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Explicit Instruction in Problem-Solving Skills, Creative and Critical Thinking Skills of the Elementary Education Students

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Abstract **– This quasi-experimental research sought to determine the effectiveness of explicit instruction (EI) on a Problem Solving course, specifically on students' problem-solving skills, creative and critical thinking skills. The 66 matched-paired participants were from the two intact classes of the Bachelor in Elementary Education students of University of Antique, Sibalom, Antique, Philippines. One group of students was taught using EI and the other group using traditional instruction (TI) for nine weeks. The statistical tool used were paired *t*-test, and *t*-test for independent samples. Results revealed both EI and TI have effectively changed the scores of the students from the pretest to the posttest performance in the problem-solving skills and creative thinking skills with a much higher confidence interval in the EI group however, no significant differences were found in the critical thinking skills. Furthermore, EI shows significantly higher mean gain scores than the TI in problem-solving skills and creative thinking skills however, no significant difference between groups in the critical thinking skills. Students in the EI group changed their perception of looking at mathematics problem-solving. They have better understanding of the problem, can identify a strategy and implement them, and can create varied ideas in solving them. Likewise, students have foster positive attitude towards EI making it an optimistic approach to venture in teaching mathematics. Hence, utilization of the lessons with EI approach is highly recommended in teaching mathematics problem-solving course in improving students' performance.**

Keywords **– Cooperative Learning Strategies, Explicit Instruction, Creative Thinking Skills, Critical Thinking Skills, Problem-solving Skills.**

I. INTRODUCTION

Educators have long been aware of the importance of critical thinking skills as an outcome of student learning [5]. Despite the sustained interests in fostering critical thinking in higher education, there is evidence that college graduates lack critical thinking needed in today's workplaces [3].

Literatures mentioned that students are assessed in mathematics through speed and accuracy of computation but inadequate emphasis was given in problem-solving skills and pattern finding likewise, there was also a few opportunities for on rich mathematical activities that require creative thinking [6].

In the new K–12 mathematics curriculum in the Philippines, critical thinking and problem-solving are among its goals and creativity is one of the values and attitudes to be honed among learners. This implies that teacher education must provide training in critical thinking and problem-solving among other skills and use appropriate tools in teaching mathematics to achieve these goals, and develop key values and attitudes.

A number of researchers have recommended using explicit instruction (EI) to encourage the development of mathematical skills. As mentioned by Archer & Hughes [1], it is one of the best tools available to educators which is structured, systematic, and an effective methodology for teaching.

Several researches have concluded and supported EI as a method for significantly improved math achievement [4] and when combined with peer mentoring approach [9]; positive effect on creativity [10], [2] and an effective method for teaching critical thinking skills [7].

With the information given above, the researcher utilized EI as a teaching method to problem-solving skills, and creative and critical thinking skills in mathematics instruction specifically in Problem-solving course.

II. THEORETICAL AND CONCEPTUAL BACKGROUND

Using EI, the teacher models the behavior to be achieved by the students, students are provided with scaffolds and they could work with others. This approach in teaching and learning was emphasized in Bandura's social cognitive theory. This theory stressed the idea that human learning commonly occurs in a social environment [8].

It is also a problem solving teaching and learning environment, a typical constructivist view of schooling. Constructivist epistemology accepts that learners are capable of constructing their own knowledge and therefore should be actively involved in their learning [8].

In the Bandura's social learning theory, students are engaged in different learning instructions-the explicit and the traditional. They are also exposed to different problem solving situations, a constructivist epistemology. Through those experiences, students' performances in problem solving skills (PSS), creative (CreTS) and critical thinking skills (CTS) in a Problem Solving course (PSc) can be improved.

In view of the preceding background, the conceptual framework is shown to present relationships among variables in Fig. 1.

