ABSTRACT

Aims: The purpose of the study was to investigate the Effectiveness of the Self-Directed Learning approach in teaching Biology to grade nine students

Study Design: Convergent parallel mixed method design

Place and Duration of Study: It was conducted in Bhutan, and it took one year.

Methodology: Data were collected from 64 (32 girls, 32 boys) class nine students and one recently teaching Biology teacher (men) using closed-endedsurvey questionnaires, face-to-face semi-structured interviews andContent Achievement Tests. (**not clear**) Quantitative data were analyzed based on descriptive and inferential statistics using Statistical Package for the Social Sciences software version 22. However, qualitative data was analyzed thematically.

Findings: Analyses of the data revealed three findings. Compared to normal classroom teaching, the use of a self-directed learning approach provided noticeably improved grades in learning biology with a mean difference of 1.81, condition: $t(62) = 2.283$, $P = .02$.**(please explain *t* and*P*mean)**Further, the mean difference between post-test and delay post-test for the experimental group of 0.06 indicates self-directed learning approach has a positive impact on knowledge retention ability in learning Biology. However, there were no statistically significant differences between genders with $P = .73$. It was also evident from the finding that self-directed learning skills reports a positive medium effect size when compared to a conventional lecture-based method as the SDL approach is associated with personal autonomy in learning.

Conclusions: The study confirmed that the use of a self-directed learning approach was an effective strategy to achieve quality teaching and enhance learners' performance in learning Biology.

Key Words: Self-directed learning, Biology, Content achievement test, control group, experimental Group, effectiveness, and Student-centered

1. INTRODUCTION

The beginning of modern education in Bhutan was not an easy process as the geographical features of the country and the distances between the settlements made it difficult to provide education in every part of the country [1]. However, the Royal Government of Bhutan (RGoB) under the guidance of His Majesty the King of Bhutan has given priority to the education system realizing its full potential in educationand emerging modern education [2].

Despite the fact that the conventional method of delivering a lesson in class was proved less effectivein promoting students learning [3]. However,today's classroom teachings are still largely influenced by traditional education or instructions that limit learners-centeredactivities in learning biology [4].On the 17th of December, 2020 during the National Day celebration of Bhutan at Punakha, the Royal Kasho was presented to the people of Bhutan with Education Reforms. The Kasho command a need for either a major review of curriculum, pedagogy, learning processes and assessment to either transform or rewrite them in light of the problems and opportunities of the twenty-first-century learners [5]. Thus, it has become mandatory to shift the pedagogy trend from teacher-centered to student-centered learning. The time has come for teachers to be creative, and innovative and critically reflect on their current practices and update methods to better engage the students as active learners. However, a study [6] reveals that some school leaders and teachers are still inclined towards a conventional teaching style and Bhutanese students were passive participants in the classroom setting [7]. Moreover, it was evident that Bhutanese classrooms are mostly teacher-oriented settings with minimum opportunity for learners to actively participate [8]. Such approaches hardly encourage students to volunteer and carry out work of their own which needs to intervene with an enhancement of student-centered learning.

The study [9]states that self –directed learning (SDL)approach is one of the proven innovative teaching pedagogies used in classroom teaching and experimental settings of creating an experience to empower learners to make decisions about the material they want to learn. The study [10] suggested that limited attention to SDL has been given to learning for the improvement of performance and that expertise was needed among the learners when learning was deemed to be the appropriate performance improvement intervention. Similarly, the findings [11]claim that the concept of SDL has a rich history of research and practice in the secondary education field, however it has not received considerable attention in the context made learners increasingly challenged to assume more responsibility for their learning and development in work organizations.

In this modern world, the teacher's role should be more than classroom teaching which can help students learn by imparting knowledge and requisite skills by setting up a conducive situation in which students will learn effectively. In line with this, a study [12] reported that many effective student-centered

approaches are found to enrich students' knowledge but, these approaches are found not widely practiced[13].

