THE EFFECTIVENESS OF PROJECT-BASED LEARNING IN TEACHING BIOLOGY AT HIGH SCHOOL LEVEL

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Abstract

The main purpose of the study was to investigate the effectiveness of project-based learning in teaching biology at Basic Education High School Level. An experiment was conducted with 70 Grade 10 students from No. 1 Basic Education High School, Amarapura and 69 Grade 10 students from No. 2 Basic Education High School, Amarapura of 2023-2024 Academic Year. In this study, one of the Quasi-Experimental Designs, "Nonequivalent Control Group Design" was used. Students are divided into two groups: experimental and control groups. Experimental groups were provided with project-based learning and control groups were provided with ITPR procedure. Pretest, posttest and survey questionnaire are used as instrumentations. Pretest was conducted to know the basic biological knowledge between control groups and experimental groups. According to the result of pretest mean scores, it was found that there was a significant difference between control and experimental groups in both selected schools. Therefore, posttest mean scores were analyzed by using analysis of covariance (ANCOVA) to determine whether there are significant differences between experimental groups and control groups according to the Bloom's taxonomy of cognitive domain. The result of posttest mean scores indicated that there were no significant differences between experimental group and control group in terms of remembering level. However, there were significant differences between two groups in terms of understanding, applying, analyzing and evaluating levels and overall biology achievement scores. Moreover, to interpret students' attitude towards project-based learning, questionnaire was used. According to the students' responses of questionnaire, students had positive attitude towards project-based learning. The study suggested that project-based learning is exactly a harmonious teaching method for hands-on biology activities.

Keywords: project-based learning, biology, biology achievement

Introduction

The world today is rapidly and continuously changing in every field and every phase. In this dramatic changing world, education is no exception. As children grow up in an increasing technological and scientific world, they all desire learning by practice rather than transforming theory and information. As a result, teaching methodology plays an important part and every biology teacher should try to meet methodology that can affect positively in biology teaching. Teachers should choose the correct methods and techniques in optimizing students' participation in the class for a more meaningful learning process by realizing the importance of Biology. Therefore, a sense of innovation is needed in the teaching and learning of Biology to increase the quality of education.

Now, Myanmar government is doing education reforms by implementing long-term and short-term plans including a new National Education Strategic Plan (NESP) during the period 2016-2021 with the vision of creating an education system that will generate a learning society capable of facing the challenges of the Knowledge Age (Wint Zaw Htet, 2020). Therefore, teachers in Myanmar should try to meet the latest, modest teaching methods in order to catch the aims of new curriculum. Various teaching strategies can be applied to get the needs of 21st century skills and all-round development of students.

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Project-based learning is more relevant to students and increases students' motivation and interest to complete the task. Moreover, project-based learning is more effective in a wide variety of subject area including mathematics, science, economics and history (Bender, 2012). This study therefore investigated the effectiveness of project-based learning in teaching Biology at high school level.

Statement of the Problem

The new basic education curriculum should have greater focus on learning concepts, problem-solving processes and understanding of basic principles and reasons behind the knowledge (NESP, Ministry of Education, 2016). However, many teachers still used lecture method and it can lead to minimize students' creation, critical thinking, problem solving and reasoning. Besides, students emphasized rote-learning because of exam-oriented system. According to the updated curriculum reform, the importance of teaching and learning at school is increasing, likewise in biology teaching. Biology is a scientific and practical subject. The subject matter can be effective only if students can learn practically rather than deliver information. Therefore, hands-on, creative and innovative teaching methods are needed to increase with good acceleration. Project-based learning can be the solution to this problem because it emphasizes learning by doing and decreases rote learning.

Purpose of the Study

The aim of this study is to investigate the effectiveness of project-based learning in teaching biology at high school level. The specific objectives are as follows:

1. To compare the biology achievement between students who are taught by project-based learning and those who are taught by ITPR procedure
2. To compare the biology achievement between students who are taught by project-based learning and those who are taught by ITPR procedure in terms of cognitive level
3. To offer related discussion and recommendations for improving biology teaching and learning based on result of the study

Research Questions

1. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure?
2. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure in terms of remembering level of learning?
3. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure in terms of understanding level of learning?
4. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure in terms of applying level of learning?
5. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure in terms of analyzing level of learning?

6. Is there any significant difference between biology achievement of the students who are taught by project-based learning and those who are taught by ITPR procedure in terms of evaluating level of learning?
7. What kind of attitude do the students develop towards project-based learning?

Definition of Key Terms

Definition of key terms are presented as follows:

Project- Project is a piece of work involving careful study of a subject over a period of time, done by school or college students (Hornby, 2010)

Project-Based Learning- Project-based learning can be defined as an in-depth learning focusing on real-world problems and challenges that engages students who work as a team through meaningful activities resulting in an end product (Simpson, 2011)

Biology-Biology is the scientific study of the life and structure of plants and animals (Hornby, 2010)

Biology achievement-Biology performance of students as measured by the grades taken from the Biology Achievement Test (BAT) used in the study (Ozkan, 2003)

Scope of the Study

The following points are the scope of the study;

1. This study is geographically restricted to B.E.H.S 1 and B.E.H.S 2 in Amarapura Township in Mandalay Region.
2. Participants in the research are Grade-10 biology students from the selected high schools in (2023-2024) Academic Year.
3. The topic for the study is "Chapter 5 Continuation of Life: Reproduction in Fungi and Plants" in Grade10 Biology Textbook.

