DESIGN THINKING APPROACH IN PHYSICAL SCIENCE: ITS EFFECT ON THE LEARNING SKILLS OF GRADE 11

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ABSTRACT: *This study investigated the effect of the Design Thinking Approach on the critical thinking and creativity of Grade 11 Humanities and Social Sciences learners. It was conducted in Isulan National High School, Sultan Kudarat Division during the school year 2019-2020. A descriptive research design was used in this study with a sample size of sixty participants. The participants were chosen based on their academic performance during the first, second, and third quarters in Physical Science. The lessons developed by the researcher covered the fourth quarter topics on Physical Science which consist of Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Impulse and Momentum. The researcher-made critical thinking skills test and creativity assessment tool were used to gather the needed data. The developed lessons and research instruments were validated by a panel of experts. The evaluation result was taken into account in the revision and refinement of the lessons and instruments. The findings revealed that the learners taught with the Design Thinking Approach outdid the learners taught with the K to 12 Inquiry-Based Learning Approach in critical thinking. This study recommends that design thinking helps the learners as matched with the 21st Century Skills.*

Keywords: Design Thinking, Inquiry-Based Learning, Learning Skills, Critical Thinking, Creativity

I. INTRODUCTION

Science is valued by society because the application of scientific knowledge leads to the improvement of human condition and attainment of sustainable development [1]. Science education is potentially positioned to support society in understanding and addressing global challenges, ending hunger and pandemic diseases, reducing inequality, tackling climate change, and accelerating progress [2]. In the Philippines, the K to 12 Program, envisions of scientifically, technologically, environmentally literate, and productive individuals through quality Science education. Learning the subject develops students' learning skills including critical thinking and creativity, and scientific inquiry skills, values, and attitudes, such as curiosity, objectivity, and honesty [3].

However, the poor performance of Filipino learners in Science has always been a central issue in the country. Filipino students consistently fail in international and national assessment studies in Science. This concern may have been caused by the underdevelopment of the necessary learning skills of Filipino learners. Critical thinking and creative skills were less developed because they require learners to reason, make judgments, generate solutions, and solve problems effectively. The development of these learning skills, which are associated with Science performance, may lead to the enhancement of learning in the subject. Thus, there is a pressing need to strengthen the critical thinking and creativity of Filipino learners to improve their performance in Science. It has posited that critical thinking and creative skills are highly valuable for learners to succeed in school, work, and life [4].

In the research locale of this study, Isulan National High School Senior High School, many students are not performing well in Science and most of them are from non-Science Technology Engineering Mathematics (STEM) classes. The majority of the learners from other strands in the academic track were not that engaged in learning Science, especially in Chemistry and Physics. As observed, the application of various pedagogical approaches that could support learners' critical thinking and creativity, and the development of contextualized instructional materials in teaching Physical Science were not widely practiced by the teachers. Instead, Science teachers who are non-teaching graduates generally use the Inquiry-Based Learning Approach relying on K to 12 teaching and learning materials and commonly use the chalk and board, PowerPoint slides, and video clips in teaching the subject. With this, the need for design thinking in K to 12 education is timely [5].

With a quest for a teaching pedagogy that could facilitate the critical thinking and creativity of learners, there has been a keen and wide interest in design thinking [6]. It is a humanistic approach for innovation that evolved from the study of the unique ways in which designers think and practice [7]. Design thinking has been applied to education because of its ability to advance critical thinking and creativity by applying an empathetic, flexible, and iterative approach [7]. Generally, design thinking is established on the ability of learners to merge – empathy for the context of a problem, creativity in the generation of insights and solutions, and critical thinking to analyze and match solutions to the context [8].

Essentially, design thinking supports teachers in facilitating constructivist and pragmatist learning to foster 21st-century learning skills [9]. Also, several studies considered design thinking as a great tool to be used in the teaching-learning process to develop 21st-century skills [10].

Hence, the review of literature on the Design Thinking Approach recommends the need to pursue further studies on the development of a design thinking framework for teaching, learning, curriculum design, and training. Recognizing these concerns, the researcher was propelled to employ design thinking in teaching Physical Science to Grade 11 HUMSS learners. This study aimed to investigate the effect of the Design Thinking Approach with the K to 12 Inquiry-Based Learning Approach on the learners' critical thinking and creativity.

