# A STUDY OF THE CONTRIBUTION OF TECHNOLOGY INTEGRATION IN TEACHING BIOLOGY TO GRADE NINE STUDENTS

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## Abstract

This research was conducted with the purpose of studying the contribution of technology integration in teaching biology to Grade Nine students. In this study, both the qualitative and quantitative research methods were used to study the contribution of technology integration. The posttest only control group design was used to compare the achievement between the students who were taught by integrating technology and those who were not. After administering a posttest, a set of attitude questionnaires was used to know the students' attitudes towards technology integration in teaching biology. For the qualitative study, biology teachers were interviewed to know their perspectives on the technology integration in the classroom. From Grade Nine biology textbook, Chapter (V), Variety of Living Organisms, the first five sub-topics of the topic, A Bony Fish, were selected as the learning materials. The result of the posttest showed that the achievement of the students who were taught by integrating technology was significantly higher than that of the students who were not. The results of No.4, Basic Education High School, Sanchaung was ($t$ = 3.764, $df$ = 50, MD = 7.08, $p$< .01) and that of No.6, Basic Education High School, Insein was ($t$ = 4.315, $df$ = 68, MD = 10.63, $p$< .001). Furthermore, the students who used technology as a learning tool in their study showed positive attitudes towards the integration of technology. The interview results showed that the teachers are willing to integrate technology in their classroom but they have some difficulties in using it in the classroom. They also admitted that if they were given opportunity, they would like to receive training in using technology in the classroom.

**Keywords:** Technology, Achievement, Integration, Biology

## Introduction

The most notable distinction between livings and inanimate beings is that the former maintain themselves by re-newal. Life is a self-renewing process through action upon the environment. Continuity of life means

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continual re-adaptation of the environment to the needs of living organisms. With the renewal of physical existence goes, in the case of human beings, the recreation of beliefs, ideals, hopes, happiness, misery, and practices (Dewey, 1916). Singh et al., (2008) stated that man has always desired for excellence. This desire has given birth to new inventions and innovations in all works of life. Science and technology has always been instrumental in bringing efficiency and improvement in the process and product of the human work. The world of education has always been influenced by the increase use of technology. It has provided valuable help in improving the tasks of the teacher, smoothening the process of teaching learning and enriching the goals of education.

## Objectives of the Study

(1) To study the contribution of technology integration in teaching biology to Grade Nine students

(2) To study the Grade Nine Biology students' attitudes towards integration of technology in teaching Biology.

(3) To study the Grade Nine Biology teachers' perspectives upon the integration of technology in the teaching Biology

## Research Hypothesis

There will be a significant difference in achievement between Grade Nine Biology students who are taught by integrating technology and those who are not.

## Importance of Technology Integration

In the age of technology explosion, today classrooms are moving from a pencil and paper and chalk and blackboard to technology-enriched classrooms in order to meet the needs of the society. With the aid of technology, today students especially science students can inquire and explore the required knowledge and information through the Internet (Brown, 2004). Siddiqui (2009) states technology is most powerful when it is used as a tool for problem solving, concept development and critical thinking. With technology, students can spend more time creating strategies for solving

complex problems and developing a deep understanding of the subject matter. Jakes et al. (2003) cited in Mills (2006), suggests an eight-step process for inquiry-based learning using the World Wide Web or through the Internet:

1. Students begin by generating an essential question for the inquiry. An essential question requires students to make a decision or plan a course of action.
2. After the essential question has been framed, students write foundation questions, which give structure to the investigation so that students know what they need to research. Foundation questions and answers provide a factual basis for developing an answer to the essential question. Answers to foundation questions are integrated into an answer to the essential question.
3. Students use keywords from foundation questions to develop a search strategy to locate Web information.
4. Students are then ready to locate information on the Web. They can start by using a single search engine such as Google and moving on if necessary to a met-search engine or other search tools.
5. Students evaluate the Web resources they have collected, a critical process skill that students must learn. Information quality is assessed using a three-part process:
    - *Information applicability*: students determine whether the information is related to their essential questions.
    - *Information authority*: students determine whether the information originates from a readily recognizable expert, organization, or other qualified person or group.
    - *Information reliability*: students cross-reference information among websites to ensure that information is reliable.
6. Students evaluate the quality of information to determine whether there are sufficient answers to each of the foundation questions. If not, students return to the search strategy to locate new sites.

7. Students develop the answer to the question. At this point, students must organize and synthesize.
8. Students develop a product to represent the answer, that is, their knowledge about the essential question. The product can take many forms, including a Web essay. Web essays are living documents that contains multiple information types, such as text, sound, graphics, pictures and movies that are published on the Web. Students can produce Web essays as a web blog or a Web page.

