Utilization of ICT-integrated STEM lessons on biodiversity for grade 8 learners

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Abstract. The purpose of this study is to determine the effect of the utilization of an ICT-integrated STEM lessons on biodiversity for grade 8 learners. The study used the quasi-experimental design. There were eighty (80) participants that were match sampled in terms of their average grades in Grade 8. The experimental group which composed of forty (40) participants were exposed to the developed technology based instructional material (TBIM) while another forty (40) participants were exposed to the traditional method of teaching (TMOT). Both the control group (TMOT) and the experimental group (TBIM) pretest scores lies to the Beginning (B) level of understanding. In the post-test, the experimental group scores results to Advance (A) level of understanding while the control group has a Proficient (P) level of understanding. The p-value of the control group, 0.019, is closer to the boundary (0.05) while the p-value of the experimental group, 0.000, was very far from it. This infers that the experimental group had recorded a higher difference than the control group. Thus, the utilization of an ICT-integrated STEM lessons on biodiversity for grade 8 learners were found to be effective in enhancing conceptual knowledge of the participants.

1. Introduction

STEM Education was originally called Science, Mathematics, Engineering and Technology (SMET) an initiative spearheaded by the National Science Foundation (NSF) [1]. It is an educational initiative that aims to provide all students with critical thinking skills that would enable them to become creative problem solvers and ultimately a more marketable workforce [2]. Students who participates in STEM education particularly in the K-12 setting are perceived to have an advantage if they opt for pursuing post-secondary education and a greater advantage if they choose to attend college specifically in the STEM field [3].

The rapid development of ICT and the advent of globalization are now transforming the society making STEM a necessity to meet the demands for 21st-century workplaces [4]. The extended use of ICT in STEM teaching and learning (T&L) has often been advocated as a means to engage STEM students [5]. To this end, ICT can reinforce the student skills that STEM education is supposed to develop, like problem solving, logical and critical thinking, and technological literacy [6].

As mentioned by one of the DepEd superintendent during her conversation with the researcher that they are looking for lessons that could be colorful, interactive and above all it must be localized which can cater to the need of students in Mindanao specially in the Autonomous Region in Muslim Mindanao (now Bangsamoro Autonomous Region in Muslim Mindanao) which include Lanao del Sur, Jolo, Tawi-
Tawi, Basilan, Maguindanao and Sharif Cabungsuan. In this case, the Department of Education mandated the development of localized instructional materials and lessons in order to cater the different beliefs, cultures and practices in the Philippines by providing spaces for unique cultures in the K to 12 Basic Education Program [7]. This is a key strategy for student inclusion and ensuring relevance of education processes for all learners [7]. One of the main strategies in localization is relating the learning content specified in the curriculum to local information and materials from the learner’s community [8].

The purpose of this study is to determine the effects of the utilization of an ICT-integrated STEM lessons on biodiversity for grade 8 learners.

2. Theoretical Background

The development of this study is based on the social constructivism theory of Lev Vygotsky [9, 10] wherein technology based instruction is used as a tool to make learning meaningful by situating something to be learned in the context of a "real world" activity. All knowledge is constructed [11]. Accordingly, social and cultural phenomena are also personal constructs. However, an individual is born into social and cultural environments in which all of the objects and events that are encountered have particular meaning that were also constructed. [12] states that a theory of instruction should address four major aspects: (1) predisposition towards learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishments. Good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information.

3. Methods

The participants of this study were Grade 8 high school from Marawi City Division. A total of eighty (80) participants. The distinction whether which sections were included to experimental and control group was done randomly to avoid any biases. The age of the participants for Grade 8 ranged from 13-14. Eighty (80) items multiple choice questions were constructed for Grade 8 participants. The tests were based on the lesson or subject matter on the biodiversity and ecosystem presented in the classroom. The test was validated by thirty high school science teachers. The reliability test was done through four hundred (400) randomly Grade 8 high school participants from different schools in Marawi City and Lanao Del Sur divisions answered the 80 questions. Through Cronbach Alpha, the test has a satisfactory reliability with a result of 0.876.