The overall performance of grade X students in Biology at the National level, as well as Dzongkhag level Examinations, has been shown low performance (mean score < 60%) for the past five consecutive years with a national mean score of 51.01 [14]. Moreover, overall students' performance in the Science Technology Engineering and Mathematics (STEM) subjects under Samtse Dzongkhag based on BCSEA's results for the past five consecutive years has not been meeting the requirement of 60% Annual Performance Agreement (APA) target set by the Samtse Dzongkhag except biology in 2018 [14]. As a result, the very nature of students' low performance in Biology subjects draws attention and necessitates further investigation as they continue to decline in Bhutan's Science Education system. Further, the Program for International Student Assessment for Development (PISA-D) 2019 scientific literacy assessment reports that Bhutanese students have achieved success rates in items requiring lower cognitive skills with an average solution rate of 45.10 per cent which was significantly higher than the PISA-D average solution rate of 38.28 per cent. However, there was a huge performance gap between Bhutan and PISA reference countries [15].

According to available literature, numerous studies have been conducted to inspect and find a relationship between SDL and academic achievement. The study[16] showed that SDL is a good learning approach to predict learners' academic achievement. Moreover, the implementation of the SDL approach had a significant effect on students' academic achievement [17, 18]. It was found that SDL is essential for science students to become successful students, however, limited research exists on how SDL is related to workplace-learning constructs [19]. Additionally, the study[20] directs that at the university level, students were satisfied with SDL while it was proved that SDL students are found to be proactive and have a positive tendency to manage all learning activities and perform better in the exams as well[21].

It has been found that students who take responsibility for their learning (SDL) have greater academic achievement [22,23,24]. A comparative study [25] on a meta-analytic review of the SDL approach found a moderate to strong effect size in academic performance. Similarly, when SDL was compared to a traditional lecture-based method, a study on self-directed learning skills showed a positive medium effect size as the SDL approach is associated with personal autonomy in learning [26]. The findings [27]proved that SDL learners show a high level of motivation and self-confidence that results in better academic performance. No significant difference between genders in terms of academic achievements, despite an increase in both girls' and boys' achievements[28,29,30]. However, there was inconsistency with this argument, given that girls' performances are slightly higher than Boys' in academic achievements through Self-directed learning of Secondary school students [31].

There is little evidence of study done on the SDL approach being practiced in the Bhutanese school system though the approach was found to be proactive and has a positive tendency to manage all learning activities and perform better in the exams as well [21]. Therefore, this study investigated the

effectiveness of the self-directed learning approach as it has been one of the factors determining the performance of students in learning Biology [32]. The findings of the study can serve as a guide for school management and teachers to understand the impact of SDL practice for better students' academic achievement. Further, encourage and support teachers to implement a student-centered approach to learning through SDL activities in the Biology classes. Accordingly, it promotes the development of students' proficiency levels, and ability to retain knowledge, boosts their confidence,and develops problem-solving skills for the student. Nonetheless, the study is relevant to policy-makers and curriculum developers across the country as a whole.

1.1 Research question

1. Is there a statistically significant difference between the scores of an experimental and control group in the post-test?
2. Does the use of a self-directed learning approach improve the knowledge retention ability of the learners?
3. Is there a significant difference between the performance of males and females of the experimental group in the post-test?

2. METHODOLOGY

Mixed methods research, with its focus on the meaningful integration of both quantitative and qualitative data, can provide a depth and breadth that a single approach may lack by itself [33].Similarly, it was evident that using only one research approach will not cover all aspects of the research question to study on the particular topic however, a mixed method approach provides quality coverage of the research question [34]. Thus, the study used a convergent mixed method comprising quantitative and qualitative research approaches. Even, though both quantitative and qualitative have biases and weaknesses in collecting data, however, the mixed method will create a research outcome and neutralizes the gap [35].

2.1 Participants

The participants for this study were 64 grade IX students (32 males and 32 females) and 1 recently teaching biology teacher (male)Please rephrase, redundant.

2.2 Data Collection Tools

The data collection was done using various tools to gather information. The study used (a) closed-ended survey questionnaires, (b) face-to-face semi-structured interviews and (c) Content Achievement Test for the study.

2.2.1 Survey questionnaires

One set of semi-structured questions was used as survey questionnaires for respondents to answer and collect quantitative data from grade nine students of the selected school. Through questionnaire items, the researcher intended to investigate students' perception of the SDL approach in learning Biology. The survey questionnaire consists of two sections. Section A consists of demographic information, and section B with 30 items to collect information on participants' readiness, knowledge retention ability of the learners, academic performance, and benefits of the SDL approach. The survey questionnaires were based on five points Likert Scale: 1 (Strongly Disagree), 2 (Disagree), 3 (Neutral), 4(Agree), and 5 (Strongly Agree) with a given value of 1, 2, 3, 4 and 5 respectively.