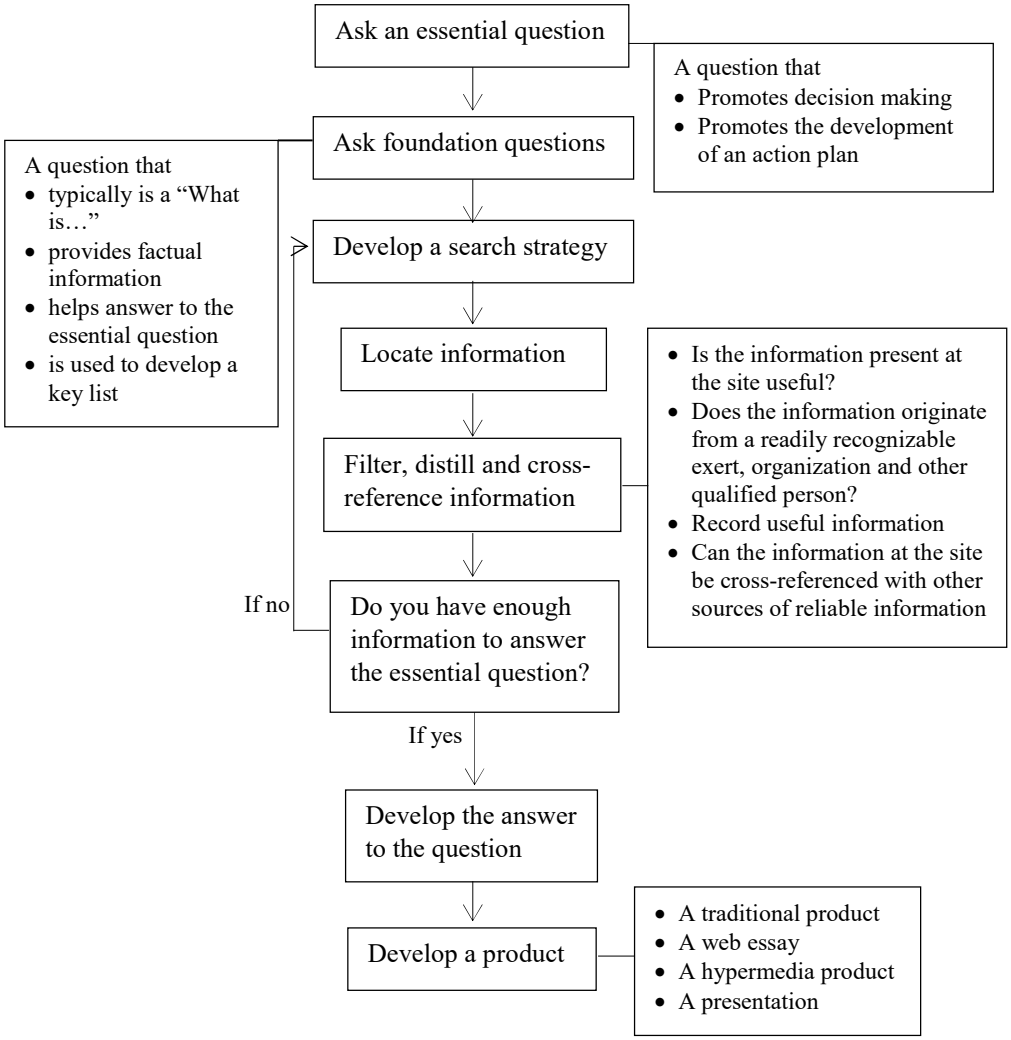


**Figure 1:** Inquiry-based Learning Process
**Source:** From Mills (2006), p. 177.

## Research Method

This research is concerned with the study of the contribution of technology integration into the classroom in teaching Biology to Grade Nine students. Qualitative and quantitative research methodologies were used to compare the effects of technology integration between the two groups of experimental and control.

### Population and Sample Size

This study was geographically restricted to Yangon Region. The required sample schools are selected by using simple random sampling method. The selected sample schools were No.4, Basic Education High School, Sanchaung and No.6, Basic Education High School, Insein. There were totally (52) students who are learning Biology in Grade Nine at No.4, BEHS, Sanchaung and (70) students who are learning the same subject in the same Grade at No.6, BEHS, Insein. All students from each school are grouped into two; the experimental and control groups by randomization. Therefore there were (35) students each in the experimental and control groups in No.6, BEHS, Insein and there were (26) students each in the experimental and control group in No.4, BEHS, Sanchaung. Although many experimental studies are being recommended to have a minimum of (30) subjects per group, experimental studies with tight experimental controls may be valid with as few as 15 subjects per group (Gay, 1987).The experimental group was given the treatment of technology integration in teaching and the control group was taught by using formal instruction.

**Table1**: Population and Sample Size

| No | Township | School | Population | Number of students | | |
|---|---|---|---|---|---|---|
| | | | | Experimental Group | Control Group | Total |
| 1 | Insein | BEHS (6) | 70 | 35 | 35 | 70 |
| 2 | Sanchaung | BEHS (4) | 52 | 26 | 26 | 52 |

***Note***. BEHS = Basic Education High School

## Research Design

The posttest only control group design (True Experimental Design) was used to study the contribution of technology integration into the classroom in teaching Biology to Grade Nine students. This design was selected because it controls for many sources of invalidity and because random assignment of subjects to groups was possible. Administration of a pretest was not necessary because the sample subjects were grouped in accordance with the test scores of first semester examination. Major potential threat to internal validity associated with this design is mortality. This threat did not prove to be a problem, because the group sizes remained constant throughout the duration of the study.

**Table 2**: Experimental Design

| Group | Assignment | Number | | Treatment | Posttest |
|---|---|---|---|---|---|
| | | S1 | S2 | | |
| Experimental | Random | 35 | 26 | Technology Integrated Instruction | Achievement Test |
| Control | Random | 35 | 26 | Formal Instruction | Achievement Test |

***Note***.S1= No.6, Basic Education High School, Insein
S2= No.4, Basic Education High School, Sanchaung

## Instruments

Since the selected research design was posttest only control group design, the instruments for this study were constructed as a posttest and additionally a set of questionnaires. A posttest was developed to measure the achievements of Grade Nine Biology students. The test was constructed based on Grade Nine Biology Textbook according to the guidance of the supervisor. The students have to answer all the questions. Time allocation for the test is (90) minutes and the total marks given to the test is (50). True/false items for (5) marks, completion items for (5) marks, multiple choice items for (5) marks, short questions for (10) marks, long questions for (20) marks and quizzes for (5) marks. The test items were constructed based on the first three levels of Bloom's Cognitive Domain; knowledge, comprehension and

application. The posttest was constructed according to the following table of specifications.