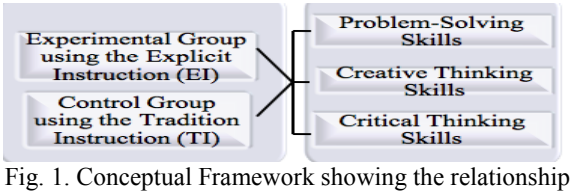

Fig. 1. Conceptual Framework showing the relationship between the Independent variables (control and experimental group) to the dependent variables (PSS, CreTS, and CTS)

A. *Research Questions*

The main purpose of the study is to determine the effectiveness of EI in developing PSS, CreTS, and CTS of students. Specifically, it sought to answer the following questions:

1) What is the level of problem-solving skills, creative thinking skills, and critical thinking skills of students before and after exposure to a) traditional instruction; and b) explicit instruction?
2) What is the mean gain in problem-solving skills, creative thinking skills, and critical thinking skills of students before and after exposure to a) traditional instruction; and b) explicit instruction?
3) Is there a significant difference in the pretest and posttest performance of students in problem-solving skills, creative thinking skills, and critical thinking skills of students before and after exposure to a) traditional instruction; and b) explicit instruction?
4) Is there a significant difference in the mean gains in problem-solving skills, creative thinking skills, and critical thinking skills of students before and after exposure to a) traditional instruction; and b) explicit instruction?
5) How do students perceive explicit instruction in teaching Problem Solving course?

B. *Hypotheses*

Based on the aforementioned problems, the following hypotheses were advanced to be tested.

1) There is no significant difference in the pretest and posttest performance of students in problem-solving skills, creative thinking skills, and critical thinking skills in a) traditional instruction; and b) explicit instruction.
2) There is no significant difference in the mean gains in problem-solving skills, creative thinking skills, and critical thinking skills of students between traditional and explicit instructions.

III. METHODOLOGY

A. *Design*

The researcher used quasi-experimental design specifica--lly, the matching-only pretest-posttest design. It is an experimental design wherein researcher matches the participants in the experimental and control groups. Then, the two groups were pretested, after which it will be exposed to different instructions as an intervention. After the intervention, the two groups were given posttest.

The design is illustrated as follows:

Group A (Explicit Instruction)	M	O_1	X	O_3
Group B (Traditional Instruction)	M	O_2	C	O_4

Fig. 2. Research Design Paradigm

Legend: O_1 and O_2 Pretest
O_3 and O_4 Posttest
X Treatment (Explicit Instruction)
C Control (Traditional Instruction)

B. *The Participants*

The study took place at the College of Teacher Education, University of Antique in Sibalom, Antique, Philippines. The participants were the 66 fourth year Bachelor in Elementary Education (BEED) students coming from two intact classes enrolled in the PSc during the first semester of SY 2016-2017. Students from each group were chosen through a comprehensive match-pairing based on their general weighted average (GWA) in mathematics courses from prior semesters, sex, and age. Such match pairing yields no significant difference establishing no difference comparability of the two groups at the start of the study. Table 1 shows the distribution of the participants.

Table 1. Distribution of the Respondents per Group.

Group	Male f	Female f	Total no. of students	Percentage
Group A (Explicit Instruction)	3	30	33	50%
Group B (Traditional Instruction)	3	30	33	50%
Total	6	60	66	100%

C. *The Intervention*

The researcher wanted to employ the use of EI in teaching PSc by changing the classroom environment and type of test to be given.

EI is skill-based and students are active participants in the learning process using cooperative strategies. The critical thinking strategy was introduced using the problem-solving strategy which may include decision-making, comparison and contrast, observing, planning, make predictions, and questioning. Creativity in this instruction can be acquired by introducing to students the different strategies and varieties of ways in answering problems, while problem-solving is through the four-step process suggested by Polya (1945).

Two sections from the fourth year BEED students were utilized, each section was taught with the same topics in problem-solving and the same amount of exercises and assignments were also given.

The teaching strategies were randomly assigned to the groups through draw lots. In the EI, journal writing and cooperative strategies were added as part of the activity of the students. To assure that lessons followed how the strategy was taught, validated and revised lesson plans were utilized.

The respondents were taught for three hours per week in nine weeks, equivalent to 27 hours for the entire duration of the experiment. To prevent intrusion of extraneous variables, all the selected groups have their classes in the morning. Observers were also assigned during the intervention phase in both instructions.