Significance of the Study

Since the current national curriculum and national education plan places a strong emphasis on lifelong learning, learner-centered approaches and communicative competence should be used in the meaningful way. It is vital to investigate a change in the way that biology is taught and how students can learn biology more effectively. Teachers today are under incredible pressure to cover all of the content standards in the curriculum and increase students' achievement, and they wonder how project-based learning fits into that imperative (Bender, 2012). Thus, this study attempts to introduce project-based learning as a teaching method. The results of the study will provide valuable contributions in the field of education. Hopefully, the result will also provide an insight into the nature of project-based learning and other relevant teaching techniques that can enhance students' achievement in teaching biology. This study sets an aim to inform teachers, especially biology teachers, the ways and means of project-based learning. And then, for students, they will attain communication and collaboration skills by learning and doing together, creative thinking skills by sharing and caring one another. To sum up, this study expects to be a little support in moving effective biology teaching.

Review of Related Literature

Importance of Biology

There are numerous indications of the importance of biology. Biology is primarily concerned with studying life. In addition, it offers a thorough scientific explanation of how all

living and nonliving things interact with one another. Their structures and functions are associated with one another in their respective environments (Ministry of Education [MOE], 2019). Over the nineteenth centuries, biological sciences such as botany and zoology became increasingly professional scientific disciplines (LibreTexts, 2023). Biological knowledge contributes to agriculture, diet, health and hygiene. Biology, therefore, can play an important role and essential part for all human's existence, convenience and achieving socio-cultural change.

Effective Teaching Methods in Teaching Biology

Biology is a process of ordering and classifying, of formulations, explanations and hypothesis through experiments. To learn science is to do science. For teaching of biology, an appropriate method is needed. Teaching of biology gains significant importance. Some methods are more of teacher centered and some are more of student centered. It is up to a teacher's discretion to choose the method which is most suitable for a certain topic in a certain class (Rajan, 2012). Therefore, in choosing teaching method, teacher has a chance to choose any of the method of teaching according to his knowledge, interest, experience and selecting content area. Rather than using a single method for all topics, using the combination of methods can be more effective. The purpose of learner-centered approach is to develop the learner's skills and abilities in independent way. Examples of effective learner-centered teaching methods in biology are laboratory method, concept mapping, problem solving method, project method and discovery learning. Among them, project-based learning integrates knowing and doing. Students can not only learn knowledge but also apply what they know to solve authentic problems. Thus, it can be effective teaching method in teaching biology.

Project-Based Learning (PBL)

The project-based learning (PBL) has been part of the educational practice approximately at the beginning of the 1980s and it was greatly influenced by the communicative approach. Project-based learning was first introduced by John Dewey at the end of 1890.

Project-based learning may be defined as using authentic, real-world projects, based on highly motivating and engaging question, task, or problem, to teach students academic content in the context of working cooperatively to solve the problems. Project-based learning increases motivation to learn, teamwork, and collaborative skills, it is now recommended as a 21st century teaching technique (Cole & Wasburn-Moses, 2010, cited in Bender, 2012).

Project-based learning highlights giving students concrete experiences in order to fulfill the objectives of a lesson. It includes integrated skills, and point toward authentic, real-world purposes. It emphasizes the psychomotor aspects of learning by involving physical action. Through action, students are drawn into a utilization of multiple skills (Brown & Lee,2015,p-50). Actually, project-based learning is a learner-centered instruction and increase student's autonomy, investigation, collaboration, communication and reflection.

Theoretical Framework of Project-Based Learning

Project-based Learning (PBL) is one of the constructivist teaching strategies and is getting more and more common in science education (Frank & Barzilai, 2004, cited in Kızkapan & Bektaş, 2017).

From a constructivist perspective, learning is an individual process. Learners constructs new ideas by linking experience what already knows. A fundamental assumption of

constructivism is that learners interact with the physical and/or social environment and learn new things. Thus, constructivism extends the theory of project-based learning. Especially, Piaget's and Vygosky's constructivist theories equivalent to learning theory of PBL.

Piaget constructivism is concerned with knowledge that focuses on the individual and psychological sources of learning. Piaget views learning as the process of exploration and discovery; experience influences thinking and thinking in its turn influences knowledge. Piaget further refers to four stages of cognitive development that all humans go through: The sensorimotor stage, the pre-operational stage, the concrete operational stage, and the formal operational stage.

In fact, a child's development is influenced by social and culture directly or indirectly. Vygotsky, while seeing a role for maturation, believed that it was children's interaction with others that most strongly influenced the levels of conceptual understanding they could reach (Vygotsky, 1978, cited in Muijs & Reynolds, 2011). In determining a child's overall development level, it should be considered two aspects of development levels. The first is the actual level and the second is the potential level. Vygotsky noticed and named the distinction between these two levels as zone of proximal development (ZPD). Vygotsky (1930) defined zone of proximal development (ZPD) as the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.

Constructivism suggested how learners can construct new knowledge and concept based on the experience of oneself or help of others. Moreover, it is based on an action and hands-on learning experience while dealing with real-world problem. Therefore, project-based learning (PBL) is very much related with this conception.

Characteristics of Project-based Learning

According to Thomas (2000), PBL has five key characteristics as follow.