**Table 3**: Table of Specifications

| Question Type | T/F | C | MC | SQ | LQ | Quizzes | Total Marks |
|---|---|---|---|---|---|---|---|
| **Knowledge** | 3 | 3 | 3 | 6 | 6 | - | 21 |
| **Comprehension** | 2 | 2 | 2 | 2 | 6 | 4 | 18 |
| **Application** | - | - | - | 2 | 8 | 1 | 11 |
| **Total Marks** | 5 | 5 | 5 | 10 | 20 | 5 | 50 |

***Note.*** T/F = True or False, C = Completion, MC = Multiple Choice, SQ = Short Question, LQ = Long Question

The marking scheme for the test was constructed according to the guidance of the experienced teachers. To measure the test reliability, Chronbach's Alpha was calculated. Since the acceptable value was within 0.6 to 0.7 and 0.7 to 0.9, the calculated value of the test (0.73) was accepted. A set of questionnaires was used to know the attitudes of the students who were participated in the experimental research. The questionnaire was constructed based on the five levels of Bloom's Affective Domain; receiving, responding, valuing, organization and characterization. Since there were (5) items for each level, the total items for attitude test was (25) items. These items were constructed in five point likert scale format (strongly disagree to strongly agree). To validate the questionnaire, it was modified according to the suggestions and guidance of five experienced teachers. Then, the questionnaire was piloted with (20) students inNo.1, Basic Education High School, Sanchaung. The Chronbach's Alpha value was .734. After testing the students of both experimental and control groups with the posttest question, the experimental group was tested again with the attitude questionnaires. The demographic data of the attitude questionnaire was collected from the students. Finally, formal interview was conducted to know the attitudes of the Biology teachers towards the integration of technology in teaching Biology. Biology teachers from two selected sample schools were interviewed by using an interview guide.

## Procedure

Before the experiment was conducted, the experimental group was trained how to use technology especially the way to search information with Laptop, tablet and smart-phones linked with Internet access for three days. In this study, the teachers who participated to teach the control groups have the same Degree, B.Ed. Both teachers taught their control groups according to their formal lesson plans. The experimental group was given a treatment with the integration of technology by the researcher. The duration for the treatment took three weeks excluding the posttest and training duration. After teaching with the different lesson plans for each group, the posttest questions were developed to evaluate the achievements of each group. The participation and performance of the experimental group was observed by the researcher and mainly used rubrics for the students' performance. Finally, a set of questionnaires was used to study the attitudes of the students towards the integration of technology into the classroom. And then, Biology teachers from the selected sample schools were interviewed.

Before the experiment was conducted, validation for posttest and questionnaires was determined by five experienced teachers in Yangon University of Education. According to their suggestions, the instruments were modified again. On 12$^{th}$ December, 2016, the pilot study was conducted with (20) Grade Nine students inNo.1, Basic Education High School, Sanchaung. By the results of the pilot study, the instruments were revised and modified to conduct the experiment in the selected sample schools. Finally, the results of the experiment were compared by using the independent samples *t*-test.

## Learning Materials

Biology is the study of living things. Living things include both plants and animals. Thus, biology deals with the study of all plants and animals that live or have ever lived on the earth. Biology is also the basic to many applied sciences such as medicine, animal husbandry, agriculture and forestry. According to Myanmar Education System, biology is taught as one of the

elective subjects in Grade Nine and Ten. There are five chapters in Grade Nine biology including the basis of both plants and animals. From these chapters, Chapter (V); Variety of Living Organisms: A Bony Fish was selected as the learning materials for this study. There are about ten sub-topics under the topic of A Bony Fish. Among them, such sub-topics as Characteristics of bony fish, External features of bony fish, Muscular system, Swim bladder and Digestive system of bony fish were selected. The same sub-topics were taught to both experimental and control groups with different lesson plans.

## Research Findings

### Experimental Research Findings

This study is designed to find out the contribution of technology integration in teaching biology to Grade Nine students. After administering the posttest in each selected school, the data were recorded and analyzed by using the independent samples *t*-test to explore the difference between the experimental and control groups.

**Table 4**: *t*-Values for Posttest Biology Achievement Scores

| School | Group | N | M | SD | MD | *t* | *df* | Sig. (2 tailed) |
|---|---|---|---|---|---|---|---|---|
| BEHS (4) | Experimental | 26 | 39.77 | 3.648 | 7.08 | 3.764 | 50 | .001** |
| | Control | 26 | 32.69 | 8.867 | | | | |
| BEHS (6) | Experimental | 35 | 36.69 | 9.116 | 10.63 | 4.315 | 68 | .000*** |
| | Control | 35 | 26.06 | 11.368 | | | | |

***Note***. **$p$< .01, ***$p$<.001

BEHS (4) = No.4, Basic Education High School, Sanchaung
BEHS (6) = No.6, Basic Education High School, Insein

According to the results, the means of the experimental groups were significantly higher than that of the control groups in two selected schools. It showed that there was a significant difference between the students who were taught by integrating technology especially through the Internet resources and

those who were not for the scores on biology achievement in both selected schools.

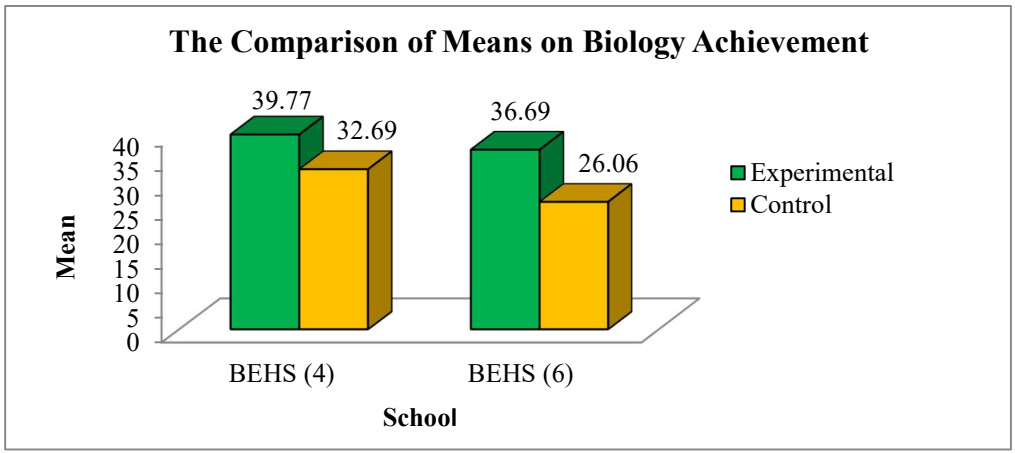


**Figure 2:** The Comparison of Means on Biology Achievement

In accordance with the findings, it can be interpreted that teaching biology by integration technology has significant effect on biology achievement of the students. Therefore, teaching biology by integration technology positively contributes to teaching biology for Grade Nine students.

