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# A Guided-Discovery Approach to Problem Solving: An Explicit Instruction

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**Abstract**

In the quest to maximize students' academic growth, one of the best tools available to educators is explicit instruction, a structured, systematic, and effective methodology for teaching academic skills that facilitates important instructional interactions between teachers and students. This quasi-experimental matching only pretest-posttest control group design of research aimed to determine the effectiveness of explicit instruction on students' mathematics achievement and problem-solving skills. This involved 40 Grade 11 Senior High School students as participants. One group of students was taught using explicit instruction and the other group used the traditional instruction. The statistical tools used to determine the effectiveness of the instruction in the lessons presented were mean, mean gain, independent t-test, and Wilcoxon Signed Rank test. Results showed that explicit instruction had significantly increased students' performance in mathematics achievement and problem-solving skills. Both traditional and explicit instructions had effectively changed the scores of the students from the pretest to the post-test performance in mathematics achievement and problem-solving skills. Also, explicit instruction showed a significantly higher value of mean gain scores than the traditional instruction in mathematics achievement and problem-solving skills.

**Keywords**— Guided-discovery approach, Problem Solving, Explicit Instruction

## INTRODUCTION

Mathematics is deemed integral in all aspects of daily life. It has been a part of the human understanding affecting one's performance in the job, school, home, and community and successfully applied in the voting process, data analysis, and predicting sustainable development to mention a few. Thus, teaching Mathematics is a particular task, which if sincerely undertaken, will challenge the best efforts of the best teacher. Many things are expected of Mathematics teacher. His obligations are not only confined within the four walls of the classroom but also extended in many other directions. It must not be forgotten, however, that his first and foremost obligation is to teach his subject effectively.

Several researchers have recommended using particular instructional strategies to encourage the development of critical thinking skills and abilities, such as explicit instruction, collaborative or cooperative learning, modeling, and constructivist techniques (Lai, 2011). Explicit instruction is characterized by a series of supports or scaffolds, whereby students are guided through the learning process with clear statements about the purpose and rationale for learning the new skill, clear explanations and demonstrations of the instructional target, and supported practice with feedback until independent mastery has been achieved (Archer & Hughes, 2011). Likewise, as mentioned by Archer & Hughes (2011), one of the best tools available to educators is explicit instruction, a structured, systematic, and effective methodology for teaching academic skills. It is called explicit because it is an unambiguous and direct approach to teaching that includes both instructional design and delivery procedures.

As a Mathematics teacher for several years, the researcher observed that the students are experiencing mathematical learning difficulties especially in solving mathematical problems. Also, students could not comprehend simple mathematics problems. They were hesitant to participate in the activity. Various styles and strategies were used in teaching Mathematics just to improve students' comprehension, but still, the same problem occurs. Even other teachers teaching Mathematics subject encountered the same different levels of difficulties in handling the subject. Thus, the researcher was inspired to utilize the guided-discovery approach, an explicit instruction to promote problem-solving skills in Mathematics instruction.

This study generally aimed to ascertain the effectiveness of the guided-discovery approach to problem-solving. Specifically, it seeks answers to the following questions:

1. determine the level of mathematics achievement and problem-solving skills of students before and after the exposure to traditional and explicit instructions;
2. determine the mean gain in mathematics achievement and problem-solvingskills, of students in the traditional and explicit instructions.
3. find out if there is a significant difference in the pre-test and post-test performance of students in the mathematics achievement and problem-solving skills in the traditional instruction and explicit instructions;
4. determine if there is a significant difference in the mean gains of mathematics achievement and problem-solving skills of students in the traditional and explicit instructions;

## Materials and Methods or Methodology

Participants. The participants were taken from the one section composed of 40 students of Grade 11 Senior High School Capiz State University-Main Campus, Roxas City. The student participants were chosen through a comprehensive match-pairing based on their grades in the general Mathematsubjectsject in the previous semester. Two groups were formed by ranking their grades from highest to lowest. After ranking, all odd numbers were assigned to the first group and all the even numbers were assigned to the other group. Then the researcher did a toss coin to determine which group would be assigned as the traditional and explicit instruction groups respectively. There was a separate schedule for each group for the instructions.