- **Projects related to the curriculum**. The target contents through the projects that students are taught had a link to the curriculum.
- **A driving question related to target content**. Questions, problems or topics must "drive" or lead to the target contents.
- **Constructive investigation**. Projects must allow students to investigate the topic to build up new knowledge or skills related to the target content through inquiry, planning, exploring, decision-making, problem-solving, and reporting the findings.
- **Autonomy**. PBL projects should allow considerable amount of time for students to work on their own. Students are responsible for completing their projects under the supervision of their teacher. They have a chance to decide on their own and create a new one.
- **Real-life application**. Topics, tasks, products or performances that the students are assigned to make a project should encounter or use in real life situations**.**

Phases of Project-Based Learning

These well-designed phases are originally based on Stoller's ten-step PBL framework and adapted by Kalabzova in 2015. Project work is divided into four major phases which are: preparation phase, realization phase, presentation phase and finally evaluation phase.

(a) Preparation Phase

The preparation phase is gradually recorded into a logical framework form and covers: selecting the purpose, determination of the educational aims, selecting the final product, creating a general structure and timeline, forming teams and producing the final written framework. Teachers should launch the project with an "entry event" that arouses students' interest and initiates their questioning. Learners form teams into heterogenous groups Students had the autonomy to select the topic and students should be allowed the "Voice and Choice" in products depending on student's interest, style of learning, experience or creativity.

(b) Realization Phase

This phase covers stages of launching project work; planning and realizing concrete activities along with project finishing. It consists of: information gathering cycle and information processing cycle. In information gathering cycle, teachers prepare and carefully scaffold various tasks to promote students understanding of the content material along with the progress of critical thinking skills. In information processing cycle, students practice how to categorize, make comparison, identify, analyze, organize and compile the useful information for completion of the project.

(c) Presentation Phase

Students present the final outcome on the bases of initial decisions and standards. Stoller describes this stage as Information reporting cycle, where teachers create activities helping students successfully present the final project outcomes. In this phase, students finalize or present tangible outcome and teacher prepares students for the strategy demands of finalizing and presenting tangible outcome.

(d) Evaluation Phase

PBL assessment does not concern only the final product, in fact, students are assessed throughout the process of PBL, which stresses formative assessment and accepts the necessity of final summative assessment. Formative assessment is generally desired for giving feedback throughout the process of creating projects, while summative assessment provides students with the overall degree of their performance at the end of the course (Markham et al., 2003, cited in Simpson, 2011).

Research Method

Design of the Study

In this study, it was not possible to assign individual participants to group randomly. Quasi-experimental design can be used when it is not feasible to use a true-experimental design (Mills & Gay, 2019).

Table 1 Experimental Design

Group	No. of Students		Pretest	Treatment	Posttest
	BEHS 1	BEHS 2			
Experimental	36	33	T 1	Project-based learning	T2
Control	34	36	T 1	ITPR method	T2

Note. T1= Biology Knowledge Test, T2= Biology Achievement Test

Both groups were randomly assigned and administered by a pretest at the beginning of the study. After that the experimental groups were taught with project-based learning and control groups were taught with conventional method of teaching in both selected schools. After being taught, all groups received a posttest. According to this procedure, this design is a nonequivalent control group design.

Population and Sample Size

This study was geographically restricted to Amarapura Township, Mandalay Region. The required sample schools were randomly selected. The sample schools were BEHS 1, Amarapura and BEHS 2, Amarapura. At BEHS 1, (70) students were selected from the population of (108) Grade 10 students in (2023-2024) Academic Year. In the same way, (69) students were selected from the population of (83) Grade 10 students at BEHS 2, Amarapura (See Table2).

Table 2 Population and Sample Size

Sample of School	Number of Population	Sample Size
BEHS 1, Amarapura	108	70
BEHS 2, Amarapura	83	69
Total	191	139

Instruments

Three instruments: (1) a pretest and its marking scheme, (2) a posttest and its marking scheme and (3) questionnaire to measure the effectiveness of project-based learning were used in this study. In pretest, 1 mark each for (15) items of True/False, 1 mark each for (15) items of multiple choice, 1 mark each for (10) items of selecting picture and 2 marks each for (5) items of short questions are included. In posttest, questions are constructed based on five levels of Bloom's taxonomy of cognitive domain, namely, remember, understand, apply, analyze, and evaluate. The posttest questions consist of 1 mark each for (10) items of True/False, 1 mark each for (10) items of multiple choice, 1 mark each for (10) items of completion items, 2 marks each for (4) items of short questions and 4 marks each for (3) items of short questions. The allocated time was 1:30 hours and given marks were 50marks for both pretest and posttest. The content area was restricted in Chapter 5, Reproduction in Fungi and Plants from the Grade 10 biology textbook. Questionnaire for students' attitude towards project-based learning was developed by Taha (2021). In this questionnaire, ten items included and five-point Likert-scale was used. The students rated their response by assigning 1 to strongly disagree, 2 to disagree, 3 to undecided, 4 to agree and 5 to strongly agree.

Procedure

For gathering the essential concept of this research, the related literature was accumulated. The lesson plans for the experimental groups and control groups were prepared. Pretest and posttest were constructed. Content validity was determined by expert judgment. The pilot study was conducted with a sample of 20 students from Practicing High School, UDNR. After that Grade-10students from No.1 Basic Education High School, Amarapura and Grade 10 students from No.2 Basic Education High School, Amarapura were selected. In each school, students are divided into experimental and control groups. All students are provided pretest. Then, experimental groups were provided with project-based learning and control groups were

provided with ITPR procedure. The treatment is conducted in November, 2023 and last one month. The collected data was computed by using SPSS and interpreted the result.