**Table 5:** *t*-Values for Scores on Knowledge Level Questions

| School | Group | N | M | SD | MD | *t* | *df* | Sig. (2 tailed) |
|---|---|---|---|---|---|---|---|---|
| BEHS (4) | Experimental | 26 | 18.60 | 1.755 | 2.02 | 2.246 | 50 | .029* |
| | Control | 26 | 16.58 | 4.235 | | | | |
| BEHS (6) | Experimental | 35 | 17.60 | 4.009 | 4.00 | 3.506 | 68 | .001** |
| | Control | 35 | 13.60 | 5.430 | | | | |

***Note.*** *$p < .05$, **$p < .01$

BEHS (4) = No.4, Basic Education High School, Sanchaung

BEHS (6) = No.6, Basic Education High School, Insein

The results of the knowledge level questions showed that the means of the experimental groups were significantly higher than that of the control groups in two selected schools. Therefore, it showed that there was a significant difference in the scores of knowledge level questions between the

students who received inquiry-based learning through Internet resources and those who didn't in both selected schools.

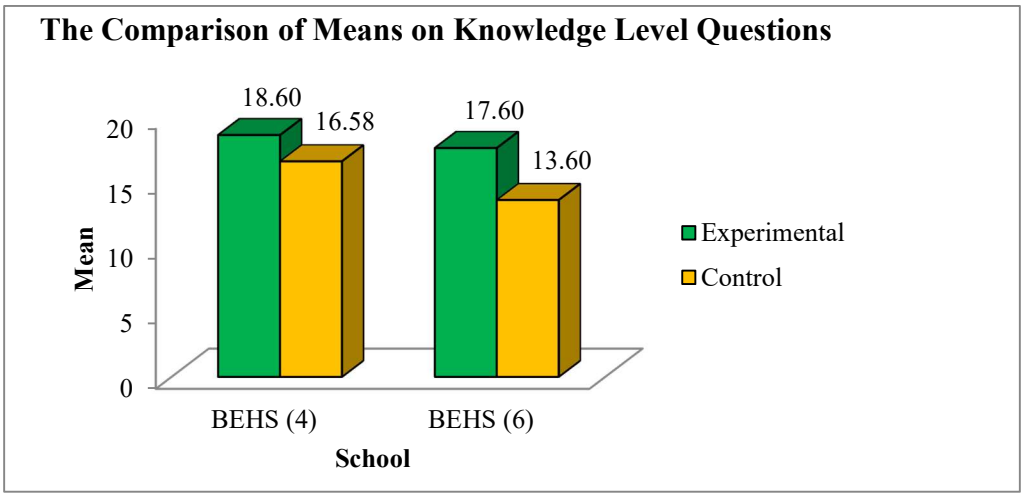


**Figure 3**: The Comparison of Meanson Knowledge Level Questions

Since there was a significant difference on the scores of knowledge level questions between the experimental and control groups in both selected schools, it can be interpreted that teaching biology by the integration of technology supports the improvement of students' recognition and recall ability.

**Table 6**: *t*-Values for Scores on Comprehension Level Questions

| School | Group | N | M | SD | MD | *t* | *df* | Sig. (2 tailed) |
|---|---|---|---|---|---|---|---|---|
| BEHS (4) | Experimental | 26 | 14.29 | 1.940 | 3.17 | 4.383 | 50 | .000*** |
| | Control | 26 | 11.12 | 3.141 | | | | |
| BEHS (6) | Experimental | 35 | 13.29 | 4.342 | 5.03 | 5.016 | 68 | .000*** |
| | Control | 35 | 8.26 | 4.039 | | | | |

***Note*** .****p*< .001

BEHS (4) = No.4, Basic Education High School, Sanchaung

BEHS (6) = No.6, Basic Education High School, Insein

According to the results of comprehension level questions, the means of the experimental groups were significantly higher than that of the control

groups in both selected schools. So, it proved that there was a significant difference on the scores of comprehension level questions between the students who received inquiry-based learning through Internet resources and those who didn't in both selected schools.

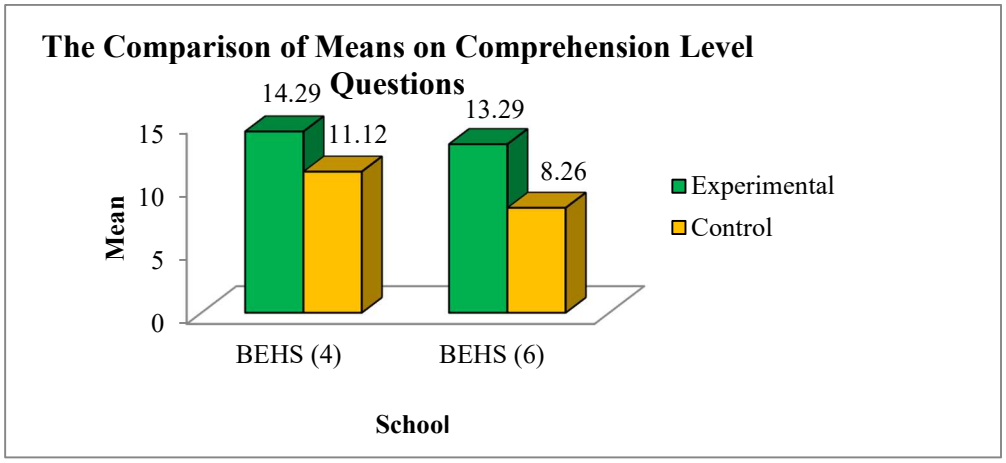


**Figure 4:** The Comparison of Means on Comprehension Level Questions

According to the findings of the comprehension level questions, it can be interpreted that teaching biology by the integration of technology positively contributes to improve the ability of the students to grasp and understand the meaning of the learned materials.

