievement test (PLAT) scores were analyzed using paired t-tests to determine if the increase in students' scores is significant or not. Table 2 clearly showed the mean difference between pretest and posttest for the EG was 7.08. This indicates that the mean scores of posttest have increased by 7.08 after the implementation of FCA. It is revealed that the intervention is significant based on the *t*-value of 10.677 and which *p*-value is less than 0.01. Likewise, Table 3 indicated the increase in mean difference for CG was 4.32. There is also a significant difference between pretest and posttest scores of the control group as p-value is less than .05. This indicates that both the groups have statistically significant differences in posttest scores.

Table 1. *Comparison of pretest and posttest for EG group*

	Mean	SD	Mean Difference	T	df	Sig. (2-tailed)
Pretest	8.60	2.739				.000
Posttest	15.68	3.497	7.08	10.677	24	

p<.01

Source: *Field data*

Table 2. *Comparison of pretest and posttest for CG group*

	Mean	SD	Mean Difference	T	df	Sig. (2-tailed)
Pretest	9.32	2.268				.000
Posttest	13.64	2.018	4.32	10.506	24	

p<.01

Source: *Field data*

The 5-Point Likert Scale interpretation and distribution of values was adapted from Pimentel (2010). The interpretation of 5-Point Likert Scale description is as reflected in Table 3

Likert-Scale Description	Likert-Scale	Likert Scale Range	Level of Interpretation
Strongly Disagree	1	1.00-1.80	Very Low
Disagree	2	1.81-2.60	Low
Neutral	3	2.61-3.40	Moderate
Agree	4	3.41-4.20	High
Strongly Agree	5	4.21-5.00	Very High

Table 3. Qualitative Interpretation of 5-Point Likert Scale Measurements

Note. Adapted from Pimentel (2010)

The overall composite mean and standard deviation for flipped classroom approach was 3.72 and 0.33 respectively which fallsin the“high” category, suggesting that flipped classroom approach helps in learning thermal energy. It provides opportunities for students to access resources, motivation, self-learning, HOTs, and positive learning

experience as it is reflected in Table 4. Thus, the implementation of FCA has had a positive impact and benefited the students' learning of thermal energy.

Table 4. Students' opinion toward Flipped classroom approach in learning physics.

Theme	Mean	SD	Level of Interpretation
Accessibility	4.22	.46	**Very High**
Motivation	4.09	.59	**High**
Self-learning	4.23	.55	**Very High**
HOTs	3.97	.43	**High**
Students' learning experience	3.91	.66	**High**
Challenges of Flipped Classroom	1.93	.68	**Low**
Composite	**3.72**	**.33**	**High**

Source: *Field data*

The participants rated 'very high' category in accessibility and self-learning indicating learning resources are accessible, teachers and friends too are available for discussion, students explore and learn on their own experiencing self-learning.

Similarly, the qualitative data analysis showed that many student-participants said that the resources were available which was helpful and understandable in learning thermal energy during out of the class. For example, P_5 shared:

I get enough time to learn and copy the notes before the class. While discussing in the class I would be able to understand easily and I would be able to discuss more and participate in the class. The learning materials (notes & videos) were short and precise as provided by the researcher for pre-learning and it was very helpful.

According to qualitative data, all the interviewees had positive responses toward self-learning. For example, P_1 said that self-learning enables us to learn through exploration since we have our own time and convenient place to learn. In addition, P_6 pointed out that studying at home before the class discussion has made me confident to explain the concepts and get more knowledge.

Likewise the qualitative data revealed some of the positive learning experiences of FCA as shared by student participants P_1 and P_2. For example, P_1 said:
FCA allows me to prepare for class discussion, get opportunities to discuss in class, it helps me to learn at my own pace, it promotes habits of self-learning and enhances my learning. It was more student centered learning as we engaged fully in learning.

Similarly P_2 opined:

It was a good experience. We got the opportunity to have a glance or study before the teacher teaches us and it was much better than having regular lectures. It would give us a hint about what the topic is going to be in the next class. Moreover, FCA was more effective than regular classes.