II. Framework of the Study

This study is anchored on Dewey's constructivism, which holds that learning is achieved through experience. In constructivism, learning is an active process of individually making meaning and constructing knowledge. By grounding learning activities in an authentic, real-world context,

constructivism engages learners in the teaching and learning process. In design thinking, learning entails empathy in identifying challenges and gathering information, creativity in generating potential solutions, and critical thinking refining ideas and testing solutions [11]. By focusing on context and experiential support, design thinking conforms with constructivism. Hence, learning by doing and complex problem-solving are fulfilled in the phases of the design process. According to [12], design thinking functions as a framework for supporting constructivist teaching and learning. It empowers teachers to facilitate constructivist learning to foster 21st-century learning skills.

III. STATEMENT OF THE PROBLEM

This study investigated the effect of the Design Thinking Approach in Physical Science on the critical thinking skills and creative skills of Grade 11 Humanities and Social Sciences learners. This was conducted in Isulan National High School during the school year 2019-2020.

Specifically, this study sought to answer the given research problem:

1. How does the level of critical thinking skills of the learners taught with the Design Thinking Approach compare to those taught with the K to 12 Inquiry-Based Learning Approach?

IV. METHODS

To investigate the effects of the Design Thinking Approach on the learning skills of Grade 11, this study employed the descriptive research design with two intact classes as participants. The study was conducted in Isulan National High School (INHS) situated at Isulan, the landlocked provincial capital of Sultan Kudarat.

V. RESULTS AND DISCUSSION

Performance of Grade 11 Science Learners in Critical Thinking Skills

The critical thinking skills of the participants in this study were based on their pretest and posttest scores on the researcher-made critical thinking skills test. Table 1 presents the frequencies, percentages, mean scores, and standard deviations gathered from the experimental group and control group before and after the conduct of this study.

The pretest scores of the participants from both the experimental and control groups fall in Did Not Meet Expectations proficiency level on the lessons in Physics, particularly Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Impulse and Momentum. This indicates that both groups have not acquired or developed the fundamental knowledge, skills, and core understanding in the subject, but needed help throughout the performance of the different tasks.

As reflected in Table 1, the mean in the pretest scores of the participants in the experimental group and control group is generally in the same proficiency level. This indicates that the learners in both groups struggle with their understanding of the prerequisite and fundamental knowledge in Physical Science.

Moreover, the standard deviations indicated that the pretest scores of the participants in the experimental group were more dispersed compared with the scores of the learners in the control group. This denotes that the entry-level critical thinking skills of the participants in the experimental group are more scattered than those of the control group.

Table 1
Profile of Pretest and Posttest Scores in Critical Thinking Skills of the Experimental and Control Groups

Level of Proficiency	Range of Scores	Experimental Group				Control Group			
		Pretest		Posttest		Pretest		Posttest	
		f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
Outstanding	26-30	0	0	0	0	0	0	0	0
Very Satisfactory	23-25	0	0	2	6	0	0	0	0
Satisfactory	21-22	0	0	3	10	0	0	0	0
Fairly Satisfactory	18-20	0	0	8	27	0	0	0	0
Did Not Meet Expectations	0-17	30	100	17	57	30	100	30	100
$\bar{x}$		8.20		17.03		9.07		12.83	
Proficiency Level		DNME		DNME		DNME		DNME	
SD		3.14		3.37		2.13		1.72	

Legend: *f = Frequency; % = Percentage; $\bar{x}$ = Mean; sd = Standard Deviation; DNME = Did Not Meet Expectations*

The pretest result shows that the critical thinking skills of the participants in both groups were low. This result suggests the use of approaches in teaching Science that would assist the development of learners' critical thinking skills. A similar result in the pretest scores was reported in the studies implemented by [13], wherein the Mathematics and Science performance pretest scores of the learners were low.

As shown in Table 1, the mean in the posttest scores of the learners in the experimental group is higher than that of the learners in the control group. This indicates that the participants in the experimental group had a more considerable improvement compared to the participants in the control group in the level of critical thinking skills.