**Table 7:** *t*-Values for Scores on Application Level Questions

| School | Group | N | M | SD | MD | *t* | *df* | Sig. (2 tailed) |
|---|---|---|---|---|---|---|---|---|
| BEHS (4) | Experimental | 26 | 6.79 | 1.491 | 2.173 | 4.278 | 50 | .000*** |
| | Control | 26 | 4.62 | 2.118 | | | | |
| BEHS (6) | Experimental | 35 | 6.11 | 2.069 | 2.2 | 3.965 | 68 | .000*** |
| | Control | 35 | 3.91 | 2.548 | | | | |

***Note.*** ***$p < .001$

BEHS (4) = No.4, Basic Education High School, Sanchaung

BEHS (6) = No.6, Basic Education High School, Insein

According to the results of the application level questions, the means of the experimental groups were significantly higher than that of the control groups in two selected schools. Thus, it proved that there was a significant difference on the scores of application level questions between the students who received inquiry-based learning through the Internet resources and those who didn't in both selected schools.

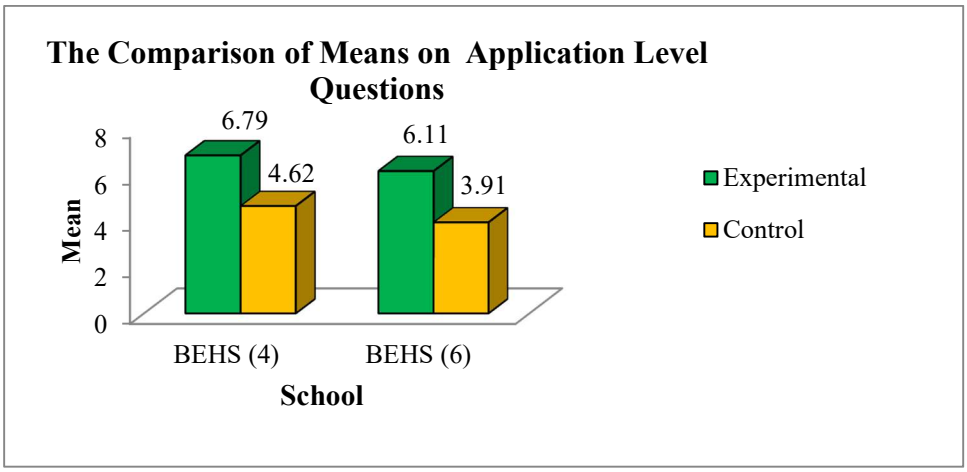


**Figure 5:** The Comparison of Means on Application Level Questions

According to the findings with respect to the application level questions, it can be interpreted that teaching biology by integration technology could bring about the improvement of students' ability to use the learned materials in new and concrete situations.

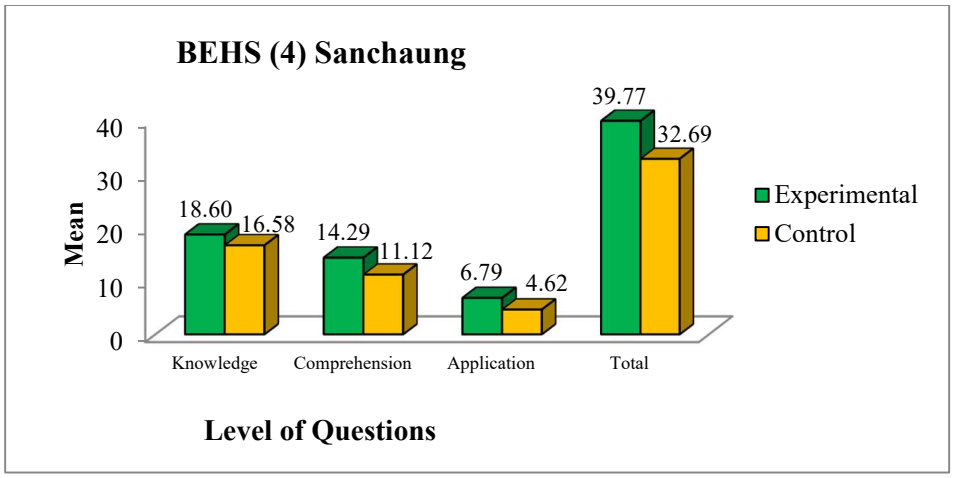


**Figure 6**: The Comparison of Means on Posttest for BEHS (4) Sanchaung

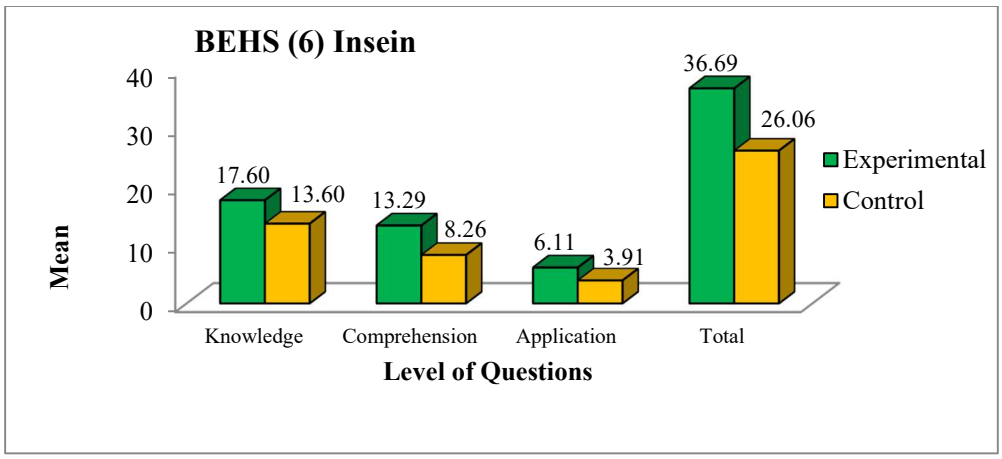


**Figure 7**: The Comparison of Means on Posttest for BEHS (6) Insein

## Summary of the Experimental Findings

The results of the research findings for two selected schools are as follows:

- There were significant differences on the achievement (overall scores) of biology between the students who were taught by integrating technology and those who were not in both selected schools.

