Utilization of Errorless Learning Worksheets in Improving Students' Conceptual Understanding and Procedural Skills on Integers

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1. Abstract: Most of the students entered high school level with severe gaps in their concept and skills in Mathematics. It was found out the many students were facing difficulties in the topic integers, specifically, the operations. In Tanza National Trade School, where the researcher teaches, it was observed that the students can follow steps in solving the problem. But, when it comes to simplifying it where the operation on integer is involved, the students committed errors. Due to this situation, the researcher used Errorless Learning Worksheets as an intervention to address this issue. In this type of worksheets, the students were encouraged to locate the correct answers on the top right corner of the page to increase their fluency and speed in solving integers. This study made use of One Group, Pre-test, Post-Test Experimental Design of Research. The participants of this study were 15 grade 10 students who obtained Low Mastery on the topic Integers. The study revealed that a) the mean score of the participants on the pre-test is 12.80 (Low Mastery), b) the mean score of the participants on the post test is 35.80 (Mastered) c) there is a high significant difference between the pre-test and post-test of the participants. The salient findings of this study were as follows: After the 4-week implementation of the intervention, the students mastered the concepts and operations on integers. The result also showed a significant difference between the pre- and post- test of the participants. It was concluded that students improve their conceptual understanding and procedural skills on integers.

Keywords: Integers, Conceptual Understanding, Procedural Skills, Errorless Learning, Worksheets

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Most importantly, to dear GOD ALMIGHTY, for all the blessings, strength and wisdom showered upon her that made her forever grateful and blessed. E. C. Z.

3. Context and Rationale

Many secondary mathematics teachers from different public schools have expressed their concern over poor performance of students in Mathematics (Khalid, 2008). Based on their experiences, it was found that many students were facing difficulties in understanding the topic of integers, specifically, the operations. It is a fact that understanding integers is considered basic for progression to other topics. Most of the students entered high school level with severe gaps in their concept and skills in mathematics. One of these basic foundational knowledge and skills is the integers, a necessary prerequisite skill to solve equations. Performing operations on integers involves signs of the numbers and the signs of required operation. Students tend to get confused with the signs and operations on integers although teachers had attempted to explain about it several times. It is difficult when students are taught to follow rules and
procedures in a very abstract manner without going through models for better conceptual understanding (Muñoz, 2010). The number line model that is popular among the teachers is also confusing to the students. If students have not mastered the basics, their future success in mathematics will become very challenging.

The concepts and operations on integers are extremely difficult for students to learn with meaning since it cannot be represented physically according to Stephan, M., & Cobb, P. (2013). At the same time, the time allotment that this topic can be taught, following the K to 12 Basic Education Mathematics Curriculum Guide (as of 2013, page 80 of 109) is only 6 hours which is not enough for the students to obtain 100% level of mastery.

On the study of Zurbano (2016), about Analysis of Errors in the Study of Integers, it was revealed that students are least proficient in Comparing Integers and Multiplication of Integers with Unlike Signs. They also have misconception that numbers have the same value with positive numbers. Students also disregard negative sign when performing the operation. They always affix, as the sign of the answer, the sign of the integer with the higher absolute value in the given. Lastly, student's low performance on the conceptual understanding affects their performance on procedural skills.

4. **Conceptual Understanding.** Conceptual understanding is about comprehension of mathematical concepts, operations, and relations (National Research Council, 2001). It allows a student to apply and possibly adopt some acquired mathematical ideas to new situations.

Students demonstrate conceptual understanding in mathematics when they provide evidence that they can recognize, label, and generate examples of concepts; use and interrelate models, diagrams, manipulatives, and varied representations of concepts; identify and apply principles; know and apply facts and definitions; compare, contrast, and integrate related concepts and principles; recognize, interpret, and apply the signs, symbols, and terms used to represent concepts. Conceptual understanding reflects a student's ability to reason in settings involving the careful application of concept definitions, relations, or representations of either (National Council of Teachers of Mathematics, 2000).

5. **Procedural Skills.** Procedural mathematics understanding is a knowledge that focuses on skills and step-to-step procedures without explicit reference to mathematical ideas (Hope, 2006). Students who are fluent in mathematical procedures have skills in carrying out procedures flexibly, accurately, efficiently, and appropriately.

To develop procedural skills, students need experience in integrating concepts and procedures and building on familiar procedures as they create their own informal strategies and procedures. Students need opportunities to justify both informal strategies and commonly used procedures mathematically, to support and justify their choices of appropriate procedures, and to strengthen their understanding and skill through distributed practice.

For decades, the focus of mathematics program is the procedural skills and failed to pay attention to understanding of mathematical concepts. The result of this is the poor mathematics performance of the students. Hence, the National Mathematics Advisory Panel (2008) and the National Research Council (2001) stated that conceptual and procedural understanding cannot always be separated.