*Table 1*

*Distribution of the participants*

| Group | Total number of Students | Percent (%) |
|---|---|---|
| Group A (Explicit Instruction) | 20 | 50 |
| Group B (Traditional Instruction) | 20 | 50 |
| Total | 40 | 100 |

## Materials

Mathematics Achievement Test. The test was composed of 40 multiple choice items researcher-made test which included the following learning competencies: Illustrating simple and compound interests; Distinguishing between simple and compound interests; Computing interest, maturity value, future value, and present value in simple interest and compound interest environment; Solving problems involving simple and compound interests; Illustrating simple and general annuities; Distinguishing between simple and general annuities; Finding the future value and present value of both simple annuities and general annuities. The three (3) experts in Mathematics checked the validity of the research-made test focusing on the content. A table of specifications was made to estimate the number of items for each competency. It was pilot tested on the thirty (30) Grade 11 Senior High STEM students of Inzo Arnado Village Integrated School. After which, item analysis of the test was done for revision and retention of items. The final draft of the text was prepared before the pretest was administered. The same instrument was utilized for the post-test but choices were rearranged to avoid familiarity with the answers.

Students' Problem-Solving Skills. The problem-solving skills of the students were determined using the test adapted from Problem Solving Strat book by Ted Herr and Ken Johnson (1994). The test was composed of 10-item extended response problems. The egiesitems constructed were anchored on the topics and the strategies discussed within the intervention period such as guess and check, draw a picture, make a systematic listing, look for a pattern, look for a formula, use a variable/(s) (one and two variables), draw a diagram, solve a simpler problem, work backward, and make a logical deduction. There were 100 total points in the problem-solving skills test. Each item was equivalent to 10 points and would be scored using the rubric adapted from Problem Solving Strategies book by Ted Herr and Ken Johnson (1994).

## Design and Procedure

This study used a quasi-experimental design of research, specifically the matching-only design of the pretest-posttest control group design. The matching only pretest-posttest control group design according to Fraenkel and Wallen (2010), is an experimental design wherein the researcher matches the participants in experimental and control groups using the previous semesters of two (2) intact groups. The groups were randomly assigned as Group A (Control-Traditional instruction) and Group B (Experimental Explicit instruction), the participants in Group A are matched with student-participants in Group B. The pre-test was administered to the two groups before giving the intervention. After the pre-test, each group was exposed to the different strategies – the traditional and explicit instructions for 24 days. For traditional instruction, the schedule was 9:30 to 10:30 in the morning while the explicit instruction was scheduled from 10:30 to 11:30 in the morning from Monday to Thursday for six (6)weeks. In the explicit instruction group, it was started by gaining attention by making sure that the students were ready to start the class. It was followed by presenting a problem and a preview of what was discussed and its importance or relevance to real-life situation or subject matter. Then, reviewed the critical prerequisite requirement skills for the topics discussed were given attention. Next, the teacher proceeded to the topic itself by mmodeling("I do") in this phase, the teacher "shows and tells" the topic making sure that students are involved. In this stage, problem-solving skills were integrated by giving different variations of ways in finding the solution using Polya's four-step process in ddiscussion After which, prompted or guided practice ("We do"), wherein the teacher guided the students in performing the skill by providing physical, verbal, or visual prompts gradually fading at the same time integrating problem-solving skills. Then, unprompted practice was given to them. This time, the teacher used collaborative learning strategies and students performed the skill without prompts. Lastly, the review of critical content was discussed, a preview of the content of the next lesson, assigned independent work, and journal writing about the strategy that was discussed. The traditional instruction, on the other hand, included first the review of the ideas necessary for the topic, followed by a motivation to trigger the students to listen and think, then the lesson was presented by stating the goal. Then topic was discussed, after which generalization was asked to give ovan erview of the topic discussed. Practice exercises were given to everyone, after that if there were no more questions, a formative test was given and then an assignment.

## Results and Discussions

Level of Students' Mathematics Achievement and Problem-Solving Before and After the Intervention

Table 2 shows the level of students' mathematics achievement and problem-solving in both traditional and explicit instruction groups before and after the intervention. Before the intervention, the level of mathematics achievement of students in the traditional and explicit instructions was “Low” with means of 9.95 and 11.10 respectively. The level of problem-solving skills of students in the traditional and explicit instructions was “Poorly Developed”. The traditional instruction had a mean of 26.10, while the explicit instruction had a mean of 28.70. This indicates that students both in the traditional and explicit instruction groups had the same level of performance in their mathematics achievement and problem-solving skills, before the conduct of the interventions. After the intervention, students’ level of mathematics achievement in the traditional instruction was “average” with a mean of 19.35. On the other hand, students in the explicit instruction had a “very high” level of mathematics achievement as shown by the mean of 35.00. Moreover, the level of problem-solving skills of students in the traditional instruction was “developed” with a mean of 58.50, while ihe explicit instruction was “highly developed” with a mean of 87.00.