- There were significant differences on the scores of knowledge level questions between the students who were taught by integrating technology and those who were not in both selected schools.
- There were significant differences on the scores of comprehension level questions between the students who were taught by integrating technology and those who were not in both selected schools.
- There were significant differences on the scores of application level questions between the students who were taught by integrating technology and those who were not in both selected schools.
- In this study, technology integration was supportive not only for the development of students' cognition but also for the improvement of technology skills and higher order thinking skills such as problem solving, cooperative and presentation skills. This is because the students had to search the information by themselves to solve the problems collaboratively, had to decide whether or not the information is suitable and enough to solve the problem, had to create a product of their work and finally they had to share their product with the whole class.

## Descriptive Research Findings

In order to find out the attitudes of the students who were taught by technology integration, the experimental groups in both selected schools were asked the questions concerning the attitudes of the students towards the integration of technology in teaching biology. The results were shown as positive, neutral and negative in percentage form in order to distinguish their feelings and attitudes towards integrating technology in learning biology.

**Table 8:** Students' Attitudes towards Technology Integration in Teaching Biology

| No. | Items | BEHS (4) Sanchaung (%) | | | BEHS (6) Insein (%) | | |
|---|---|---|---|---|---|---|---|
| | | (-) | (0) | (+) | (-) | (0) | (+) |
| 1. | ***Receiving level***<br>I enjoy doing practical works when | 8 | 8 | 84 | 14 | 14 | 72 |

| No. | Items | BEHS (4) Sanchaung (%) | | | BEHS (6) Insein (%) | | |
|---|---|---|---|---|---|---|---|
| | | (-) | (0) | (+) | (-) | (0) | (+) |
| | learning biology. | | | | | | |
| 2. | I enjoy creating pictures and charts by finding related information when learning biology. | 4 | 19 | 77 | 9 | 23 | 68 |
| 3. | I enjoy searching information related with biology lessons on websites. | 19 | 12 | 69 | 8 | 20 | 72 |
| 4. | I like to search related information collaboratively when learning biology. | 12 | 19 | 69 | 14 | 14 | 72 |
| 5. | I like to discuss and share information with others when learning biology. | 19 | 19 | 62 | 11 | 22 | 67 |
| | **Students' Attitude for Receiving Level** | **12** | **15** | **73** | **11** | **18** | **71** |
| 1. | ***Responding Level*** I participate in doing practical works when learning biology. | 5 | 11 | 84 | 11 | 20 | 69 |
| 2. | I create pictures and charts by finding related information when learning biology. | 8 | 12 | 80 | 14 | 17 | 69 |
| 3. | I search information related with biology lessons on websites. | 23 | 11 | 66 | 12 | 14 | 74 |
| 4. | I search related information collaboratively when learning biology. | 11 | 12 | 77 | 6 | 20 | 74 |
| 5. | I discuss and share information with others when learning biology. | 8 | 23 | 69 | 12 | 17 | 71 |
| | **Students' Attitude for Responding Level** | **10** | **14** | **76** | **10** | **18** | **72** |
| 1. | ***Valuing Level*** I prefer doing practical works to rote memorization when learning biology. | 2 | 10 | 88 | 11 | 12 | 77 |
| 2. | I value to search information related with biology lessons on websites. | 5 | 15 | 80 | 14 | 15 | 71 |
| 3. | I recognize learning by using modern technologies makes learning biology more meaningful and effective. | 0 | 12 | 88 | 2 | 26 | 72 |
| 4. | I recognize technology integration in learning biology is helpful to make | 0 | 11 | 89 | 2 | 20 | 78 |

| No. | Items | BEHS (4) Sanchaung (%) | | | BEHS (6) Insein (%) | | |
|---|---|---|---|---|---|---|---|
| | | (-) | (0) | (+) | (-) | (0) | (+) |
| | learning process more authentic. | | | | | | |
| 5. | I accept that modern communication technologies are helpful to discuss the lessons with friends, teachers and experts. | 0 | 8 | 92 | 3 | 5 | 92 |
| | **Students' Attitude for Valuing Level** | **1** | **10** | **89** | **6** | **16** | **78** |
| 1. | ***Organization Level***<br><br>I adjust and use the learned biological knowledge and information in real life. | 3 | 23 | 74 | 11 | 31 | 58 |
| 2. | I learn and develop new biological knowledge by relating with the old knowledge. | 3 | 30 | 67 | 14 | 20 | 66 |
| 3. | Learning biology by using modern technologies is helpful to improve knowledge. | 11 | 19 | 70 | 20 | 20 | 60 |
| 4. | I modify the learned information by discussing with others when learning biology. | 3 | 30 | 67 | 17 | 28 | 55 |
| 5. | I practice to search further information by using modern technologies when learning biology. | 7 | 8 | 85 | 14 | 31 | 54 |
| | **Students' Attitude for Organization Level** | **7** | **23** | **70** | **15** | **26** | **59** |
| 1. | ***Characterization Level***<br>I always participate in doing practical works when learning biology. | 19 | 22 | 59 | 17 | 25 | 58 |
| 2. | I always cooperate and discuss with others when learning biology. | 15 | 19 | 66 | 20 | 28 | 52 |
| 3. | I always search information related with biology lessons by using modern technologies. | 19 | 5 | 76 | 17 | 28 | 54 |
| 4. | I always use modern communication technologies to discuss and solve the | 19 | 15 | 66 | 22 | 31 | 45 |

| No. | Items | BEHS (4) Sanchaung (%) | | | BEHS (6) Insein (%) | | |
|---|---|---|---|---|---|---|---|
| | | (-) | (0) | (+) | (-) | (0) | (+) |
| | problems when learning biology. | | | | | | |
| 5. | Learning biology by integrating technology supports to understand more about biological concepts. | 19 | 22 | 59 | 8 | 37 | 55 |
| | **Students' Attitude for Characterization Level** | **18** | **17** | **65** | **17** | **30** | **53** |

***Note.*** (-) refers to the percentage of negative attitudes of the students.
(0) refers to the percentage of neutral attitudes of the students.
(+) refers to the percentage of positive attitudes of the students.