Data Analysis

The data were analyzed by using inferential statistics such as independent samples *t* test and analysis of covariance, ANCOVA to determine whether there were significant differences between the experimental and control groups. And then, to examine the attitude towards project-based learning, descriptive statistics was used.

Research Findings

Findings of Students' Basic Biology Knowledge on the Pretest

First of all, the pretest for both experimental and control groups was tested to examine whether or not the equivalency on their basic biology knowledge between two groups before treatment period. Pretest scores were analyzed by using independent samples *t* test. The result can be seen in Table 3 and Figure 1.

Table 3 The Results of *t* test on the Pretest Scores

School	Group	*n*	*M*	*SD*	*MD*	*t*	*p*
BEHS 1	Experimental	36	37.36	4.09	8.62	6.870	.000***
	Control	34	28.74	6.15			
BEHS 2	Experimental	33	31.03	4.76	3.47	2.608	.011*
	Control	36	27.56	6.15			

Note. BEHS 1= No.1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

*$p < .05$. ***$p < .001$.

The result revealed that there were significant differences between experimental group and control group in both selected schools. Therefore, it can be interpreted that there was imbalance biological knowledge between two groups of both selected schools. Therefore, pretest scores should be considered as a covariate in analyzing the posttest score. So, the posttest scores were analyzed by using analysis of covariance, ANCOVA. Graphic presentation is illustrated in Figure1.

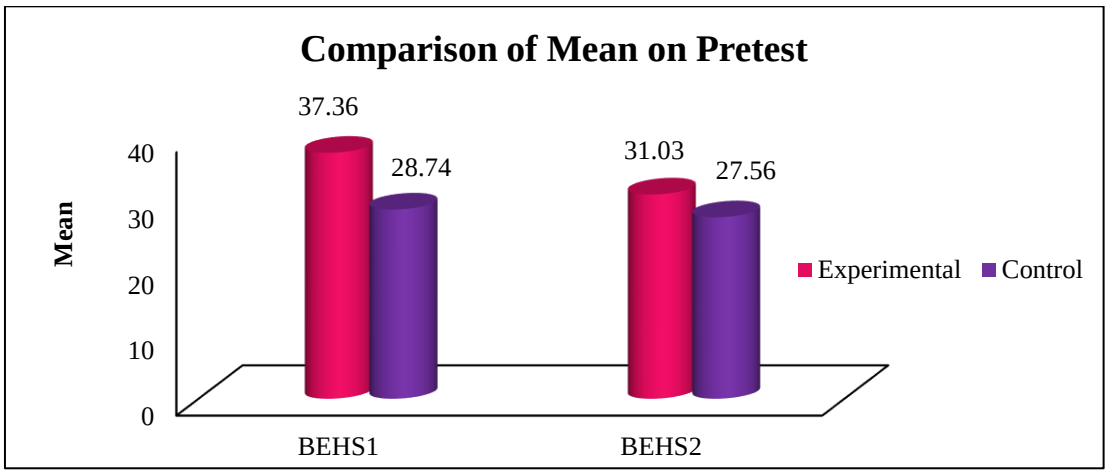

Figure 1. The comparison of means for students' basic biology knowledge on the pretest.

Findings of Students' Overall Biology Achievement on the Posttest

Table 4 The Results of Analysis of Covariance on the Posttest Scores

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*SD*	*MD*	*F*	*p*
BEHS 1	Experimental	36	35.99	35.29	4.91	7.42	30.695	.000***
	Control	34	27.13	27.87	3.63			
BEHS 2	Experimental	33	34.64	34.28	4.36	4.86	12.432	.001***
	Control	36	29.10	29.42	6.39			

Note. BEHS 1= No.1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

***$p \leq .001$.

In consideration of the mean scores of two groups in each selected school, the mean scores of experimental groups were higher than those of control groups. Therefore, it can be concluded that there were significant differences between experimental and control groups in each selected school. The result highlighted that the use of project-based learning was more effective on the overall achievement of biology students in selected schools at cognitive level than ITPR procedure. Graphic presentation is illustrated in Figure2.