4. Results and Discussion

Conceptual Knowledge Performance of the Participants

Upon the implementation of the Technology-based Instructional Materials among the Grade 8 participants, the results of both Traditional Method of Teaching (TMOT) and Technology-based Instructional Material (TBIM) of both groups were gathered. The comparison of performance between the control and experimental groups in both pretest and posttest are shown in Table 1 below:
Table 1. Conceptual Knowledge Performance of the two groups (TMOT and TBIM) of Grade 8 participants

| Score     | Control Group | Experimental Group | Description     |
|-----------|---------------|--------------------|-----------------|
|           | Pre test | % | Post Test | % | Pre test | % | Post test | % |
| 77-80     | 100      |   | 100      |   | 100      |   | 100      |   |
| 73-76     | 95       | 1 | 95       | 1 | 95       | 13| 95       | 13|
| 69-72     | 90       | 6 | 90       | 12| 90       | 12| 90       | 12|
| 65-68     | 85       | 14| 85       | 8 | 85       | 10| 85       | 10|
| 61-64     | 80       | 11| 80       | 5 | 80       | 5 | 80       | 5 |
| 57-60     | 75       | 6 | 75       | 1 | 75       | 1 | 75       | 1 |
| 53-56     | 70       | 1 | 70       |   | 70       |   | 70       |   |
| 49-52     | 65       |   | 65       |   | 65       |   | 65       |   |
| 45-48     | 60       |   | 60       |   | 60       |   | 60       |   |
| 41-44     | 55       | 1 | 55       |   | 55       |   | 55       |   |
| 37-40     | 50       |   | 50       |   | 50       |   | 50       |   |
| 33-36     | 45       |   | 45       |   | 45       |   | 45       |   |
| 29-32     | 40       |   | 40       |   | 40       |   | 40       |   |
| 25-28     | 35       |   | 35       |   | 35       |   | 35       |   |
| 21-24     | 30       |   | 30       |   | 30       |   | 30       |   |
| 17-20     | 3        | 25| 25       | 2 | 25       | 25| 25       | 25|
| 13-16     | 14       | 20| 20       | 13| 20       | 13| 20       | 13|
| 9-12      | 18       | 15| 15       | 18| 15       | 18| 15       | 18|
| 5-8       | 5        | 10| 10       | 7 | 10       | 7 | 10       | 7 |

As shown in Table 1 the conceptual knowledge performance of the Grade 8 participants, both the control group (TMOT) and the experimental group (TBIM) on the pretest and posttest, the least and highest scores of the pretests of the both group have reached the same percentage which is 10%, and 25%, respectively, which lies to the Beginning (B) level of understanding. On the other hand, looking at the posttest score of both groups, it can be seen that the experimental group’s score reached a relatively higher scores than the control group. The least scores of the control group’s posttest score lies on the percentage of 55% which is under, still, the Beginning (B) level. There was only one participant who obtained 95% which is interpreted as Advance. While on the experimental group, no one scored on the Beginning (B) level. The lowest score that the experimental group gotten was 57 which lies on the 75% under the Developing (D) level. Moreover, 95% of the participants have a scores ranged from 73-76 and one participant had a perfect score which means reached the 100% level. Overall, it can be seen in the posttest, that the experimental group scores results to Advance (A) level of understanding while the control group has a Proficient (P) level of understanding which means that the experimental group performed better than the control group even just by looking at this table. The experimental group reached higher scores than the control group hence, it can be implied that the learning intervention that was applied in the experimental group was effective in helping the participants better learn the topic.

As support, assessments that occur prior to random assignment, pretests, are typically the single best covariates for explaining posttest variation and are recommended co-variates to improve precision in prospective study designs. The difference cannot be positive if the pretest score of an item has already been maximal [13]. In this data, it is clear that the pretest scores did not reached the maximum range,
even is sitting near the minimum hence it really gives the benchmark of the precise difference of the posttests. A positive stance experimental group was higher than the control group. Although some of the participants of the control group reached sixty, still, they had much lower scores than the other group.