According to the results of the table, although some students seem to be unable to decide (neutral) because of some of the limitations of using technological devices such as smart-phones, tablets, laptops, etc. in most basic education schools, most of the students in both selected schools showed the highest percentage in positive attitudes towards the integration of technology in teaching biology for each level. When compared, the total percentage of attitude for each level, the students in No.6, BEHS, Insein showed less percentage in positive attitude than the students in No.4, BEHS, Sanchaung. The reason may be due to the socioeconomic status of the students. Because most of the students in No.6, BEHS (Insein) were found to be unable to use and unfamiliar with modern technologies. When the results of both selected schools were combined, it exhibited that (11%) of the students showed negative, (19%) could not determine whether they accept or reject the technology, and (70%) of the students admitted that they were willing to integrate technology in learning biology.

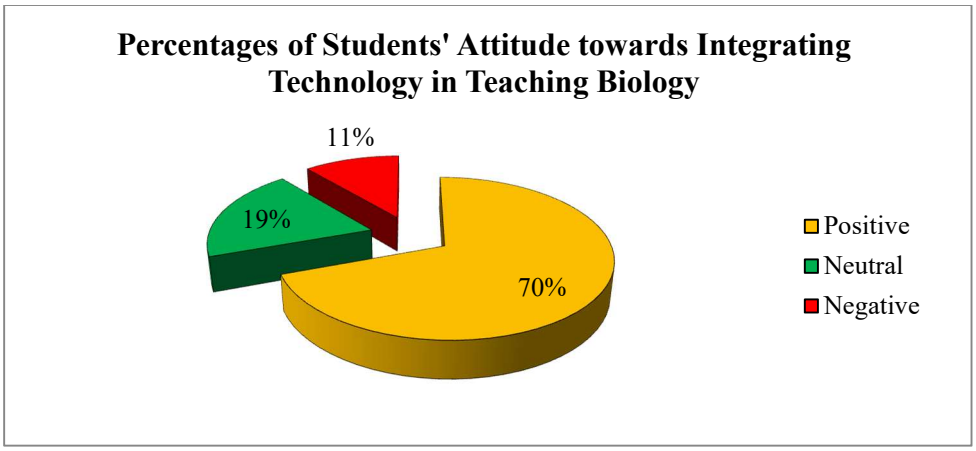


**Figure 8**: Pie Chart Showing the Percentages of Students' Attitude towards the Technology Integration in Teaching Biology

According to the results of attitude questionnaire, it can be interpreted that most of the students who are taught by technology integration are willing to use technology in their learning process and they are eager to inquire further information, to solve the problems collaboratively and to create their own product by using modern technologies such as computers, laptops, smart-phones provided with Internet access in learning biology.

**Research Findings from the Interview of Biology Teachers**

After experimenting with technology integration in teaching biology for Grade Nine students, the respective Grade Nine biology teachers were interviewed to know their attitudes and opinions. They admitted that they find difficulties to get further knowledge beyond the content of the prescribed textbook, to get further colorful diagrams, and to get the ways to demonstrate the practical works. They wondered when they know the ways to get further knowledge, colorful diagrams and video files of demonstrations of practical works with the help of Internet technologies. In spite of knowing that integrating technology in the classroom is helpful to motivate students' curiosity and attention, they do not have enough knowledge to use technological devices and also do not get enough technological devices. Even they do have such knowledge and devices, they cannot use more time to spend in integrating technology because they have to teach the content of the

textbook according to the limited time span. Nevertheless, they all are eager to receive trainings in using technology in the classroom to upgrade their existing content and technological knowledge and to teach their students effectively and meaningfully especially by using inquiry-based learning process through the Internet access.

## Discussion, Suggestions and Conclusion

### Discussion and Suggestions

The objective of the study is to study the contribution of technology integration in teaching biology to Grade Nine students. So, a posttest, questionnaires for testing the attitude of the students and semi-structured interviews were used in this study. The results of the posttest showed that the means of the experimental groups in both selected schools are higher in all of the knowledge, comprehension and application levels than that of the control groups. Therefore, technology integration in teaching biology contributed positively to the achievement of the students.

The integration of technology in teaching biology not only improves the achievement of the students but also supports the students' innate ability and creativity. Through inquiry-based learning, the students can think about the problem, search the ways to solve the problems, solve the problems in the most effective ways in collaboration with peers and others. When teaching biology, most of the biological concepts can be engaged sufficiently by using colorful images and videos, showing real objects and sometimes the real events. Some of the biology lessons can only be understood when seeing lively (video) such as reproduction of animals, fertilization, circulation of the blood, etc. In such situation, the teacher needs to search relevant aids for the lessons but these audio-visual aids and further information of biology lessons are all available on the Internet. Technology allowed in-depth exploration of a smaller number of ideas and related facts around authentic, challenging tasks (Means and Olson, 1997 cited in Koc, 2005). Therefore, when students are using technology as a tool or a support for communicating with others, they are in an active role rather than the passive role of recipient of information transmitted by a teacher, textbook, or broadcast. The student is actively

making choices about how to generate, obtain manipulate, or display information.