D. *Procedures*

Permission to conduct the research, pilot testing, and the utilization of two sections of the fourth year BEED students as participants were asked from the president of the university. As soon as the necessary permissions were granted, the researcher started the study with the pilot testing of the validated instruments to the fourth-year BEED students who are not included in the experimental and control groups. After which, reliability of the test was tested and final draft of the test was prepared for the pretest.

The study, being quasi-experimental in design, involved pretest and posttest for the control and experimental groups. This study used three tests validated and were tested for reliability. The instrument is composed of 12 extended response problems for students' PSS, 20-item test to determine the CTS, and six-open-ended questions to determine students' CreTS.

In administering the pretest, directions were read carefully to ensure students' understanding of what they are going to do. The test for problem-solving skills must be accomplished for 90 minutes and the critical and creative thinking skills for 60 minutes each. The groups were given one test each day. After the pretest, each group was exposed to the different approaches for nine weeks-experimental group exposed to EI while, the control group to TI.

In the experimentation proper, only one teacher handled the classes of the two groups. After nine weeks of intervention, the groups were given a posttest to determine if there were improvements on the students' PSS, CreTS and CTS.

E. *Statistical Data analysis Procedure*

The data gathered were analyzed using frequency distribution and percentage, mean, mean gain, paired *t*-test and *t*-test for independent samples, through Statistical Packages for Social Sciences (SPSS) version 20.

The decision to reject or not to reject the null hypotheses in this study was set at alpha 0.05 level of significance.

IV. Results and Discussions

A. *The Level of PSS, CreTS and CTS before and after the Interventions*

Table 2 results revealed that the students' level of PSS, CreTS, and CTS were the same labeled as "very poorly developed", "imitative", and "beginning" respectively in both TI and EI groups before the intervention took place.

After the intervention, there was an increase in the level of performance in the PSS from "very poorly to moderately developed", and CreTS from "imitative to ordinary" in the EI group however, remained in the "beginning" in the CTS. On the other hand, the level of performance of the TI group in PSS, CreTS and CTS stay in the same level as to before the intervention which were "very poorly developed", "imitative", and "beginning" respectively.

Table 2. Level of problem-solving Skills, Creative Thinking Skills, and Critical Thinking Skills before and after the Intervention

Variables	Traditional Instruction			Explicit Instruction		
	M	SD	Description	M	SD	Description
PSS Before	14.58	7.45	Very Poorly Developed	18.67	8.58	Very Poorly Developed
PSS After	45.91	14.27	Poorly Developed	60.88	15.71	Moderately Developed
CreTS Before	10.48	3.78	Imitative	13.27	4.18	Imitative
CreTS After	14.94	3.51	Imitative	20.85	5.27	Ordinary
CTS Before	8.91	1.67	Beginning	10.88	1.96	Beginning
CTS After	9.36	2.26	Beginning	11.64	2.03	Beginning

Note: Interpretation is based on the following scale.
Problem-Solving Skills – Very High Developed (96.00-120.00), High Developed (72.00-95.99), Moderately Developed (48.00-71.99), Poorly Developed (24.00-47.99), Very Poorly Developed (0.00-23.99);
Creative Thinking Skills – Very Creative (40.50-54.00), Creative (27.00-40.49), Ordinary/Routine (13.50-26.99), Imitative (00.00-13.49);
Critical Thinking Skills – Advanced Thinker (16.00-20.00), Practicing Thinker (12.00-15.99), Beginning Thinker (8.00-11.99), Challenged Thinker (4.00-7.99), Unreflective Thinker (00.00-3.99).

B. *The Mean Gain in PSS, CreTS, and CTS*

The difference of the mean scores of the students in the pretest and posttest were identified. As revealed in Table 3, in PSS, TI has a mean gain of $MG = 31.33$ while EI has $MG = 42.21$. In CreTS, TI has a mean gain of $MG = 4.45$ and EI has $MG = 7.58$, and in the CTS, TI has a mean gain of $MG = .45$ while EI with $MG = .76$.