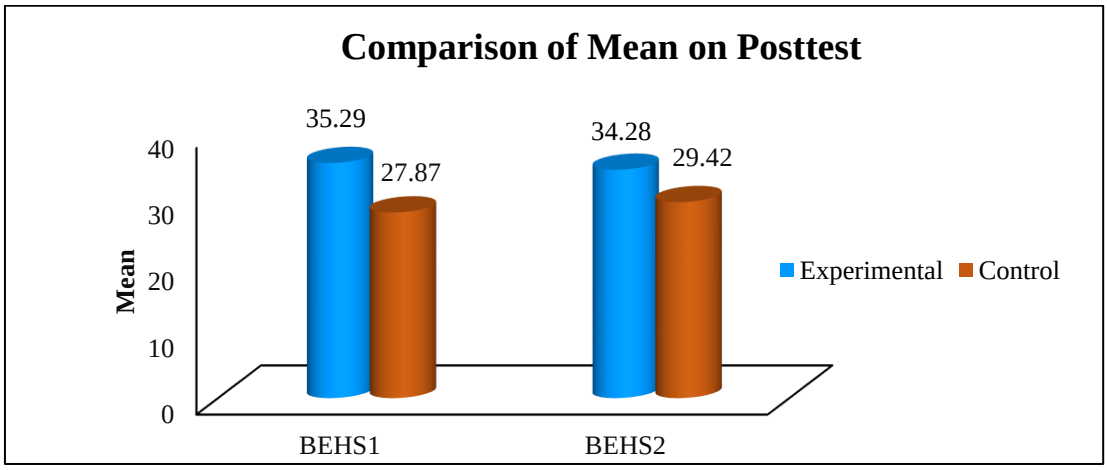

Figure 2. The comparison of means for posttest scores

Comparison of Achievement Scores at Remembering Level

Table 5 The Results of Analysis of Covariance on the Remembering Level Scores

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*SD*	*MD*	*F*	*p*
BEHS 1	Experimental	36	6.61	6.65	1.46	0.63	1.992	.163 (ns)
	Control	34	6.06	6.02	1.35			
BEHS 2	Experimental	33	7.42	7.34	1.20	-	3.288	.074 (ns)
	Control	36	7.78	7.85	1.07	0.51		

Note. BEHS 1= No.1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

ns = not significant.

The result indicated that there were no significant differences between experimental and control groups in each selected school in answering remembering level questions. Thus, it can

draw on conclusion that the both methods had equal ability in memory retention, rote learning and repetition of the lessons learned by students. Graphic presentation is illustrated in Figure3.

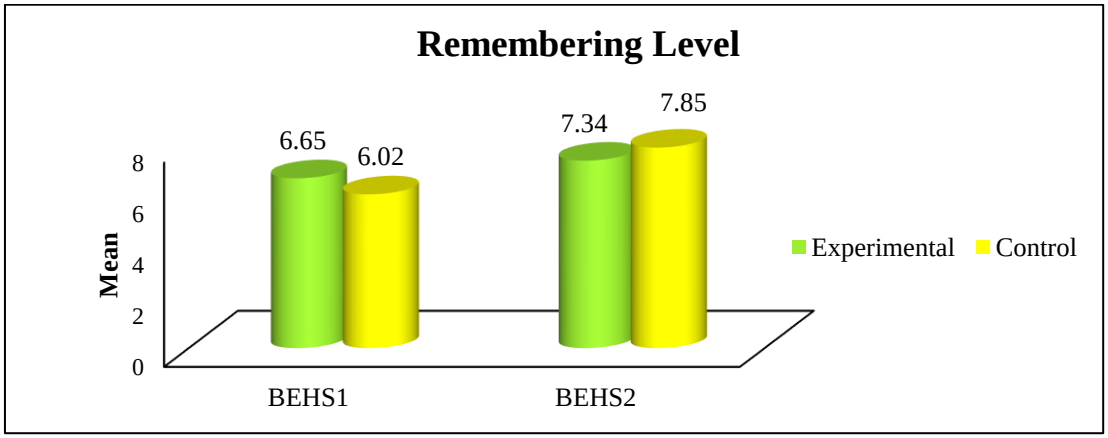

Figure 3. The comparison of means for students' biology achievement at remembering level.

Comparison of Achievement Scores at Understanding Level

Table 6 The Results of Analysis of Covariance on the Understanding Level Scores

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*SD*	*MD*	*F*	*p*
BEHS 1	Experimental	36	9.17	8.95	1.86	1.33	6.900	.011*
	Control	34	7.38	7.62	1.35			
BEHS 2	Experimental	33	8.67	8.67	1.41	1.17	5.937	.018*
	Control	36	7.50	7.50	2.24			

Note. BEHS 1= No.1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

*$p < .05$.

The result showed that there were significant differences between experimental and control groups in each selected school in answering understanding level questions. This meant that teaching with project-based learning was more effective in explaining, relating and generalizing the biological knowledge than teaching with ITPR procedure in the subject of biology. Graphic presentation is illustrated in Figure 4.

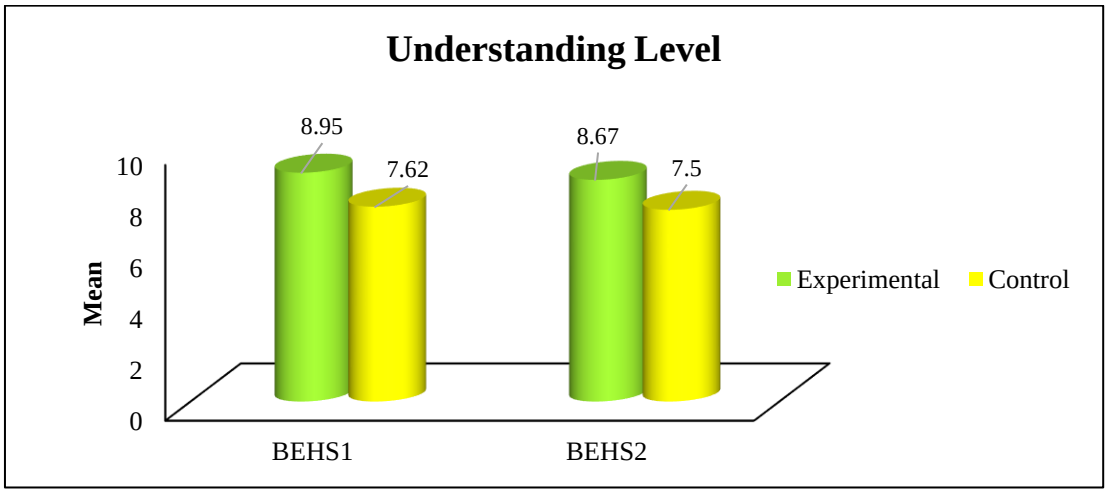

Figure 4. The comparison of means for students' biology achievement at understanding level.