5. DISCUSSION

The data confirmed that there was a significant difference in learning performance between the two groups (p = 0.015). Experimental group learning thermal energy using the flipped classroom performed better than control group learning using the conventional method. This occurs due to the researcher providing learners with interactive video lessons and hands-out on thermal energy before the class session as students get enough time to learn the concepts anytime at their own pace. Learners have enjoyed and engaged the learning at home. It is apparent from the study that FCA helps learners to learn thermal energy better.Moreover, the flipped lessons provide an efficient way of teaching and students get immersed in learning materials. It leads learners to perform well and learn better. Furthermore, the positive learning outcomes of the students in this study was in line with several studies [1-6].The mean score for motivation was 4.09 (*SD*=0.589) indicating that students were motivated to learn thermal energy. The finding was consistent with the findings of [12] where they conducted study on the flipped classroom: supporting a diverse group of students in their learning. Their analysis indicated that 75.5% of students were motivated to learn with flipped lessons. Moreover, present findings were also in congruent with that of study conducted by [13] where their study revealed that motivation to learn was one of the advantages of the flipped classroom. Further, qualitative data confirmed that flipped learning creates opportunity for self-learning and it encourages learning the concept. The result found that FCA motivates students to learn and provides an opportunity to learn at home, where they can learn more and explore the concept with the help of the internet at home.

It also creates an opportunity to engage their learning. P_5 opined that FCA enables students to participate actively and engage in learning. These findings were supported by [14] that they agreed with active learning and engagement as positive impacts of FCA. Flipped learning leads learners to learn the basic concept independently. Learning is self-directed where an individual learner takes own time and place to learn. The findings was validated by [15] that classroom learning was based on student-centered letting them to engage and self-learning. Students experience the change of learning culture from teacher-centered to learner-centered creating students' active learners. The findings were

supported by [16] that the flipped classroom offers active learning and hands-on activities. The quantitative analysis indicated that students preferred FCA than lecture sessions with agreement level of 3.80 and students experienced a positive learning culture due to the student-centric classroom. Likewise, the qualitative analysis confirmed that students get exposure to interact and discuss with friends which improves their learning. For instance, P_5 opined that I experienced more students centered in flipped learning and it improves my learning. In addition, I am engaged in learning and it gives me a platform to share my views. The flipped classroom as the 21st century allows student-centered learning as reported by [17]. They reported that the student-centered approach provides opportunity to explore and gain richer learning experience. Although the results of the study show positive impacts of flipped learning model and yet some of the students encounter challenges in using the flipped classroom. These problems are the lack of internet in the home environment, low internet speed or the lack of technical equipment of smartphones (P_3 & P_6). The results of this study are consistent with [18] that lack of accessibility of the videos and the internet connection, and study [19], where the students expressed the lack of technical tools as a disadvantage of the flipped learning model. Also similar to the results of this study, [17] has mentioned technical problems as one of the difficulties faced in flipped classroom practice.

6. CONCLUSION

In general, the flipped learning approach in education leads to higher academic outcomes and promotes improvements in students' learning performance. The result of this study shows that EG performs significantly better in the PLAT compared to CG in the posttest. It was also found that the test mean scores of EG were better than CG. Furthermore, the comparison between pretest and posttest in EG indicates that the test mean scores in posttest were significantly higher and better compared to CG. Therefore, the findings of this study evidently showed that there was significant improvement in students' academic performance.

The second objective of this study was to find out the impacts of a flipped classroom approach on students' learning of thermal energy. Student-centered learning is a pedagogical focus of the flipped classroom approach. This helps to enhance students' learning and achievement by emphasizing classroom activities on student understanding and discussions rather than the lecture session. Students enhance their engagement in class activities, participate in discussions, exchange ideas and solve problems with their friends. It also promotes students' motivation and develops the ability to learn independently at their own pace. Moreover, students get opportunities to interact, communicate and learn with a teacher and friends. Thus, the findings from student survey

questionnaires and interviews showed that the majority of the students had positive learning experiences towards the flipped classroom.Flipped classroom approach offers opportunities to improve students' learning as students get opportunity to learn at their own pace and work collaboratively in the class. The individual students get to interact, participate, and engage in learning thermal energy. This study also highlights some potential challenges that need to be addressed for an effective flipped classroom.

