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Flipped classroom in teaching biology assessing students' academic achievement in Tang central school, Bumthang district

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ABSTRACT

Flipped Classroom is a new teaching pedagogy in Bhutanese context classrooms, it is an innovative teaching pedagogy used as a blended learning approach that involves providing learning materials through either online/offline instructional design that helps students to acquire the pre-notional concept lesson prior to the commencement of classroom teaching. What is done at the home is completed in the classroom. For instance, students complete their homework and the higher-order thinking activities through interactive group discussion and presentation within the classroom. Moreover, activities done in the classes are leveraged by the peers and the subject teacher. Consequently, this study investigated the effectiveness of the flipped classroom on students' academic achievement relative to Biology learning in secondary level schools. Control group was taught with traditional lecture method and experimental group was taught with using flipped classroom for two weeks on the topic cell division, a topic from class 10 Biology, a Bhutanese curriculum. The findings from the qualitative data were used to support the findings of the quantitative collected data adheres the biological achievement test scores of the control group and experimental after the intervention. The findings of both analyses provided insights into the applicability of flipped classroom as innovative pedagogy in the teaching of Biology and other subjects in Bhutanese schools. Therefore, finding recommends teachers to adapt the flipped classroom to enhance academic performance promoting lifelong learners and to have a meaningful teaching-learning process.

Keywords: Biological Achievement Test, Control group, Experimental group, Flipped Classroom

1. INTRODUCTION

The educational paradigm shift in the Bhutanese education system has taken place with the adoption of new teaching pedagogies to promote child-centred learning, knowledge-based learning, assessment-based learning, and community-based learning. In an attempt

to promote these approaches, recently, the Ministry of Education (MoE) has provided the professional development program on the 21st century transformation pedagogies to all teachers in the country intending to equip our teachers with the latest teaching-learning tools or approaches [1]. In this connection, the Flipped Classroom (FC) is a proven effective teaching

pedagogy popularly used in other parts of the world to meet the needs of educational goals for 21st century learners.

The FC tool was initially developed and introduced to schools in the US. For example, Bergmann and Sams 2007 started the concept of using FC at Woodland Park High School, in Colorado, USA, and the concept became popular among the school teachers [2]. This teaching pedagogy or model encompasses teacher-created videos or any other teaching-learning materials made accessible to students before to the commencement of classroom lesson delivery. For instance, the FC includes podcasts such as educational video clips, reading materials, practices at home, and other digital gadgets, technology-based resources outside the classroom for engaging students in a meaningful learning environment [3-4]. They called it the Flipped Classroom because the whole classroom/homework paradigm is "flipped"-meaning the conventional notion of classroom-based learning is inverted so that students are introduced to the learning material before the classroom teaching begins. Flip Classroom has four pillars that include (i) Flexible Environment (ii) Learning Culture (iii) Intentional Content, and (iv) Professional Educator [5]. Several other studies have also claimed that the advantages of FC include students getting help from teachers and peers on the difficult concepts learning, their interaction enhancement, allows for differentiation, creates conducive learning atmosphere, and students learn at their own ability and pace [6-8]. Thus, the pedagogy was proven to be effective in the classroom setting, where students take charge of their own learning, enhancing academic achievement of the learners.

However, in Bhutan, FC is a new concept in the teaching-learning process. Therefore, this study explored the effectiveness of the use of FC to teach Biology at the secondary level schools in Bhutan.

The study findings will serve as baseline data to inform teachers and other relevant stakeholders about students' conceptual understanding of Biology teaching in Bhutanese secondary schools through FC as a means of intervention. The finding will disclose the FC an effective pedagogy to improve students' academic performance. Similarly, finding will also help to redefine the role of the teachers in imparting the lesson on Biology and other subjects in Bhutan. As a result, this study will help to provide research-based information for the relevant stakeholders such as education colleges, policy-makers, school Biology teachers, other subject teachers and Royal Education Council (REC) in the education system

2. METHOD AND MATERIALS

2.1. Research Paradigm

The effectiveness of flipped classroom in teaching Biology through quasi-experiments used non-randomised assignments pre-test and post-test questions (quantitative) and semi-structured interview (qualitative).

2.2. Research Design

Field data collection was performed based on the explanatory sequential methods, and build on the quantitative results to explain in more detail with qualitative data.

2.3. Study Location

The study was conducted in one of the central schools under Bumthang district, Bhutan. School selection was done based on the availability of facilities such as good internet connectivity proper computer laboratory set up, and projectors.

2.4. Target Population and Size

The targeted population for the study was all grade 10 students from Central Schools of Bumthang district. A

Table 1. Sampling Size for Quasi-experiment

Group	Male	Female	Total
CG	14	12	26
EG	13	13	26
Total			52

Table 2. Sampling Size for Semi-Structured Interview

Group	Male	Female	Total
EG	3	1	4

total of 52 students participated in this study. Two sections were targeted population for quasi-experiment studying for the academic year 2019-20.