Comparison of Achievement Scores at Applying Level

Table 7 The Results of Analysis of Covariance on the Applying Level Scores

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*SD*	*MD*	*F*	*p*
BEHS 1	Experimental	36	6.82	6.73	1.72	2.33	26.633	.000***
	Control	34	4.31	4.40	1.05			
BEHS 2	Experimental	33	5.79	5.65	1.71	1.13	7.615	.007**
	Control	36	4.39	4.52	1.63			

Note. BEHS 1= No.1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

**$p < .01$. ***$p < .001$.

The result showed that there were significant differences between experimental and control groups in each selected school in answering applying level questions. Thus, it can be clearly interpreted that teaching with project-based learning can enhance the students' ability of applying biological knowledge in new conditions by interpreting, sketching and implementing the concepts and ideas they learned. Graphic presentation is illustrated in Figure 5.

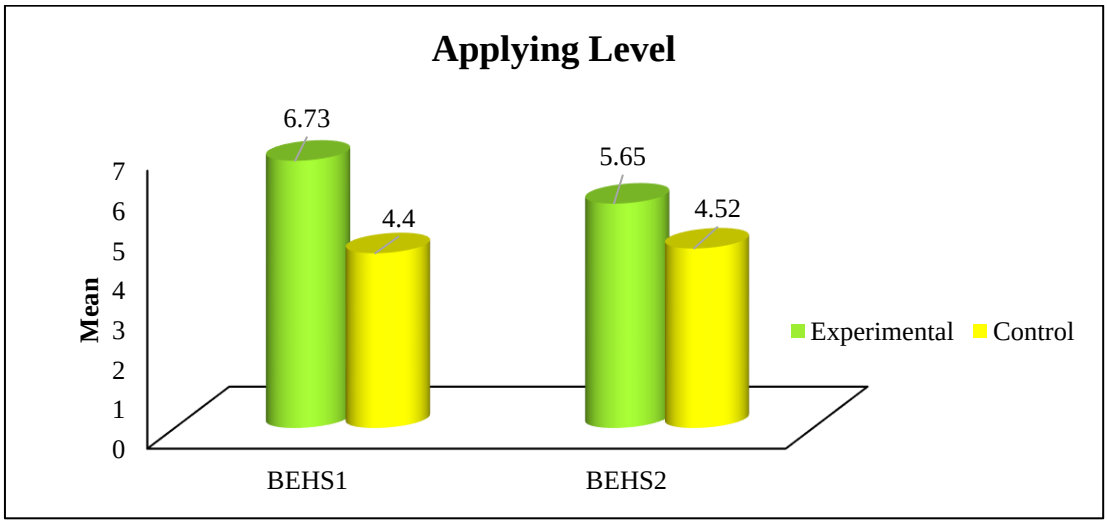

Figure 5. The comparison of means for students' biology achievement at applying level.

Comparison of Achievement Scores at Analyzing Level

Table 8 The Results of Analysis of Covariance on the Analyzing Level Scores

School	**Group**	***n***	**Unadjusted Mean**	**Adjusted Mean**	***SD***	***MD***	***F***	***p***
BEHS 1	Experimental	36	9.19	8.96	1.15	1.76	21.047	.000***
	Control	34	6.96	7.20	1.35			
BEHS 2	Experimental	33	8.97	8.86	1.33	2.02	11.027	.001***
	Control	36	6.74	6.84	3.08			

Note. BEHS 1= No. 1 Basic Education High School, Amarapura, BEHS 2= No.2 Basic Education High School, Amarapura.

***$p \leq .001$.

The result suggested that there were significant differences between experimental and control groups in each selected school in answering analyzing level questions. Thus, it can be inferred that teaching with project-based learning has positive effect in comparing and contrasting ideas, organizing relationship and connections of biological concepts. Graphic presentation is illustrated in Figure 6.

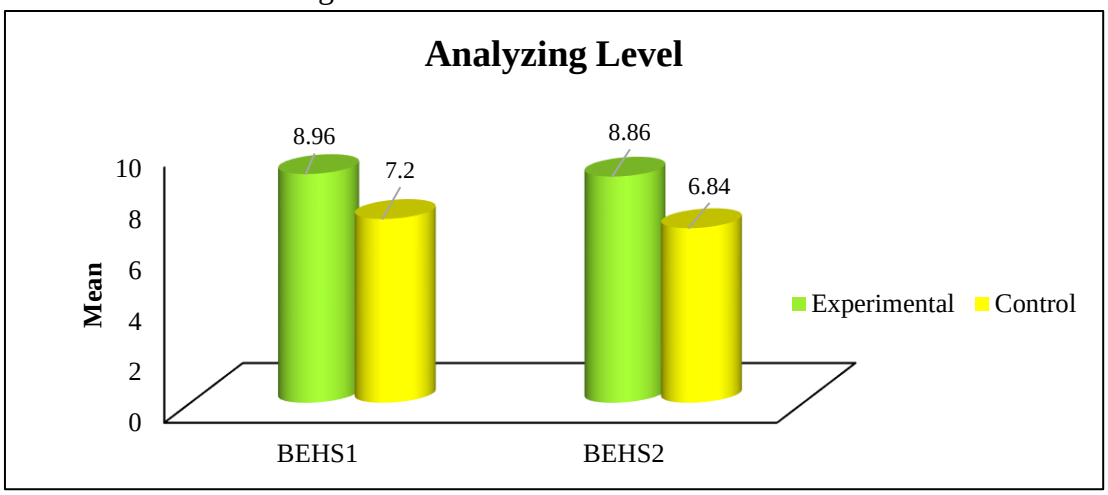

Figure 6. The comparison of means for students' biology achievement at analyzing level.