Integrating technology not only involves the attainment of computer skills but also consists of a process in which learners try, fail, access, evaluate, analyze and apply meaningful tasks including but not limited to researching, analyzing data, applying and representing knowledge, communication and collaborating. The results of authentic assessment showed that the students who integrated technology in learning biology are better not only in their computer skills but also in their collaborative, problem solving and presentation skills. Thus, the integration of technology into education is useful as a tool to teach the subject matter, and to promote problem-solving and higher-order thinking skills of the students.

According to the results of the students' attitude questionnaires, it showed that most of the students admitted that they enjoy exploring further information of biology, and to do practical works cooperatively with peers and to discuss and share the searched information with the whole class. Besides, the findings of the authentic assessment, they explore information to solve the problems and finally they create a product by using technology such as power point presentation, worksheets or booklets about the topic. During their work, they gave strong attention to their learning because of the motivation of the multimedia environment which includes text, sound, pictures, video, animation etc. that they have never learned. Learning is authentic and meaningful in such multimedia environment. Thus, inquiry-based learning incorporated with technology can provide meaningful and authentic learning environment to the students. Williams and Williams (1997) cited in Koc (2005) also supported that effective technology use should incorporate a variety of applications that focus on problem-solving and help development of creativity, adaptability and collaborative problem-solving skills. Thus, it is sure that technology integration not only contributes to improve the achievement of the students but also supports them to emerge their innate ability, curiosity and creativity.

According to the findings of the semi-structured interview of biology teachers, they showed similar difficulties that Onyegegbu stated in his research including; (a) Lack of technological skills and knowledge of using

the technological devices in the classroom (lack of training), (b) Non-availability of new devices in the classroom, and (c) Large class size and (d) Lack of time to integrate technology in the classroom because of the limited monthly and yearly course plans in Myanmar. Such authentic works as inquiry-based learning takes more time than the formal teaching methods so it is challenging for Myanmar teachers to integrate technology in the classroom even though they have desire to do so. However, they can use technology to search necessary and related information such as diagrams and other supportive software first, and then integrate them into their teaching to improve the students' interest and understanding of the content.

It is obvious that technology integration is necessary to make 21st century teaching learning process more effective and efficient. Students' successful use of technology mainly depends on the way of teacher's systematic modeling. However, some teachers may want to side step technology and they want to omit it because they are scared to change to their normal state of recitation and repetition. Teachers' beliefs about knowledge acquisition and effective use of technology are correlated with the ways they use technology in their classrooms (Hannafin and Freeman 1995, cited in Koc, 2005). And the teacher's view of learning may be another factor to successful technology integration. Therefore, teachers should be trained systematically so that technology can be successfully integrated in the classroom. In Myanmar, teacher trainings should be first incorporated with the technology integration courses because the successful technology use of the students mainly depend on the teachers' successful technology integration in the classroom.

Furthermore, teachers should be provided with the required technological devices to incorporate in their teaching learning process. To become more effective in technology integration, learning environments should be changed from passive to active. The role of the teacher should be as a facilitator, coach or guide of the students' learning. In this way, the students may become the active manipulators of their learning process. To do so, teachers need to have enough time and appropriate class size. The following points would like to be suggested with respect to this study.

- Firstly, technology integration should be effectively implemented at the higher education level especially in the teacher training colleges

and universities as a module before it is implemented in the basic education level.

- Secondly, in-service teachers should be given special trainings to improve their technological skills and to know the ways to integrate technology effectively in their classrooms.
- Technology integration ought to be done from primary and middle to secondary levels in basic education schools. And if necessary, International Society for Technology in Education (ISTE) National Educational Technology Standards for teachers and students should be followed.
- Instead of paper and pencil testing system which favors memorization, authentic assessments such as performance-based assessment (using rubrics) should be used so that technology integration becomes more meaningful and effective.
- It is necessary to support sufficient time, suitable class size and appropriate devices for successful technology integration.
- When integrating technology in the classroom, teachers-team system which includes all respective subject teachers who cooperate with each other may be a solution to overcome large class size problem.
- To implement such integration programs as rapidly as possible, the collaboration of community and the State may be a solution to the budget problem of supporting sufficient man and non-human resources.
- When using inquiry-based learning through the Internet resources in Myanmar basic education schools, there may be some difficulties to understand the language (mostly written in English) posed on the online websites. Therefore, to be able to more effectively inquire through the Internet, proper command of English is necessary for Myanmar students.
- Furthermore, only with the results of this study is not sufficient to implement an innovation process, it is necessary to conduct further

valid researches in other grades with longer period and broader content areas in other regions of Myanmar.

## Conclusion

Information explosion occurs in all aspects of education as soon as technology develops at top speed. Therefore, pedagogical content knowledge alone is not sufficient for 21st century teachers, technological knowledge becomes essential for the teachers to create meaningful teaching learning processes. In any aspects of education, everybody has different learning styles but teachers cannot represent all the styles in a traditional classroom environment. But technology allows teachers to better serve the diverse learning styles of the students and educate them for wider range of intelligence.

With the flexibilities and helps of technologies, meaningful classroom environments can be designed so that students can manage and construct their own representation of knowledge in their minds. Therefore, it is time to more fully integrate technology into the educational setting since skillful use of technology supports the development of process skills such as higher order thinking skills, adaptability, and collaboration that are essential to succeed in the rapidly changing information age. Koc (2005) also suggested that technology is the most valuable to teaching and learning once teachers integrate it as a tool into everyday classroom practice and into subject matter curricula

Teaching biology becomes more and more challenging to match the rapid growth of biological knowledge in this information explosion society. The world is changing drastically in the era of technology and need people of highest potential who can teach biology with understanding, with enthusiasm and success. Dewey (1916) stated that if the teachers teach today as they taught yesterday, they rob the children of tomorrow. Today teachers should not teach the children of today as they taught yesterday because it is very dangerous for the future and because it is also undeniable that the world is changing and developing constantly. Thus, today's teachers should not hesitate to change their one-size-fits-all teaching methods in a technologically oriented society. In spite of some difficulties, technology integration in the

classroom becomes one of the points to be considered in creating an education system that can generate a learning society capable of facing the challenges of the knowledge age.

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