The use of ICT in the learning process is very interesting and it increases the student interest in the various topics addressed in a normal class [14]. While it is true that the TBIM group’s posttest was higher than its pretest score, it is also very clear that it is even higher than the posttest of the control group. Meaning, we can visually examine and claim that the intervention of a learning material made a difference in learning the topic.

Table 2. Statistical comparison between the pretest and posttest of the control group and experimental group of Grade 8 participants

| Sample | Sample N | Mean  | StDev | p-value |
|--------|----------|-------|-------|---------|
| TMOT   | Pretest  | 40    | 11.975| 3.198   |
|        | Posttest | 40    | 63.975| 5.051   |
| TBIM   | Pretest  | 40    | 11.800| 3.040   |
|        | Posttest | 40    | 70.000| 4.640   |

*Significant to the null hypothesis at α=0.05

The table above shows the difference between the pretest and posttest scores of the two groups (TMOT and TBIM) of Grade 8 participants. This shows the average scores of the participants after taking the pretest and posttest. The results tell us that there is an increase of mean scores of the two groups but the mean scores of the TBIM group is evidently higher. The TMOT group increased from 11.975 to 63.975, while the TBIM group increased from 11.8 to 70. The TMOT group had an increase of 52 points while the TBIM group had an increase of 58.2 points. Additionally, to know how dispersed the data, the standard deviation value was computed. Standard deviation is a quantity calculated to show how much variation exists from the average. A low standard deviation indicates that the data points tend to be very close to the mean and a high standard deviation indicates that the data points are spread out over a large range of values.

As shown in table 2, the computed p-value of the control group (TMOT) was 0.019 and the computed p-value of the experimental group (TBIM) was 0.000. Both p-values of the two groups were less than 0.05, lesser than the significant effect of treatment. Therefore, there is a significant difference between the pretest and posttest. This implies that the participants have gained knowledge after their discussion of the topic for both the control group and experimental group. However, if we take a closer look at the p-values, the p-value of the control group, 0.019, is closer to the boundary (0.05) while the p-value of the experimental group, 0.000, was very far from it. This infers that the experimental group had recorded a higher difference than the control group. Having this big difference with their p-values it can be claimed that the instruction done in the experimental group is more effective for the participants’ learning, as evidenced by their high performance on the pretest and posttest. Pupils who use ICT get better results than those who don’t [14]. This is true across all abilities, communities, and subjects. Indeed, the technology based learning material implemented in the experimental group was effective in the participants’ learning.

The use of ICT in the learning process is very interesting and it increases the student interest in the various topics addressed in a normal class [15]. In addition, this study found similar results with that of [16], where an ICT instructional material was used and posttest scores between the control and experimental group were found significantly different which means that there is an existing impact after the utilization of the said instructional material. While it is true that the TBIM group’s posttest was higher than its pretest score, it is also very clear that it is even higher than the posttest of the control group. Also in this study, confirms the results of [17] that through the use of technology-based activities
can enhance learning and really captured the heart of every participant wherein they enjoyed every single activity in the computer laboratory.

5. Conclusion
The results show that there is a significant difference between the performance scores of the two groups. The performance of the participants exposed to the developed technology-based instructional materials (TBIM) recorded higher scores than those exposed to traditional methods of teaching (TMOT). The paired t-test result analysis showed that the performance of the participants exposed to the technology based instructional materials is significantly higher than the performance of the participants exposed to Traditional methods of teaching. Thus, the null hypothesis which states that there is no significant difference in the performance of participants taught using intervention is rejected at 0.05 level of significance. Thus, the utilization of an ICT-integrated STEM lessons on biodiversity for grade 8 learners were found to be effective in enhancing conceptual knowledge of the participants.

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