7. RECOMMENDATIONS

The results of this study on investigating the impacts of the flipped classroom on students learning in thermal energy could provide complementary data to inform the curriculum developer to align flipped lessons in curriculum for teachers to implement in the school. The study findings encourage teachers to use flipped classroom approach in teaching-learning process as it improved the academic performance of students. In addition, the findings urge preparing pre-service teachers at colleges of education to have adequate training to use flipped classroom strategy. Further, this finding recommended providing schools with adequate modern technology tools, and high speed internet to assist teachers to prepare resources required for the flipped classroom.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the author(s).

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Appendices

Appendix A: Test blueprint for PLAT

Chapter No.	PLAT	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	*Total*
1.1	Heat and temperature	PI-MCQ1		PI-MCQ2				**2**
1.2	Thermal energy		PI-MCQ3,	PIII-Q2	PI-MCQ4,	PII-TF 3		**6**

			PII-TF 2					
1.3	Modes of heat transfer	PII-TF 5	PI-MCQ 5				PIII-Q1	**5**
1.4	Specific heat capacity				PII-TF4			**1**
1.5	Insulation			PII-TF 1				**1**
Score		2	3	6	2	1	3	16

Note. PI- Part I, PII-Part II and PIII-Part III

Appendix B: Survey Questionnaires

Dear participants

I am conducting a survey with regard to implementation of flipped classroom for the fulfillment of master thesis in Physics. This is basically to investigate the impact of flipped classroom in learning physics concepts. Your response including your identity will be kept confidential. Therefore, your honest response is highly appreciated and valued.

Demographic

Gender: Male ☐ Female ☐

Age: 10-15 ☐ 16-20 ☐ 21 above ☐

Direction: Please tick your response against the statement on **flipped classroom**.

(Note: SD- Strongly Disagree, **D**-Disagree, **N**- Neither, **A**- Agree, **SA**- Strongly Agree**)**

Students' Learning experience towards Flipped Classroom						
I.	**Accessibility**	**SD**	**D**	**N**	**A**	**SA**
1	I can easily get learning materials.					
2	I have gone through the provided study material.					
3	Provided study material was useful					
4	I get the opportunity to communicate with other students.					
5	I get opportunity to communicate with the teacher					
II.	**Motivation**					
1	I am motivated in a flipped classroom.					

2	I participated more in flipped classroom.					
3	I engaged myself more in flipped classroom					
4	I am happy and satisfied with the flipped classroom					
5	I became more active learner in the flipped classroom					
III.	**Self-learning**					
1	I get a chance to watch video in my own pace.					
2	I learn the simple concept myself at home.					
3	I explore myself to learn the concept.					
4	I participate in the class discussion when the teacher provides self-learning materials.					
5	I engage in class activities when I am thorough with learning materials.					
IV.	**Higher Order Thinking Skills**					
1	I learned more and better in the flipped classroom					
2	I devoted myself more to the class activities in the flipped classroom					
3	I learned complex problems in the flipped classroom.					
4	I was made to think more in the flipped classroom.					
5	I have improved high level thinking skills while discussing and interacting in the class.					
V.	**Impacts of flipped classroom**					
1	I preferred the flipped classroom than lecture-based classroom					
2	I experienced student-centered in the flipped classroom					
3	I spent more time and effort in the flipped learning activities.					
4	I considered flipped classrooms to be a more effective and efficient way to learn.					

5	I enjoyed the flipped classroom approach in learning.					
VI.	**Challenges**					
1	Watching video or going through reading materials at home was time consuming					
2	Watching video or going through reading materials gave me too much burden and pressure					
3	The length of the video was too long and boring.					
4	Unable to watch video due to lack of facilities(Internet connectivity, smart phone)					
5	Reading materials and watching videosdemotivates me.					

Share your opinions on the impact of the flipped classroom?

Appendix C: Semi-Structured interview

1. Did you enjoy the learning resources provided to you? How was it?
2. How was the flipped lesson? Share your experiences on it.
3. How does the flipped classroom help you in learning?
4. Will you be able to participate in class activities? How?
5. What could be some advantages of implementing the flipped classroom approach?
6. What are the challenges you face during flipped classroom?