As a whole, EI group of students exhibits a higher gain of scores in the PSS, CreTS, and CTS as compared to the TI group of students.

Table 3. Mean Gain in Problem-solving Skills, Creative Thinking Skills, and Critical Thinking Skills in TI and EI Groups

Variables	Traditional Instruction		Explicit Instruction	
	Mean Gain	*SD*	Mean Gain	*SD*
Problem-Solving Skills	31.33	13.21	42.21	12.73
Creative Thinking Skills	4.45	3.77	7.58	4.80
Critical Thinking Skills	.45	2.65	.76	2.29

C. *The difference of Pretest and Posttest Scores in PSS, CreTS, and CTS*

Table 4 results revealed that there were significant differences in the pretest and posttest scores of students in the PSS and CreTS in the TI and EI groups. However, there were no significant differences were found in the pretest and posttest scores of students in the CTS in both groups.

It is also noted in the result that in PSS, the EI group could get a score of 37 up to 46 points than in the TI of 26 up to 36 points only. Also, in the CreTS, the EI group could get a score of 5-9 points while in the TI group only from 3-5 points. And in the CTS, both TI and EI group of students can score up to 1 point.

Results revealed that both TI and EI have significantly increased students' performance with a much-larger-than-typical effect sizes in the PSS and CreTS. EI group has a much higher confidence interval values than the TI. However, it was not as effective as in the CTS of students in both groups.

Table 4. The t-test Result in the Differences of Pretest and Posttest Scores in the Problem-Solving Skills, Creative Thinking Skills, and Critical Thinking Skills in TI and EI Groups.

Variables							Confidence Interval	
	M	*SD*	*t*	*df*	*p*	*d*	Lower	Upper
TI- PSS								
Pretest	14.58	7.45	13.627*	32	.000	2.88	26.65	36.02
Posttest	45.91	14.27						
EI- PSS								
Pretest	18.67	8.58	19.04*	32	.000	3.28	37.70	46.73
Posttest	60.88	15.71						
TI- CreTS								
Pretest	10.48	3.78	6.792*	32	.000	1.22	3.12	5.79
Posttest	14.94	3.51						
EI- CreTS								
Pretest	13.27	4.18	9.07*	32	.000	1.60	5.88	9.28
Posttest	20.85	5.27						
TI-CTS								
Pretest	8.91	1.67	.987	32	.331	.23	-.48	1.39
Posttest	9.36	2.26						
EI-CTS								
Pretest	10.88	1.96	1.90	32	.067	.38	-.06	1.57
Posttest	11.64	2.03						

*p≤ .001
Note: Interpretation of the effect size (*d*) is based on the following scale. small or smaller than typical=.20, medium or typical=.50, large or larger than typical=.80, much larger than typical ≥1.00, *d* greater than .90 (or less than -.90) would be described as "much larger than typical".

D. *The Difference in the Mean Gains in PSS, CreTS, and CTS of Students in the TI and EI Groups*

Results revealed that there were significant differences noted in the PSS ($t(64) = 3.406$, p = .001, d = .84) with a larger-than-typical effect size and CreTS ($t(64) = 2.940$, p = .005, d = .73) with a typical effect size of students with significantly higher mean gain in the EI group. Whereas no significant difference was found in the CTS ($t(64) = .497$, p = .621) between groups. The EI group of students can gain as much 4 up to 17 points in the PSS and 1 up to 5 points in the CreTS.

EI had a significant improvement in the gains of students' scores in the PSS and CreTS however, no significant increase in the gains of CTS of students.

Table 5. The t-test Result of differences in the Mean Gain of Scores in the Problem-Solving Skills, Creative Thinking Skills, and Critical Thinking Skills in TI and EI Groups

Variable	M	SD	t	df	p	d	Confidence Interval	
							Lower	Upper
PSS								
TI	31.33	13.21	3.406 **	64	.001	.84	4.50	17.26
EI	42.21	12.73						
CreTS								
TI	4.46	3.77	2.940 *	64	.005	.73	1.00	5.24
EI	7.58	4.80						
CTS								
TI	.45	2.65	.497	64	.621	.13	-.91	1.52
EI	.76	2.29						

*p < .01, **p≤ .001
Note: Interpretation of the effect size (*d*) is based on the following scale. small or smaller than typical=.20, medium or typical=.50, large or larger than typical=.80, much larger than typical ≥1.00, *d* greater than .90 (or less than -.90) would be described as "much larger than typical".