The posttest scores reveal certain improvements in the level of critical thinking skills of the participants taught with the Design Thinking Approach. Forty-three percent of the participants in the experimental group reached the Very Satisfactory, Satisfactory, and Fairly Satisfactory proficiency levels; while, the rest remained in the Did Not Meet Expectations proficiency level. Based on the proficiency level statements set in the scoring procedure, this indicates that several learners in the experimental group have developed the fundamental knowledge, skills, and core understanding in the subject and can transfer them independently and flexibly through authentic performance tasks.

On the other hand, all of the participants taught with the K to 12 Inquiry-Based Learning Approach remained in the Did Not Meet Expectations proficiency level. Analyzing the posttest mean scores of the two groups, the experimental group had a more considerable improvement compared with the control group. However, the majority of the participants in both groups still fall in Did Not Meet Expectations proficiency level after the conduct of the study.

Furthermore, the posttest score of the participants in the experimental group was more scattered compared to the scores of the participants in the control group. The standard deviations suggest that the critical thinking skills of the participants in the experimental group were still more dispersed than those of the control group after the implementation.

The posttest result shows that the critical thinking skills of the majority of the participants in both groups Did Not Meet Expectations proficiency level. The learners commented that the difficulty of the content and competencies included in the critical thinking skills test contributed to their poor performance. To draw out critical thinking, the multiple-choice questions in the researcher-made critical thinking skills test were tailored to fall in the higher levels of the cognitive domain in the Revised Bloom's Taxonomy. The test also covered the fourth quarter topics on Physical Science, which were Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Impulse and Momentum. These reasons help justify the weak performance of most of the participants in the critical thinking skills test.

Also, as observed during the conduct of this study was the poor problem-solving skills of the learners, which directly affected their performance in the critical thinking skills test, for it required them to solve problems by analyzing concepts and deriving formulas. The majority of the learners from both groups were unable to solve Physics problems correctly. The result of this study suggests the need to strengthen learners' problem-solving skills to advance their performance in Science. Also, this implies that the Science teachers in the research locale should use various pedagogical approaches that could also address the problem-solving skills of learners.

The poor performance of the participants in the critical thinking skills test is parallel with the result of [14], who found that the critical thinking skills of Grade 8 learners in Chemistry and Mathematics fall in Did Not Meet Expectations proficiency level before and after their implementation. Also, the result of this study agrees with the findings of [15] that the critical thinking skills of Filipino Senior High School learners were underdeveloped. The finding of his study indicated the need to infuse and develop the critical thinking of learners in Senior High School.

Furthermore, the result of this study aligns with the finding of [16] that the critical thinking skills of Grade 11 learners were categorized as low. The researchers suggested that teachers may design and develop innovative learning models that can capacitate learners with critical thinking. Hence, [17] associated the lack of critical thinking skills among high school students with the effects of education policies, memorizing, and passive learning. The study assumed that design education plays a unique role in preparing learners to become critical thinkers in the 21st-century.

VI. CONCLUSION

From the findings which showed that the learners taught with the Design Thinking Approach improved better than the learners taught with K to 12 Inquiry-Based Learning Approach in their 21st-century learning skills, the following conclusions were drawn:

1. The use of the Design Thinking Approach could help learners to develop the fundamental knowledge, skills, and understanding in Physical Science and can transfer them independently and flexibly through authentic performance tasks. Hence, the Design Thinking Approach may improve the critical thinking skills of Grade 11 learners in Physical Science.
2. The Design Thinking Approach could improve the creative skills of learners, particularly in the creativity indicators, including fluency, flexibility, elaboration, and usefulness exempting the originality indicator. Thus, the Design Thinking Approach could enhance the learners' quantity, range, build-up, and utility of ideas except for the generation of unique ideas.

VII. RECOMMENDATIONS

Considering the results and conclusion, the following are recommended:

1. Science teachers may use the Design Thinking Approach in teaching Physics concepts, specifically Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Impulse and Momentum, to improve learners' critical thinking and creativity.
2. Teacher-researchers may conduct further investigations on the effect of the Design Thinking Approach against other approaches, besides the Inquiry-Based Learning Approach, on critical thinking and creativity of learners at different grade levels in Junior High School.
3 Administrators may propose in-service training and seminar-workshop on the use of the Design Thinking Approach in developing learners' critical thinking and creativity in Science during the conduct of learning action cell sessions.

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VIII. REFERENCES

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