In Tanza National Trade School, the school where the researcher teaches. The common problems encountered by the teachers is evaluating integers. From the quizzes and activities gathered by the researcher from different grade levels, it was observed that students followed the steps in solving the given problem but when it comes to simplifying it where in the Operations on Integers is Involved, the student committed an error.

However, the use of interventions may help the teacher to fill the gaps between students and their conceptual understanding and procedural skills in mathematics. By the use of interventions, students' understanding in operations on integers, will improve. At the same time, through practice using such interventions may help students in the retention of the operations on integers. The researcher is a Grade 10 teacher for three years but had an experience in handling all the Grade levels in Junior High School. Furthermore, she is familiar on the struggles of students in integers. However, the teachers attempted to solve this problem by using ICT, games and other activities, still students get low performance in Mathematics. The performance of students in Mathematics is not improving since prerequisite knowledge in integers can be found in almost
all of the lessons in Mathematics. In this study, the researcher will attempt to improve the conceptual understanding and procedural skills of the students through the use of errorless learning worksheets.

6. Innovation, Intervention, Strategies:
The researcher made use of the Errorless Learning Worksheets to improve students' Conceptual Understanding and Procedural Skills in Integers.

7. Errorless Learning. An Errorless learning is a strategy that is contrast to trial and error learning or errorful learning. It is a method usually used for people with language disorders or memory impairments. People usually remember their mistakes rather than the correct things they did. With this type of learning, people learn something by doing or saying it rather than by being told by someone. Moreover, they were not allowed to commit mistakes. (Gillen, 2009)

In the field of Education, Errorless learning refers to a strategy where the students are not allowed to commit mistakes while learning new information or procedures. Though, Errorless learning decreases frustrations and discouragements to learners and is helpful to increase motivation and delight in studying (https://www.relias.com/resource/errorless-learning-teaching-strategies), it was opposed to the study of Prather D. (1971) where trial and error learning or errorful learning was superior or more effective than errorless learning. While in the study of Mount et al (2007) there was no significant difference found between the effectivity of errorful learning and errorless learning, thus, it was concluded that the learning style depends on the activity and learning style of each individual.

8. Use of Worksheets. New gadgets and technology are wonderful additions to a teacher's toolbox, however technologies have disadvantages especially in some public schools in the Philippines. Because of that some teachers are still embracing worksheets as useful resources to enrich their lessons. Worksheets are an effective tool in ongoing efforts encouraging our students to engage their brains during class. It helps students to construct knowledge, used to assess students and get feedback, use as supplemental material to text books in authentic lesson, and build scaffold for some teaching strategies (Demircioglu & Kaymakci, 2011). Worksheets used in class can also help direct students' learning out-of-class (Wyels, 2014). It can be engaging, interactive, creative, hands-on, fun, and useful tools for classroom teachers.

In 2007, Carron made use of Errorless Learning worksheets in Mathematics to motivate students and build computational fluency by including answer key displayed on the top right corner of the page. In this type of worksheets, the students are directed to solve math facts as quickly as possible. If they cannot solve the given, the students were encouraged to locate the correct answers on the top of the page. The researcher will attempt to use the same method in improving students' conceptual understanding and procedural skills. Aside from promoting fluency in solving integers, it will also help the students to increase their speed in computation. This will be used as an intervention to learners which has low performance in solving integers.

10. Action Research Questions:
This study aimed to determine the effect of Errorless Learning Worksheets in improving Grade 10 Students' conceptual understanding and procedural skills on integers.

Specifically, the study sought to answer the following questions:
1. What is the level of performance of students on integers before the conduct of the study?
2. What is the level of performance of students on integers after the conduct of the study?
3. Is there a significant difference on the level of performance of the students before and after the use of errorless learning worksheets?

11. Action Research Methods:
a. Participants and/or other sources of data information. The participants of the study were Grade 10 enrolled students for School Year 2019 – 2020. They were selected since consistent errors in solving integers was still observed in this grade level and integers is being used frequently all throughout the school year.

Purposive Sampling was used in this study. It is a non-probability sampling that is selected based on the characteristics of the population and the objective of the study. The researcher administered pre-test to five sections she is handling. Initially, eighteen (18) students got Low Level Mastery or at most 20% of the correct answers. But only fifteen (15) students finished the intervention due to unavoidable reasons. The researcher made used of One Group Pre-test Post
test design. A single group of sample was exposed in a treatment since Errorless Learning Worksheets was used as an intervention strategy to students struggling in integers.