2.2.2 Interview

The interview provides information that may not be necessarily obtained through a survey questionnaire. However, interviews provide a useful way for the researcher to learn about the world of others [36].In this study, two sets of semi-structured audio recording interviews were conducted for the selected studentsand teachers to collect data and use in addressing the research objectives. The semi-structured interview was more of the flexible version of the structured interview, where the researcher prepares a limited number of questions in advance and plans to follow up questions during the interview which is more convenient with sample selection [37].Similarly, a study [38]states that the interview needs to be flexible where other important information can still arise. The interview questions contain both open-ended and closed-ended questions as it helps to get a deeper understanding of the study.

The researcher focused on two different groups, teacher and student focus groups to conduct the interview and gather qualitative data. The student focus group consisted of three males and three females. However, only 1 Biology teacher currently teaching Biology subject in grade IX were interviewed.

2.2.3 Content Achievement Test

The Content Achievement Test designs are widely used in behavioural research, primarily to compare groups and measure change resulting from experimental treatments [39]. To investigate the effectiveness of the intervention, a pretest and post-test were conducted before and after the intervention respectively. Further, a delay post-test was conducted to examine the retention knowledge of the learners.

2.3 Validity & Reliability of the tools

Reliability and validity are the two utmost significant and ultimate features in the evaluation of any measurement instrument for worthy research [40]. Validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher, the participants, or the readers [41]. To establish the validity and reliability of the research instrument of the survey questionnaire, the researcher conducted a pilot test for fifty grade nine students at one of the Secondary Schools under Samtse Dzongkhag. The reliability test was analyzed using SPSS upon survey questionnaire resulting in Cronbach's Alpha Coefficient value of 0.87.

Similarly, for language appropriateness, clarity, content coverage, and content relevancy of the questionnaire and interview questions tools were subjected to check and comment by at least two experts besides the supervisor. Member checking was done after the transcription of data collected through the interview. Moreover, the researcher ensured that the elements in the questionnaire and interview questions have all the components that enable answering all the research questions. Content Achievement Test questions were developed by consulting two Biology teachers currently teaching grade nine and using standard Bloom's Taxonomy. Further, the tool was corrected and adjusted following comments and recommendations by the supervisor. In this process, the content tools were checked and validated by two experts.

2.4 Data Analysis

For the convenience of the researcher to interpret the data collected, the quantitative data and qualitative data were analyzed separately using inferential statistics and descriptive statistics to classify the data from two different sources using Statistical Package for Social Sciences (SPSS). For validation of the result, the data were triangulated by directly comparing the quantitative statistical results with the qualitative findings from the interview.

The quantitative data gathered through the Content Achievement Test (pretest, posttest, delay posttest) and survey questionnaire were analyzed using SPSS software version 22. To find the relationship, between the self-directed learning approach and the conventional learning method in learning Biology, Concept Achievement Test data were analyzed using inferential statistics such as; independent sample t-test, pair sample t-test, ANOVA test, and correlation.

Survey questionnaire data were analyzed using descriptive statistics using features of SPSS such as percentage, mean, standard deviation, and graphical representation. To analyze the data, the scale for the score range used to find the level of perceptions on the SDL approach was adapted from Brown's [42] scale. The score range was divided into 5 categories: Very Low (1-1.50), Low (1.51 - 2.50), Moderate (2.51 -3.50), High (3.51 4.50), and Very High (4.51 -5.00). The lowest possible mean score was 1 and the highest score was 5.

For qualitative data analysis, the participants' responses to semi-structured questions were obtained using audio recording. By listening to the audio-based data repeatedly, the data were transcribed for analysis. Further, the transcription was read line by line and coded the relative words to obtain in-depth information. The categorization of qualitative data was analyzed thematically.

3. FINDINGS

This section reports the analyses of the Content Achievement Test, interview transcriptions and open-ended questionnaire responses. There are three sections.