Comparison of Achievement Scores at Evaluating Level

Table 9 ***The Results of Analysis of Covariance on the Evaluating Level Scores***

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*SD*	*MD*	*F*	*p*
BEHS 1	Experimental	36	4.19	4.01	1.14	1.38	18.874	.000***
	Control	34	2.43	2.63	0.91			
BEHS 2	Experimental	33	3.79	3.76	0.74	1.04	24.173	.000***
	Control	36	2.69	2.72	0.92			

Note. BEHS 1= No. 1 Basic Education High School, Amarapura, BEHS 2= No. 2 Basic Education High School, Amarapura.

***$p < .001$.

The result suggested that there were significant differences between experimental and control groups in each selected school in answering evaluating level questions. Thus, it can be inferred that teaching with project-based learning can improve students' evaluating skills by helping to judge and recommend the biological concepts. Graphic presentation is illustrated in Figure 7.

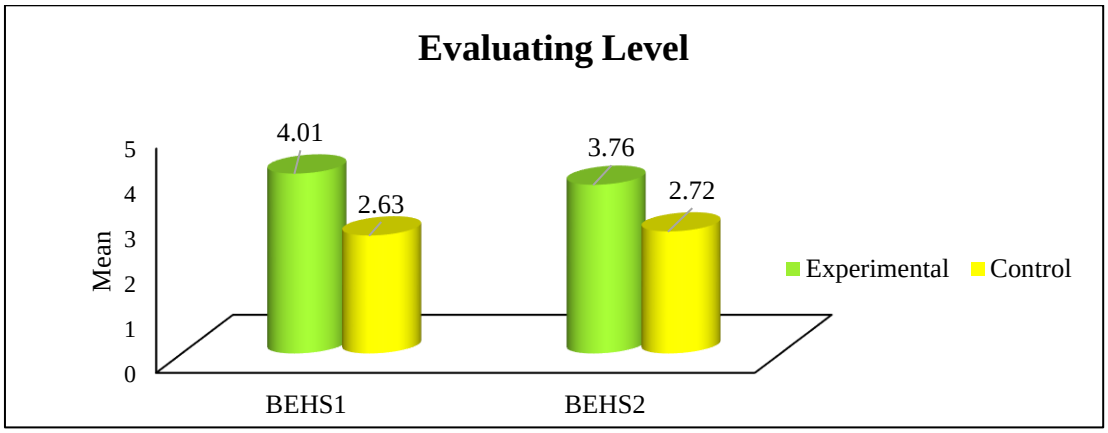

Figure 7. The comparison of means for students' biology achievement at evaluating level.

Results of Students' Attitude towards Project-based Learning

The data about students' attitude towards project-based learning activity was collected through attitude questionnaire. It included ten items and five-point Likert scale, strongly disagree, disagree, undecided, agree and strongly agree. The result was shown with percentage in Table 10.

Table 10 The Percentage of Students' Response on General View about Project-based Learning Activity

No.	Item	N	SDA	DA	UD	A	SA
			Percentage (%)				
1	Projects are more interesting than ITPR instruction.	68	-	-	-	36.8	63.2
2	I feel satisfied to learn biology with projects than textbook.	68	-	-	1.5	51.5	47
3	Projects help me understand biology concepts more.	68	-	1.5	1.5	51.5	45.5
4	Projects can increase my motivation to learn biology.	68	-	-	4.4	55.9	39.7
5	I prefer participating in biology projects to learning on my own way.	68	-	-	8.8	58.8	32.4
6	I wish to learn biology with more projects in later lessons.	68	-	-	13.3	44.1	42.6
7	I gain a lot of biological content knowledge from projects.	68	1.5	-	5.8	55.9	36.8
8	I can improve team spirit and interpersonal skills by participating in projects than by ITPR instruction.	68	-	-	25	32.4	42.6
9	I can reflect my progress in learning biology by participating in projects.	68	1.5	-	10.3	48.5	39.7
10	I think projects are one of the effective and efficient means to learn biology.	68	-	-	1.5	38.2	60.3

Note. SDA = Strongly Disagree, DA = Disagree, UD = Undecided, A = Agree, SA = Strongly Agree

The first item deals with projects are more interesting than ITPR instruction. In both selected schools, 36.8% of students agreed and majority of students (63.2%) strongly agreed to this item. It was found that students fully agreed this item among all items.

The eighth item deals with students can improve team spirit and interpersonal skills by participating in projects. In both selected schools, some students (32.4%) agreed and nearly half of students (42.6%) strongly agreed, but some others were undecided about (25%) to this item. It was found that students responded undecided most only in this item.