*Table 2*

*Level of students’ Mathematics achievement and problem-solving skills before and after the intervention*

| Instructions | Mathematics Achievement | | Problem Solving Skills | |
|---|---|---|---|---|
| | **Before** | **After** | **Before** | **After** |
| **Traditional** | | | | |
| **Mean** | **9.95** | **19.00** | **26.10** | **58.50** |
| **Verbal Interpretation** | **Low** | **Average** | **Poorly Developed** | **Developed** |
| **Explicit** | | | | |
| **Mean** | **11.10** | **35.00** | **28.70** | **87.00** |
| **Verbal Interpretation** | **Low** | **Very High** | **Poorly Developed** | **Highly Developed** |

Interpretation is based on the following scale
Legend:

Mathematics Achievement
32.01–40.00 Very High
24.01–32.00 High
16.01–24.00 Average
8.01–16.00 Low
0.00–8.00 Very Low

Problem-Solving Skills
80.01-100.00 Very Highly Developed
60.01-80.00 Highly Developed
40.01-60.00 Moderately Developed
20.01-40.00 Poorly Developed
0.00-20.00) Very Poorly Developed

Mean Gains in the Mathematics Achievement and Problem-Solving skills in Both Instructions

The mean gain value of students’ mathematics achievement and problem-solving skills were stated as shown in Table 3. In terms of mathematics achievement, the explicit instruction had a higher mean gain value of 23.9 than the traditional instruction with a mean gain value of 9.05 and a difference of 14.85. In the problem-solving skills, explicit instruction had a higher mean gain value of 58.30 than the traditional instruction with a mean gain value of 32.40 and a difference of 25.90.

*Table 3*

*Mean gains in Mathematics achievement and problem-solving of students in both instructions*

| | **Pre-test** | **Post-test** | **Mean Gain** |
|---|---|---|---|
| **Mathematics Achievement Test** | | | |
| **Traditional** | **9.95** | **19.00** | **9.05** |
| **Explicit** | **11.10** | **35.00** | **23.90** |
| **Problem-Solving Skills** | | | |
| **Traditional** | **26.10** | **58.50** | **32.40** |
| **Explicit** | **28.70** | **87.00** | **58.30** |

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The difference in the Pre-test and Post-test on the Mathematics Achievement and Problem-Solving in the Traditional and Explicit Instruction

The researcher used the Wilcoxon Signed Ranked Test in determining any significant difference in the pre-test and post-test scores on the mathematics achievement and problem-solving skills of the explicit instructions group. Table 4 shows that the result for the test of difference in the pre-test and post-test scores in the mathematics achievement of the traditional instruction group was (z-value¬ =-3.85, p-value¬ = 0.000), which was highly significant at 0.05 alpha. This suggests that students performed better in the post-test than in the pre-test as shown by the negative values in the scores. Likewise, there was a significant difference in the pre-test and post-test scores of students in the problem-solving skills (z-value¬ =-3.92, p-value¬ =.000). Hence, traditional instruction had a positive effect on the performance of students in terms of problem-solving skills. The comparison in the pre-test and the post-test in the mathematics achievement of students in the explicit instruction was significantly different (z-value =-3.3929, p-value =.000). This implies that the explicit instruction as an intervention was effective in improving the performance of students in their mathematics achievement. Likewise, there was a significant difference in the pre-test and post-test scores of students in the problem-solving skills (z-value =-3.92, p-value =.000). Thus, explicit instruction had an affirmative effect on the performance of students in problem-solving skills. Generally, explicit instruction was effective in improving students' performance in mathematics achievement and problem-solving skills.