3.1 Effectiveness of SDL approach on Content Achievement Test

This section answers the statistically significant difference between the scores of an experimental group (EG) and control group (CG) in the pre-test and post-test. The pre-test was intended to examine the homogeneity of the students in learning abilities for the formation of CG and EG before the commencement of the intervention. Post-test data was meant to examine the mean significant difference between the groups on the effect of the SDL approach in learning Biology.

To analyze the effect of the SDL approach on the Content Achievement Tests between the groups and within the groups, an independent sample t-test and pair sample t-test were performed.

3.1.1 Analysis of pre-test data for EG and CG

To achieve an even distribution of the students in terms of their learning ability, a pretest was carried out before the intervention. The pre-test scores of the experimental and control groups show that there was no difference between the groups in the knowledge of the digestive system before the intervention of the study. The condition: t (62) = -1.36, P = .178 showed that the test failed to reject the null hypothesis: *There is no significant difference between the ability of CG and EG*. Similarly, Cohen's *d* value (*d=0.03*) indicates a small size effect between the groups revealing that before the exposure of students to the SDL approach, the learners had similar academic achievements (Table1).

Therefore, these results show that it is appropriate to conduct the experiment and subsequently compare the learning achievement on the topic of the digestion system. Thus, to test the effectiveness of the SDL approach, the group with the lowest mean scores on the pre-test was chosen as the experimental group.

Table 1. Independent sample t-test on pre-test result

	Group	N	Mean	Mean Difference	SD	df	t	*P*-value	Cohen's d
Pre-test	CG	32	6.62		1.60				
				0.59		62	-1.36	.178	0.03
	EG	32	6.03		1.87				

A significant level of p<0.05

Cohen's d value: d=0.2 - small effect, d=0.5 - medium effect, d=0.8 - large effect

3.1.2 Analysis of post-test data for EG and CG

An independent t-test was conducted to analyze significant differences between the mean scores of the CG and EG. The analysis showed that the students of the EG performed better than the students of CG in the content achievement test with a mean difference of 1.81, condition: *t* (62) =2.28, *P*= .02, indicating the positive impact of the SDL intervention on students' performance in biology during the study period (Table 2). Further, the effect size of the SDL approach in the academic achievement of the students was found with Cohen's *d* value equal to 0.58. The effect size (*d=0.58*) indicated that the SDL approach has a medium impact on students' academic learning scores.

Table 2. Comparison of post-test between CG and EG

	Group	N	Mean	Mean Difference	SD	df	t	*P*-value	Cohen's d
Post-test	Control	32	9.03		2.75				
				1.81		62	2.283	.026	0.58
	Experimental	32	10.84		3.54				

A significant level of p<0.05

Cohen's d value: d=0.2 - small effect, d=0.5 - medium effect, d=0.8 - large effect

3.1.3 Comparison of Pre-Test and Post-Test within EG and CG

To find the statistically significant difference within the group, the Paired Sample t-test was conducted for comparative analysis. Table 3 shows that there is a statistical difference between the pre-test and the post-test score of the control group (*t (31)= -3.91, P<0.05*) in students' learning achievement after treatment with the post-test mean score (*M=9.03*) and the pre-test mean score (*M = 6.62*). This indicates that the lessons which are studied in a conventional approach show an effect on students' learning. On the other side, the experimental group (*t* (31) = *-6.66, P<0.05*) also shows that there is a statistically meaningful difference between the test score in the students' learning after treatment with the post-test mean score (*M=10.86*) and the pre-test score (*M = 6.03*).

Thus, the finding indicated that students who had learned the digestive system using the SDL approach were significantly better in their achievement test compared to students who learned using the conventional approach.

Further, the standard deviation of the means of the pre-test in the control group and the experimental group were 1.60 and 1.87 respectively. The difference between the standard deviation of means of the pre-test was 0.27 which is less and it indicated that the level of variation in the scores of both the groups was similar. This means that the learning ability of the students was almost similar in both groups.

However, the standard deviation of the means of post-test in the control group and the experimental groups were 2.75 and 3.54 respectively. The difference between the standard deviation of the means of the post-test was 0.79 which indicated that the level of variation in the scores for the groups differs. This means students' learning abilities varied between the groups.