The seventh item deals with students gain a lot of biological content knowledge from projects. In both selected schools, over half of students (55.9%) agreed and some students

(36.8%) strongly agreed, but some others were undecided about (5.8%) and only (1.5%) strongly disagreed to this item.

The ninth item deals with students can reflect their progress in learning biology by participating in projects. In both selected schools, nearly half of students (48.5%) agreed and some students (39.7%) strongly agreed, but some others were undecided about (10.3%) and only (1.5%) strongly disagreed to this item. It was found that students strongly disagreed only in item seven and item nine.

Based on above findings, it could be interpreted that many biology students in both selected schools had positive attitude towards project-based learning.

Discussion

According to the experimental results, there were significant differences between the control and the experimental groups for the pretest in both schools. It can be interpreted that, there were imbalance biological knowledge between the students from experimental group and the control group in each school. In determining the posttest mean scores, the posttest mean score of the experimental groups was significantly higher than that of the control group in each school. Thus, it can be interpreted that the use of project-based learning is more effective than the use of ITPR procedure in the restricted content area of biology used in this study. Moreover, according to the indication of each level of Bloom's taxonomy, there were not significant differences in remembering level. As a result, it can be interpreted that both project-based learning and ITPR procedure have the ability to retain the students' memory equally. However, there were significant differences in understanding level. According to the results, it can be concluded that the use of project-based learning helps students to understand biology concepts and it can also develop students' rewriting and constructing meaning based on their meaningful understanding. Similarly, there were significant differences in applying level. It can be concluded that students can apply their valuable information and experience by participating in projects in real world situations. Similarly, there were significant differences in analyzing level. It can be concluded that project-based learning can bring the improvement of the students' ability to analyze the information into isolated pieces and to use them in new situations. Similarly, there were significant differences in evaluating level. It can be concluded that students may refer to the knowledge that they have learned to make thoughtful value decisions and may develop personal opinions and judgements when they are taught by project-based learning. Thus, all the findings pointed out that project-based learning had positive effect in developing students' ability to catch the biological concepts, to utilize in real life situation, to analyze and evaluate another condition. The finding is in line with the research conducted by Hermanto, Sarwi and Yusuf (2019). They discussed that project-based learning can improve students' cognitive skills.

Moreover, questionnaire was used to know students' attitude towards project-based learning. According to quantitative questionnaire survey, students responded that projects are more interesting than ITPR procedure in the opinion biology students. Students feel satisfied to learn biology with projects than textbook. Projects help students understand biology concepts more and increase their motivation to learn biology. Furthermore, students prefer participating in biology projects to learning on their own way and they wish to learn biology with more projects in later lessons. Students gain a lot of biological content knowledge from projects. Moreover,

they can improve team spirit and interpersonal skills by participating in projects. Students can reflect their progress in learning biology by participating in projects. Finally, students think projects are one of the effective and efficient means to learn biology. Based on the result findings, students had a positive attitude towards project-based learning and they had a preference to learn with project-based learning.

Suggestions

A single instructional strategy is not appropriate all the time. Project-based learning focuses on learning by doing. Thus, the choosing of topic should be based on doing hands-on experiments and activities. As project-based learning is a team work, teacher should assign heterogeneous groups. In grouping, small group setting is required for effectiveness. In implementing project-based learning, teacher should consider the available resources such as budget, students' abilities. Furthermore, time investment is needed for long-term experience and better result.

To promote 21st century skills, the teacher should support students to collaborate, to give respect each other, to define their responsibilities and to appreciate their collaborative effort. To promote higher order thinking, teacher need to stay actively engaged with their students, constantly pushing them to choose on their own interest content, collect data, analyze data, synthesize information, evaluate their project work and make decision clearly. Moreover, teacher should initiate Entry event with good driving questions to motivate students' interest. The recommendations for further researches were that the time spend should be allowed more. A large sample size in different State and Region and different grade levels should be carried out. Moreover, not only the whole biology content area but also other subject areas should be studied to claim the effectiveness of project-based learning. In addition, qualitative research method and mix method should be conducted.

Conclusion

Project-based learning had positive effect in teaching biology at high school level according to the results of finding. Moreover, students had a positive attitude towards project-based learning and they had a preference to learn with project-based learning. Project-based learning is a practical learning. Students learn on their own. They are provided autonomy from choosing topic to presenting the final product. They combine old and present experiences to form new concept. They use their new concepts in applying hands-on activity. As they develop their ideas and products, student team can review and critique on another team's work. And then they can analyze and evaluate as a chain reaction. It made not only to improve their achievement but also to strengthen their friendship and team spirit. They became realized and appreciated the role of leader, supporter and mutual interdependence. It can be clearly seen that project-based learning can connect the demands of 21st century.

In ITPR procedure, students can absorb teacher's ideas and concepts. Since teacher deliver conceptual knowledge, it can avoid students' misconception. Then, this method is also designed to meet the need of 21st century. Although students are provided with learner-centered activities such practical learning, discussion, presentation etc., student independent learning is insufficient.

Nevertheless, this study indicated that project-based learning had a positive effect only in restricted content area in biology teaching of the two selected schools. No single instructional strategy is appropriate all the time and not all lessons from the textbook are consistent with the same approach. All teaching methods are valuable. But only if the teacher uses them correctly and systematically, they can be more beneficial in the field of education. If the purpose of the instruction is to increase students' achievement by doing hands-on activities, project-based learning is exactly a harmonious teaching method.

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