*Table 4*

*The difference in the pre-test and post-test on the Mathematics achievement and problem-solving skills of students in the traditional and explicit instruction*

| **Instruction** | | **Mean** | **z-value** | **p-value** | **Remarks** |
|---|---|---|---|---|---|
| **Traditional** | **Mathematics Achievement** | | | | |
| | **Pretest** | **9.95** | **-3.85** | **0** | **s** |
| | **Post-test** | **19** | | | |
| | **Problem-solving Skills** | | | | |
| | **Pre-test** | **26.1** | **-3.92** | **0** | **s** |
| | **Post-test** | **58.5** | | | |
| **Explicit** | **Mathematics Achievement** | | | | |
| | **Pre-test** | **11.1** | **-3.93** | **0** | **s** |
| | **Post-test** | **35** | | | |
| | **Problem Solving Skills** | | | | |
| | **Pre-test** | **28.7** | **-3.92** | **0** | **s** |
| | **Post-test** | **87** | | | |

P<0.05, significant @ 5% level

**The difference in the Mean Gains on the Mathematics Achievement and Problem Solving and of students**

Table 5 shows that the mathematics achievement means gain scores of students in both groups were significantly different (t-value=10.31, p-value =.000). The explicit instruction group had a mean gain score of 23.9, which was significantly higher than the traditional instruction group with a mean gain score of 9.05. This implies that explicit instruction is more effective in the improvement of students' gain in mathematics achievement.

Also, there was a significant difference in the problem-solving skills (t-value =5.30, p-value =.000) of students in both groups. The mean gain in the problem-solving skills score of students in the explicit instruction group was 58.30, which was significantly higher than the traditional instruction group with a mean gain of 32.4. Thus, explicit instruction had pointedly improved students' gain in problem-solving skills. To sum up, explicit instruction had a significant improvement in the gains of students' performance in mathematics achievement and problem-solving skills. However, a little increase in the gains in their critical thinking skills was noticed.

*Table 5*

*The difference in the mean gains on the Mathematics achievement and problem-solving skills of students in both instructions*

| **Variables/ Instruction** | **M** | **Df** | **t**-value | **P**-value | **95% Confidence Interval** Lower | **Upper** | **Remarks** |
|---|---|---|---|---|---|---|---|
| Mathematics Achievement | | | | | | | |
| Traditional | 9.05 | 29 | 10.31 | .000 | -17.80 | -11.90 | s |
| Explicit | 23.90 | | | | | | |
| Problem-Solving Skills | | | | | | | |
| Traditional | 32.40 | 38 | 5.30 | .000 | -35.01 | -16.79 | s |
| Explicit | 58.30 | | | | | | |

P<0.05, significant @ 5% level; P>0.05, not significant @ 5% level

## Conclusions and Recommendations

The participants have diverse skills prior to the onset of the study. The increase of the level of participants' performance in the explicit instruction indicates that the intervention brought positive effects or benefits to the students. The step-up in the mean gain scores on the mathematics achievement and problem solving skills of participants in the explicit instruction is higher compared to those participants in the traditional instruction. This evidence indicates that explicit instruction is an effective strategies in improving mathematics achievement and problem-solving skills of students. The students in both groups are on the same level prior to the conduct of the intervention. They have the same mathematical knowledge and skills. However, the explicit instruction has made a contribution in the increase of mathematics achievement and problem-solving skills of students. Thus, explicit instruction is an effective intervention in improving students' performance in the Mathematics subject compared with traditional instruction. The notable increase in the post-test scores in mathematics achievement and problem-solving skills of students in the explicit instruction shows that it is an effective approach to enhance their high engagement inside the classroom. Likewise it is an effective and a better approach than traditional instruction to help improve students' performance and skills in mathematics. Hence, the use of explicit instructions by mathematics teachers is an optimistic and useful approach to venture on.

It is highly recommended to use the lesson exemplars designed by the researcher in the study using explicit instruction approach in the teaching of mathematics subject in improving students' performance and problem solving skills. Educational policy makers may implement realistic guidelines in terms of pursuing the use of explicit instruction and help in disseminating information among members of the academe to consider the use of explicit instruction in their respective learning environment. Teachers may implement explicit instruction as an approach in teaching

Mathematics to meet instructional objectives and improve learners' ability and problem solving skills That will serve as a motivator to put forth to learn the content in an enjoyable, interactive, and collaborative way. Future researchers may endeavour which instructional strategy apart from explicit instruction works best for critical thinking skills, different cultures, learning difficulties, learning style. Further studies on explicit instruction should be undertaken or replicated to generalize the result such as a combination of two (2) approaches. These future studies may be on a wider scope or conducted utilizing another design.

**Output**

Development of Explicit Instruction Model Lesson Exemplars for Students' Mathematics Skills
Enhancement

**Technology Transfer Activity Conducted**

Instructional Process (Explicit Instruction Model Lesson Exemplars for Students' Mathematics Skills Enhancement)

**Economic Analysis**

Not applicable

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