Table 3. Comparison of pre-test and post-test within experimental and control groups (Paired Sample t-test)

Group	Test	Mean	Mean Difference	S.D	T	df	*P*-value
Control	Pre-Test	6.62		1.60			.000
	Post-Test	9.03	2.39	2.75	-3.91	31	
Experimental	Pre-Test	6.03		1.87			.000
	Post-Test	10.84	4.81	3.54	-6.66	31	

A significant level of p<0.05

3.1.4 Learning Performance and SDL Approach

Descriptive analyses were conducted to examine learners' performance using the SDL approach. Table 4 represents the mean, standard deviation and level of perception on learner's performance of EG participants in learning Biology.

Table 4. Rating of Learning Performance towards SDL

Item No.	Items	Mean	S.D	Degree of perception
1	I feel Self-directed learning will help in remembering for a longer duration	4.13	1.18	High
2	Self- self-directed learning approach helps in academic achievement	4.06	.948	High
3	Self-directed learning helps to be proactive, have a positive tendency to manage all learning activities and perform better in the exams as well	3.97	.99	High
4	Taking responsibility for own learning has greater academic performance	3.88	1.15	High
5	learners show a high level of motivation and self-confidence that results in better academic performance	3.52	1.14	High
6	A better financial (rich) background helps in high academic performance	2.63	1.38	Moderate

7	A literate family background is related to better academic performance	3.28	1.22	Moderate
	Overall	3.64	1.33	High

Note: The level of perception is based on Brown (2010). Very Poor: 1-1.50, Poor: 1.51-2.50, Moderate: 2.51-3.50, High: 3.51-4.50, Very High: 4.51-5.00

Table 4represents the average mean (*M=3.64*) and standard deviation (*S.D=1.33*) indicating that participants have a high level of perception of learning performance using the SDL approach. This revealed that participants involved in the SDL approach can perform better in learning Biology.

Corresponding to quantitative data findings, the data collected from students' interviews revealed similarities. When learners are involved in the exploration of information on the digestive system using the SDL approach, learners participate actively with full curiosity which is the basis for better learning performance. For instance, PS5 expressed, "SDL approach helps to build self-confidence to learn independently, skills to explore unlimited information, validate the information and remember better resulting productive learning outcome".My diary also revealed that other participants in the focused group nodded their heads in acceptance of the PS5 view.

A similar statement was pointed out by PT, "SDL approach is interesting and inquires students to explore the information more than one source (Textbook) that improves their performance".

Surprisingly, the statement "Better financial (rich) background helps in high academic performance" and "Literate family background is related to better academic performance" provided in Table 4 were lowest-rated with the mean (*M=2.63, M=3.28*) and standard deviation (*S.D=1.38, SD=1.22*) respectively, which fall in a moderate level of perception. This symbolized that participants are not able to judge the difference in learning performance using the SDL approach for different family backgrounds. The statement was further accentuated by PS1:

> SDL approach is appropriate for every learner with a different financial background if the teaching and learning happening within school premises as learners can utilize the resources from the school. However, learners with a low financial (poor) background will certainly encounter some difficulties if the learning extends beyond school hours.

3.2 SDL approach and the knowledge retention ability of the learners

The delay post-test was intended to investigate the knowledge retention ability of the learners which was conducted two weeks after the post-test consisting of the same question for the EG and CG. The arithmetic mean of delay post-test scores was calculated for EG, and the results were compared with post-test scores (Table5).

In Table 5, the mean difference between the post-test (*M=10.84*) and delay post-test (*M=10.90*) for EG was 0.06 which indicates the SDL approach has a positive effect on knowledge retention ability for the learners in learning Biology.

Table 5. *Comparison of mean scores between post-test and delay post-test*

Group	N	Mean (post-Test)	Mean (Delay post-Test)	Mean Difference
EG	32	10.84	10.90	0.06

Further, a Paired Sample t-test was conducted for comparative analysis between the delay post-test of CG and EG. Table 6 shows that there is a statistical difference between the mean score of the CG delay post-test (*M=8.06*) and the EG delay post-test score (*M=10.90*). Moreover, t (31) = -3.56, p = .001 revealed that there was a statistically significant difference between the tests. Thus, the finding indicated that the use of the SDL approach helps better knowledge retention ability of the learners than the use of the conventional method in learning Biology.

Table 6. Compare the Delay post-test score of E G and CG (Pair sample t-test)

	Test	N	SD	t	df	*P*-value
Control Group	Delay post-test	32	8.06			
Experimental Group	Delay Post-test	32	10.90	2.84	31	.001

A significant level of p<0.05

Similarly, the findings from students' and teachers' interviews correspond with the quantitative data findings. All the participants accept that the SDL approach helps to improve the knowledge retention ability of the learners in learning Biology. For instance, PS1 expressed, “Students learning in our own way helps to understand better and remember for a longer duration than learners listening passively to teachers lecture”. Correspondingly, PS5 pointed out that the SDL approach helps in the knowledge retention of learners as students learn by doing themselves which supports remembering for more

extended periods. Further, PS1 shared that the SDL approach involves students learning, exploring, and experiencing themselves which enhances learners' memory.

3.3 Analysis Based on Post-test Data between the Genders

An independent sample t-test was performed at a 95% confidence interval to examine statistically significant differences between genders learning digestive systems using the SDL approach. This finding was to address research sub-question 3 (refer to Chapter 1). Table 7 shows that there was no statistically significant difference between the mean scores of males (M =11.06, SD=3.29) and females (M =10.62, SD=3.87); t (30) =.344, *P*= .73.

Table 7. Comparison of post-test between male and female

	Gender	N	Mean	Mean Difference	SD	T	DF	P-value
Post-test	Male	16	11.06		3.29			
				0.44		.344	30	.73
	Female	16	10.62		3.87			

A significant level of p<0.05

Similarly, the findings from student and teacher interviews resemble the quantitative data findings. All the interviewees felt that the SDL approach has no difference in learning achievement between genders. PT shared, "I do not have a specific answer regarding gender difference in academic performance using SDL approach. Both the genders are academically sound". Moreover, PS2 remarked, "To have better academic performance using SDL, gender does not differ as learners who all are interested to learn independently obviously perform better than learners without interest". My diary also revealed that all other student interviewees nodded their heads in acceptance of the PS2 statement.

4. DISCUSSION

The purpose of this study was to investigate the effectiveness of using the self-directed learning (SDL) approach over the conventional learning method (regular normal lesson) in teaching grade ninth Biology. In this section, the effectiveness of the SDL approach was discussed guided by the three research questions of this study. The research questions draw the findings on the academic performance of students in the Experiment Group (EG) through content achievement tests and participants' perceptions of the use of the SDL approach. Thus, this section presents the findings of the study in the following sequences:

4.1 Effectiveness of self-directed learning approach on teaching Biology

Content achievement tests were conducted on the topic ‘Digestive System’ for students of both CG and EG to address research questions.

The equal distribution of students in terms of their learning ability for CG and EG was necessary at the beginning of the study before the commencement of the intervention [43]. The data analysis done for the pre-test of CG and EG showed that there was no statistically significant difference between the groups indicating similar learning abilities of the students in the groups for the researcher to experiment on the selected sample.

To address the first research question, the study aimed to examine the effect of the SDL approach on learning biology in ninth-grade students using quantitative and qualitative data evidence. Quantitative findings based on the post-test data revealed that the two groups were significantly different from one another, t (62) = 2.28, $p < .05$), suggesting that two weeks of intervention using SDL has shown an effect on the improvement of student performance in biology. The students of EG who were exposed to the SDL approach performed significantly better than the students of CG who were taught conventionally. This difference in their performance may be attributed to good aspects of the SDL approach that this strategy allows students to be more creative, curious, and motivated in their learning. This finding is consistent with several studies [44,45,25] that stated several benefits or advantages of using the SDL approach in a teaching context. Other studies have proved that students’ initiating to take responsibility for their learning using SDL results in better academic achievement [22,23,24].The present quantitative finding was also in agreement with those ofthe study [17] which reported that the SDL approach has a positive effect on overall students' academic achievement.

Further, the overall Cohen's effect size of this study based on the post-test data indicated a moderate medium (Cohen's d=0.58). This finding suggested that the SDL approach as an intervention had a moderate medium effect size on the academic outcome that measures students' learning. The medium effect size in this study was mainly influenced by the limited resources in the school during the time of intervention. The finding was in line with the study [46] on a meta-analytic review of the SDL approach that has shown a moderate to strong effect size in academic performance. In addition,a study [26] on self-directed learning skills reports a positive medium effect size when compared to a conventional lecture-based method as the SDL approach is associated with personal autonomy in learning.

Students in the EG benefited the most from the intervention as their scores improved from the pre-test mean score of 6.03 to a post-test mean score of 10.84. This is because students in the EG are interested in exploring information beyond the information given in the textbook through information and communication technology (ICT) facilities to validate their information. Moreover, taking responsibility for their learning enables them to study better and concentrate more on the subject matter allowing for a

better understanding of the concept. Similarly, qualitative findings revealed that most of the participants shared that the SDL approach is an interesting and productive way to learn which requires students to explore information from more than one source (Textbook) that improves their performance. For example, student participants (PS5) expressed that "To have better academic performance using SDL, gender does not differ as learners who all are interested to learn independently obviously perform better than learners without interest". In addition, the majority of students stated that 21st-century learners do not like teacher lecturing in class which is monotonous for learners and limits information to one person's knowledge in learning. Furthermore, one of the student participants pointed out that "the SDL approach encourages working independently and enhances the use of ICT facilities that enable increased in academic performance". These present findings were consistent with the finding [19] that highly self-directed students can depend on themselves in learning and have greater academic achievement in science education. In the same context, it was revealed that technology and SDL have a strong relationship related to student academic achievement [47].

The student's achievement in biology education depends on the use of different strategies for teaching and learning biology. The present study showed most of the students affirmed that learning Biology through the SDL approach helps them to understand biological concepts better. Therefore, the SDL approach in teaching biology brought significant improvements in student learning and uplifted the learning capacity of students in this study.

4.2 SDL approach and the knowledge retention ability of the learners

To address the second research question, the delayed post-test which was administered two weeks after the post-test for the CG and EG was designed to look into the learners' capacity for knowledge retention. Firstly, the results were compared with post-test scores after calculating the arithmetic mean of delay post-test scores for EG. The mean difference between the post-test (*M=10.84*) and delay post-test (*M=10.90*) for EG was 0.06 which indicates the SDL approach has a positive effect that helps knowledge retention ability for the learners in learning Biology. The findings in the present study were consistent with the findings that case-based learning (CBL) in endocrine physiology using the SDL approach helps in knowledge retention of the learners as the intervention makes students responsible for their learning and work independently [48].

Secondly, a comparative analysis between the delay post-test of CG and EG showed that there is a statistically significant difference between the mean score of the delay post-test of CG and EG. The finding showed that compared to students who learned using a conventional method, learners who used the SDL approach had improved knowledge retention abilities. This could be because students need to set goals independently, explore and experience themselves to inculcate knowledge rather than the teacher providing the information. In line with the findings, the study showed that the student-centered learning strategy boosts the learner's ability to retain knowledge when compared to conventional learning

methods [49,50,28]. Accordingly, it was discovered that a student-centered learning approach has favourable effects on information retention [51].

Similarly, the findings from students' and teachers' interviews correspond with the quantitative data findings. All the participants accepted that the SDL approach helps in the knowledge retention ability of the learners in learning Biology. For instance, one of the student participants expressed that by passively listening to the teacher's lecture, learners forget faster. However, comprehending conceptsretains information for a longer duration if learners study in their own way. Correspondingly, other student participants pointed out that the SDL approach involved students learning by exploring and experiencing themselves which enhances learners' memory. These findings were in agreement with the study [52]whichinvestigateddeconstructing the effect of self-directed study on episodic memory. They found that self-directed learning is often associated with better long-term memory retention. The results suggest that improvements to memory following the SDL approach may be related to the ability to match stimulus presentation with the learner's current state of readiness and attention.

4.3 Gender-Wise Performance in the Self-Directed Learning Approach

This section discusses toaddresses the research sub-question 3 about the gender-wise difference in the academic performance of grade nine students after intervention (SDL approach). The finding of this study revealed that there was no statistically significant difference between males and females in learning the digestive system using the SDL approach. This is supported by the lack of significant differences ($p = .733$) with the mean value difference of 0.44 between the genders in the content achievement test conducted after the intervention. This finding is consistent with previous studies [30] that the performance of students using the SDL approach in learning had not shown gender differences. Further, the findings were supported by the study [29] on SDL and academic achievement in secondary online students that there is no significant difference in SDL according to gender. The possible reason could be due to self-confidence and interest of the learner to explore independently tend to have a higher academic performance rather than gender. In addition, it has been discovered that students who take responsibility for independent learning (SDL) have greater academic performance rather than gender differences [22,23,24].