E. *Perception of Students towards EI in Teaching Problem Solving Course*

The perception of the students in the EI revealed that, problem solving activity was challenging yet, they have managed to enjoy the lesson through cooperative activities. Their perspective in mathematics problem solving had positively changed after they experienced the instruction. Additionally, they learned to love the course and feel the need to learn the new strategies in solving mathematical problems.

V. Conclusions

Based on the findings of the study, the following conclusions were drawn:

The EI intervention expands positive benefits and has augmented the scores of the participants. They were better in understanding the problem or mathematical concepts, introducing a strategy and implement them, think of new or different ideas, and solve problems. It is also an effective approach that can be substituted for the TI to help improve students' performance in PSS and CreTS.

Participants commend EI as an effective and efficient way of learning PSc paired with cooperative learning activities. Students found collaborative work as a help in solving problems with ease since they do the planning, understanding and solving the problems together. Also, the scaffolding clues, prompts or questions provided by the teacher and through the logically sequenced process of the instruction serve as an effective way of learning.

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References

[1] A.L. Archer & C.A. Hughes. *Explicit instruction: Effective and efficient teaching*. Guilford Press New York, 2011.

[2] E. Hong, H.F.J. O'Neil, & Y. Peng. (2016) Effects of explicit instructions, metacognition, and motivation on creative performa--nce. *Creative Research Journal*, Vol 28, No.1. Available: http://www.tandf.co.uk/journals.

[3] Institute of Education Sciences, National Center for Education Statistics. (2006). *The Condition of Education 2006*. Available: https://nces.ed.gov/pubs2006/2006071.pdf

[4] E.H. Kroesbergen, J.E. Van Luit, & C.J. Maas. (2004). Effectiveness of explicit and constructivist mathematics instruction for low-achieving students in the nether lands *Elementary School Journal*, v104 n3. University of Chicago Press, Journals Division, *P.O. Box 37005, Chicago, Illinois.* Available: http: //eric.ed.gov/?q=explicit+instruction+in+mathematics&id=EJ695971

[5] E.R. Lai. (2011). *Critical thinking: A literature review research report*. Pearson Publication. Available: https://images.pearsonassessments.com/images/tmrs/CriticalThinkingReviewFINAL.pdf.

[6] E.L. Mann. (2005). *Mathematical creativity and school mathematics: Indicators of mathematical creativity in middle sc-*

-*hool mathematics*. Available: http://EJ750778

[7] L.M. Marin & D.F. Halpern. (2011). Pedagogy for developing critical thinking in adolescents: explicit instruction produces greatest gains. *Thinking skills and creativity*, v6 n1. Elsevier, Orlando, Florida. Available: http: //eric.ed.gov/?q=scaffolding+in+developing+critical+thinking&id=EJ915708

[8] D.H. Schunk. *Learning theories: An educational perspective.* Fourth edition. Pearson Education, Inc. Upper Saddle River, New Jersey, 2004.

[9] A. Tella. (2013). The effect of peer tutoring and explicit Instructional strategies on primary school pupils learning outcomes in mathematics. *Bulgarian Journal of Science and Education Policy*, Volume 7, number 1. Available: http://bjsep.org/getfile.php?id=132

[10] M.-T. Van de Kamp, W. Admiraal, J. van Drie, & G. Rijlaarsdam. (2014). Enhancing divergent thinking in visual arts education: Effects of explicit instruction of meta-cognition. *The British Psychological Society, British Journal of Educational Psychology*. Available: https://www.researchgate.net/profile/Gert_Rijlaarsdam/publication/268816396_Enhancing_divergent_thinking_in_visual_arts_education_Effects_of_explicit_instruction_of_meta-cognition/links/5478890e0cf2a961e48778d8.pdf

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