For the quantitative study, cluster sampling was adopted to select 52 students from two sections out of 90 students from three sections (Table 1). Each section had 26 students from selected clusters. One of the sections of grade 10 was involved as an experimental group and another one as the control group. Every section comprised of students with mixed abilities.

For a qualitative study, 4 students were selected using simple random sampling for a semi-structured interview to collect the qualitative data (Table 2). The questions for the semi-structured interview were designed based on the topic of cell division following Bhutanese curriculum.

2.5. Sampling Technique and Instrument

The researcher used convenience sampling while choosing one of the central schools in Bumthang district. A cluster sampling procedure was followed while forming Experimental group (EG) and Control group (CG) in one of the central schools. In a clustering sampling, first classifies the groups, collection of participant's names within those clusters, and then samples within them. Moreover, it is an effective technique to determine the characteristics of a group and can be implemented without the need for other

elements of the population. Most importantly, cluster sampling provides four key advantages such as convenience, takes less time and costs less, easy to be implemented, and a higher margin on data accuracy [9-10]. In addition, 4 students participated in a semi-structured interview.

A post-test was conducted to evaluate whether the intervention has an impact on the BAT at the end of the experiment responding to the researcher's first and third questions. BAT questions were framed based on the Bhutanese Secondary School Biology curriculum 2016. In addition, some of the questions were adapted from Bhutan Certificate Secondary Examination (BCSE). The questions contain good numbers of Competency-Based Questions (CBQ) to validate the learning outcome.

The study used a semi-structured interview to find students' in-depth conceptual understanding of the topic in the Biology classroom. Four students from the experimental group were interviewed to evaluate the students' conceptual understanding of the topic. The use of such an instrument helped the researcher to triangulate the data and make the findings more valid.

2.6. The Intervention in the Experimental Group and Control Group

The experimental group was taught the biological concept with the help of FC for a week long. Although not every student had the facility of video/PowerPoint at home or at the hostel, therefore arrangements were made for them to watch the clips in the school Information Technology Laboratory (IT lab) during their free hours. The treatment in the experimental group indicated the effectiveness of FC to teach the biological concept when compared with traditional lecture method. Finally, a semi-structured interview was conducted to collect data from 4 students to triangulate the effectiveness of FC.

Table 3. Data Collection Tools

	EG	CG
Pre-test	PREBAT1	PREBAT1
Intervention	FC	TLM
Post-test	PREBAT2 SI	PREBAT2

PREBAT1: Pre-test of Biology Achievement Test
 PREBAT2: Post-test of Biology Achievement Test
 TLM: Traditional Lecture Method
 FC: Flipped Classroom
 SI: Semi-structured Interview

The control group did not receive the FC intervention, thus CG was used as a baseline to distinguish groups and evaluate the impact of the intervention. The control group was taught in the traditional lecture method for a week long. Instruction for the both group was based on Bhutanese curriculum 2016 (table 3).

2.7. Data Analysis

The quantitative data were investigated using the SPSS version 22 and Microsoft excels 2013. Similarly, the qualitative data were transcribed and analysed based on the approaches of Creswell's thematic coding technique.

To examine the prevalence of any statistically significant differences between pre-test and post-test scores within the groups, a paired sample t-test was performed. Similarly, an independent t-test was conducted to compare the statistically significant differences in the learning achievement of the participants in FC and in the traditional lecture method based on the post-test scores.

The semi-structured interview provided participants the freedom to communicate their opinions in their own terms about the FC as interactive learning. To compare the effectiveness of FC in teaching biological concepts the use of FC in learning Biology, the data were coded and transcribed.

3. RESULTS AND DISCUSSION

An independent sample t-test was performed at 95% confidence interval to examine the prevalence of any

statistically significant difference between the test scores of EG and CG. Data indicated that there was no statistically significant difference $p < 0.437$ between CG and EG during the pre-test with a mean difference of 0.46, indicating that the distribution of students between CG and EG were equally considered in terms of learning abilities before the intervention was made detail in table 4. This finding is consistent with research studies in Bhutan and Indonesia [4-11].

However, statistical result of an independent sample t-test subject to post-test data analysis indicated that there was a statistically significant difference $p < 0.001$ between CG and EG with the mean difference value of 1.73, indicating the effectiveness of FC over the traditional method (Table 5). The study indicated that EG outperformed CG during post-test indicating the effectiveness of FC as an innovative teaching-learning tool in Biology. This result is similar to those of previous researchers, where they noted an improvement of students' performances and achievement in English, Chemistry and health allied courses, under a flipped classroom [4, 12-14].

To examine the effectiveness of the traditional method and FC as an interactive tool, pre-test and post-test data were analysed based on mark ranges. Differences in the marks between CG and EG of post-test scores are indicated in table 6 and 7 respectively, depicting that academic performance in FC was considerably better than the traditional teaching method.

This finding suggests that the FC is a useful teaching tool that can be used by the Biology teachers for enhancing the learning outcomes of students in the Bhutanese classroom teaching. This finding was consistent with that of the finding by the researchers who claimed that 70% of their students increased their standardized test scores, and 80% of the students developed better attitudes when they were taught via the FC [15-16].

Table 4. Independent Sample T-Test of Pre-test between Groups

	Groups	N	Mean	Mean difference	SD	Sig(2 Tailed)
Pre-test	CG	26	10.19	0.46	2.10	0.437
	EG	26	9.73		2.15	

* Significant (p<0.05)

Table 5. Independent Sample T-Test of Post-test between Groups

	Groups	N	Mean	Mean difference	SD	Sig(2 Tailed)
Post-test	CG	26	14.42	1.73	2.14	0.001
	EG	26	16.15		1.49	

Table 6. Comparison of Marks between Pre-test and Post-test Scores of CG

Mark range	Pre-test		Post-test	
	No of stds	Percent	No of stds	Percent
91-100	0	0.00	0	0.00
81-90	0	0.00	4	15.38
71-80	0	0.00	6	23.08
61-70	5	19.23	6	23.08
<60	21	80.77	10	38.46

Table 7. Comparison of Marks between Pre-test and Post-test Scores of EG

Mark range	Pre-test		Post-test	
	No of stds	Percent	No of stds	Percent
91-100	0	0.00	2	7.69
81-90	0	0.00	5	19.23
71-80	0	0.00	14	53.85
61-70	3	11.54	5	19.23
<60	23	88.46	0	0.00

The effectiveness of FC in this study may be attributed to associated features of the tool such as flexibility, self-paced learning, interactive video, and activity-based learning with close interaction with the subject teacher. One way to explain why students outperform in FC is due to its flexibility and provision of ensuring the distribution of learning materials prior to the commencement of actual classroom teaching [15-17]. All learning materials are distributed to students via offline ICT tools prior to the commencement of the lesson to

allow students for the pre-notion concepts generation of the lesson been taught in the class. It was a great opportunity for the students to have a greater choice of learning platform being created through FC.

Similarly, analysis based on qualitative data also confirmed that the FC enhances academic performance in Biology amongst the grade 10 students, pertaining to biological concepts on the topic cell division. For

instance, S1, S3, and S4 stated the definition of the term mitosis in similar ways.

Further, all the interviewees were able to explain the relationship between karyokinesis and cytokinesis, division of nucleus (karyokinesis) followed by division of cytoplasm (cytokinesis). The significance of crossing over was explained based on the genetic variation. For instance, S2 said, "*Significance of crossing over during the meiosis helps in the genetic variations; daughter cells are not exactly like their parents because of the crossing over*". S2 and S3 shared a similar opinion that the most unforgettable experience of FC was learning by watching videos using ICT and completing homework in the class. This qualitative data finding corresponds to the similar study by researchers that qualitative results suggest students have benefited from interactive learning, which required them to construct and negotiate meaning with their peers during the group discussion and the presentation [18-19].

Therefore, the finding of this study, both the quantitative and qualitative data confirmed that the FC has been a focal point in teaching reform. Academic performance is considerably better in FC than in traditional lecture method, this is because within the FC students are better able to prepare for the class meetings and have more opportunities to interact with the teachers and peers than during traditional lecture method. As a result, FC is more effective in teaching and learning Biology for Secondary Schools and to enhance the students' academic performance promoting lifelong learning.

4. CONCLUSION

The present study confirmed the use of the FC as an effective teaching-learning pedagogy in teaching biological abstract concepts, particularly the cell division at the secondary level schools in Bhutan. Similarly, effective implementation of FC will enhance academic performance promoting lifelong learners.

The better performance of students in FC is evidenced in this study whereby, the EG performed significantly higher $p < 0.001$ in terms of test scores as compared to CG during the post-test results. It was also noted that the mean and average test scores of the EG were considerably better than the CG in the post-test result. Therefore, the result of the study manifested a significant improvement in academic achievement towards Biology learning using FC.

Therefore, FC is one of the latest proven 21st-century pedagogy that leverages the academic performance of the learners and promotes child-centred learning, knowledge-based learning, assessment-based learning, and community-based learning. Hence, FC is found to be one of the most effective teaching pedagogy to have a meaningful teaching-learning process.

This study found that the FC is an effective pedagogy to enhance the motivation and learning of students in Biology. Hence, the study recommends Biology teachers as well as other subject teachers to access the information to be equipped with the pedagogical knowledge of FC and correspondingly, implement FC in the teaching-learning process. The effective implementation of FC depends upon the teacher's competency in using FC. The study also recommends policymakers such as principals, District Education Officers, and Teacher Professional Support Division to conduct professional development programs for in-service teachers on FC to provide adequate resources in the school.

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6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

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