Similarly, the findings from the interview resemble the quantitative data findings. In contrast to earlier findings [31] that girls' performances are slightly higher than boys in academic achievements through the SDL approach of secondary school students, all of the interviewees believed that the SDL approach does not differentiate between genders in terms of learning achievement. For instance, one of the participants remarked that "To have better academic performance using SDL, gender does not differ as learners who all are interested to learn independently obviously perform better than learners without interest".

Therefore, findings concluded that the SDL approach does not have a difference in impact on students' learning achievement towards the subject, between male and female students.

4. CONCLUSION

This study was intended to investigate the effectiveness of using the Self-Directed Learning (SDL) approach for grade nine students in one of the secondary schools in Bhutan. A mixed method research design with both quantitative and qualitative aspects with three different instruments (such as a survey questionnaire, semi-structured interview, and content achievement test) was implemented to answer the research question. A total of 64 students of grade IX and a teacher currently teaching Biology participated in the study. The findings are addressed based on research sub-questions and a detailed interpretation of the study was presented in the discussion chapter.

The present study confirmed the use of the SDL approach as an effective teaching-learning approach in teaching biological concepts, the particularly digestive system at secondary-level schools in Bhutan. The better performance of students in the SDL approach was evident in this study whereby, the EG performed significantly higher in terms of content achievement test scores as compared to CG during the post-test results. It was also shown that the mean scores of the EG were considerably better than the CG in the post-test result as discussed in chapter four. Thus, the result of the study revealed a significant improvement in the academic performance of the students implementing the SDL approach as a teaching-learning strategy.

In addition, students selected for the present teaching-learning intervention in the form of the SDL approach have shown better knowledge retention abilities of the learners compared to students involved in the conventional method. This difference may be attributed to worthy aspects of the SDL approach that this intervention allows students to be more creative, curious, and motivated, and be responsible for their learning. On the other hand, the study revealed that there was no significant gender difference in terms of academic performance using SDL. These may be attributed to the fact that every individual's learning profile is taken into consideration and everyone gets an equal share of learning based on their learning interest and choice. Furthermore, the close interaction, self-confidence, and interest of the learner to explore independently tend to learn the concept better irrespective of their gender.

5. RECOMMENDATIONS

This study concluded that the SDL approach is an effective pedagogy that enhances students' academic achievement and helps in improving students' creative thinking, critical thinking, collaboration, independent learning, and motivation toward learning Biology. Therefore, the study recommends Biology teachers as well as other subject teachers implement the SDL approach to have reliable teaching-learning practice. The study also recommends every level of policymakers conduct professional

development programs for in-service teachers on the SDL approach that could enhance the academic performance and responsibility for independent learning of the students.

The study recommends further studies on the following areas:

1. A similar study can be carried out covering a larger area with an increased sample size to generate the impact of the SDL approach in Bhutan and validate the findings of this study.
2. To acquire effective results on the knowledge retention abilities of the learners, the duration between the conduct of delay post-test and post-test can be increased.
3. To get a profound understanding of the effects of the SDL approach on students' achievement and students' perceptions, future studies can be done using additional tools such as observation and document analysis.
4. SDL approach demands better ICT facilities, it would be better to conduct future studies in the school with available facilities.

CONSENT

Consent forms defining the objectives and purposes of the study were emailed and signed by every participant thattheir involvement in this study was purely voluntary.

ETHICAL APPROVAL

The researcher needs to get a clearance letter from the concerned authority to visit the site and participants before conducting the study [41]. For this study, written approval from the Dean of Research and Industrial Linkages (DRIL), SCE, Chief Dzongkhag Education Officer under Samtse Dzongkhag, and the principal of the representative sample school was availed. At the same time, the researcher ensured that the normal functioning and programs of the schools were not disturbed.

While conducting research, the researcher assures respect privacy, confidentiality, and anonymity of the participants. Before administering the questionnaires and interview the participants were made aware of conducting research or the nature of the research. The study was purely based on the participant's interest, voluntarism with the right to withdraw at any time [53]. Further, Participants were informed about the research ethics, the confidentiality of the information as it was purely used for the research purpose and the consent form.

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