A validated and reliability tested teacher-made test in operations on integers was used as a pre-test and post-test. The 40-item test was adapted from the study of Zurbano (2016). The 40-item test assessed students’ conceptual understanding and procedural skills on integers. The test was divided into two parts, the Conceptual Understanding and the Procedural Skills. It was divided based on the number of days they were taught. Twelve items (12) was allotted for Conceptual Understanding and thirty-eight (38) was allotted for Procedural Skills. Conceptual Understanding includes the basic concepts on integers like the number line and comparison of integers while Procedural Skills include the four basic operations on integers. The worksheets that was used was adapted from “Errorless Learning” Worksheets (Caron, 2007) by the researcher.

b. Data gathering methods. Permission to conduct the study was secured to the OIC/Head of the Mathematics Department. Parental consent and informed consent was sought before the conduct of the study. The errorless learning worksheets was also validated by the head teacher and master teacher in school. One day after the test administration to the grade 10 students, the researcher selected the whole population of students who got Low Level Mastery or at least 20% correct answer in the test, as participants. The study was conducted for four (4) weeks. Three days per week was allotted to each fundamental operations on integers. After 4 weeks of intervention, the students took a post-test.

Ethical issues. The researcher sought consent of the parents or guardians of the participants before the conduct of the study. The researchers made sure that no participants were harmed during the conduct of the study in all aspects. The researcher also made sure the anonymity of the participants, thus, the result of the study did not affect the grades of the respondents in Mathematics. All of the information that was obtained in connection with this study were remained confidential and was disclosed to anyone without the permission of the parent.

12. Discussion of Results and Reflection: The present study utilized Errorless Learning Worksheets to enhance learning, grasp the necessary skills and improve student's skills and understanding on the topic integers. As stated in the previous chapters, the researchers selected the total population of the students who obtained Low Level of Mastery. The result obtained were put through statistical analysis and are presented in this chapter.

a. Level of performance of the students on pre-test.

<table>
<thead>
<tr>
<th>Test</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Highest Score</th>
<th>Lowest Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>12</td>
<td>12.8</td>
<td>1.9</td>
<td>16</td>
<td>9</td>
</tr>
</tbody>
</table>

The table above shows the Pre-test result of the participants. It can be gleaned that the mean score of the participants is 12.80 out of 40 with the standard deviation of 1.90. It means that the participants are homogenous and have Low Level of Mastery on the topic integers. The highest and lowest score obtained on pre-test are sixteen (16) and nine (9) respectively.

b. Level of performance of the students on post-test.

<table>
<thead>
<tr>
<th>Test</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Highest Score</th>
<th>Lowest Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>15</td>
<td>35.8</td>
<td>2.40</td>
<td>38</td>
<td>30</td>
</tr>
</tbody>
</table>

The table above shows the Post-test result of the participants. It can be gleaned that the mean score of the participants is 35.80 out of 40 with the standard deviation of 2.40. It means that the participants are homogenous and Mastered the topic integers. Mastered level is equivalent to minimum of 80% or thirty-two (32) out of forty (40) correct answers. The highest and lowest score obtained on post-test were thirty-eight (38) and thirty (30), respectively. From the fifteen (15) participants only one (1) obtained a score of 30 which is equivalent to Closely Approaching to Mastery Level.

c. Significant difference between the pre-test and post-test result of Grade 10 students

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>12.8</td>
<td>1.9</td>
<td>30.1757</td>
<td>&lt;0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>Post</td>
<td>35.8</td>
<td>2.40</td>
<td>0.05</td>
<td>0.0001</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 3 shows the test difference between the pre-test and the post-test result, the pre-test and the post-test result. It indicates that the result is significant at p ≤ 0.05. This means that there is a significant difference between the pre-test and post-test result. Findings revealed that there is a high significant improvement on the performance of students in integers using Errorless Learning Worksheet. It also means that the developed intervention is effective.

After the 4-week implementation of the intervention, the students Mastered the concepts and operations on
integers. It was concluded that students improve their conceptual understanding and procedural skills on integers. The researcher recommended to use the worksheets to other grade level as an intervention to master the concept and skills in solving integers.

13. Action Plan:

After the conduct of the study, the following activities and/or strategies will be conducted:

<table>
<thead>
<tr>
<th>Activities Scheduled</th>
<th>Time Frame</th>
<th>Forms Initiated</th>
<th>Expected Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation or detailed research paper to conference</td>
<td>Dec 2019 – March 2020</td>
<td>Researcher</td>
<td>Presented research paper to conferences</td>
</tr>
<tr>
<td>Conduct Focus Group Discussion among colleagues</td>
<td>January 2020</td>
<td>Teacher</td>
<td>100% attendance of participants</td>
</tr>
<tr>
<td>Utilization of Errorless Learning Worksheets to other grade levels</td>
<td>June 2020</td>
<td>Researcher &amp; Head Teacher</td>
<td>Increased performance of students to lessons where integer is involved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Math Teachers &amp; Students</td>
<td></td>
</tr>
</tbody>
</table>

14. Financial Report:
The following are the expenses of the research all throughout the conduct of this study:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>team</td>
<td>A4 Bond paper</td>
</tr>
<tr>
<td>1</td>
<td>bottle</td>
<td>Black Ink</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. References:


