ASIA RESEARCH NETWORK JOURNAL OF EDUCATION

ARNJE

Vol. 3 No. 3 (2023): Sep. - Dec.

e-ISSN : 2773-9228

Asia Research Network Journal of Education
Vol. 3, No. 3, Sep. – Dec. 2023

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Publisher: Asia Research Network

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Vol. 3, No. 3, pp. 108-118, Sep. – Dec. 2023

The Innovative Lesson Study for Enhancing Grade 2 Students' Multiplication Conception through Open Approach

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Received: 14 May 2023 Revised: 07 Sep 2023 Accepted: 29 Sep 2023

Abstract: The paper aimed to clarify the innovative lesson study learning activities for enhancing Grade 2 students' multiplication conception. The paper provided the lesson study environment which allowed the primary school teacher to develop the lesson plan about multiplication conception through open approach. Regarding on the open approach, the cycle of lesson study focused how to provide students' openly constructing their meaning of multiplication based on everyday life situation. The lesson plans about multiplication concept were developed based on the situations of calculating amount of things in groups that each group has same number of thing. The paper will highlight these situations in order to visualize how they allow students to construct their concepts of multiplication and to generate multiplication symbols. The paper has implications for developing constructivist mathematics learning for Grade 2 students.

Keywords: multiplication, representation, connection, lesson study, open approach

1.Introduction

Learner-centered education arose from the constructivist learning paradigm. Thai educational reform is based on the constructivist philosophy. The learner-centered approach refers to learning methods that aim to grow people and enrich their lives. Learners should be provided with learning experiences that allow them to reach their full potential while also catering to their aptitude, interests, and requirements. Individual characteristics should be considered while organizing learning activities. They should allow learners to interact with people, nature, and technology that are relevant to their learning environment in everyday life (Tupsai et.al., 2015; Yuenyong and Thathong, 2015).

Regarding the philosophy of constructivism, mathematical understanding has often been described as involving both procedural and conceptual knowledge (Barmby et al., 2009; Rittle-Johnson, Schneider, & Star, 2015; Star, 2005). Procedural knowledge is characterized as step-by-step knowledge, such as how to do an algorithm calculation. (Maciejewski & Star, 2016; Rittle-Johnson et al., 2015). Conceptual knowledge is

frequently stated as being linked to other "units of knowledge" (Hiebert & Carpenter, 1992) or as a "connected web of knowledge" (Hiebert & Lefevre, 1986). According to the literature, well-connected conceptual and procedural knowledge is defined as an indication of deeper comprehension in numerous frameworks for students' understanding in mathematics. (Baroody et al., 2007; Star, 2005). Indeed, connectivity is indicated as being essential to developing a deep and powerful knowledge. (Barmby et al., 2009; Baroody et al., 2007; Gray & Tall, 1994; Richland, Stigler, & Holyoak, 2012).

This suggests that in order to explore multiplication understandings, both procedural and conceptual knowledge, as well as the links between them, must be studied. Procedural knowledge can be observed in procedures, while conceptual knowledge and connections must be externally represented in order to be observed. A multiplication model can be represented either verbally as a word problem or visually as a drawing. Representations in one mode, such as visual, can be subdivided into diagrams, concrete materials, or drawings. Concrete things, such as manipulatives arranged in rows and columns or sketched drawings of a chocolate bar, are instances of rectangular array representations (Barmby et al., 2009). External representations can be used as thinking tools for the abstract mathematics they represent (Pape & Tchoshanov, 2001; Selling, 2016).

Understanding can be viewed as connections between representations of different types of knowledge, and the nature of connections proposed to be reasoning (Barmby et al., 2009). Reasoning is a significant research subject in mathematics education and is defined in a variety of ways, such as making generalizations and constructing arguments for whether generalizations are true or untrue (Stylianides, Stylianides, & Shilling-Traina, 2013; Suanse and Yuenyong, 2023)

Representation and connection provide ways of making sense of multiplication. Larsson (2016, p.30) showed that "the small cubes of the cuboid represent three-way connections. An example of a such a connection is to calculate $16 \cdot 25$ by use of the distributive property, as $10 \cdot 25 + 6 \cdot 25$, and connecting it to the model of equal groups by explaining that one can first calculate 10 of the groups and then the remaining 6 groups, irrespective whether knowledge of distributivity is implicit or explicit. Larsson, Pettersson, and Andrews (2017) discovered that the method teachers taught multiplication as repetitive addition was problematic, particularly when dealing with multi-digit and decimal multiplication. According to Chin and Jiew (2019), participants were requested to generate mathematical expressions based on real-life difficulties, i.e. from distinct real-life circumstances to symbolic. We believe it would be beneficial to investigate how participants translate their mathematical thoughts in real life into mathematical symbols.

The development of multiplicative thinking is described as a learning trajectory in four central phases: (1) direct counting, (2) rhythmic or skip counting, (3) additive thinking (possibly by saying the count-by sequence), and (4) multiplicative thinking (Anghileri 1989; Battista 1999; Downton and Sullivan 2017; Larsson 2016; Mulligan and Watson 1998; Ruwisch 1998; Siemon et al. 2005; Simon and Blume 1994; Sherin and Fuson 2005; Steffe 1992; Sullivan et al. 2001; Thompson and Saldanha 2003). In the beginning, repeated addition is thought to be more sophisticated than counting all or counting by multiples; nevertheless, equating multiplication with repeated addition is restrictive because this style of thinking is no longer possible beyond natural numbers. In contrast to additive thinking, multiplicative thinking requires the ability to coordinate bundled units on a higher abstract level and requires the recognition of the different meanings of the multiplier and the multiplicand. (Clark and Kamii 1996; Downton and Sullivan 2017; Larsson 2016; Singh 2000; Steffe 1992). This ability is often called 'unitizing' (Lamon 1994) or 'dealing with composite units' (Steffe 1992). However, many children struggle with the transition from additive to multiplicative thinking (Ehlert et al. 2013). Götze and Baiker (2021) argued that the study about how multiplicative thinking as unitizing should be supported in young children. They proposed that more study be conducted to provide

information on how to construct multiplicative meaning-making processes and how youngsters can learn to think multiplicatively. Such meaning-making processes can be demonstrably assisted by linking forward and backward distinct mathematical representations (concrete, graphical, symbolic, and verbal) and language registers (everyday, academic, and technical) with a focus on verbalizing multiplicative structures.

Multiplication conception should be provided in the real-world problems. The multiplication conception problem should enhance students to learn mathematics related to their context and to develop their divergent thinking on problem solving**.** According to the literature, the mathematics problem should not be presented as a closed problem. Instead, open-ended issues should be used to challenge and encourage students to use divergent thinking and reasoning to develop their own concrete and informal problem-solving solutions. The open-ended tasks will introduce students to new mathematical situations, allowing them to happily and actively learn. Another aspect of providing a learning environment for constructing mathematical knowledge is the use of open-ended puzzles (Gravemeijer & Doorman, 1999; Pehkonen, 1995; Woranetsudathip & Yuenyong, 2015). In Thailand, Maitree Inprasitha drove open-ended problems in Thailand as an open approach, which was first adopted in Thailand mathematics classrooms in 2002. In addition, he proposed that the lesson study be used to build mathematics learning activities based on an open approach (Inprasitha, 2010; Kim et.al., 2019; Phaikhumnam & Yuenyong, 2018; Woranetsudathip et.al., 2021; Woranetsudathip & Yuenyong, 2015)

The lesson study helped teachers find effective approaches to teach mathematical concepts using an open approach (Woranetsudathip, 2021). According to the literature, the most effective area to improve teaching is in the context of a classroom lesson. The lesson study may enable us to develop and deliver mathematics lessons on multiplication using an open method (Stigler & Hiebert, 1999). Because teachers must form small groups (4-6 teachers) of teachers who teach children at the same level and/or material, the lesson study is a collaborative design of a research lesson. Then they start working collaboratively to design the lesson. After the lesson has been designed, a teacher from the group will teach it. The rest of the group will observe and collect data on the lesson process. Data collecting may concentrate on students' learning for the specific topic presented, as well as a range of students' learning concerns. Then, as individual reflections, each group member will provide his or her interpretation of classroom data collected to the group. Based on these reflections, the group must review and update the lesson for the following lesson. The new lesson plan will subsequently be taught to another set of students by another member of the group. Furthermore, the group may continue to observe classrooms and analyse data in order to provide feedback for future development (Matoba, 2005)**.** Many educators proposed the cycle of lesson study to suggest teachers adopting a culture of lesson study. One of those is about the cycle of plan, do, and see. Inprasitha (2010) proposed that lesson learning in Thai schools be adopted in three easy steps. These included collectively creating the research lesson (Plan), collaboratively witnessing a group member give the research lesson (Do), and collaboratively conducting a post-discussion or reflection on teaching practice (See).

According to the research and experiences on lesson study, it would be difficult for mathematics teachers to construct learning activities for young children (Grade 2 students) through open-ended mathematics problems. The lesson research may assist our group in determining effective methods of open approach mathematics teaching about multiplication for Grade 2 students.

2. Methodology

Methodology was concerned with the interpretive paradigm. The practice of lesson study helped to acquire an understanding of new learning activities. Participant observation, reflection of lesson study teachers, and generating lesson plan document were among the interpretive strategies used.

Method of inquiry

Based on Lesson Study, the initiative's new lesson study learning activities on mathematical multiplication were developed. The process includes 76 Grade 2 Thai children learning about mathematical theories on multiplication through an open approach in a classroom setting.

Teachers addressed ways to improve students' mathematical thoughts on multiplication using an open method based on lesson study. Teachers began to bring up real-world situations that were relevant to their pupils' context of multiplication. Teachers chose some real-world situations that could be related to Thailand's mathematics curriculum. One of the teachers decided to provide the lesson based on the lesson plan created in collaboration with his or her colleagues. The rest of the member group teachers served as active observers, taking notes on what happened in the classroom. The instructors then reconvened as a group to analyze, critique, and evaluate the lesson plan in order to assess the appropriateness of the teacher's performance, resources used, and challenges involved in boosting students' understanding of mathematical notions on multiplication. Finally, teachers discussed any changes to the lesson plan that were necessary based on their observations and reflections. The creative learning activities will subsequently be classified based on the lesson study.

3. Findings

Through the process of lesson study, the innovative lesson study learning activities of multiplication was developed into four lesson plans of open approach multiplication. The open-ended problems were provided to enhance student to develop representation and connection in multiplication. These included 1) making sense of multiplication via developing the new unit for counting, 2) Arranging objects into groups with equal numbers in each group and connecting on writing sentences with multiplication symbols, and 3) finding the number of items that have the same unit and writing a multiplication sentence.

3.1 Making sense of multiplication via developing the new unit for counting

Conception of multiplication could be constructed when students are counting things in various unit of counting. For example, we can count by one e.g. 1, 2, 3,… Some units, for example, we can count by two e.g. 2, 4, 6, 8, .. for unit of two eggs in boxes. And we can use various units to count by any. The lesson plan provided a party situation that there were many foods on the plate including apples, oranges, cake, donuts, strawberries and bananas as shown in figure 1. However, the number of apples in each dish is not the same. Unlike, other fruits and other desserts were provided in the same amount for every plate. This makes it a problematic situation for students. And it will be able to stimulate students to think about developing units of counting.

Figure 1: Plates of fruits and desserts for problem of developing units of counting

This lesson aims to connect students to understanding how to write symbolic sentences and the meaning of multiplication when the number of objects placed on the plate is the same. Students would be enhanced to make sense that the total number of objects can be represented by the number of plates and the number of items in each plate Including when the number of items placed on the plate is the same. Students would be enhanced to make sense that the total number of objects can be represented by the number of plates and the number of items on each plate. Then, they could develop the unit of counting regarding on things on a plate. In order to enhance students to develop unit of counting, teachers may provide the scaffolding questions. The following dialogue is examples of scaffolding for representation and connection on concept about multiplication.

Teacher: “What do students notice in the picture on the board?”
Student: In the picture there is a child, an apple, an orange, and a cake.
Teacher: “Observe the number of each item on the plate. How can students explain it?
Student: The number of oranges and cakes on each plate is the same. But the number of apples in each dish is different.
Teacher: “How many apples are there?”
Students: 9 apples
Teacher: “How do students find the total number of apples?”
Student: Count in increments of 1 according to the picture, 4 + 3 + 2.
Students work together to conclude that they used the counting or addition method to find the total number of apples.
……
Teacher: From finding the number of items placed on the table. There is the same number of dishes on each plate. How can we explain the total number of cakes?
Student: “Each plate has 2 cakes and there are 8 plates, so there are 16 cakes in total.”
Teacher: How can we explain the total number of oranges?
Student: “Each plate has 4 oranges and there are 6 plates, so there are 24 oranges in total.”
……
Teacher: You may learn that why we could easier count cakes and oranges than count apples.
Student: If the number of each item is the same on every plate, it will be easier to find the number of items.
Teacher: Can we do the same on counting apples? How can we do?
Student: We can move one apple from the plate that consists of 4 apples to a plate of two apples. Then, the number of apples on each plate is the same. (See picture 2)
……
Teacher: Regarding on counting the apples, can you explain the ideas of counting cakes, oranges, strawberry.
Student: “Each plate has 2 cakes and there are 8 plates, so there are 16 cakes in total.”
“There are 4 oranges on each plate and there are 6 plates, so there are 24 oranges in total.”
“ Each plate had 7 strawberries, and there were 4 plates, so there were all strawberries.
28 results”

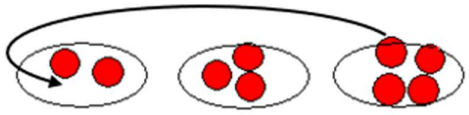

Figure 2: making the number of apples on each plate is the same.

3.2 Arranging objects into groups with equal numbers in each group and connecting on writing sentences with multiplication symbols

Students learned to represent and connect multiplication concepts through counting total numbers of things by arranging objects into groups with equal numbers in each group and writing sentences with multiplication symbols. The learning activity consists of 1) show how to find the number of items that have the same unit, 2) write sentences with multiplication symbols, 3) show how to arrange objects into groups with the same number in each group, and 4) tell the number in multiples. In order to enhance students to arrange object into groups and writing sentences with, teachers may provide the scaffolding questions. The following dialogue is examples of scaffolding for representation and connection on concept about multiplication.

Remind students about counting all objects that each group has the same number of items. Ask students look at figure 3 then teacher asks the students: Each plate has 3 donuts, and there are 5 plates total, so there are15 donuts in total.

Figure 3: same number of donuts in each plate

Ask students to excise the represent and connect multiplication concept through the following dialogue:

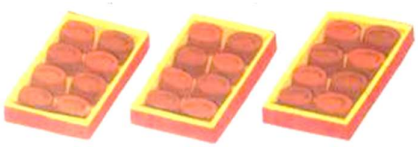

Figure 4: same number of chocolate in each boxes

Teacher: Students look at picture 4 and have each group write a message to indicate the number of objects.
Student: There are 8 pieces in each box, and there are 3 boxes, so there are 24 chocolates in total.

Figure 5: same number of fishes in each pack

Teacher: Students look at figure 5 and have each group write a message to indicate the number of objects.
Student: There are 2 fish in each pack, and there are 6 packs, so there are 12 fish in total.

Figure 6: same number of jellies in each bag

Teacher: Students look at figure 6 and have each group write a message to indicate the number of objects.
Student: There are 6 jellies in each bag, and there are 5 bags, so there are 30 jellies in total.

Figure 7: same number of pears in each plate

Teacher: Students look at figure 7 and have each group write a message to indicate the number of objects.
Student: There were 9 pears on each plate, and there were 2 plates, so there were 18 pears in total.

Ask students how to find the number of all objects to make connections with writing them in symbolic sentences. The following dialogue is examples of scaffolding for making connections with writing them in symbolic sentences about multiplication.
How many cakes are there? Together, they can be linked together to write a multiplication symbol sentence as follows.
See Figure 8. Each box has 2 items, and there are 5 boxes, so there are 10 items in total. Represent it with the symbolic sentence 2x5 = 10 and reads, “2 multiplied by 5 equals 10”
This type of calculation is called “multiplication.”

Figure 8: same number of cakes in each box

3.3 Find the number of items that have the same unit and write a multiplication sentence.

The lesson plan of finding the number of items that have the same unit and writing a multiplication sentence was provided in the same steps of the second lesson plan however, this lesson plan was more focused on writing multiplication symbol and connection on counting to multiplication. The learning activity, therefore, consists of 1) show how to find the number of items that have the same unit, 2) write sentences with multiplication symbols, 3) show how to arrange objects into groups with the same number in each group, and 4) tell the number in multiples. The learning activity was provided to challenge students to apply multiplication concepts to explain everyday life situations. The following dialogue is examples of scaffolding students to represent and connect conception about multiplication in everyday life experiences.

Teacher: "What do you notice in the picture?"
Student: apple, fish, cake, fish, etc.
Teacher: "What are the characteristics of the objects or animals in the picture?"
Student: Some things are in groups. Some things don't belong in groups, things or animals that are in groups, some groups have the same number of members, such as fish, and some groups have an unequal number of members, such as fish, etc.
Students observed the figure 9 of the Let's Go to the Zoo activity that was given. Show how to find the number of things or animals that each group has the same number of group members by writing multiplication symbol sentences.
Students wrote the multiplication symbol sentences as following:
number of apples is 8 ×2 = 16
Number of dogs is 4 ×2 = 8
number of balloons is 2 ×4 = 8
number of horses is 6 ×3 = 18
number of birds is 5 ×4 = 20
number of cakes is 7 ×4 = 28
number of oranges is 9 ×3 = 27

Figure 9: Let's Go to the Zoo (Inprasitha, 2011)

4. Conclusion

The study's most notable finding is the uncertain significance of equal groups and repeated addition in kids' understandings of multiplication. In this study, students understood multiplication as a technique of repeated addition, a model of equal groups, or a combination of the two. I don't think of repeated addition as a model for multiplication; rather, I think of it as a mathematical technique. Equal groupings and repetitive addition

could be expected to play a significant influence. The multiplier effect, for example, is generally known to be based on a view of multiplication as matching multiplicative expressions (e.g., De Corte & Verschaffel, 1996). The robustness of the students' asymmetrical viewpoint, on the other hand, comprises details about advantages and disadvantages that are not reported for students in traditional education at the time when multi-digit and decimal multiplication is introduced. Different ideas can explain the persistence of equal groupings and recurrent addition. According to the intuitive model theory, repeated addition is deeply rooted and resistant to change for two reasons: it is the first multiplication method taught and "corresponds to features of human mental behavior that are primary, natural, and basic" (Fischbein et al., 1985, p. 15). According to the intuitive model theory, repeated addition will influence reasoning long after more generalised models and calculations have been added into the students' repertory. The long-term influence of initial training is widely accepted, however there are differing perspectives on the roots of multiplicative reasoning. For example, it has been proposed that the intuitive and informal concept of multiplication that children have prior to instruction is embedded in a one-to-many correspondence (Nunes & Bryant, 2010) or as splitting (Confrey & Smith, 1995), rather than as repeated addition, which distinguishes multiplication from addition conceptually.

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Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 119-142, Sep. – Dec. 2023

Development and Implementation of Vodcast in Teaching Light for Grade 8 Students

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Received: 19 May 2023 Revised: 30 Nov 2023 Accepted: 15 Dec 2023

Abstract. The study was about the development and implementation of vodcast for teaching light. The development flow followed the ADDIE framework. Analysis stage strongly suggests the need for effective material for teaching light. The developed vodcast was rated very satisfactory by experts and a very good material for classroom use. Student performance based on pretest and posttest yielded a 4.88 signifying a very positive perception of student user. The study concludes the effectiveness of vodcast in optimally presenting an abstract concept. The comments of the experts greatly improved the vodcast. The study concludes that the vodcast is a very effective vehicle for a meaningful delivery of a science lesson and would support high motivation of learners.

Keywords: Vodcast; Light; Development; Perception; Conceptual understanding

1. Introduction

Pandemic significantly affects not just our economic growth but also the educational aspect of society. The Philippines were startled by the sudden change in just a short period. In just a short span of a moment, the Philippine educational approach becomes distance learning for safety purposes. As our mode of learning changes, teachers and students are continuously adjusting. It creates a significant problem for teachers and students regarding complementing objectives with this type of learning method. Low internet connection and low resource material are those problems encountered in this new learning approach. It is essential to strategize a learning tool aligned with the lesson objectives and accessible to the students. In this study, a specific instructional/learning tool will be developed to utilize learning light effectively. The reason for this approach is that vodcasts are trending nowadays.

Furthermore, students are becoming aware that these trends may be employed for educational purposes rather than amusement and personal gain. As for its benefits, many vodcasts are informative, yet it has a relaxing or chill vibe that students will be able to focus on a topic with virtual actualization with the aid of interactive simulation.

Also, students' views about a course influence their understanding and learning of the course. Many students think and say, "Physics is challenging." Angell et al. (2004) examines the views of high school students and physics teachers about Physics. They conclude that students find physics challenging because they have to contend with different representations, such as experiments, formulas and calculations, graphs, and

conceptual explanations at the same time. Moreover, they have to make transformations among them. Moreover, the geographic distance between the students and the teacher also poses a serious problem (Ulla, 2021 - Unpublished Thesis).

With the fast growth of wireless networks and mobile technology, learners have become more digital literate, and learning has become more accessible and pervasive than ever before (Boulos et al., 2006). This concept of 'anytime, anywhere' learning has offered multiple challenges to educators and learning technologists, as well as a motivation for learning to be given at the right time, right location, and right form (Bomsdorf, 2005). It is commonly acknowledged that in today's world, when mobile infrastructure is becoming prevalent, educators must adapt to the problems of personal, accessible, and flexible learning.

With the advent of high-speed bandwidths, there has been a major shift to audio podcasts and integrated videos (VODcasts - where the 'VOD' dictionary stands for 'video on-demand'; Meng, 2006). Vodcast instruction is found to be effective in increasing productivity, promoting creativity, and facilitating academic learning (Nwachokor et al., 2019). Vodcasts yielded positive results comparable to that of the traditional face-to-face instruction in teaching trigonometry (Larisma et al., 2017) and significantly helped improve the achievement of students' in a flipped classroom utilizing a module on a topic (Pierce & Fox, 2012).

Schreiber et al. (2010) pointed out that podcasts have several advantages such as lecturers using it to augment their teaching and to teach without restrictions in time or place; secondly, students appreciate learning on the go as they can repeat learning. There have been some little intricacies in Podcast (Campbell, 2005), which are barriers in the increase of workload for the faculty who must learn the technology and upload audio files, understanding the basics of digital audio files, copyright issue, editing of recorded file consumes time and for the most part, podcast for students with disabilities are not achieved because they are not properly edited and these students can't contribute after it has been uploaded. Schreiber et al. (2010) stated that there are some downsides to the podcast which are reduced interaction between students and lecturers, the inability of students to ask questions, the inability of lecturers to gauge the understanding from non-verbal cues and questions. Students may be less engaged in the learning and motivation may suffer. It is important to note that vodcast is the video version of the podcast. To address this situation, running interactive simulations while delivering learning instructions through teacher/researcher-created video podcasts or vodcasts points to promising results (Ulla, 2021 – Unpublished Thesis)

The researchers used an intervention like a developed vodcast - a podcast that works on the concept of video rather than audio, in imparting knowledge about the light because it is more likely to be suggested. After all, this approach has an important stand in learning light. Light must be discussed with a visual aid to address the concept of the topic effectively. Developing a vodcast about light is an intervention to teach light to grade 8 students effectively.

1.2 Statement of the Problem

One of the biggest challenges facing teachers in this pandemic is the learning outcomes that students need to achieve. With the existing challenges such as infrastructure factors, poor learning environment, and nature of content/academic barrier in the Philippine education system, it can be predicted that this challenge can drastically affect the upholding of the quality education in the Philippines (Pitogo, 2021). Thus, this study developed a vodcast-based teaching strategy as a reinforcement to guide students with their experiential and remote learning.

In this study, vodcast which consists of various activities with interactive simulations on light would be utilized first with prior knowledge through the pretest achievement. This simulation would be tried out to find out its effect on students' performance especially to

achieve the specific learning objectives given as the standard curriculum set by Department of Education (DepEd) and to know their conceptual understanding and perception on the developed vodcast as reinforcement in learning light.

1.3 Research Objectives

This study aims to develop vodcast and utilize it as a tool to demonstrate and teach the concept of light specifically to:

1. Develop a vodcast on light.
2. Evaluation of vodcast
    a. By the experts
    b. By the learners
3. Investigate the performance of the learners.
    a. Difference in pretest and posttest
    b. The normalize gain of the learners
4. Investigate the intrinsic motivation to the developed vodcast.

1.4 Null Hypothesis

H0: There is no significant difference in pretest and posttest scores.

1.5 Scope and Delimitation

This study would focus on developing a vodcast on light and how it affects the students' performance and conceptual understanding based on the post-test result and the perception of the developed vodcast through a survey questionnaire.

The developed vodcast would be based on the K-12 Science MELC's given by the Department of Education (DepEd) and the designed vodcast would be evaluated by the students, research panels, research adviser, and content experts.

Table 1. Learning Competencies for Grade 8 Science

Content	Content Standards	Performance Standards	Most Essential Learning Competency
Light	*The learners demonstrate the understanding of:* • some properties and characteristics of visible ligh t	*The learners should be able to:* • discuss phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light	• Explain the hierarchy of colors in relation to the energy of visible light

1.6 Significance of the Study

Physics has been connoted as a challenging subject in school. Based on this perception, it is one of the reasons why some students cannot excel in this area of science. This reputation has to be reduced and let students see the positive side of learning Physics. When an average person is asked to describe physics, a term they use is "challenging." Some find the algebraic emphasis difficult, the physical concepts challenging to wrap around their mind, workload, or the level of critical thought required is intimidating (Checkly, 2010). To aid this wrong perception, the researchers would conduct a study that would develop a vodcast in teaching light for grade 8 students effectively. Hopefully, this study would benefit the following:

The students. The direct recipients of this study are the students taking up Physics. Any development of learning light through vodcast can pave the way for a better conceptual understanding about light.

The Physics Teachers. The study would help them to figure out different approaches that can be used effectively in teaching light. This would give them a diverse scope of educational approach that they would use during discussion of the concept.

The Curricularist. The research would benefit those people who are involved in curriculum planning. This development of different approaches in teaching would guide them to plan an effective curriculum that can be applied in the classroom due to the fact that the curriculum is constantly changing to meet the different and changing learning styles of the students.

The School Administrators. The study would serve as a guide or a basis for implementing the said curriculum and on how to improve the learning progress of the students.

Future Researchers. The outcome of this study would serve as a resource material for future researchers whose study is in connection with the development of the vodcast approach in teaching light.

1.7 Theoretical Framework

This study was influenced from the Cognitive Theory of Multimedia Learning which is based on three fundamental ideas: (a) that audio and visual stimuli are the two types of sensory input, (b) that learners can only take in a limited amount of sensory information at any given time, and (c) that learners engage in an active process of selecting images and sounds, organizing these sensory inputs, and integrating (SOI) these images and sounds from a multimedia presentation (Clark & Mayer, 2007). Although the CTML is heavily based on SOI theory, the three main foundational ideas of the CTML are also derivative of several other theories, including: (a) Paivo's theory of dual coding, which posits that audio and visual codes for representing information are used to construct knowledge; (b) Sweller's cognitive load theory and Baddeley's model of working memory, which refer to the amount of information stored in working memory; and (c) Sweller's cognitive load theory and Baddeley (Mayer & Moreno, 1998). The CTML is used to guide the creation of vodcasts as well as to encourage their usage as a revision tool.

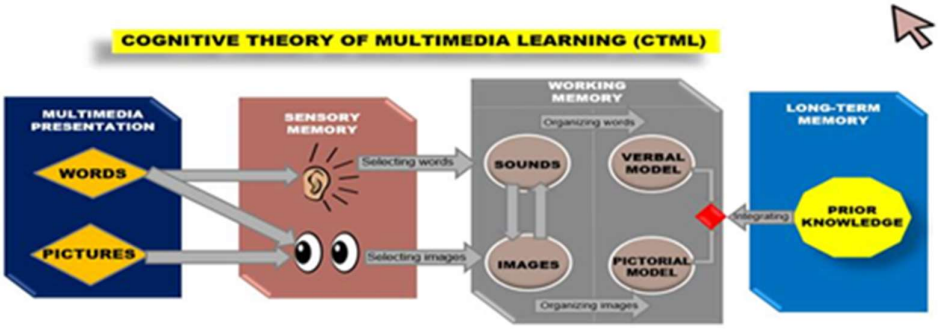

Figure 1. Cognitive Theory of Multimedia Learning (CTML)

The cognitive theory of multimedia learning serves as the major theoretical basis for this study (CTML). Cognitive theory, as applied to learning through multimedia presentations such as review vodcasts, says that learners absorb sensory information through their eyes and ears and then store this knowledge in working memory, where the learner constructs graphical and verbal models (Clark & Mayer, 2007). The learner then combines these graphic and verbal models with prior information to build long-term memory and knowledge of the information taught.

1.8 Review of Related Literature

1.8.1 Challenges Encountered by Educators

The name physics conjures up images of complexity. Therefore, teachers must devise methods for stimulating learners' interest in the physics subject while also convincing them

that learning the various lessons of the physics subject is not rigid but rather exciting and interesting. Learning physics can be both of these things. Learning physics will open your eyes to many new possibilities, and you will be amazed by the world around you and by everything that happens in it.

Educators must deal with the variety of learning styles among their students. Physics can be a complex subject for some students, and educators' job was to encourage them to continue learning. Things will take time to change, but they will. As long as educators successfully pique students' interest and motivate them to study physics, they will eventually enjoy the subject and learn more about it. Life's difficulties, including the problems in the teaching-learning process, are unavoidable. For a variety of reasons, educators may find it challenging to teach physics. Obstacles to teaching physics for educators include a lack of lab space or outdated lab facilities, malfunctioning laboratory equipment and supplies, poor administration or teacher recognition, subpar reference volumes in the library, and a lack of online connectivity (internet access) (Solomon et al. 2015). Among others, the availability of instruments in teaching Physics is one of the most stressed defining attributes of a successful Physics classroom (Diate et al. 2021). The challenges that a physicist educator faces will differ depending on where they teach.

Light is one of the lessons that learners should learn in physics. Challenges that teachers might encounter in teaching the concept of light vary depending on the situation. The difficulties in introducing the idea of light are the mode of delivering it to the student, like will the learners be able to learn when it teaches in this way? Is this activity effective in learning? And many more. Introducing the concept of light will be challenging for the educator because they should think of and make ways to effectively deliver the lesson to the learners.

1.8.2 Vodcast

In the study of innovative use of vodcast (video-podcast) to enrich learning experience in structures laboratory (Mann et al. 2009), it used material consisting of a questionnaire completed by the students, follow-up semi structured interviews and the practical reports submitted by them for assessment. It shows that most of the students who have not fully grasped the theory after the practical, managed to gain the required knowledge by viewing the vodcasts. According to their feedback, the students felt that they had control over how to use the material and to view it as many times as they wished. Some students who have understood the theory may choose to view it once or not at all. Their understanding was demonstrated by their explanations in their reports, and was illustrated by the approach they took to explicate the results of their experimental work. The findings are valuable to instructors who design, develop and deliver different types of blended learning, and are beneficial to learners who try different blended approaches. This study recommended the role of the innovative application of vodcasts in the knowledge construction for structures laboratory and to guide future work in this area of research.

A study on E-learning tools and their impact on pedagogy (Chug, 2010), it explained that educators' expectations and the needs of their students will help determine the kind of e-learning tool to be used. This study has identified some key intrinsic strengths and weaknesses of e-learning tools, which have implications for teaching and learning. E-learning should be seen as an innovative force that improves pedagogy and engages students in productive and exciting ways. Pedagogically richer forms of e-learning can be accomplished by anticipating the requirements of a growing technology savvy generation. This study also discussed that the nature of students, nature of content and infrastructure issues are key areas that educators need to explore before implementing e-learning. Globalization and the trend towards a competitive educational environment have certainly accelerated the development and use of various e-learning tools. It is important to

remember that e-learning tools such as vodcasts are best when considered more broadly than as technology alone. In an educators' perspective, the impact these tools will have on shaping the future and present needs of the student is well worth consideration and should not create any discord and distraction for students. It concluded that E-learning using tools like vodcasts may not necessarily be a panacea for education but a starting point for educators to make educational practices contemporary in the 21st century.

1.8.3 Vodcasting as a Tool to Develop the Skills of Information

By the standards of American Association of School Libraries, the use of video podcasts develops in students the following matters:

• Read, watch, and listen to the information in any format for gathering knowledge. Students would be qualified to evaluate the video podcast and include it in their range of knowledge.

• Collaboration with others to enlarge and deepen their knowledge. With the vodcast, the learning is more attractive for young people and it is easier to reach to more persons, being the action of sharing computer issues a type of divulgation of the knowledge very common among students.

• Using technology to create new knowledge. It is an innovative way to get information to students and create projects that develop information skills.

• Use technology and other information tools for organizing and presenting knowledge, and understanding the ways that others see, use and access (Jeyakumar, Mr., 2014)

1.8.4 PhET Interactive Simulations

According to Mallari et al. (2020), the integration of PhET interactive simulation-based activities significantly improves students' academic performance in Science. Utilizing PhET interactive simulation-based activities saves time for the teacher and the students in terms of laboratory experiments. And the simulations have implicit guidance and balanced challenges, which encourage engaged exploration where students approach problem-solving and knowledge acquisition similarly to experts.

One of the problems that educators face as their profession is the way students approach their schoolwork. Educators want their students to do more than answer questions and retain a little knowledge since they are unprepared, do not care, and are in a hurry. But, this matter already has a solution with the help of technological advancement. With PhET Interactive simulations, students engage in scientist-like exploration, resulting in greater and deeper learning of scientific concepts and balanced challenges and eliciting the correct mode of engagement (W.K. Adams, 2010). The PHET simulations are created with an easy-to-use interface and little text for pupils. The sims are dynamic and interactive, reacting instantly to student input. Real-world objects (for example, light bulbs, bicycle pumps, and skateboards) are utilized to help students see the links between the occurrences and their prior knowledge. Nonetheless, sims benefit from making the invisible visible and providing multiple representations such as macroscopic, microscopic, graphs, etc. (W.K. Adams, 2010). Based on the valuable things mentioned, indeed, PHET interactive simulations are a massive help for the teachers and students to achieve the goal of the education team (W.K Adams, 2010).

1.8.5 Online Education Qualities

Learning enhanced by online technologies follows the principle of "anywhere" and "anytime". Personalization and flexibility are the leading keywords when we think about online-based learning. Students can choose when to attend a particular study unit, and can

usually personalize their learning schedule to a large extent (making allowances for unrelated work and family issues, etc.). Teachers can set up general guidelines and deadlines to be followed, the rest of course time management, however, remains the responsibility of students themselves. Furthermore, students can self-regulate the pace of their learning and progress according to their skills and abilities (Zounek et al. 2012).

Multimedia approaches in physics teaching and learning have been applied through ICT pedagogy in many schools, including lesson recordings, animated videos, internet resources, simulations and virtual laboratories. Adeyemo (2010) summarized previous research on the benefits and impact of ICT (including simulation programs) on physics education, one of the benefits was that students were able to apply higher reasoning skills in order to process complex and challenging situations. In addition, simulations also provide equality in learning opportunities in terms of different styles of learning and levels of ability because they allow more time and place flexibility.

Students tend to better respond to situations in which they have more time to think about and perhaps also post-edit the individual questions, comments, and other contributions.

In this way, implementing online technologies may result in increased student self-confidence, especially when application of e-learning tools closely correlates with student success in a particular course. Also, the reductions in a variety of expenses (travel, printing, buying books, etc.) should also be taken into account when considering the overall implications of installing selected e-learning solutions.

Students may lack sufficient knowledge and skills to use these technologies efficiently in order to enhance their study experiences. In particular, students often struggle to utilize various time-management, presentation, word-processing, collaboration, and other kinds of tools for personal learning purposes; a situation which many times leads to replicating old, ineffective ways of ICT implementation and sometimes even to a complete refusal of any e-solutions whatsoever. In addition, prior negative attitudes towards information technologies in general may present a significant block for some people, whatever the original reasons.

Technology-enhanced learning may also cause negative resentments with students who lack sufficient motivation and the ability to organize workload and learn independently. For unmotivated students with poor learning habits, therefore, technologies may become the reason for decreased productivity and worse study results. Furthermore, students may sometimes feel isolated and abandoned in the virtual environment (i.e. "lost in cyberspace"), especially in cases where there is a prolonged period of no face-to-face instruction, nor any other forms of offline interaction (e.g. in distance education programs).

ICT-based education also raises some health-related issues connected predominantly to spending long periods of time working with computers. Problems such as eye-strain, back pain, lack of movement, and even mental disorders may be listed among the major considerations (Zounek et al. 2012).

1.8.6 Problems Associated With Online Teaching and Learning

Online learning has become common in high school science instruction, but it is often designed in ways that do not accommodate the varied characteristics of high school learners. The cognitive approach to learning holds that the learner's current knowledge has a significant effect on learning.

E-learning has specific weaknesses: it can hamper the learner and the educator; direct contact and human touch are lost. Users can face many technical difficulties that hinder and slow down the teaching-learning process (Favale et al. 2020). Time and location flexibility is the strength of online learning; these aspects are fragile and create problems. Students' irresponsible behavior in terms of time and flexibility might generate plenty of

issues. All students and learners are not the same; they differ in words of their talents and confidence level. Some people may not feel at ease when studying online, which leads to more significant irritation and misunderstanding. Inadequate compatibility between the design of the technology and the component of psychology required by the learning process; and insufficient customization of learning processes can impede and produce an imbalance in the teaching process.

There are several technologies available for online education, but sometimes they create a lot of difficulties. Downloading failures, installation issues, login issues, audio and visual problems, and so on are all examples of challenges and problems connected with contemporary technology. Online teaching may be uninteresting for students at times. Students never have time to conduct online learning since it requires so much time and flexibility. Personal attention is also a significant concern in online education. Students want two-way interaction, which sometimes gets challenging to implement. The learning process cannot reach its full potential until students practice what they learn. Sometimes, online content is all theoretical and does not let students practice and know effectively. Mediocre course content is also a significant issue. Students feel that lack of community, technical problems, and difficulties in understanding instructional goals are substantial barriers to online learning (Song et al. 2004). In a study, students were not sufficiently prepared to balance their work, family, and social lives with their research in an online learning environment. Students were also found to be poorly designed for several e-learning competencies and academic-type competencies. Also, there is a low-level preparedness among the students concerning the usage of Learning Management Systems (Parkes et al. 2014).

1.9 Conceptual Framework

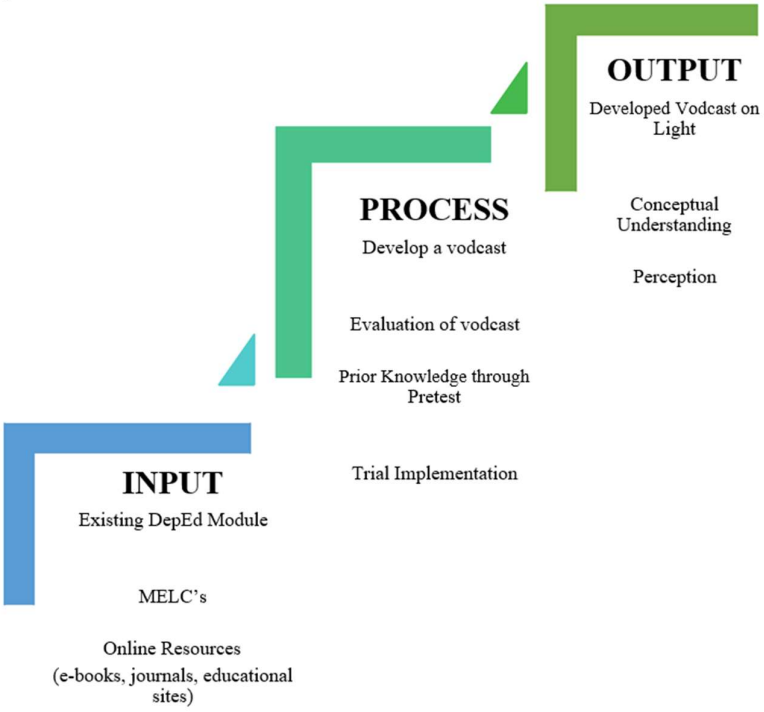

Figure 2. Conceptual Framework of the Study

For the first phase, the science topic and the target respondents were determined. The second phase involved developing a vodcast, evaluation of vodcast, prior knowledge through pretest and trial implementation. The developed vodcast on light would be

evaluated by the panel of experts to assess its appropriateness for implementation. The utilization of the developed vodcast on light in promoting conceptual understanding was measured and identified through the posttest and the qualitative description of students' perception of the usefulness of vodcast.

Input involved the existing DepEd module, MELC's, Online Resources (e-books, journals, educational sites). Process involves developing a vodcast, evaluation of vodcast, prior knowledge through pretest. In developing the learning material, the researchers aligned the objectives to the learning competencies of K to 12 Basic Education Curriculum as seen in the Matrix of Competencies. The ratings, comments, and suggestions would be used for revision purposes on the learning material.

Conceptual understanding was based on their normalized gain result and the perception was assessed through the perception survey questionnaire.

1.10 Operational Definition of Terms

For purposes of clarification, the following key terms are hereby defined:

Conceptual Understanding. It refers to knowing more than isolated facts and methods, which explains that a successful student understands mathematical ideas, and has the ability to transfer their knowledge into new situations and apply it to new contexts; it refers to the score of the respondents in the pretest and posttest of items about light in Grade 8 Science.

Development. It refers to a process of changing or improving teaching strategies/materials/approaches/aid to effectively apply in the classroom.

Diagnostic Test. It is a form of pre-assessment that allows a teacher to determine students' individual strengths, weaknesses, knowledge, and skills prior to instruction.

Evaluation. It is` a process of characterizing and appraising some aspect/s of an educational process.

Implementation. This involves putting a plan into effect, including the process of monitoring progress, making adjustments, and evaluating.

Interactive Simulation. It refers to the use of simulation software, tools, and serious games to enrich the teaching and learning processes.

MELCs. It refers to the learning competencies that will be applied in the developed video podcasting of the researchers.

Perception. It refers to the insights, thoughts and feedback about light of the target students. Prior Knowledge. It refers to the information about light that the learner has before and to the pretest score of the respondents in Research-made Achievement Test items. Light. It is the specific topic to be tackled in the developed video podcasting.

Utilization. It refers to the use of developed video podcasting.

Vodcast. It refers to video files that are distributed in a digital format through the Internet using personal computers or mobile devices. (McGarr, 2009)

2. Research Methods

This chapter covers the discussion on the research design, research setting, research participants, research instruments, and data gathering procedure, statistical tools and ethical considerations.

2.1 Research Design

This research aimed to develop vodcast in teaching light for 8th grade students with the aid of interactive simulation. The study utilized a combination of descriptive and development approaches to examine the data. The research involved the vodcast, implementation of the vodcast and the impact of the vodcast on the learners.

2.2 Research Setting

This study was conducted at Iligan City East National High School – Santiago Annex which falls under Purok 5B, Brgy. Santiago, Iligan City, Philippines. Iligan City East National High School – Santiago Annex is a public secondary institution duly recognized by the Department of Education (DepEd) providing quality and affordable education to the municipality of Iligan City. In line with this, the school conducted limited face-to-face classes.

2.3 Research Participants

The study was limited only to twenty (20) grade 8 students currently enrolled this year.

2.4 Research Instruments

This study would utilize five research instruments which are the K-12 Curriculum Guide and its existing module, achievement test in Light, adapted CTML-based survey questionnaire, vodcast usefulness questionnaire and research-made vodcast.

Achievement Test on Light. – A set of questions would be used in this study for the assessment of the prior knowledge/pretest and posttest. The researchers would used the data result for the analysis of the conceptual understanding of the respondents on light.

Adapted CTML-Based Survey Questionnaire. – This would be used for vodcast evaluation by the content experts.

Vodcast Usefulness Questionnaire. – This would be used to evaluate the perception of the usefulness of the vodcast in learning light.

Research-made Vodcast – The researchers produced a vodcast on light through laptop and different video editing applications that would be used as a supplementary material.

2.5 Data Gathering Procedure

The following steps are the process of gathering data that should be followed in conducting this study. Hence, the steps are:

Analysis Stage- Before conducting the study, the researchers would choose a science topic aligned with the curriculum guide which gives students a hard time in learning.

Design Stage – The researchers would plan a storyboard on the vodcast, identify the tools to be used and used an adapted CTML-based survey questionnaire for the evaluation.

Development Stage – The researchers would develop vodcast and would be evaluated by the content experts if revision is recommended.

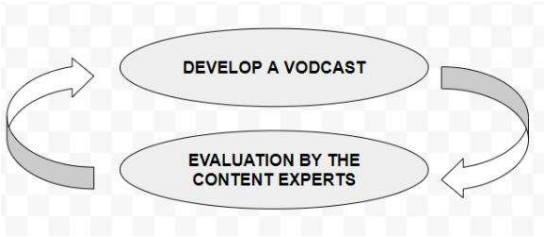

Figure 3. Development Stage

To evaluate the vodcast by the content experts, the researchers used data on the average evaluation rating of the vodcast as obtained from the researcher-developed vodcast evaluation survey result. Based on the five-point Likert scale-response, the range was calculated to be four (4). Dividing the range by five (5) corresponds to the researcher-articulated vodcast evaluation descriptions of very satisfactory, satisfactory, fairly satisfactory, unsatisfactory, and very unsatisfactory).

Table 2. Interpretation of Vodcast Evaluation (Teachers)

Mean Distribution	Description	Interpretation
Description		
4.20-5.00	Very Satisfactory	The vodcast is very useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light is strongly recommended as supplementary learning material on the topic of light
3.40-4.19	Satisfactory	The vodcast is very useful as a supplementary Learning material for properties and characteristics of light, light phenomena, and colors of light is reasonably recommended as supplementary learning material on the topic of light.
2.60-3.39	Fairly Satisfactory	The vodcast is fairly useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.
1.80-2.59	Unsatisfactory	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.
1.00-1.79	Very Unsatisfactory	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.

Implementation Stage – The researchers conducted a pretest, implemented the study by viewing the vodcast in class, and conducted a posttest.

Evaluation Stage – After the Vodcast lesson proper, the researchers would use a perception survey questionnaire for the respondents to evaluate the usefulness of Vodcast in learning light.

To evaluate the usefulness of the vodcast, the researchers used data on the average evaluation rating of the vodcast as obtained from the vodcast usefulness survey result. Based on the five-point Likert scale response, the range was calculated to be four (4). Dividing the range by five (5) corresponds to the researcher-articulated vodcast evaluation descriptions of very useful, useful, fairly useful, unuseful, and very unuseful).

Table 3. Interpretation of Vodcast Usefulness (Students)

Mean Distribution Description	Description	Interpretation
4.20-5.00	Very Useful	The vodcast is very useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colours of light is strongly recommended as supplementary learning material on the topic of light
3.40-4.19	Useful	The vodcast is very useful as a supplementary Learning material for properties and characteristics of light, light phenomena and colors of light is reasonably recommended as supplementary learning material on the topic of light.
2.60-3.39	Fairly Useful	The vodcast is fairly useful as a supplementary learning material for properties and characteristics of light, light phenomena and colors of light on the topic light.
1.80-2.59	Unuseful	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic of light.
1.00-1.79	Very Unuseful	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.

2.6 Statistical Tools

The researchers would use the following statistical tools to interpret and analyze the data.

a) Normalized Gain

For the achievement test, the mean for pretest and posttest would be investigated. The normalized gain would also be calculated to identify the meaningful incremental change in the achievement test result.

$$< g >= \frac{(post\ test\ score - pre\ test\ score)}{(perfect\ scoe - pre\ test\ score)}$$

Standard Gain Score <g>	Criteria
0.70 < g	High
0.30 < g < 0.70	Medium
G < 0.30	Low

b) Mean would be used to determine the usefulness of the vodcast.

2.7 Ethical Consideration

To ensure quality and integrity of this research study the proponent have considered the following:

1. Seek, inform, and consent the people that will be involved in the study,
2. Respect the confidentiality and anonymity of the research respondents,
3. Ensure that the participants will participate in the study willingly,
4. Show that the research is independent and impartial specifically in treating results,
5. Acknowledge all references and sources,
6. Results will be treated with confidentiality.

3. Results and Discussions

This chapter presents the results and discussions according to the overall procedure of the study following the ADDIE model. Details concerning the results and discussions, therefore, were organized according to the order of stages in the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation.

3.1 Analysis Stage

The respondents of this study were the grade 8 students under the Science class of the teacher-researcher. There were students who were randomly picked to attend the limited face-to-face classes. This population of students was selected from Grade 8 sections by the school.

In the study of Mongan et.al (2021), they stated that students have significant misconceptions about the direction of light refraction, how light is refracted, how to determine its position from an image, and light as a ray. The study emphasized misconceptions on the importance of concept teaching. From elementary school to college, light refraction is one of the subjects that continue to present difficulties for students. Fredlund (2012) examined a group of physics students using multiple representations to describe the refraction of light on a ray diagram. The results of Fredlund's research indicate that there is interactive involvement of students in learning using multiple representations. In line with this study, researchers chose the topic light for it has a lot of misconceptions in teaching its concept. Integrating the concept through teaching method/strategy will be a good influence for continuous advancement of the curriculum which aims students to be globally competitive. Scientific concepts of light refraction are basic and yet important contents in physics education. In the context of Thailand basic education, students need to gain this scientific concept properly in order to understand related and advanced physics concepts in the future, i.e., interference of light waves and spectrum of light. Without understanding the concept of light and its properties, students may not understand many scientific domains (Djanett et al. 2013). Unfortunately, researchers have reported that the Thai students hold alternative conceptions in science phenomena about refraction of light.

A few examples are they are confused about the meaning of light reflection and refraction; the direction of propagation of light; how light refraction occurs at an interface; and how to determine a position of image (Kaewkhong et al. 2010).

The MELC chosen for this study bears the code S8FE-If-26/27/28, which requires students to describe properties and characteristics of visible light, explains the hierarchy of colors in relation to the energy of visible light and discuss phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light.

The MELC was decided based on the availability of SLMs as of October 2020. Since the scheduled delivery fell on the first quarter of the school year, the topic was one of the identified least learned competencies because it was not covered in the previous school year when face-to-face classes were already suspended due to the COVID- 19 pandemic. Luckily, the said school conducted a review class for students who attended limited face-to-face in the mid-April for the upcoming parallel examination.

3.2 Design Stage

During this stage, the storyboard was planned out aligned with the curriculum guide of the chosen topic. For a teacher to produce an educational vodcast, some specifications of hardware and software must be met. For this study, Appendix N presents the available hardware and software used by the researcher to develop the vodcast. It must be noted that the vodcast production cost no money from the teacher/researcher as an existing laptop was used.

The vodcast was divided into four parts: introduction, properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). The storyboard of the vodcast prototype is shown in the following figure.

Figure 4. Sample pages of first version the storyboard of the vodcast outline

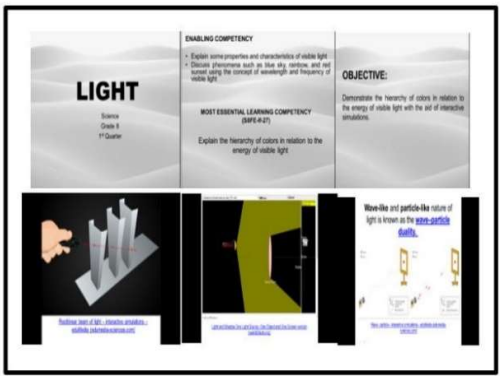

Figure 5. Sample pages of the final version of the storyboard of the vodcast outline

As shown in Figure 4, a raw version of the storyboard was outlined. After further planning and improvisation, a final version of the storyboard is produced on figure 5. Then, the researchers used an adapted CTML-based contextualized survey questionnaire which consists of three indicators of a good instructional vodcast that were identified: content, delivery, and technical production. The researcher decided to conduct a vodcast evaluation survey (Appendix E) with content experts as respondents.

3.3 Development Stage

During this stage, the development of the vodcast which covered the different versions prior to the comments and suggestions of the evaluators and the achievement test were made.

Figure 6. Sample pages of the first version of the vodcast

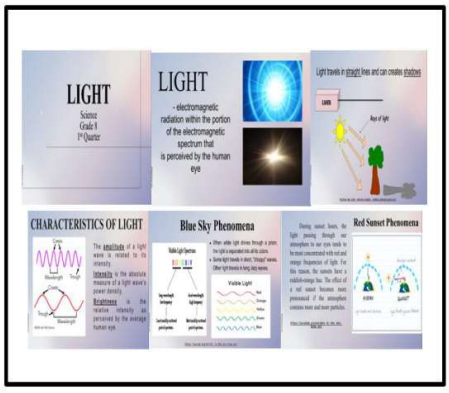

Figure 7. Sample pages of the final version of the vodcast

This first version of the vodcast was essentially a continuation of the prototype with added simulations to cover the properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). The duration of this version of the vodcast was 31 minutes and 5 seconds.

Overall, the first version of the vodcast featured eight different interactive simulations that were freely available on the internet. It was then uploaded as a video clip on Google Drive and was only accessible to the research panel and some selected teachers who were given the link. The Google Drive link of the first version of the vodcast contained the video clip and vodcast evaluation survey questionnaire. The adapted CTML-based survey questionnaire had 12 items that were distributed equally under the three indicators– content, delivery, and technical production. The first version of the vodcast was subjected

to initial evaluation and validation involving the researcher's research panel and selected teacher-colleagues. Their initial feedback served as the basis for revision and was incorporated accordingly.

The first version of the vodcast was then evaluated through a survey by learning resource evaluators and science teachers. The vodcast undergoes revisions after the evaluation of the evaluators. The following are the comments and suggestions by the evaluators:

	Content	**Delivery**	**Technical Problem**
Evaluator 1	It is clearly seen that the content was comprehensive.	I suggest that you make your video interactive as if you are talking to the camera as if you are looking into the eyes of your students watching you.	None
Evaluator 2	None	The researcher showed mastery of the topic. However, some presenters need to make their voice louder because it can be a barrier in efficient learning when the listener cannot properly comprehend what you are saying.	The video is way too long.
Evaluator 3	The speaker in the vodcast clearly explained the content. And it was significantly enriched and had appealing visuals.	Much louder audio is needed.	Although the whole production is good, the researchers need to help each other to find a better space for audio-video recording where unnecessary noise is prevented.
Evaluator 4	Vodcast should only focus on the set objective and other parts should be removed.	Modulation of the voice should be improved so the vodcast be more engaging.	Remove background noise.
Evaluator 5	None	None	Have a uniform background for the PPT and make the PPT less wordy.
Evaluator 6	It is learner-friendly and well-presented.	None	No comment. I hope it will be published for reference purposes.

As shown in Figure 7, the final version of the vodcast already had the same background throughout the clip. It has a runtime shorter than the first version. After the revision, the unnecessary noise was removed. The PowerPoint was less wordy and focused on the simulations and diagrams, aligned with the MELCs. The modulation of the voice of the speakers was improved. The vodcast discussion was lessened and focused entirely on the specific objectives selected in MELCs. While the shorter duration primarily addresses the short attention span of students, it also works compatible with the unreliable

internet data access of the students and the relatively low storage capacity typical of the smartphones they are using.

The vodcast was edited for the final version with the feedback from the research panel and selected teachers during the design stage incorporated in it. This version of the vodcast was trimmed into 12 minutes and 30 seconds of runtime.

Table 5. Vodcast Evaluation Survey Result

The vodcast I watched..	**CONTENT**	**MEAN RATING**	**DESCRIPTION**
1. is targeted according to the Most Essential Learning Competencies (MELC).		5.0	Very Satisfactory
2. will help students learn better about some properties and characteristics of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
3. will help the students to learn better about the phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
4. will help students learn better the overall topic about the hierarchy of colors in relation to the energy of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
The vodcast I watched…	**DELIVERY**		
1. made the topic easier to understand with its language/narration.		5.0	Very Satisfactory
2. will hold the attention of students throughout the duration with its conversational voice/narration.		4.6	Very Satisfactory
3. will make the students feel like their teacher is there with them keeping them company and helping them in learning content/topic.		4.8	Very Satisfactory
4. featured guide questions that will get students "thinking critically" about the topic.		4.8	Very Satisfactory
The vodcast I watched…	**TECHNICAL PRODUCTION**		
1. is clear and free from unnecessary or distracting texts, images, or scenes.		4.6	Very Satisfactory
2. have clear audio/voice/narration and are free from distracting noise,		4.5	Very Satisfactory
3. have matching on-screen visual information (texts, images, or scenes) and audio/voice/narration.		4.5	Very Satisfactory
4. is not too long or too short in duration that students will be able to watch from start to end.		4.6	Very Satisfactory
OVERALL MEAN		**4.8**	**Very Satisfactory**

As shown in Table 8 above, the first version of the vodcast was evaluated as very satisfactory in all three indicators, with an overall mean rating of 4.80. This is interpreted as that the evaluators found the vodcast very useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light. It strongly recommended its use as supplementary learning material on the topic light. Simultaneous

to the vodcast evaluation, the achievement test was administered in a posttest with grade 8 students from the same school as the respondents.

3.4 Implementation Stage

This stage was the actual implementation of the study. The achievement test consists of 30 multiple choice questions distributed among the concepts of the properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). Following the positive results of the vodcast evaluation survey, the achievement test was then subjected to minor revisions. It was then administered as a pretest in printed format. The researchers ask for permission before conducting the study to the school principal and class adviser with a letter (Appendix A & C).

The following are the pictures during the implementation of the study:

The conduct of the study started with the students practicing the health protocols before entering the school premises. The class adviser informed the students of their involvement in the study. Before conducting the study, researchers had an overview of the background of the study for students to have a proper knowledge of what they would do.

The pretest was given first with a time frame of 20 minutes to answer. For the proper implementation, researchers let the students view the vodcast twice. The posttest was given afterwards with a time frame of 20 minutes to answer.

There are various challenges met by the researchers during the implementation. One of them is the availability of the students. Although the school conducted a limited face-to-face class, there are various adjustments with the number of students. At first, one class contained thirteen (13) students only. Afterwards, the school adjusted it with a much larger number of students. The researchers had a lot of adjustment time when it comes to the proper implementation of the vodcast. With the adjustments of the number of students, the school had plenty of adjustments when it comes with the schedule. The specific date for the 8th grade students always falls on school events or holidays. That is why researchers had a hard time gathering data. Nevertheless, the students were passionate to participate in the study. The researchers observed that the students were active and attentive when sessions were involved with multimedia clips.

During this stage, the pretest and posttest results were further analyzed towards a better understanding of the influence of the vodcast on the achievement of the student-respondents on properties and characteristics of light, colors of light and light phenomena. The results of the pretest and posttest were incorporated in the normalized gain score computation as summarized in the following table:

Table 6. Normalized Gain Score Analysis

Respondents	Pretest Raw Score	Posttest Raw Score	Normalized Gain	Description
#1	9	14	0.24	Low
#2	14	20	0.38	Medium
#3	15	13	-0.13	Low
#4	9	14	0.23	Low
#5	10	17	0.35	Medium
#6	9	14	0.24	Low
#7	14	20	0.38	Medium
#8	14	18	0.25	Low
#9	14	21	0.43	Medium
#10	4	13	0.35	Medium
#11	7	16	0.39	Medium
#12	2	9	0.25	Low
#13	15	23	0.53	Medium
#14	7	14	0.30	Low

#15	15	13	-0.13	Low
#16	6	13	0.29	Low
#17	9	19	0.48	Medium
#18	18	27	0.75	High
#19	18	25	0.58	Medium
#20	14	21	0.44	Medium
Overall Mean	**11**	**17**	**0.33**	**Medium**

As shown in Table 9, one (1) got a high normalized gain, ten (10) got medium and nine had a low normalized gain. Overall, the respondents posted a uniform medium gain score on the topic light. The overall pretest mean score was 11.15 while the overall posttest mean score was 17. Using the normalized gain score formula shown in chapter 2, the overall normalized gain score was computed to be 0.33 – a medium normalized gain score.

A medium normalized gain in an achievement test on science process skills using PhET Simulation under a face-to-face teaching-learning modality was considered a dramatic improvement. The present study yielded a medium normalized gain even though the study was conducted on the first week of students to experience face-to-face classes after almost three years of modular learning. Hailikari et.al (2008) suggested that prior knowledge from previous lessons significantly influenced student achievement. It has long been considered the most important factor influencing learning and student achievement and the amount and quality of prior knowledge positively influence both knowledge acquisition. Aligned with the spiral curriculum of MELCs, the prior knowledge from Grade 7 science which was the basic concept of light, it was continued with complex discussion on light. This shows the importance of prior knowledge in introducing new topics. Students can easily grasp information with continuity of the concept.

3.5 Evaluation Stage

Table 7. Vodcast Usefulness Survey Result

Adapted from Liwanag's (2021) Student Perception Questionnaire which she adapted from Deci and Ryan (1994)

1= Not all true; 2=Occasionally true; 3=Somewhat true; 4=Frequently true; 5= Very true

Statements	Mean	Description Rating
1. I believe that watching the vodcast made me more interested with the lesson.	4.75	
2. I believe that the vodcast enabled me to relate real-life situations.	5.00	
3. I felt like the vodcast I watched and interacted with is helping me develop good conceptual understanding and even good communications skills.	4.85	
4. I enjoy learning from the lesson presented in the vodcast.	5.00	
5. For me, the vodcast embedded with PhET simulation is important for my improvement because it encourages me to find more information and ask questions.	4.90	
6. The vodcast allow us to develop and acquire good values and character.	4.85	
7. I believe that the question and answer activities in the vodcast challenge me to succeed and do my very best.	4.50	

8. I gained new self-regulated learning strategies and techniques through vodcast such as taking down notes, sharing ideas with others and having further research.	4.75	
9. I watched and learned from the vodcast because I wanted and liked it.	4.85	
10. I think that the vodcast motivated me to perform better because I believe it is not about having good grades, but it is learning that I could use in the future.	4.80	
11. The vodcast makes me feel that the teacher is there with me helping me in learning the content/topic.	5.00	
12. The vodcast is not too long or too short in duration that I can watch from start to end.	4.95	
13. I find the topic easier to understand by watching the vodcast.	5.00	
14. I can control the rate and sequence of the vodcast and review the topic anytime.	5.00	
15. The vodcast cleared out my misconceptions about light.	4.95	
OVERALL RATING	**4.88**	**Very Useful**

As shown in Table 10, the vodcast was perceived as very useful by the same 20 student-respondents who took the achievement test in both pre- and post-vodcast instructions. This means that the respondents perceived the vodcast as very helpful to them on the topic of properties and characteristics of light, light phenomena, and colors of light. All vodcast indicators were perceived as very useful with an overall rating of 4.88. The same 20 student-respondents strongly recommended its use as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light. Čubrilo et.al (2014) stated in their study that multimedia teaching has statistically significant increase in the retention of knowledge quality compared to the traditional teaching method in the category of applying that leads to the conclusion that the use of multimedia had the greatest effect on the highest level of knowledge. In connection with the study, the vodcast on light did not yield the expected positive effect but there is a significant increase in the achievement performance of the respondents.

3.6 Summary of Findings

This study was guided by three objectives: develop a vodcast as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light to determine the achievement level of grade 8 Science students in pre- and post-vodcast instructions; and ascertain the level of usefulness of the vodcast as perceived by the grade 8 Science students. The findings of the study are as follows:

1. The vodcast was developed with a duration of twelve (12) minutes and thirty (30) seconds and was uploaded in Google Drive. It was rated as very satisfactory with the overall mean rating of 4.8 by 6 content-expert evaluators. Earning the "very satisfactory" rating, the vodcast was highly recommended for use on the topic properties and characteristics of light, light phenomena, and colors of light in grade 8 Science by 6 content-expert evaluators.
2. The pre-vodcast achievement of the grade 8 Science student- respondents was at the low level with the mean raw score of 11. The post-vodcast achievement of the grade 8 Science student-respondents was at the average level with the mean raw score of 17. The improvement represents an average normalized gain score of 0.33. The vodcast developed for the topic properties and characteristics of light, light phenomena, and colors of light in the coverage of grade 8 Science helped the student-respondents improve their achievement from the "low" level into "medium" level or "medium" level into "high" level as made evident by the average normalized gain score of 0.33. The average normalized gain score indicates that the vodcast had a positive influence on the achievement of the respondents.

3. The vodcast usefulness level was at “very useful” with the mean rating of 4.88 as perceived and rated by the grade 8 Science student- respondents. The grade 8 Science student-respondents perceived the vodcast as very useful and recommended its use as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light in the grade 8 Science.

The average normalized gain score indicated that the vodcast positively influenced student-respondents' achievement, helping them pass the achievement test from the “low” to the “medium” level. The “very satisfactory” rating from the 6 content-expert evaluators and the “very useful” rating of the same vodcast from the 20 student-respondents corroborated the positive influence of the vodcast on the achievement level of the student-respondents for the topic properties and characteristics of light, light phenomena, and colors of light of the grade 8 Science topics.

4. Conclusion and Recommendation

The researchers have found out that there are various elements and parameters to be considered when formulating an instructional video material which includes the preferences of the students. It was also shown that with regards to the elements found in the video material, students prefer a combination of textual and visual lecture presentation with a conceptual discussion on light. The researchers concluded that the developed supplementary vodcast for the topic of light can engender an average normalized gain. The results coincided with the findings of the study conducted by Ercan (2014) that showed multimedia has an important role for students’ achievement and that there is a significant difference in the achievement post-test.

Considering the conclusions of this study, the following points are hereby recommended:

1. The evaluation tool used in evaluating the vodcast developed in this study was the researcher-made vodcast evaluation survey questionnaire adapted from Ulla (2021). Future researchers could make improvements by adapting and using established multimedia evaluation tools or open educational resources (OER) evaluation tools in evaluating vodcasts.
2. Local literature on the use of vodcast to improve science achievement could be established by conducting more studies on the same topic as well as other topics.
3. Supplementary statistical analyses on top of using normalized gain score could also be utilized in analyzing data to gain a better understanding on the influence of vodcast on the students’ achievement.
4. More vodcasts may be developed as supplementary learning materials for other topics following the CTML principles and the recommendations of the evaluators.
5. Other parameters can be explored as intervening factors in the efficacy of vodcast in learning science concepts

The results of this study could also be used to help build baseline information that would enable school administrators to craft a school improvement plan that would empower teachers to develop their instructional vodcasts across varied science topics.

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Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 143-150, Sep. – Dec. 2023

ICNSF-Honor Society: Adopt a Learner Program in Aid of the Learning Gap Experienced by the ICNSF Learners

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Received: 12 June 2023 Revised: 9 Nov 2023 Accepted: 10 Dec 2023

Abstract. This research was undertaken to give aid to the learning gap of the learners caused by the two-year lockdown brought about by the global pandemic. The intervention was crafted under the leadership and supervision of the EsP Club-ICNSF Honor Society which is the official school organization for honor students. The Senior High School members of the club were the ones tasked to do the remediation under the Adopt a Learner Program by the said club. In observance of the "No Disruption of Classes" Policy of the Department of Education, the Chairman and Club Adviser handed a letter stipulating the purpose of the program as well as the schedule for the remediation which was set every second period of their LRCP that ran for three consecutive months (October-December 2022) which was then approved by the school administration. Because of the number of available SHS club members the ratio of the remedial was at minimal thus arriving at a small sample size (n=8). The participants were from the JHS department and were chosen as identified by their respective classroom advisers as learners having academic challenges. The study measured the effectiveness of the program in relation to the learners' academic performance and class participation as observed by their class adviser with their class record and anecdotal as the primary basis for their responses to the survey form they answered. The results showed that effectiveness and class participation increase and the relationship are statistically significant $\tau_b = .260$, $p=.473$. This implies that, as per observation by their adviser, their performance in the classroom has improved and is moderately attributed to the intervention provided-the adopt a learner program. However, Effectiveness and Improved Academics were not found to be significant which is constant to the perception of the participants.

Keywords: School Club, School Organization, Honor Society, Peer tutoring

1. Context and Rationale

The Department of Education has long been consistent with its mission and vision of providing quality education to our youth. School Heads, Teachers and Staff are consistently looking for inventive strategies to address global competence amongst graduates and Iligan City National School of Fisheries is not far behind. To ensure a pedagogical, educative and welcoming learning environment, Iligan City National School of Fisheries crafted the Honor Society under the EsP Department. The organization was crafted to create an avenue where learners showing exemplary academic performance

would foster and their knowledge and skills be honed. Members of the Honor Society are also expected to impart their knowledge and help the academically challenged learners.

The two-year suspension of face-to-face classes proved to be detrimental to the learners learning gains evidenced by their scores on the reading scale. This is also evident by the feedbacks of the teachers wherein they noticed that some learners who are at their prime, like grades 8 and 9 could barely read. Math teachers also experienced difficulty, some learners were somewhat in a daze in performing basic operations: fractions, laws of exponent, and dealing with positive and negative numbers. These issues and concerns are the prime focus of the Department of Education (DepEd) alongside the different schools nationwide and Iligan City National School of Fisheries (ICNSF) is one with the Department in addressing this inevitable ordeal.

It is a common knowledge that each school has different existing clubs and other student organizations. These organizations can be a contributing factor in addressing the detrimental effects of the two-year non-face-to-face education.

School clubs and organizations do not only exist to celebrate their month; Science month, English month, Filipino Month, EsP month, and many others. But more importantly, they exist to alleviate the academic performance of the learners. Thus, it is not only on the specific month, Science month for example, that they are expected to showcase and create a school-based and month-long complementary activities that will prove beneficial to the advancement of the knowledge of all learners. It is important to note, that each learning area has its monthly schedule to conduct activities that would address learning gaps and would surely spark the interest of the learners in accordance to the governing school policies on the conduct of co-curricular activities. Clubs and other student organizations exist to strengthen and further hone their knowledge and skills in the specific subject area they chose. The ICNSF-Honor Society has these objectives:

1. To strengthen the academic foundations of the learners on the core subjects
2. To have a faster and easier identification of participants for School and or inter-school contest
3. To hone the leadership skills and social competence of the learners
4. To promote peer tutoring, instill and propagate the Filipino value: "Bayanihan"

2. Literature Review

To give clarity on the nature, context, and purpose of this study, related papers, studies, journals and literatures from the internet and libraries were studied and summarized in this paper.

Othoo & Omondi (2022) in their study on the Impact of Students' Involvement in Co-curricular Activities on Academic Performance in Gem Sub Country, Siaya County, Kenya firmly suggest that participation in co-curricular activities positively influences students' academic performance. It is for this reason that the researcher is convinced that strengthening club existence by doing activities aimed at improving the academic performance of non-club members is imperative.

Cooperative learning as used in this study will pave way for the progress and attainment of the objective of the club. Additionally, cooperative learning is a viable and effective instructional method because it guarantees the building of higher-level thinking skills and academic achievements (Eyayu et al., 2018).

In a study conducted by Sumague, R. (2023) revealed that involvement in extracurricular such as joining in clubs and/or organizations influence the development of leadership skills of the students. This also boost the student's communications skulls and improves academic performance. Student's involvement on clubs and organizations also help community.

Similarly, the researcher in this study, is convinced on the importance of having a well-structured school clubs and organization geared towards the holistic development of the learners.

Additionally, in a study by Cabejas & Mendoza (2023) showed that engaging in the different activities provided by the clubs and organizations helps develop students holistically and sustain their wellness as they face challenges in the flexible learning modality. Further, the findings also point to the need for the professionals and club moderators not only to collaborate but also to be innovative in their strategies of providing engaging and meaningful activities and programs.

With this in mind, the researcher is convinced as to the relevance of putting emphasis on the creation of school clubs and organizations for it fosters holistic development of the learners.

The researcher was able to find research study that involves high school students. According to Collings (2020) "Overall participation in extracurricular activities has been proven to be beneficial for high school students. While students participate in a wide range of activities, each one has shown to have positive impacts. These impacts include higher academic performance, greater enjoyment in school, school connectedness, higher educational attainment, and less risky behaviors. Students also were found to have a greater sense of belonging, positive impacts I their mental health, create peer and adult connections, as well as increase non-cognitive skills."

Consecutively in another study entitled "Impact of Extracurricular Activities on Academic Performance of Students at Secondary Level" the researcher found emphasized that students participating in extracurricular activities also have more self-confidence, teacher perception, and a positive attitude towards school. Additionally, the researcher further exclaimed that students participating in extracurricular activities are less likely to drop out and are more likely to achieve higher academic achievement. Participation in extracurricular activities also reduces absenteeism and late arrival of students (Anjum, 2021).

With the aforementioned study, the researcher also considered confidence as a variable and incorporated it in the questionnaire by means of perception of the learner, specifically on question number one as reflected on Table 5. Degree of agreeableness in terms of help received by the learners.

3. Research Method

A. Research Design

The researcher utilized a descriptive research design. This research design allowed the researcher to accurately define the results of the intervention by investigating if the learning gap experienced by some learners of ICNSF were successfully aided by the Adopt a Learner Program of the ICNSF-HS.

B. Sample Participants and/or other Sources of Data and Information

The participants of this study were the Junior High School (JHS) learners identified by their advisers as having difficulty across the three core subjects: English, Science and Mathematics for the current school year 2022-2023.

a. Sampling Technique

The researcher made use of a purposive sampling design since the participants of this study were the existing members of the ICNSF-Honor Society and the identified students from the JHS Department.

b. Research Instrument

Two questionnaires-One intended for the advisers and the other is intended for the Learners- was used by the researcher.

Research Instrument for the Adviser

This survey questionnaire was intended for the Classroom Advisers of the Learners. The researcher made use of a 5 point Likert scale questionnaire with 3 questions: 1- Never , 2- Rarely, 3-Sometimes, 4- Most of the Time, 5- Always.

Research Instrument for the Learners

Since the age ranged of this research study were from the Grade 7 and Grade 8, age equivalent to 13-15 years of age. The researcher made certain that research questions were easy to understand. Thus, the questions were written in vernacular form to ascertain that the respondents understood the questions thus eliminating the vagueness and assuring clarity.

C. Data Gathering Method

c.1. Data Collection Procedures

The SHS members of the ICNSF-HS were utilized to conduct remedial sessions under the Adopt a Program. A Letter was forwarded to the administration informing the conduct of remedial sessions during the LRCP period-second period only. The letter was then disseminated informing the teachers of ICNSF about the said program. The advisers from the JHS Department became the priority, thus some advisers identified some students from their advisory as having difficulty in any of the three core subjects. A total of 10 students were absorbed under the adopt a learner program. This number is small since the ratio for the remedial session is at most 1:2. That is, 1 tutor in at most 2 students. This ratio was determined by the Club Adviser to ensure that transfer of knowledge will take place and peer relationship (Ate/Kuya relationship) will be established especially that all of the identified learners were minors.

c.2.Ethical Issues

In compliance with the Data Privacy Act of 2012 and the Republic Act 7610: Special Protection of Children Against Abuse, Exploitation, and Discrimination Act. Personal information and other relative information that would jeopardize the identity of the participants were held with the utmost confidentiality. Phone numbers, name of their Facebook account, and other means of communication were subject to anonymity. Proper information dissemination was initiated by the researcher before the conduct of the study.

D. Data Analysis Plan

Measures of Central Tendency were utilized in this study to determine the progress of the learners using the questionnaire adopting a five-point likert scale. To accurately analyze the data, the researcher made use of the Statistical Package for the Social Sciences (SPSS) software program. Data and its analysis was run using this program. Additionally, Kendall's tau-b correlation was used in this study to determine the relationship between the effectiveness of the adopt a learner program to the Class Participation and Improved Academic Performance of the participants. Kendall tau-b correlation is a non-parametric

tool used to determine the relationship between ordinal variables. Moreover, it is also appropriate considering the sample size is less than 20.

Since the scope of this study did not include any previous scores and or grades obtained by these identified learners, only the adviser and the tutored learners' perception on the efficacy of the Adopt a Learner Program was determined and measured.

4. Results and Discussion

The researcher made use of the Statistical Package for the Social Sciences (SPSS) to analyze the data gathered.

Table 1. Frequency distribution in terms of class participation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely	1	12.5	12.5	12.5
	Sometimes	3	37.5	37.5	50.0
	Most of the Time	4	50.0	50.0	100.0
	Total	8	100.0	100.0	

Table 1 shows the frequency distribution in terms of improved class participation of the participants as observed by their adviser. The results showed that out of the total sample size of n=8 participants, 4 showed improved class participation. These are the same learners who underwent tutorial sessions facilitated by the Honor Society. This implies that there is a significant improvement on the participants' classroom participation.

Table 2. Result of Kendall's tau-b Rank Correlation in terms of the efficacy of remedial sessions conducted by the Honor Society as perceived by their adviser

Variables		Correlation (tau-b)	p-value	Remarks
Effectiveness	Class Participation	.260	.473	Significant
	Improved Academics	.655	.083	Not Significant

Kendall's tau-b correlation was ran to determine the relationship between the effectiveness of the adopt a learner program to the Class Participation and Improved Academic Performance among 8 learners. The results showed that effectiveness and class participation increase and the relationship are statistically significant $\tau_b = .260$, p=.473. This implies that, as per observation by their adviser, their performance in the classroom has improved and is moderately attributed to the intervention provided-the adopt a learner program. However, Effectiveness and Improved Academics were not found to be significant. This might be caused by their grades having a small and negligible increment from 75-78 as reported by some of the advisers.

Table 5. Degree of agreeableness in terms of help received by the learners

Descriptive Statistics			
	N	Mean	Std. Deviation
Naa koy nakat-unan sa gi-tudlo	8	4.75	.463
Maka answer nako sa quiz	8	4.25	.707
Nakasabot ko gitudlo sa ako	8	4.50	.756
Nakatabang ang Honor Society nako	8	4.13	1.126
Makahimo nakog assignment basis a gitudlo sa ako	8	3.75	1.035
Valid N (listwise)	8		

The table above shows the frequency distribution of the degree of help received by the learners extended by the members of the Honor Society. The results revealed that the participants are convinced that the program in which they are a part of has been of great help to them for the advancement of their education as reflected on the fourth question with a mean of $\bar{x}$=4.13 which is translated to "Uyon" or in the English translation "Agree". This result is consistent to the results of the adviser's perception on improved academic performance having no significant relationship as shown on table 4 which may be attributed to their minimal increase of grades. This result is further supported by a research study conducted by Arhin et.al. (2021) wherein they found that face-to-face tutoring significantly affected students' academic performance.

5. Conclusion

The results of this study affirmed the importance of mobilizing the school clubs and organizations for the continued advancement of education. It is through active collaboration by the school and its stakeholders that issues and concerns on academic performance be addressed. ICNSF-Honor Society under the umbrella of the EsP Club is an example where school administration, teachers and students were able to alleviate academic gap experienced by some of the learners in the school. This innovative action should therefore be fostered for the continued development and learning of the students.

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Appendix 1: Research Instrument for Participants

Statement	1 Dili Gayud Uyon	2 Dili Uyon	3 Ok ra	4 Uyon	5 Dakong Uyon
Naa koy nakat-unan sa gipang tudlo ni ate/kuya					
Maka answer nako sa quiz					
Nakasabot ko sa gi tudlo sa ako ni ate/kuya					
Nakatabang ang Honor Society sa ako					
Makahimo nakog assignment basis a gitudlo sa ako ni ate ug kuya					

Appendix 2: Research Instrument for Advisers

Statement	1 Never	2 Rarely	3 Sometimes	4 Most of the Time	5 Always
As the adviser, I noticed an improvement of the learner who underwent tutorial sessions facilitated by the Honor Society.					
There is an improvement on the academic performance of the learner					
Remedial Sessions conducted by the Honor Society is one of the factors attributed to the learners' academic progress					

Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 151-156, Sep. – Dec. 2023

Enhancing Senior High School Students' Research Knowledge and Skills through Coins

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Received: 30 Jul 2023 Revised: 25 Nov 2023 Accepted: 27 Dec 2023

Abstract: Contextualized instruction, as a teaching approach is designed to link the learning of foundational content and skills by focusing teaching and learning squarely on concrete applications in a specific context that is of interest to the students. The primary goal of this study was to determine how contextualized instruction affects the research knowledge and skills among senior high school students. An experimental research, particularly the one-group pretest and posttest design were utilized. A total of fifty (50) Grade 12 students currently enrolled in practical research subject was purposely chosen as the respondents of this study. The results revealed that there was a significant difference in the students' performance in terms of achievement test and research skills. This implies that the use of contextualized instruction is considered a potential approach for teaching research subject. Further investigation was done to determine the effect size using Cohen's D. It was found that out that use of contextualized instruction had a medium and large effect on students' achievement and research skills, respectively. Contextualized instruction can be used as strategy in enhancing research knowledge and skills of the students. Hence, it is recommended that this approach can be adapted to provide a more meaningful and engaging learning experiences in learning research subject and other areas of discipline.

Keywords: Research knowledge and skills, contextualized instruction

1. Introduction

Republic Act 10533 of the Philippines, or the Enhanced Basic Education Act of 2013 provides that the curriculum to be offered shall be contextualized and global and at the same way shall be flexible enough to enable and allow localizing, indigenizing, and enhancing the same based on their respective educational social context (DepEd, 2013). Contextualization becomes the major thrust of the Department of Education. Hence, the process of contextualizing the curriculum is therefore a must, and that contextualized learning resources should be developed so that learners can better understand and attain mastery of competencies (Perin, 2011).

Contextualization refers to the educational process of relating the curriculum to a particular setting, situation, or area of application to make the competencies relevant, meaningful and useful to the learners (Torres, 2015) as cited by Olivera (2021). As Moltz

(2010) mentioned, contextualization is a form of "deep learning" which aims to make the learning process profound, objective, and meaningful through placing the target language in a vivid and realistic situation. Contextualization is an incredible technique steering learners' interest in exploring the content in a meaningful and relevant setting. Teachers and pupils are encouraged to participate actively and effectively in lesson sessions giving room for the acquisition of new ideas, skills, knowledge, and learning experiences and the development of self - belief and self - actualization through the power of contextualization and localization (Flores, 2020). Moreover, contextualization is a prerequisite in addressing the content and organization of activities to be undertaken in the classroom. Students' engagement in their schoolwork increases significantly when they are taught, why they are learning the concepts and how those concepts can be used in real-world contexts (Mouraz & Leite, 2013).

Corollary to contextualization, contextualized instruction, as a diverse family of instructional strategies is designed to link the learning of foundational skills and academic or occupational content more seamlessly by focusing teaching and learning squarely on concrete applications in a specific context that is of interest to the student (Kalchik & Oertle, 2010). In contextualized instruction, the critical features of a context are considered important for the acquisition and transfer of a skill. One of the primary goals of contextualized instruction is to increase the likelihood that what is taught in the training or classroom setting will be used in future applicable settings (Reboy, 1991).

Further, contextualized instruction was proven to be an effective approach to improve learners' success across learning areas. Rivet and Krajcik (2008) pointed out that contextualizing instruction is the utilization of particular situations or events that occur outside of science class or are of particular interest to students to motivate and guide the presentation of science ideas and concepts. These findings provide evidence to support claims of contextualizing instruction as a means to facilitate student learning, and point toward future consideration of this instructional method in broader research studies and the design of science learning environments. Similarly, Bottge (1999) investigated the effect of contextualized math instruction on the problem-solving performance. Results showed that the use of contextualized problems to enhance the problem-solving skills of students in general and remedial class. Furthermore, in the field of language learning/ teaching, contextualization occurs through bridging the ideas and concepts across courses. The findings of the study compared in t-test substantiated and showed that the contextualization teaching framework had remarkably promoted the learners' performance and enhanced the participants' knowledge of English in grammar, vocabulary, reading comprehension and writing (Moghaddas, 2013).

Additionally, it is believed that contextualization is a promising manner in growing and adapting curricula to meet students and context, without neglecting curricula important aspects and traits, however turning them into something comprehensible (Kalchik & Oertle, 2010). Silseth and Erstad (2018) also pointed out that in this instructional method, teachers use students' everyday experiences as tools for teaching subject matter at school. Research has documented that contextualizing instruction can support classroom learning.

In the present study, the concept of contextualized instruction is used as an approach of teaching Practical Research subject to enhance the research knowledge and skills of the senior high school students. Research skills are the abilities needed to undertake a research, including strategies and tools which can be acquired. It covers problem solving, critical thinking, analysis and dissemination. The acquisition of the skills depends on how thorough the teachers had taught the research skills in terms how the teacher let the students go about using the knowledge and skills to examine an issue, make decision, research on an idea, synthesize the research, do the presentation, and initiate a project (Meerah & Arsad, 2010).

The implementation of contextualized instruction in teaching Practical Research was the main focus of this study. Additionally, its effect on the research knowledge and skills among senior high school students was also determined.

2. Methodology

COINS or contextualized instruction is an approach in teaching practical research subject in the senior high school. Its idea is anchored on the teaching students based on their interest and context. Contextualized instruction as a teaching strategy was implemented in three (3) phases. Phase one (1) was the development of a contextualized lesson plans. Based on the chosen most essential learning competencies, two (2) lesson plans were developed for the academic track and TVL track, respectively. Content and pedagogy vary for both lesson plans as it contextualized.

Phase two (2) was the evaluation of the lesson plans. Experts in the field of humanities and social sciences (HUMSS) for academic track and tourism for TVL track were chosen as evaluators. Additionally, research teachers also served as evaluators. The criteria for the evaluation of the lesson plans were suitability of learning activities, clarity of objectives and appropriateness of assessment or evaluation.

Phase three (3) was the implementation of the lesson plans conducted during the actual learning session of the respondents. The practical research teacher, who was at the same the researcher of the present study, was the one who utilized the contextualized lesson plans.

Participants

The respondents of this study were the Grade 12 students of Iligan City National School of Fisheries for SY 2022-2023. A total of 50 respondents, of which, 15 were from the academic track (HUMSS) and 35 respondents were from the TVL track. These respondents were currently taking up practical research subject during the conduct of this research.

The present study utilized the purposive non-probability sampling technique. This technique was used since the researcher relies on the judgment to choose the participant who will be part of the study. These participants also signify their voluntary participation in this research study.

Data Collection

Prior to the implementation of the contextualized instruction through the developed contextualized lesson plans, a pretest was conducted to determine the prior knowledge of the respondents on research as well as their research skills. Two weeks after the conduct of the pretest, the implementation of the contextualized instruction as a teaching approach commenced. In a period of three (3) months, lessons were discussed using contextualized instruction. Further, posttests (achievement and research skills) were administered towards the end of the 1st semester SY 2022-2023. Additionally, the research outputs of the respondents were showcased during the Senior High School School-Based Research Congress (SHS-SBRC) 2023.

Data Analysis

The primary source of data in this study were the scores in the pretest and posttest for both teacher-made test and research skills questionnaire. Mean percentage and standard deviation, as measures of central tendency, were used to determine the level of performance of the respondents in the pretests and posttests. Further, to determine if there is a significant difference between these scores, paired t-test was utilized. Paired t-test was used since using the same participants eliminated a variation between the samples and

measured only what was being tested, and not caused any other factors. Additionally, to measure the effect size, Cohen's D was calculated.

3. Results and Discussion

Based on the data gathered in this study, the following results were drawn:

A. Performance of the Students in Achievement Test

The performance of students using the researcher made-test test for both the prior knowledge and achievement were determined and compared using the pretest and posttest scores as shown in Table 1.

Table 1. Students' Performance in Achievement Test

	Mean		**Standard Deviation**		**Cohen's D**
	Pretest	Posttest	Pretest	Posttest	
N (50)	11.4	12.9	1.95	2.25	0.712

The data presented in the table shows the performance of the students in the pretest and posttest which measures the knowledge gained by the respondents using contextualized instruction. The posttest mean score (12.9) is higher that the pretest mean score (11.4). This implies that the research knowledge of the respondents significantly increased with the use of contextualized instruction. This results agreed with the results of the study conducted by Moghaddas (2013) that contextualization teaching remarkably promoted the learners' performance and enhanced the participants' knowledge. The use of contextualized instruction significantly increased, with a medium effect size (*Cohen's D= 0.712*) on the research knowledge of the respondents.

B. Performance of the Students in terms of Research Skills

The performance of students in terms of their research skills was determined and compared using the pretest and posttest scores as shown in Table 2.

Table 2. Students' Performance in terms of Research Skills

	Mean		**Standard Deviation**		**Cohen's D**
	Pretest	Posttest	Pretest	Posttest	
N (50)	37.8	47.0	4.82	5.73	0.820

The data presented in the table shows the performance of the respondents in terms of research skills. The posttest mean score (47.0) is higher that the pretest mean score (37.8). This implies that the research skills of the respondents significantly increased, with a large effect size (Cohen's D= 0.820) using the contextualized instruction as an approach in teaching. This results coincide with the study of Meerah and Arsad (2010), that the acquisition of the skills depends on how thorough the teachers had taught the research skills, and how the students go about using the knowledge and skills to examine an issue, make decision, research on an idea, synthesize the research, do the presentation, and initiate a project.

To compare the performance of the respondents and its significant difference in the pretest and posttest for both achievement test and research skills questionnaire, paired t-test was utilized.

Table 3. Paired t-test Results of the Pretest and Posttest Scores

Source	Mean		df	T statistic	p-value
Achievement Test	11.3	12.9	48	3.71	0.016
Research Skills	37.8	47.0	49	5.34	0.002

The paired t-test results shows that both achievement and the research skills of the respondents had significant increase. It implies that contextualized instruction enhanced not only the research knowledge but also the research skills of the senior high school students.

4. Conclusion

The results of the present study can contribute to the body of knowledge especially on the implementation of new strategies and approaches in teaching research subject in the senior high school. The contextualized instruction is a potential approach since it does only enhance the knowledge of the students but also develop their research skills. Further, it also provided a more meaningful learning experience to senior high school students as they learn research knowledge and skills since the content is presented in their context more specifically on their interests. As a result, the research topics chosen by the respondents were contextualized based on their track, whether academic or TVL. Additionally, since their research topics were aligned with their interest, they were able to come up with satisfactory to good research outputs. The outputs were presented during the culminating activity of the practical research subject.

Declaration of competing interest

The authors declare that they have no competing interests that could have appeared to influence the work reported in this paper.

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Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 157-174, Sep. – Dec. 2023

Student Teachers' Perception on Using Stakeholders' Discussion as a Teaching Strategy in Engaging in Active Learning and Critical Thinking

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Received: 2 Aug 2023 Revised: 19 Nov 2023 Accepted: 12 Dec 2023

Abstract. Teaching methods and strategies are considered to engaging in active learning and critical thinking skills that have the highest impact on students' learning performance and support the development of the learners' characteristics. The aim of this study was to find out student teachers' perception on Using Stakeholders' Discussion as a teaching strategy in engaging student teachers' active learning and to improve critical thinking skills of general science-Environmental subject. The mixed-method research was used by applying survey design for conducting the research and the participants of the research were the first-year student teachers (75). The research was conducted with observation, distributed questionnaire, and conducted interview. It was found that the student teachers had a positive perception on the use of Stakeholders' Discussion as a teaching strategy in engaging in active learning and critical thinking skills. Most respondents agreed that Stakeholders' Discussion can help them in improving in learning performance and critical thinking skills; 57.89% strongly agree and 42.11% agree. However, the research was also found the student teachers' negative perception about the difficulty in having an internet access to support the data for Stakeholders' Discussion. For the contribution in active learning, Stakeholders' Discussion can make student teachers' learning performance skills acceptable and effective. While for the contribution in critical thinking, Stakeholders' Discussion can make the student teachers' critical thinking skills develop well. Finally, the future research is expected and it will focus on dealing with the shortcomings issue about the negative perception of internet access for learning materials so that any strengths and weaknesses can be identified and solved.

Keywords: Stakeholders' Discussion; Teaching Strategy; Active learning; Critical Thinking; Perception; Student Teacher

1. Introduction

The importance of educational theory cannot be underestimated as it acts as a road map or blueprint guiding teaching and learning and the constructivism and Constructive controversy theory are crucial. The constructivism theory emphasizes that learning should be an active process in which learners construct new ideas or concepts based on their

current or past knowledge (Brandon and All, 2010). According to the authors, the constructive theory model sees constructivism as a spiral with the students at the center point of learning. The constructive controversy involves deliberative discussions aimed at creative problem-solving (Johnson, Johnson, and Tjosvold, 2000). Students must be skilled collaborators, and follow the norms of cooperation and the rules of rational argumentation. Students are strongly motivated to produce solutions and display high-level reasoning and greater mastery and retention of new knowledge gained. They generate high-quality and creative solutions. Approaches and strategies to teaching and learning are considered to be the teaching that has the highest impact on students' learning and performance and supports the development of the learners' characteristics. Vygotsky and Cole (1978) described that the most effective teaching practices and learning environments challenge learners' thinking beyond what students could achieve independently and the role of the teacher is to support (sometimes referred to as 'scaffold') student learning as the 'zone of proximal development'. A collection of practices and principles is the active learning.

The word 'active' refers to learners' being actively engaged in learning rather than passive recipients of teaching. The activities are the backbone of the active leaders of learning rather than passive learning. This involves constantly challenging students thinking, monitoring the impact of their instructional approaches, and adjusting with Active Learning. However, teaching and learning in Cambodia did not respond to the 21st-century context in which teachers still based on traditional methods and textbooks. According to Nith et al. (2010) briefed in their research results from the classroom observations revealed some classrooms were very traditional teaching techniques where teachers stood at the front of the classroom lecturing and/or modeling problem solutions on the board.

Although the Active-Learning Pedagogies had reformed initiatively in Cambodia in order to enhance teaching and learning, the teaching and learning had not fully emphasized learning activities and the purpose of the activities is not simply to keep children happy until they can get through the "real" learning tasks which often affected their ability to make what they considered to be real learning tasks stimulating and contextually meaningful. Based on the research findings reported on Student Readiness Program assessments (KAPE, 2004) have shown that teachers scored the lowest on the measure of "Student Engagement," which is the movement and impacts on Children's Learning: Practical Applications in Cambodia. Therefore, this study is a crucial model to enhance active learning and critical thinking skills that teachers can use it in their teaching.

According to the vision of Teacher Education College (TEC), TEC is the outstanding teacher education college in Cambodia which variety of teaching methods and strategies have been and are applied and the future teachers need to employ a variety of teaching methods and strategies in the classroom. This will normally include carefully designed self-directed learning activities, group work, whole-class instruction, and so on. The key element is the quality of learner engagement and the opportunities provided for feedback between the learners and teachers to guide the next learning steps. Whole class instruction can be a highly effective instructional approach if it includes discussion and learners have the opportunity to respond and contribute. The teaching strategy means to achieve learning objectives. According to Stones and Morris (1972), a teaching strategy is a generalized plan for a lesson that includes structure, desired learner behavior in terms of goals of instruction, and an outline of planned tactics necessary to implement the strategy. For example, Stakeholders' Discussion is a teaching strategy in which students organize planned discussions and presentation ideas from various viewpoints.

Learning performance

Learning performance can be defined in different ways. For example, according to Ferguson and DeFelice (2010); Ekwunife-Orakwue and Teng (2014); Law and Geng (2019) it can be referred to students' test scores. Moreover, Yuan et al., (2020) defined as satisfaction with learning, and Yang et al., (2016) focused on students' performance logged in the online learning system. This research, however, adopts the definition of learning performance as described by the Association for Educational Communications and Technology in 2004, which states that learning performance is the ability of a learner to apply the newly acquired knowledge or skills. In essence, it does not only involve the basic knowledge and skills learned, but the capability to apply them, and there are many factors for learning performance (Broadbent, 2017; Li and Tsai, 2017; Li et al., 2018; Wei and Chou, 2020). Hence, the activities differ by the variety of techniques and methods that students acquire and apply during classes and in their daily routines. In PTEC, schools and lecturers integrate a variety of teaching resources and methods in curriculum and teaching based on the shifts in expected skills for the future abilities (cognitive abilities and physical abilities), basic skills (content skills and process skills) and cross-functional skills (social skills, system skills, complex problem-solving skills, resource management skills, and technical skills).

Active learning

According to Bonwell and Eison (1991), active learning is the instructional activities involving students in doing things and thinking about what they are doing and Handelsman et al., (2007) defined that active learning implies that students are engaged in their own learning. Active teaching strategies have students do something other than taking notes or following directions. students participate in activities to construct new knowledge and build new scientific skills. Moreover, Freeman et al., (2014) defined the definition of active learning as active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work. While, Carr et al., (2015) defined active learning as students' efforts to actively construct their knowledge. Nickels (2000) defined that there could be various active learning techniques that could be implemented in almost any classroom learning activity, including lectures, tutorials, seminars, and laboratory training. Krivickas (2005) added that active learning is anything that engages students in undertaking something besides listening to a lecture and taking notes to help them learn and apply course notes and there are a few teaching strategies that can be employed in active learning by an instructor, including problem-solving, laboratory work, home assignments, and group discussions. Thus, active learning is commonly defined as activities that students do to construct knowledge and understanding. The activities vary but require students to do higher-order thinking. Although not always explicitly noted, metacognition—students' thinking about their own learning—is an important element, providing the link between activity and learning.

Critical thinking

According to Ennis et al. (2005), critical thinking is reasonable reflective thinking that is focused on deciding what to believe or do and the critical thinking skills were the ability in the areas of induction, deduction, value judging, observation, credibility, assumptions, and meaning. The approaches to obtain critical thinking skills in education which were considered as Global Skills were summarized focused specifically on the general approach, global approach, immersion approach, mixed approach, reflective thinking, and tertiary attainment, and 21st-century skills (Ennis et al., 2005). Ennis (1987), on the other hand, identified five key ideas of critical thinking: practical, reflective, reasonable, belief, and action and he defined critical thinking dispositions as: Seeking a

clear statement of the thesis or question, seek reasons, try to be well informed, use and mention credible sources, take into account the total situation, try to remain relevant to the main point, keep in mind the original and/or basic concern, look for alternatives, be open-minded, take a position (and change a position) when the evidence and reasons are sufficient to do so, seek as much precision as the subject permits, deal in an orderly manner with the parts of a complex whole, use one's critical thinking abilities, and be sensitive to the feelings, level of knowledge, and degree of sophistication of other.

Based on the current report of Partnership for 21st Century Skills (2008), critical thinking is needed in education to ensure for future generations a prepared workforce, enhance a democratic society, and allow students the ability to compete globally. Moreover, Dewey (1916), beginning in the early 20th century, brought critical thinking to the forefront of education and considered critical thinking a necessary skill. His definition of critical thinking described it as a reflective process that "includes the sense of the problem, the observation of conditions, the formation of rational elaboration of a suggested conclusion, and the active experimental testing. "He particularly stressed on preparing students with critical thinking skills so they could be prepared to work in an ever-changing world" (Becker, 2007).

Dewey (1933) suggested a five-phase critical thinking model and described the phases as non-linear. Noting the phases were the "indispensable traits of reflective thinking" and the "sequence of the five phases is not fixed" as in the following:

1. Suggestions, in which the mind leaps forward to a possible solution.
2. An intellectualization of the difficulty or perplexity that has been felt (directly experienced) into a problem to be solved, a question for which the answer must be sought.
3. The use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide observation and other operations in the collection of factual material.
4. The mental elaboration of the idea or supposition as an idea or supposition (reasoning, in the sense in which reasoning is a part, not the whole, of inference).
5. Testing the hypotheses by overt or imaginative action.

Therefore, the process of critical thinking brings awareness to the progression of developing critical thinking skills in students and identifies the impact of experiences in the development of critical thinking. The process of measuring the development of critical thinking skills began with the idea of developing a consensus definition of critical thinking and its cognitive skills.

2. Research Method

Research Design

The survey study is employed in this research. It was chosen because this research needs to know the student teachers' perceptions. The survey study was chosen as the research design in order to gain a deep perception of the debate members. In addition, the research was used mixed-method research. The method is adequate in gaining the student teachers' perception of their experiences in joining the debate as a teaching strategy. Data collection was set in naturalistic observation in which the researcher observes the situations, frequencies, patterns, and trends in the reading class. This situation corresponds with the cyclical procedures, continuously refined methods, and interpretations based on cycles' understandings (Cohen, Manion, and Morrison, 2007) to accommodate the following qualitative descriptions of the cycles.

Research Site and Participants

This study was carried out at Phnom Penh Teacher Education College (PTEC), Science Department–General Science (Environmental Subject) and the research

participants in this study were from the 3 classes. A total of 75 student teachers were purposively sampled for the survey: 25 in B1, 25 in D1, and 25 in F1 of primary level teacher education who experienced in the first time joining this program.

Data Collection Techniques

There are three ways of collecting the data; the ways of collecting the data make the research well-organized. The first is observation; the researcher used the observational sheet which researchers tended to observe directly toward student teachers' attitudes from the first time till the fifth time of implementing teaching method in teaching and learning. There were 5 times of observations. The observation started during implementing the teaching method process in teaching and learning. The lesson plans were designed for contents applied teaching method. The secondly, the survey collected data on student teachers' perceptions about teaching and learning which was an online close-ended questionnaire through Google form. The close- ended questionnaire was used to elaborate on student teachers' perceptions about teaching and learning by using Stakeholders' Discussion as a Teaching Strategy in Engaging in Active Learning and Critical Thinking. Furthermore, semi-structured interviews were conducted with 9 student teachers which were randomly selected from 3 classes (75 student teachers). The interviews were conducted after primary findings from the survey were available. Questions were used to clarify and elaborate on key findings from the survey.

Data Analysis

In this study, Miles and Huberman based data analysis technique (1994: 247-252) was used for the research which consists of three steps: data reduction, data display, and drawing conclusion. Furthermore, the data analysis used the conditionally mixed-design analysis of the cyclical spiral of planning, acting, observing and reflecting (Kemmis and McTaggert, 1992) and the non-parametric statistics that analyze as the percentage in reading student teachers' perceptions.

Research Procedure

The first procedure of the study is determining the participants; the members of the Environment subject Stakeholders' Discussion to be the participants was selected for the research, the member consists of 75 student teachers. The members of the Stakeholders' Discussion were chosen because it was suitable to the research question about their perception of the use of Stakeholders' Discussion as a teaching strategy.

The second is deciding the type of survey; observation, questionnaire, and interview were chosen in conducting the research to gain a deep understanding of the student teachers' perception of the use of Stakeholders' Discussion as a teaching strategy for their improvement of learning performance and critical thinking skills. The third was validating the survey question, the researcher did the instrument validation to the expert on the core research topic before distributing to the participants. The fourth was distributing the survey; after validating the instruments, the instruments were distributed to the participants through Google documents and interviews. In addition, the Stakeholders' Discussion class situation was observed to know their activities and the improvement of performance and critical thinking. In this part, the observational list to write the data about activities was used. The fifth is analyzing the responses; after doing the survey to the participants the research data was analyzed the result based on the data analysis technique. Those are data reduction, data display, and drawing conclusion/verification. In addition, the result of the questionnaire was calculated with the chosen formula by the research study, while observation and interview were the sources of the information that helped in writing the results.

The last was writing up the results, this was the last procedure of the survey study. The result of the survey study in the form of a descriptive explanation was written. The description was based on the result of the calculated data. In this part, the finding and discussion was written.

Stakeholders' Discussion Process

The process of doing the Stakeholders' discussion was divided into 3 main states. The first state was pre-stakeholders' Discussion which was on group forming, introduction to how and process of stakeholders' discussion with the role responsibilities, and the process of doing research on related documents for supporting ideas for 2 to 3 weeks. The second stage was to conduct the process of Stakeholders' Discussion with a specific topic related to the environmental issues and specific roles of each team member for 1 hour and ended with the group's result report for 20 to 30 minutes. The final state was post-Stakeholders' Discussion which was on feedback and evaluation.

Table 1: Proposal of a structured guide for debate of role responsibility

	Evaluation of the pedagogical effectiveness of the Stakeholders' Discussion		
	Pre-Stakeholders' Discussion	**Evaluation of learning outcomes** - Vignettes/scientific scenarios - Declarative questions - Argumentative questions - Validated questionnaires	**Post-**Stakeholders' Discussion
	Pre- Stakeholders' Discussion **activities (2-3 weeks)**	**Mise -in- scene (1 hr. discussion and 20-30 minutes for group's result reporting)**	**Post-** Stakeholders' Discussion **alternative activities**
Aim	- Setting context - Acquiring information - Applying knowledge - Student autonomy	- Experimenting - Retrieval information - Applying knowledge	- Engagement - Iteration - improvement
How	Random groups of 5-8 student teachers Instruction on how to Stakeholders' Discussion	Phase: - Instruction - Two Refutation turns - Conclusion	Group discussion
	State the Stakeholders' Discussion question (explore existing knowledge, identify what student teachers do not know)	Role of the Non-Stakeholders' Discussion student teachers: - Moderator - Evaluate Stakeholders' Discussion	Feedback of the teacher Feedback of the non-Stakeholders' Discussion student teachers
	Each group collects evidence and constructs arguments to support both positions	Role of the teacher: - Moderator - Evaluate Stakeholders' Discussion	Evaluation Essay/Case Participant questions

3. Findings and Discussion

Student teachers' perception of the use of Stakeholders' Discussion to improve student teachers' learning performance and critical thinking skills.

Positive Perception

Based on the Stakeholders' Discussion presented in the findings, the Stakeholders' Discussion members in Environmental science classes had a good perception of the use of Stakeholders' Discussion as a teaching strategy to improve learning performance and critical thinking skills. 75 members of the classes agreed that the Stakeholders' Discussion as a teaching strategy can improve their learning performance and critical thinking skills after joining the Stakeholders' Discussion over one semester. The positive perception of Stakeholders' Discussion members can be proven by reviewing the results of observation, questionnaire, and interview. From those research instruments, some results were found to answer the research question. The first is about the benefits of using Stakeholders' Discussion as a teaching strategy. After joining the environmental subject Stakeholders' Discussion, the members gained some benefits. Those benefits are:

1. Environmental problem Stakeholders' Discussion

Based on the result of interviews with seventy-five Stakeholders' Discussion members, most of the Stakeholders' Discussion members said that before joining the Stakeholders' Discussion they felt shy and were not confident to talk with evidence in front of people ("*In the past, I really couldn't give a presentation, and I didn't dare to speak in front of many people, and at least I could argue, now in class activities this Stakeholders' Discussion can improve my ability to be more courageous*"). The student teachers had speaking anxiety, and lack of participation and did not have self-directed learning, they were afraid to talk and share because worried about making mistakes. Some student teachers also said that they did not have many discussion activities within group work and preferred to do it alone ("*Until we have participated in the first year in PTEC that we didn't have fully participating in deep discussion, presentation, and self-directed learning*"). After joining the Stakeholders' Discussion activities, the student teachers found a new world because they found confidence in active learning in class and with team members and they felt confident to talk in front of the classes. ("*After he participated in the Stakeholders' Discussion activities with the problem and solution discussion, they finally felt so confident to talk and share too*"). In the Stakeholders' Discussion activity, student teachers were demanded to talk in front of their friends to discuss some issue or against the proposition and/or role and duty about the motion given in environmental issues. So, the Stakeholders' Discussion encouraged the student teachers to reduce their speaking anxiety. Freely (1696: 35) argues that debate is an ideal forum for students to build coping strategies to control their speech anxiety.

2. Stakeholders' Discussion as teaching strategy made the student teachers follow new issues

The Stakeholders' Discussion as a teaching strategy was decided to integrate general science (Environmental subject) teaching and learning activity because the team earth science wanted to know the latest issues and the new knowledge about some topics in the Stakeholders' Discussion. The result of an interview with seventy-five student teachers showed some student teachers said that they wanted to open their minds about some issues and exchange their ideas and opinions with their friends to get a lot of new information ("*The reason I took part in the Stakeholders' Discussion was so that we could broaden our knowledge about something that we had never studied, so we joined in on the news*

and shared opinions with our other friends, there apart from learning the material that we made Stakeholders' Discussion, we can also learn to socialize. with others").
In debate, student teachers also can learn the knowledge from the opposition side, so they can understand issues in pro or contra and/or role and duty's side. ("*I think the new information obtained can increase the courage to speak, share and think more critically because we exchange information that we didn't know at first, so knowing is very helpful for critical thinking skills because we get a lot of new insights*"). The different perspectives from both the pro and contra sides also made the Stakeholders' Discussion members have a good attitude to understand each other and to deliver opinions in a good way and rules. Quinn (2005: 23) argues by joining the Stakeholders' Discussion the students will have opportunities to know others and gain insight.

3. Stakeholders' Discussion as teaching strategy helped student teachers to enrich new skills

According to the result of an interview with seventy-five student teachers, the researcher found that most of the debate members were greatly helped by Stakeholders' Discussion activities, they said that research is the most influential aspect in improving their learning performance skill which leads to self-directed learning.

The stakeholders' Discussion activity required students to understand and master issues. In delivering issues the student teachers had to know the right information to against the opponent team or support the duty. In choosing and searching for the precise information the student teachers learned various information in different aspects based on the motion. If the motion was about water pollution the student teachers found new information about water pollution, and if the motion was about global warming the student teachers also found information from different motions about global warming ("*If it's to improve learning performance from Stakeholders' Discussion, maybe because we get a lot of information from the activity, the information that adapts also to a motion so we know more about the subject content we know*").

From the Stakeholders' Discussion activity, the student teachers were enriched by various subject content information in every issue given. This influential aspect could help the student teachers to be more confident to talk in present key ideas for supporting topics without having to be shy and doubtful. Krieger (2005: 25) comments that debating Stakeholders' Discussion is an excellent activity for learning because it engages students in a variety of cognitive.

Negative Perception

A negative perception was found in the research from the result of the interview. In the last theme about the effectiveness of debating in Stakeholders' Discussion in improving their learning performance and critical thinking, the student teachers were asked about the difficulties in getting a fact from the motion or the issue given by the lecturer. Most of the student teachers answered the same answer about their difficulty. The biggest difficulty faced by the Stakeholders' Discussion members is internet access. The student teachers found it difficult to get a fact or information about some issues when practicing the debating Stakeholders' Discussion because they were challenged in computer use and key important sources of information by searching for debating Stakeholders' Discussion. ("*The difficulty in finding facts is that they are hindered by internet sources because they are very limited. So sometimes we just exchange ideas with friends.*").

In addition, they might have challenges in facilitating internet access and in practicing debating Stakeholders' Discussion for class activities. ("*If the motion is impromptu, we can only use logic as far as we know about the motion. If it's difficult to access the internet in a boarding house, if you search on the internet, it's more like wanting to compete outside.*").

The statement about the student teachers' difficulty in having internet access becomes a negative perception because internet access is essentially important in finding and following the latest issues, without having an internet access skill they would have difficulty in finding the evidence and latest factual issue to deliver and against opposition. To come up with this, Sahin et al. (2016) emphasize that the use of the Internet in education settings allows easy access to many resources and information. This finding could be a deeper study for the next research to focus on how much influence the internet has on student teachers' debating abilities.

The results from questionnaire

The questionnaire consisted of three parts. The first part is focused on perceptions. The second part is focused on the other additional activities in improving learning performance and critical thinking, and the last part is focused on self-assessment of active learning and critical thinking skill level.

This part of the questionnaire discussed student teachers' perception of the use of Stakeholders' Discussion as a teaching strategy for improving student teachers' learning performance and critical thinking skills. The questionnaire consists of ten questions and requires student teachers to answer about their motivation, feelings, and improvement in joining the Stakeholders' Discussion and also how the learning and lecturer methods were during Stakeholders' Discussion activities.

Table 2: Student teachers' motivation in joining the Stakeholders' Discussion activities

No.	Statements	SA	A	N	D	SD
1	I joined the Stakeholders' Discussion activities to improve my learning performance skills and think critically about the environment.	44 (57.89%)	31 (42.11%)	0 (0%)	0 (0%)	0 (0%)

Table 3: Student teachers' feeling in joining the Stakeholders' Discussion activities

No.	Statements	SA	A	N	D	SD
1	I am confident when I perform in front of friends.	13 (17.1%)	38 (50%)	20 (26.3%)	4 (6.6%)	0
2	I like the Stakeholders' Discussion activities at school.	24 (31.6%)	37 (48.7%)	13 (17.1%)	2 (2.6%)	0

Table 4: Student teachers' improvement in joining the Stakeholders' Discussion activities

No.	Statements	SA	A	N	D	SD
1	The Stakeholders' Discussion helps me to improve my learning performance skills and also improve my critical thinking skills.	28 (36.8%)	40 (52.6%)	5 (6.6%)	2 (3.9%)	0
2	I feel that there has been improvement in my learning performance and critical thinking skills after	16 (21.1%)	52 (68.4%)	6 (9.2%)	1 (1.3%)	0

	participating in the Stakeholders' Discussion.					
3	I got a lot of new skills from the Stakeholders' Discussion activities.	24 (31.6%)	38 (50%)	11 (15.8%)	2 (2.6%)	0
4	I learned to look for facts from an issue that was raised according to its position (pros/cons).	14 (18.4%)	39 (51.3%)	21 (27.6%)	2 (2.6%)	0

Table 5: Student teachers' learning method in Stakeholders' Discussion activities

No.	Statements	SA	A	N	D	SD
1	I always make an outline (rough outline) before performing in front of an participants/audience.	7 (9.2%)	38 (50%)	24 (31.6%)	5 (7.9%)	1 (1.3%)
2	I always reread the results of Stakeholders' Discussion activities at home to evaluate Stakeholders' Discussion learning.	5 (6.6%)	30 (39.5%)	33 (43.4%)	7 (10.5%)	0

Table 6: Lecturer's teaching method in Stakeholders' Discussion activities

No.	Statements	SA	A	N	D	SD
1	The debate supervisor (lecturer) suggested that I speak by giving reasons during Stakeholders' Discussion activities.	17 (22.4%)	36 (47.4%)	19 (25%)	3 (5.3%)	0
2	The supervisor (lecturer) gives several questions related to the topic that will be the theme of the Stakeholders' Discussion with prior knowledge to hone critical thinking skills.	18 (23.7%)	39 (51.3%)	15 (19.7%)	3 (5.3%)	0

Part 2

The second part of the questionnaire showed the Stakeholders' Discussion members' other activities besides Stakeholders' Discussion to improve their learning performance and critical thinking skills. In this part, some activities list was made which probably student teachers did in improving those skills and the other additional items added by the participants. Table 7 shows the following activities done by student teachers to improve performance skills, and table 8 shows the following activities done by student teachers to improve critical thinking skills.

Table 7: Questionnaire result of student teachers' activities in improving performance skill

No.	Activities	quantity
1	Talking with friends by giving reason to support ideas	75
2	Listening to Stakeholders' Discussion as the sample	72
3	Watch YouTube on Stakeholders' Discussion program	57
4	Reading books/articles on environmental issues	70
5	Take the lessons/courses	66
6	Writing and taking general lessons in environmental subject	75
7	Talking in front of the mirror on the topic.	44

Based on the table above, talking with friends by giving reasons to support ideas and writing and taking general lessons in environmental subjects are the most activity chosen by student teachers to improve their performing skills. talking with friends by giving reasons to support ideas is the easiest way to learn to practice; the student teachers can get a lot of new information from discussing the practiced topic. After getting a lot of information the student teachers can apply that new information for environmental subject use to talk with their friends and in the classes. Seventy-two student teachers chose to listen to debate as the sample for their other activities. This is a great solution for improving Stakeholders' Discussion performing skills because a lot of practice can make student teachers accustomed to using performing as their daily activities.

The other activity is reading books or articles on environmental issues. Seventy student teachers chose this activity to improve their learning performance skills. Reading books or articles is another easiest way to enrich the content knowledge about some issues because the reader can take a note or highlight the important things from books to re-read it. The next activity is done by taking the lessons or courses. Environmental subject course is the practical way to living and it can be nature or man-made issues with numerous events happening in daily life.

Another fifty-seven student teachers chose to watch the YouTube debate program to improve Stakeholders' Discussion performing skills, and forty-four remaining student teachers chose to speak alone in front of the mirror on the topic for performance practice. All activities are quite good in improving learning performance skills because the student teachers will know the key sources of the issues and practical solutions so well while practicing can make the student teachers evaluate some mistakes from practice performance and learn from the mistakes to be good Stakeholders' Discussion in science.

Table 8: Questionnaire result of students' activities in improving critical thinking skill

No.	Activities	quantity
1	Discuss with friends about a current issue	75
2	Read the latest online and offline news	62
3	Watching/reading several programs related to the current issue of environment	64
4	Read books of knowledge related to the field of interest / occupied	62
5	Discuss with friends how to defend ideas	59
6	Discuss with friends how to solve real-world problems	75
7	Explore your potential	74

Table 8 shows the results of another Stakeholder Discussion member's activities in improving their critical thinking skill. From the table above, the most activity done by seventy-five student teachers was discussing the latest issues and how to solve real-world problems with friends while sixty-four members chose to watch or read several programs related to the current issue of environment, sixty-two members chose to read the latest online and offline news and read books of knowledge related to the field of interest or occupied, fifty-nine members chose to discuss with friends how to defend ideas, and seventy-four student teachers chose exploring self-potential in their learning performance.

The contribution of Stakeholders' Discussion as teaching strategy in improving student teachers' learning performance and critical thinking skill

The contribution of Stakeholders' Discussion as a teaching strategy to improve student teachers' learning performance and critical thinking also can be seen in their rate of learning performance and critical thinking skill assessment after joining the Stakeholders' Discussion activities through Google questionnaire. The questionnaire indicated the quality of student teachers' learning performance skills. It was asked by the student teachers rate their learning performance skills. However, the research not only concluded the student teachers' learning performance skill quality by the questionnaire results but also from observations. In this part, the research result showed that most of the student teachers, 62 out of 75 student teachers, rated their learning performance skills as good. 8 out of 75 student teachers rated their learning performance skills as very good. While 5 student teachers rated their learning performance skills as not so good. The following table shows specific findings on the student teachers' opinions on their learning performance skills.

Table 9: Questionnaire result of students' self- assessment in learning performance (active learning) skill

Rates	Quality
Not so good	5
Good	62
Very good	8
excellent	0

The result of the learning performance self-assessment based on table 8 showed that most of the Stakeholders' Discussion members rated their learning performance skills as level of good. It means the 62 student teachers felt that they were able to perform with sufficient structure to participate effectively in formal and informal Stakeholders' Discussions on practical, social, and professional topics.

Eight student teachers rated their learning performance skills at the level of very good. It means the eight student teachers felt that they are often able to use the performance to satisfy professional needs in a wide range of sophisticated and demanding tasks.

Five student teachers rated their learning performance skills at a level not so good. It means the five student teachers felt that they were not able to perform well at the level normally appropriated to professional needs, and no student teacher rated their learning performance skill in the level excellent. It means there are not any student teachers who feel that their performance skill is regularly superior in all respects, usually not equivalent to that of a well-educated, highly articulate skilled learning performance.

Table 10: Questionnaire result of student teachers' self- assessment in critical thinking skill

Rates	Quantity
1-2	7
3-4	68

The result of the critical thinking self-assessment based on Table 9 showed that most of the Stakeholders' Discussion members rated their critical thinking skills in levels 3-4. It means most student teachers start developing or developing well the critical thinking skill in this case, all aspects of critical thinking skills such as interpretation, analysis, evaluation, inference, explanation, and self-regulation of student teachers are quite good. They said that through classroom discussions they learned to think rapidly and objectively. The student teachers claimed that they needed to find proof and facts to support their claims, tried reasons, and approach problems from various viewpoints. In fact, these abilities are features and elements of critical thinking skills (Rudd, 2007; Kosciulek & Wheaton, 2003; Zare & Othman, 2015).

Based on The previous studies also confirm that in-class Stakeholders' Discussion debating can develop, build, and cultivate critical thinking skills (Zare & Othman, 2013; Doody & Condon, 2012; Omelicheva, 2007). The student teachers added that the counter-argument and group work were two of the favorite features of the classroom Stakeholders' Discussion debate for their class activities. They said the counter-argument gives them chances to express their opinions and disagree with their point of view.

4. Conclusion

The research results found that the student teachers from PTEC, General Science (Environmental Subject) of the first-year primary level teacher education have positive perceptions of the use of debate for their learning performance and critical thinking skills. The student teachers agreed that the Stakeholders' Discussion debate as a teaching strategy can improve their learning performance and critical thinking skills. They also agreed that there are many benefits from the Stakeholders' Discussion debate in improving their active learning and critical thinking skills such as learning performance enrichment, self-confidence improvement, and new knowledge and insight improvement. In accordance, the research result also found that the student teachers can find their new skills and develop, build, and cultivate critical thinking skills, as the lecturer had from the pre-observational study that the student teachers in PTEC, General Science (Environmental Subject) of the first-year primary level teacher education prefer to used individual and isolated learning activities than learning in group as their daily used so they rarely found a partner or group for practicing their learning activities such as giving talk and participating in group discussion. However, the student teachers also have a negative perception of the Stakeholders' Discussion debate about their difficulty in having internet access to search the material for the Stakeholders' Discussion debate.

The influence of debate as a teaching strategy can be proven in student teachers' improvement in learning performance and critical thinking by doing the class performance and critical thinking self-assessment, and most of the student teachers rate their learning performance with good scores. It means most student teachers felt that they are able to satisfy most work requirements with active learning usage that is often but not always, acceptable and effective after debate, and most student teachers rated their critical thinking skills with 3-4 scores. It meant most student teachers felt quite good in critical thinking skills because the student teachers could propose solutions, explain an argument, or state problems referring to the particular given issue in the assignment clearly, and also student teachers could provide more solutions or ideas with several relevant examples. Moreover, student teachers also explain their work in good interpretation, analysis, evaluation, inference, explanation, and self-regulation.

5. Recommendation

For science lecturers or instructors, the researcher found that the Stakeholders' Discussion debate could improve students' learning performance and critical thinking skills. From these results, the lecturers and instructors will gain a deeper understanding of

the importance of Stakeholders' Discussion debate as a teaching strategy, the application, and the technique for classroom debate.

For high school and teacher education colleges, the Stakeholders' Discussion debate as a teaching strategy is recommended for improving learning performance and critical thinking skills. The student teachers in PTEC do not need to worry and be shy to talk in class activities and learning performance because the student teachers in the Stakeholders' Discussion debate have the same interest in active learning, so the student teachers can find partners for performing and practicing.

For future researchers, this study is limited to observing the Stakeholders' Discussion debate as a teaching strategy of PTEC, General Science (Environmental Subject) of the first-year primary level teacher education. Therefore, the researcher expects that future researchers will focus on the shortcomings issue in this study about the students' negative perception of the use of Stakeholders' Discussion debate as a teaching strategy so that any strengths and weaknesses can be identified and a solution for the next study in the same field about Stakeholders' Discussion debate as a teaching strategy in improving learning performance and critical thinking skill.

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Appendix 1: Tool for observation

The observation checklist

School : ……. Date:……

Grade : …….. Subject:……

Observer: …….. The number of students:……..…

Time : …….. Duration:…….…….

Process : Step 1 3 4 and 5

The …..of observation

No	Student's activities	S1		S2		S3		….		Narrative (teacher activities)
		Yes	No	Yes	No	Yes	No	Yes	No	
1	The student teachers observe the flow, phenomena, environment that teacher provided.									
2	The student teachers ask questions about the material or phenomena being studied									
3	Student teachers shares or asks to clarify their problem related to the topic									
4	Student teachers observes the specific points of materials and procedure before the doing activities									
5	Observe and record the fact from the activities									
6	Catch up the point that meet the answer of the questions									
7	Determine the relationship between cause and effect									
8	Make observations on the results of the activities									
9	Student teachers use all the finding data for discuss to prove their hypothesis or to conclude their answers									
10	In interpreting the results of observations are not influenced by others.									

11	Their conclusion always answers the question of the problem.									
12	Student teachers discuss the results of observations logically based on data findings to prove their conclusions.									
13	Present or record the result with the prove of activities to the class									
14	Student teachers change their existing idea if it doesn't support from the observation									
15	Do not immediately accept conclusions without strong evidence.									
16	Listen to the other groups' presentation and correct their answer after facilitating from teacher. (Respect the opinion / findings of others)									
17	Receive advice and recommendation, the advice from others in their learning process.									
18	Listen and record when the members in group or class share. (Not necessarily reject the opinions of others)									
19	Student teachers participate and helps each others in their learning process.									
20	Share what they think to the group									
21	The fact data had been used for conclusion									
22	Review their opinions and conclusions if the data is insufficient									
23	Follow up all steps of activities, do not cheat or skip the step.									
24	The student teachers complete all scientific activities until end									

Appendix 2

The questionnaire on Student Teachers' Perception on Using Stakeholders' Discussion as a Teaching Strategy in Engaging in Active Learning and Critical Thinking by using Likert scale (SA- **Strongly Agree, A- Agree, N- Neutral, D- disagree and SD- Strongly Disagree)**.

No.	Statements	SA	A	N	D	SD
1	I joined the debate activities to improve my learning performance skills and think critically about the environment.					
2	I am confident when I perform in front of friends.					
3	I like the debate activities at school.					
4	The debate helps me to improve my learning performance skills and also improve my critical thinking skills.					
5	I feel that there has been improvement in my learning performance and critical thinking skills after participating in the debate.					

6	I got a lot of new skills from the debate activities.					
7	I learned to look for facts from an issue that was raised according to its position (pros/cons).					
8	I always make an outline (rough outline) before performing in front of an audience.					
9	I always reread the results of debate activities at home to evaluate debate learning.					
10	The debate supervisor (Teacher) suggested that I speak by giving reasons during debate activities.					
11	The supervisor (Teacher) gives several questions related to the topic that will be the theme of the debate with prior knowledge to hone critical thinking skills.					

No.	Activities	Y/N
12	Talking with friends by giving reason to support ideas	
13	Listening to debate as the sample	
14	Watch YouTube on debate program	
15	Reading books/articles on environmental issues	
16	Take the lessons/courses	
17	Writing and taking general lessons in environmental subject	
18	Talking in front of the mirror on the topic.	
19	Discuss with friends about a current issue	
20	Read the latest online and offline news	
21	Watching/reading several programs related to the current issue of environment	
22	Read books of knowledge related to the field of interest / occupied	
23	Discuss with friends how to defend ideas	
24	Discuss with friends how to solve real-world problems	
25	Explore your potential	

Appendix 3

Students' semi-structured interview questions

- What was the purpose of participating in Environmental problem Stakeholders' Discussion?
- Why do you think we have Environmental problem Stakeholders' Discussion in science class?
- What was the most interesting part of learning about the (unit topic)?
- What was the most interesting part of using the modeling tool?
- What was the most challenging/difficult part of learning about (unit topic)?
- What was the most challenging/difficult of using the Environmental problem Stakeholders' Discussion?
- Do you have any suggestions about how we could improve the Environmental problem Stakeholders' Discussion?

Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 175-183, Sep. – Dec. 2023

Personal Resources and Work-Based Identity: Does Work Engagement Matter?

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Received: 27 Aug 2023 Revised: 1 Nov 2023 Accepted: 15 Dec 2023

Abstract: Studies show that work-based identity is an important construct in understanding work-related behaviors such as their involvement in, attachment to and performance at work. Although several studies on individual characteristics have examined the potential precursors of work-based identity, examining this in the context of psychological capital (PsyCap) as an individual characteristic has yet to be explored. The present study aims to examine the association between psychological capital and work-based identity as mediated by work engagement. A sample of 642 faculty from different private and public colleges/universities in Iligan City, Lanao del Norte and Cagayan de Oro City, Misamis Oriental answered a set of questionnaires assessing teachers' level of psychological capital, work engagement, and work-based identity. The results revealed that work engagement significantly mediated the link between psychological capital and work-based identity. This implies that teacher who possess high level of psychological capital (hope, self-efficacy, resilience and optimism) have stronger work-based identity due to higher level of work engagement. Conversely, those who reported lower level of psychological capital have reduced level of work engagement, which in turn, weakens their work-based identity. The findings of the study highlight the important role of psychological capital and work engagement toward teachers' work-based identity.

Keywords: psychological capital, work engagement, work-based identity

1. Introduction

Teachers feel less motivated due to regularly coping with stressful situations that can disturb their psychological well-being and work performance (Bermejo et al., 2013). Accordingly, factors such as role ambiguity and role conflict can be potential sources of stress (Kahn, 1964; Marqués et al., 2005; Hakanen et al., 2006; Papastylianou et al., 2009; Pas et al., 2010; Ferguson et al., 2012; Travers, 2017). Studies have found that work-based identity is an important construct in understanding work-related behaviors such as their involvement in, attachment to and performance at work (Aryee & Luk, 1996; Ashforth & Kreiner, 1999; Agostino, 2004; Buche, 2003, 2006, 2008; Pratt et al., 2006; Reijn, 2007; Walsh & Gordon, 2007; Jansen and Roodt, 2014) which would lead to clarifying work identification, enhancing task performance, increasing employee retention and providing

organizational advantage (Walsh & Gordon, 2007; Buche, 2008; Bothma and Roodt, 2012). The relevance of work-based identity led to the increasing research on its antecedents. Research have shown that the interaction between individual characteristics (age, gender, race, language, job level, geographic region, etc.) and job characteristics (job demands and job resources) result in the development of work identities (Jansen and Roodt, 2014). In addition, work identities form as a result of the interface between individual dispositions (personality, self-efficacy, self- regulatory focus, work beliefs, intrinsic motivation, organizational-based self-esteem and optimism and work characteristics (growth opportunities, organizational support and advancement, task identity, team climate, perceived external prestige, skill variety, and relationship with supervisors and peers) (Hackman and Oldham 1975; Anderson and West 1998; Kirpal, 2004; Carmeli et al., 2006; Xanthopoulou et al., 2007; Tims and Bakker 2010; Braine and Roodt, 2014). Although several studies on individual characteristics have examined the potential precursors of WBI, examining this in the context of psychological capital (PsyCap) as an individual characteristic has yet to be explored. This study contends that employees who experience high level of PysCap (i.e., hope, self-efficacy, resilience and optimism) are likely to increase work-based identity. Further, the researchers assert that the link between PsyCap and WBI is brought about by how embedded individuals are with their jobs. This is important as studies have shown the relevance of PsyCap and work-engagement (Youssef & Luthans, 2007; Sweetman and Luthans, 2010; Simons and Buitendach 2013; Paeka et al., 2015; Karatepe and Karadas, 2015; Erbasi and Ozbek, 2017) to different areas of life. The present study aims to examine how psychological capital affects teachers' work engagement, and in turn, influence their work-based identity.

1.1 Work Based Identity

Work-based identity is important in understanding and determining work-related behaviors (Aryee & Luk, 1996; Ashforth & Kreiner, 1999; Buche, 2003, 2006, 2008; Agostino, 2004; Pratt, Rockmann et al., 2006; Reijn, 2007; Walsh & Gordon, 2007; Bothma and Roodt 2012). Work-based identity is a structured constituent which consists of work centrality, person-organization fit and value congruence components (Jansen and Roodt, 2014). These three dimensions may also be classified as part of the individualpsychological dimension of the work-based identity prototype. The first dimension, workcentrality, pertains to the degree to which people consider that their work plays an important role in their life (Bagger & Li, 2012; Hirschfeld & Feild, 2000; Paullay et al., 1994; Kanungo, 1982; Jiang et al., 2017). According to identity theory, when a certain role is perceived essential, this particular identity takes up a more central position in the self-definition (Thoits, 1992; Jiang et al., 2017). Correspondingly, studies show that work centrality associates personal work identification (Hirschfeld & Feild, 2000; Diefendorff et al., 2002; Kuchinke et al., 2010; Bal & Dorien Kooij, 2011; Lu et al., 2015). The second dimension, person-organization fit, refers to the similarity between individuals and organization that takes place when (a) at least one entity affords what the other needs, or (b) they share comparable important characteristics, or (c) both (Chatman, 1989; Schneider et al. 1995; Youngs et al., 2015). The third dimension, value congruence, represents the degree to which individuals match their own values with the organizational values (Edwards and Cable 2009; Peng et al., 2015). Moreover, values are deemed vital in the personal work identity process because when individual's values are congruent with the organization's values, they demonstrate higher identity with their organizational membership ((Mowday, Steers, & Porter, 1979; Ryu, 2015).

1.2 Psychological Capital and Work-based Identity

Research suggest that work is central to the building of individual identity and is one of the life spheres and life roles one choose to identify with (Lloyd et al., 2011). Studies show that work identity is influenced by job and individual characteristics (Jansen and Roodt, 2014; Braine and Roodt, 2014). These include personality, self-efficacy, self-regulatory focus, growth opportunities and organizational support and advancement (Braine and Roodt, 2014). According to Lodi et al., (2020), and Morgan & Luthans (2013), psychological capital is a construct of individual characteristics and qualities that stimulate positive outcomes in dealing with organizational context. PsyCap is defined as the individual's positive psychological state of development that can be measured, developed, and effectively managed for performance improvement in the workplace (Luthans, 2002, (Luthans, 2002; Luthans et al., 2006; Luthans, et al., 2007; Morgan and Luthans, 2013; Karatepe and Karadas, 2015; Bogler and Somech, 2019). This personal characteristic includes 4 elements namely, hope, efficacy, resilience and optimism (Luthans et al., 2007; Cai et al., 2018). Hope refers to a derived sense of motivation or will (agency) and plan (pathways) in order to succeed at specific goal (Steven et al., 2010). Self-efficacy pertains to one's confidence in competency to mobilize the motivation and put in the actions required to accomplish a specific task within a given context (Stajkovic & Luthans, 1998). Resilience refers to bouncing back from adversity, uncertainty, conflict, failure or even a positive change, progress and increased responsibility (Luthans, 2002; Steven et al., 2010). While optimism refers to making a positive attribution to succeed now in the future (Luthans and Youssef, 2004; 2007). In a study conducted by Tüzün et al., 2018, PsyCap can be can be associated with identification variables. In line with this, individuals with higher level of PsyCap are more likely to execute better work performance, show increased job satisfaction and easily build strong organizational identity (Huimei and Xuan, 2011). Notably, these attributes contribute positive influence on the workplace which can then be used in predicting work-based identity given the positive nature of identification in the workplace (Avey et al. 2010, Bester 2012, Braine and Roodt, 2014).

1.3 The Role of Work Engagement

Aside from the likelihood of linking PsyCap to work-based identity, this study suggests that work engagement mediates this relationship. Employees who possess high in PsyCap perceive similar state as consuming high resources so they experience more motivational process that increases their level of work engagement (Grover et al., 2018). Work engagement is defined as the "harnessing of organizational member's selves to their work roles" and includes three dimensions namely, vigor, dedication, and absorption (Kahn 1990; Zhang et al., 2017). Vigor refers to high levels of energy and willingness to exert effort in work, dedication refers to one's level of involvement in work and absorption pertains to one's level of concentration on work (Bakker and Schaufeli, 2015). Studies report that employees high in work engagement are likely to form a deep structure of identification at work (Kahn 1992; Braine and Roodt, 2011). Further, engaged employees who shows psychological presence in their work reveal strong identification with work (Bakker et al., 2008; Waal and Pienaar, 2013). This study suggests that when employees have high level of PsyCap, they are likely to form strong work-based identity due to their high level of work engagement.

2.Materials and Methods

2.1 Participants

The sample was composed of 642 faculty from different private and public colleges/universities in Iligan City, Lanao del Norte and Cagayan de Oro City, Misamis Oriental. Using purposive sampling, participants were chosen based on the following

inclusion criteria: (1) must be at least 12 months in the service; and (2) faculty (lecturer, contractual, temporary, permanent) of the college/university. There were 37.7% (n=242) males and 62.3% (n=400) females. They have mean age of 37.24 (SD = 10.99 years).

2.2 Procedure

Permission to conduct the study was sought from the respective school authorities. Upon approval, the test administration was then coordinated. Respondents were given the right to be informed about the purpose and objective of the research and that participation is voluntary. Confidentiality is assured and ethical principles were observed. Clear instructions were given and the necessary contact information of the researchers were made available to the respondents in case of problems or clarifications to any aspect of the research.

2.3 Measures

The level of psychological resources was assessed using the psychological capital questionnaire (Luthans et al., 2007). It has 24 items measuring self-efficacy (e.g., "I feel confident contacting people outside the company to discuss problems"); hope (e.g., "At present time, I am energetically pursuing my work goals"); resiliency (e.g., "I can get through difficult times at work because I've experienced difficulty before"); and optimism (e.g., "When things are uncertain for me at work, I usually expect the best"). The items are rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Each of these four selected scales has considerable psychometric support across multiple samples in prior research and has also been verified in workplace studies by themselves or in combination (Peterson & Luthans, 2003; Luthans et al., 2005; Larson & Luthans, 2006; Jensen & Luthans, 2006; Luthans et al., 2007; Adil & Kamal, 2019). In this study, this scale has a Cronbach's alpha of .901. Work engagement was measured using the Utrecht work engagement scale (Schaufeli and Bakker, 2004). It has 17 items that measure three subscales: vigor (e.g., "At school, I feel bursting with energy"); dedication (e.g., "I am proud of teaching"); and absorption (e.g., "I am immersed in teaching"). The items are rated on a 7-point Likert scale ranging from 0 (never) to 6 (always). Previous studies have verified the reliability and validity of the scale (Torabinia et al., 2017; Nazari et al., 2020). In this study, this scale has a Cronbach's alpha of .933. Work identity was assessed using the work-based identity scale (Bothma and Roodt, 2012). It includes the items from different scales such as Roodt's (1997) organizational-related commitment scale (e.g., "To what extent do you regard work as the most important aspect in your life?"); Lodahl and Kejner's (1965) job involvement scale (e.g., "How likely are you to regard your work as only a small part of who you are?"); three subscales of the functions of identity scale (Serafini et al., 2006) namely, structure, goals and future; organizational identification from Mael and Ashforth's (1992) scale (e.g., "How often do you say 'we' rather than 'they' when you talk about the organization that you work for"?); and person-organization fit from Lauver and Kristof-Brown's (2001) scale (e.g., "To what degree do your values match or fit the values of the organization that you work for?". The items are rated on a 6-point Likert scale ranging from 1 (very little) to 6 (very much). Previous studies have determined the reliability and validity of the instrument by submitting the 36-item questionnaire to a first and second level factor analysis to determine factor structure. This yielded a 28-item, uni-dimensional Work based Identity Scale with a Cronbach alpha of .95 (Roodt et al., 2009). In this study, this scale has a Cronbach's alpha of .995.

2.4 Data Analysis

The statistical procedure for the gathered data was performed using the Statistical Package for the Social Sciences (SPSS) Version 2.0. To replace values that are missing at random, the researchers had examined and used the estimation-maximization technique of

imputation. The researchers also utilized a simple mediation analysis that enables the researchers to examine the effects of psychological capital (self-efficacy, optimism, hope, and resiliency) on Work-Based Identity (WBI) as mediated by Work Engagement. PROCESS MACRO for SPSS by Preacher and Heyes (2012) was used to compute the results.

3. Results

3.1 Descriptive Analysis

The means, standard deviations, and bivariate correlations between the variables of the study are shown in Table 1. Results of correlation analyses showed that psychological capital was positively associated both with work engagement and work-based identity. It is also interesting to note that work engagement is positively correlated with work-based identity.

Table 1. Results of Descriptive Statistics and Bivariate Correlations

		PCQ_TOT	UWES_TOT	WBIS_TOT
PCQ_TOT	Pearson Correlation	1	.611**	.540**
	Sig. (2-tailed)		.000	.000
	N	642	642	642
UWES_TOT	Pearson Correlation	.611**	1	.525**
	Sig. (2-tailed)	.000		.000
	N	642	642	642
WBIS_TOT	Pearson Correlation	.540**	.525**	1
	Sig. (2-tailed)	.000	.000	
	N	642	642	642

Note: A total of 642 faculty and staff participated in the study. PCQ = psychological capital questionnaire; UWES = work engagement scale; WBIS = work-based identity scale;
**. Correlation is significant at the 0.01 level (2-tailed).

3.2 Mediation Analysis

Table 2 shows the total, direct and indirect effect of psychological capital and work-based identity through work engagement. The findings of the study revealed that work engagement significantly mediated the link between psychological capital and work-based identity. The fit indices are: S-Bx^2 (75, N = 642) = 2934.292, p <.001, CFI = .956, TLI = .943, RMSEA = .058 (90% CI = .049 to .068. The results indicate that all measures have adequate fit to the data.

Table 2. Mediation Analyses of work engagement between psychological capital and work-based identity (MPLUS)

(IV)	(MV)	(DV)	Effect of IV on MV (a)	Effect of MV on DV (b)	Direct Effect (c')	Total Indirect Effect	Total Effect (c)	Indirect Effects	Std. Error	BC 95% CI	
										LL	UL
PSYCAP	UWES	WBI	0.031**	10.967**	0.535**	0.339**	0.875**	**0.339**	0.339	0.204	0.475

Note: All coefficients are unstandardized; *p< .05, **p< .01; significant indirect effects are indicated in boldface.
IV = independent variable; = MV mediating variable; DV = dependent variable; SE = standard error; BC = Bias-corrected; CI confidence interval; LL = lower limit; UL = upper limit; PSYCAP = psychological capital; UWES = work engagement scale; WBI = work-based identity; *N* = 413

4. Discussion

The primary objective of this study is to determine if psychological capital (hope, self-efficacy, resilience and optimism) increased one's work-engagement, and in turn increased the likelihood of developing a work-based identity. The results yielded that higher level of psychological capital increased work-based identity due to the high level of work engagement.

The findings of the study reveal that psychological capital (hope, self-efficacy, resilience and optimism) is significantly correlated with work-based identity. This suggests that teachers who are hopeful, self-efficient, resilient and optimistic are likely to commit to the corresponding work identity. The results are parallel to the study of Huimei and Xuan (2011), which stated that employees' psychological capital and its structural elements are explicitly positively associated with identification at work. Research has further claimed that employees who possess higher level of PsyCap tend to be more effective when it comes to creating an authentic and harmonious work team, stronger mutual trust, elevated team identity, sense of belongingness and organizational commitment (Chen et al., 2017). In this regard, organizations are obliged to reinforce their teachers' psychological capital development and growth which can be implemented by exercising individual care, ensuring high level of employee performance internally and setting a solid foundation for refining employees' performance (Huimei and Xuan, 2011). Further, fostering individual differences, positive supervision climate and job characteristics (skill variety, task significance, job feedback, job identity and job autonomy) acts to promote positive work qualities of employees such as their psychological capital (Hackman & Oldham, 1975; Sameer et al., 2019).

The second critical finding notable for further discussion is the significant relationship between PsyCap and work engagement. This implies that teachers who possess high level of PysCap are found to be highly energetic, strongly involved and fully absorbed in their work. The result is consistent with numerous studies which revealed that PysCap as an utilizable psychological state that individual performs during growth and development processes has been an essential tool for employee's progress such as improved attitudes to work engagement and in various work contexts (Luthans et al., 2006; Youssef & Luthans, 2007; Simons and Buitendach, 2013; Chaurasia and Shukla, 2014; Wang et al., 2017; Wirawan et al., 2020). To illustrate, employees who are determined to pursue goals and identify pathways (hope) tend to afford energy (vigor) and willingness (dedication) to reach goals; employees who are competent in executing work assignments and dealing with work context (self-efficacy) turn out to be more mentally absorbed in attaining the goal of the work without getting diverted (absorption), become more ready to spend effort to yield the expected results (vigor), and intensely identified with what they are doing (dedication); employees who are able to provide a positive adaptation to difficult situations and to succeed in challenging experiences (resilience) successfully bring themselves in the work through the three components of work engagement; and employees who render internal acknowledgement in the event of success and external acknowledgements in the event of difficulties and failures (optimism) strengthens dedication (Sweetman and Luthans, 2010; Alessandri et al., 2018). Moreover, the combined power of these 4 elements of PysCap are likely to produce even higher level of work engagement (Avey at el., 2008; Nigah et al., 2012). On the other hand, Soni and Rastogi et al (2019) suggested that low level of PsyCap results to reduced vigor, dedication and absorption among employees in their work.

Finally, the results show that work engagement is positively associated with work-based identity. This denotes that teachers who are equipped with high levels of energy, enthusiastically involved and fully immersed in their work are more likely to form their work identity. The result finds support from the study of Kanste (2011), demonstrating that work engagement is associated to identification with organization. Accordingly,

engaged employees possess psychological presence in their work that becomes incorporated into their identity (Kahn, 1992; Braine and Roodt, 2011) as they assume that putting more effort on their task advance themselves and feel that the organization's success is also their own personal success (Dick, 2001; Zhang et al., 2017). Hence, employees with strengthened work engagement are likely to internalize their organization's aims and goals with their own (Murray et al., 2015). It is also significant to note that dedication, as a dimension of work engagement bears some similarity in its conceptualization with work-based identity as it is considered as "an identification-based component of engagement" (Bakker et al. 2008; Halbesleben, 2010; Braine and Roodt, 2011; Bargagliotti, 2011). Hence, when teachers are strongly engaged in their work due to their high level of psychological capital, it is likely that they will be able to firmly identify with their work/organization.

5. Conclusion

Teachers who have high level of PsyCap are more likely to increase their work-based identity (Huimei and Xuan, 2011). The mediation of work engagement between psychological capital and work-based identity could be well explained with the notion that teachers who persevere toward goals (hope), who have confidence to put in the necessary effort (self-efficacy), who sustain and bounce back from adversity (resilience), and who make a positive attribution (optimism) to attain success tend to be more engaged at their the work, which in turn, cause them to display higher identity formation towards their organization and occupation. Despite the potential contribution of this study to the extant literature, some limitations must be considered in interpreting its results. First, the study used self-report indicators that make responses susceptible to prejudices towards social desirability. Future studies could use social desirability measures to statistically monitor perceived biases. Second, the study used a cross-sectional design; hence, definitive causal relationships between the predictor and outcome variables cannot be identified. Longitudinal designs would offer greater evidence for proposed causal interactions. Lastly, the generalizability of the findings may be limited to the faculty from different private and public colleges/universities in Iligan City, Lanao del Norte and Cagayan de Oro City, Misamis Oriental sample only. Future research may test this model in a variety of samples because the results may vary depending on level of psychological capital. Nonetheless, this study makes an essential contribution to teachers' work-based identity literature. First, this is one of the very few studies showing the relationship between PsyCap and work-based identity among teachers. Second, while several studies on individual characteristics have examined the potential precursors of WBI, examining this in the context of PsyCap as an individual characteristic; and the mediating role of work engagement between PsyCap and work-based identity are yet to be explored. This study addressed these gaps and found that PsyCap affects the development of work engagement, and in turn, affects teachers' work-based identity. Finally, the current findings affirmed the theory of work-based identity as it is being influenced by the job and individual characteristics. This is relevant given that work-based identity theory, to the authors' knowledge, has been rarely used in the context of teachers.

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Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 184-193, Sep. – Dec. 2023

Technological Pedagogical and Content Knowledge: Levels of Practice of Chemistry Teachers

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Received: 13 Oct 2023 Revised: 29 Nov 2023 Accepted: 3 Dec 2023

Abstract. The upsetting 88% of senior high school graduates in the Philippines having difficulty with general college chemistry is further exacerbated by the widely implemented modular distance learning in public schools. Teachers reported challenges on monitoring and validating student outputs as well as giving timely feedback. To assess the levels of practice of chemistry teachers in terms of content, pedagogy and technology was the impetus of this study. Engaging a descriptive-comparative design, an expert-validated rubric was used to cross-validate the COT-RPMS-rated levels of practice on technological, pedagogical and content knowledge (TPACK) among fourteen chemistry teachers in a public schools district in Kalibo, Aklan. The rubric adapted from Technology Proficiency Self-Assessment for the 21st Century (TPSA C21) by Christensen & Knezek (2015) and the department of education mandated pedagogies and chemistry curriculum standards. Intra-class correlation coefficients of 0.842 for content and 0.887 for pedagogy confirmed the concurrence between the scores given by the evaluators on the chemistry teachers' instructional plans. The comparative analysis revealed lower levels of practice in all areas, with pedagogy having the lowest ratings using the rubric. The lecture method and whole class discussion of direct and interactive instruction strategies, respectively, were common among participants. Wilcoxon Signed Rank Tests confirmed significant differences in levels of practice of technological, pedagogical and content knowledge of teachers when COT-RPMS and the rubric ratings are equated against each other. An in-depth investigation on pedagogical levels of practice evident in instructional plans is strongly recommended.

Keywords: chemistry teachers; TPACK; Levels of Practice; Rubric,

1. Introduction

The generation of learners in this time of pandemic has recorded the highest learning loss according to a global study by the World Bank, UNICEF and UNESCO. The learning loss translated to the learners' lifetime earnings in present value amounts to 17 trillion dollars. The study blames the currently unfamiliar and inaccessible ways of learning imposed onto learners, a scenario prevalent among Filipino learners, who continue to miss learning opportunities following a two-year school closure (Business World, 2021). In the basic education, the widely implemented modular distance learning (MDL) has been found to confront teachers in the areas of monitoring and validating student performance, checking students answers in the modules, and giving timely feedbacks (Castroverde & Acala, 2021 and Pokhrel & Chhetri, 2021). The Department of Education (DepEd) has acknowledged these limitations in distance learning modalities, especially that 87% of Filipino parents opted for printed modules for their children, a proof of their inaccessibility to other modalities available (UNICEF, 2021, and Business World, 2021), such as online distance learning, blended and home-schooling (Enclosure to DepEd Order No. 012, s. 2020, p. 30-32). Blended teaching is found to significantly address the unfamiliar learning mode for students (Pandit & Agrawal, 2021), and although this has become the new education norm according to DepEd and UNICEF reports, the Philippine government is yet to intensify distance learning modalities (Business World, 2021). This however, requires teachers to be digitally competent in online learning tools because online modality is effective for a blended approach, a necessity that calls for pioneering an alternative framework for educational delivery. The pandemic has ushered the way for digital teaching and learning to flourish and must be given a try (Lailatun & Drajati, 2019 and Pokhrel & Chhetri, 2021).

In the field of chemistry in the basic education sector, pre-pandemic research by the UP NISMED (2019) reveals an alarming 88% of senior high school graduates having difficulty with key concepts and skills for the general college chemistry. The institute reports that even students in the STEM track lack the significant background and skills for the same subject. Chemistry is difficult to learn because "instruction occurs predominantly on the most abstract level, the symbolic level" (Gabel, 1999, p. 549 as cited by Cardellini, 2012). Additionally, UP NISMED's studies over the years have established that there exists an incongruence between career preparations and teaching assignments for science teachers in public schools in the Philippines. Teachers who have inadequate preparations to teach science subjects still get hired as a result of the lack of competent applicants who are specialized in these fields (SEI-DOST & UP NISMED, 2011). The problem of the mismatch of teacher background is further impacted by the alignment of the K-12 curriculum and the availability of science teachers, so that the possibility of a learning process going on is less interactive for science subjects. The ability to do practical reasoning and experimentation is also limited, while the quality of science literacy is interrelated with their practicum experience (Antonio, 2018). Consequently, abstract science concepts such as chemical changes and reactions in high school chemistry are dodged by the teachers because they reported difficulty teaching these topics, especially that modeling and visualization are required in order to make students understand these topics (SEI-DOST & UP NISMED, 2011). Even in-service teachers who are already into graduate programs were tested in content knowledge in chemistry and were found to have less mastery of topics in solutions, chemical bonding, the mole concept, gas laws, and chemical reactions. Teachers reported they encountered challenges in teaching chemistry in the K to 12 spiral curriculum. The science curriculum under the K to 12 program progresses in terms of level of difficulty and subject areas where integrated science, biology, chemistry and physics are included within a specific grade level science subject. Furthermore, even if teachers are confident they can teach chemistry lessons, their scores in the content knowledge test showed negative departures, thereby supporting their

claimed difficulty (Mongcal, et al., 2017). UP NISMED pins down this trend as negatively affecting the performance of our learners.

The same truth is happening anywhere in Aklan. The schools division opted for modular distance learning (DepEd Aklan ManCom Meeting, 2020, August) and teachers openly lament similar limitations and failures because of very limited to totally absent teacher-learner interactions in MDL. Although teachers utilize the most-friendly online platforms such as Facebook, Messenger, SMS and phone calls (Castroverde & Acala, 2021), not all learners or their parents are able to participate in the communication lines, and not all teachers are committed to seriously augment MDL with online means. At present time, a scheduled 2022 PISA has revealed a very low pre-assessment performance of the sampled high school students in one particular high school in Aklan (personal communications). This trend was already seen in the 2018 PISA report where Filipino learners performed significantly lower than the average, scoring only an average of 357 points in Science Literacy compared to the OECD average of 489 points (Cordon & Polong, 2020). Substantial learning opportunities for Aklanon students are still out of reach while limited face-to-face classes are still on hold. Their learning continues to revolve within learner-content interactions, and their performance cannot be validated due to numerous factors such as below passing rate scores or unanswered activities in the modules. As pointed out by Pandit & Agrawal (2021), blended teaching that incorporates online means is viewed as effective and is expected to positively augment the anticipated limited face-to-face instructions in the long run.

There remain several questions in terms of the competence of chemistry teachers to teach the content area, using appropriate pedagogies and technologies in response to the present mode of instruction. These questions provide the impetus for the researcher to pursue descriptive-comparative research to assess the levels of practice of technological, pedagogical and content knowledge of chemistry teachers in Kalibo II. Towards this end, this research anchors on the following objectives:

- Design an analytic rubric for evaluating the levels of practice of TPCK of chemistry teachers;
- Determine the levels of practice of TPCK of chemistry teachers based on:
    - COT-RPMS ratings;
    - rubric-analyzed lesson plan ratings; and
- Determine the significant difference in the levels of practice of TPCK of chemistry teachers between their COT-RPMS and rubric-analyzed lesson plan ratings.

This research anchors on the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2009). For the purposes of this study, the three main knowledge types of TPACK namely the technological, pedagogical and content were measured. Primarily, the study looked into the chemistry teachers' technology-embedded instruction (Edtech Classroom, 2021) where a teacher is competent in both technological and pedagogical techniques, integrates the technology and instructional strategies to effectively teach content areas to advance learning (Lailatun & Drajati, 2019). These three main knowledge types are defined by Schmidt et al., (2009) as follows:

Technological knowledge (TK) is the overall competency of a teacher to employ a wide array of technologies from the simple low-tech tools like pencil and paper to digital technologies such as videos, interactive whiteboards and software programs. Content knowledge (CK) refers to the actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006, p. 1026 as cited by Schmidt et al., (2009). Pedagogical knowledge (PK) encompasses the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning.

For Koehler and Mishra (2009), the challenge with technologically embedded classrooms is that advances in technological applications for classroom use come along

with technical considerations that may pose difficulties for the teachers to effectively use them in instruction. Older teachers for instance, tend to behave negatively towards technological advances in instruction (Fuad et al., 2020). To be able to navigate through the complex and interactive domains of content, pedagogy and technology when teaching, translates to effective teaching and learning (Koehler & Mishra, 2009).

The Study Paradigm

FIGURE 1. The study paradigm.

The comparative analysis of the COT-RPMS and Rubric ratings of chemistry teachers' instructional plans will be central in the establishment of their levels of practice of content, pedagogy and technology in their instructions (Figure 1).

2. Methodology

Research Design

To assess the levels of practice of technological, pedagogical and content knowledge of chemistry teachers in a public schools district in the town-proper of Aklan province in Western Visayas, Philippines, a descriptive-comparative research design was espoused. This research design according to Cantrell (2011) is a "non-experimental quantitative research design also known as causal comparative and pre-experimental research, whose known properties are: independent variable is not manipulated, no random assignment to groups, and inclusion of a control or comparison group." As used in this research, the existing instructional ratings of chemistry teachers in their classroom instruction measured by the COT-RPMS rating tool was used as the 'control data' against which the research data was compared with. In the COT-RPMS rating tool, the domains of content, pedagogy and technology in classroom instruction are the three indicators rated by the school heads or delegated academic heads. The research data, on the other hand, pertained to similar ratings of teachers in the areas of content, pedagogical and technological knowledge measured as levels of practice and rated using the same instructional plans they used in their COT-RPMS evaluation. This time however, a validated analytic rubric was used for such purposes. The rubric instrument is prone to subjectivity and in order to resolve this, an external evaluator was employed to establish the inter-rater agreement via the Intra-class correlation coefficients of ratings for both the content and pedagogical knowledge.

The study involved all the fourteen chemistry teachers in four public secondary institutions in the schools district of Kalibo II, division of Aklan. The consideration of the

study population was that, this cluster of schools include a wide-array of educational and curricular programs having one regional center for science and mathematics education or the Regional Science High School for Region VI (Western Visayas), which is selective in terms of student admission. Another was a regular national secondary school and the other two are integrated schools (one being a center for special education). To have gauged the levels of practice among teachers in the domains of content, pedagogy and technology in support of learning at present times, provided field data in this area of research.

Instrument Development

The chemistry curriculum standard implemented under the Department of Education (DepEd) K to 12 basic education program was referred to in the area of content knowledge. The curriculum standard covers content, performance and the most essential learning competencies (MELCs). They were used to select the instructional plans of teacher-participants for rubric evaluation. The DepEd prescribed instructional strategies and their corresponding instructional methods in its department order no. 42, series of 2016, was used as the basis for pedagogical knowledge. The five instructional strategies stipulated in the order are the Direct, Indirect, Interactive, Experiential Instructions and Independent Study (Department of Education, 2016). Each strategy's lists of instructional methods were used to gauge the pedagogical levels of practice. The technological knowledge was measured using the Technology Proficiency Self-Assessment for the 21st Century (TPSA C21) adapted from Christensen and Knezek (2015).

The rubric was submitted for criterion validation by panelists: chemistry education expert, research education expert and a curriculum expert. The instrument was given an overall mean score of 4.76 or Excellent. The suggestions and recommendations by the panel of experts were incorporated in the final rubric as an instrument of the study (Appendices F-I). It was evaluated using nine (criteria) of 1) relevance to the problem ($\overline{X}$ = 4.7, Excellent), 2) organization ($\overline{X}$ = 4.3, Very Good), 3) appropriateness of scale used ($\overline{X}$ = 4.0, Very Good), 4) accuracy ($\bar{x}$ = 4.7, Excellent), 5) application to praxis ($\bar{x}$ = 5.0, Excellent), 6) ethics ($\overline{X}$ = 5.0, Excellent), 7) clarity ($\overline{X}$ = 5.0, Excellent), 8) scope ($\overline{X}$ = 4.7, Excellent), and 9) balance ($\overline{X}$ = 4.7, Excellent).

The analytic rubric (Appendix J) designed adopted three levels of practice in columns, namely, Competent, Proficient, and Highly Proficient as defined by Benner (1982), and three indicators in rows for Content, Pedagogy and Technology.

In the area of content knowledge, the rubric defined the competent, proficient and highly proficient levels of practice as having evident coverage without depth, evident coverage with some depth and evident coverage with depth, respectively, of the chemistry content standard, performance standard and most essential learning competencies (MELCs).

In the area of pedagogy, the rubric defined the competent, proficient and highly proficient levels of practice as having evident use of at least three, four and five instructional methods, respectively, under any of the five instructional strategies prescribed by DO No. 42, s. 2016. Beside the number of methods used, the competent level includes some processing for better understanding, the proficient level with some processing for better analysis and synthesis, and the highly proficient with expert processing leading to the application in real life situations.

The technological knowledge of teachers was gauged using the adapted TPSA C21 which outlined thirty-four indicators and self-rated using a five-point Likert scale of 1-5 for Strongly agree, Disagree, Uncertain, Agree and Strongly Agree, respectively. However, the panelists unanimously suggested to get rid of the 'uncertain' level and instead, use a forced choices of 1-4 that correspond to No knowledge, Struggling to use, Confident, and Very Confident, respectively. It was also suggested to drop items 19 and

23 as one panelist judged it to be impractical to the target participants. The numerical levels of practice were at least a $\bar{X} = \leq 2.0$ for Competent $\bar{X} = 2.1 – 3.0$ for Proficient and $\bar{X} = 3.1$ - 4.0 for Highly Proficient. The adapted TPSA C21 instrument was administered to thirty-five non-target teachers within the district via face-to-face pilot testing. The generated scores were analyzed for internal consistency using the Cronbach alpha. The result showed an $\alpha = 0.948$, equivalent to Excellent reliability (George & Mallery, 2003). This result is due the fact that the instrument "has been used for 15 years in studies regarding technology integration in the classroom in the USA and other nations" when Christensen and Knezek adapted it in 2015. The TPSA C21 survey was conducted via face to face from among the fourteen chemistry teachers for about two weeks. Each respondent was guided about the specific items of the instrument and were asked to be honest about their ratings.

Data Gathering Procedure

Prior to the actual conduct of the study, the researcher requested an approval from the office of the schools district supervisor (Appendix L) to conduct the study among the participants. When approval was secured, copies of instructional plans such as the weekly home learning plans (WHLPs), daily lesson plans (DLPs) and Daily Lesson Logs (DLLs) officially used by the teachers during their rated classroom observation with their respective school or academic heads, were gathered while simultaneously administering the TPSA C21 survey to them. The variation in the instructional plans was due to the use of WHLP in modular distance learning and use of the DLPs or DLLs during their COT-RMPS evaluations. For ethical purposes, these instructional plans are not appended in the paper to espouse privacy of the documents and the identities of the teachers who made them.

An external coder or evaluator in the person of the Senior Education Program Specialist (SEPS) for Planning and Research of the DepEd Division of Aklan was asked to do independent evaluation (Appendix M of the collected weekly home WHLPs, DLPs, and DLLs, officially used by the teachers during their rated classroom observation with their respective school or academic heads

Data analysis included computation of the weighted mean in the TPSA C21 survey and of the rubric ratings (Appendix N). Intra-class correlation coefficient was used to determine the concurrence rubric rating of both the researcher and the external coder or evaluator on the areas of content and pedagogy. Significant difference in the ratings was determined using the Wilcoxon Signed Rank Test. Analyses were carried out using the SPSS ver. 23. Data presentation for the comparative levels of TPCK was generated using the clustered column available in Microsoft Excel, where a line on the secondary axis would highlight the difference in the two sets of data.

3. Findings and Discussion

The data covered revealed the levels of practice in terms of content, pedagogical knowledge of chemistry teachers as shown in their instructional plans and their technological knowledge in terms of their self-report survey using the Technology Proficiency Self-Assessment for the 21st Century tool.

Comparative Levels of Practice of Content, Pedagogical and Technological Knowledge

The comparative levels of practice of the content, pedagogical and technological knowledge of chemistry teachers, measured by the COT-RPMS rating tool are represented by the blue bars and that of the analytic rubric tool are shown by the red zigzag lines. It can be glimpsed that the levels of practice among chemistry teachers were lower when

measured using the rubric and compared against the COT-RPMS ratings: Proficient in the Content Knowledge, Competent in the Pedagogical Knowledge and Proficient in the Technological Knowledge. Pedagogical knowledge of teachers is significantly lower. The rubric analyses showed strong subscriptions to the lecture and whole class methods of the Direct and Interactive Instructions.

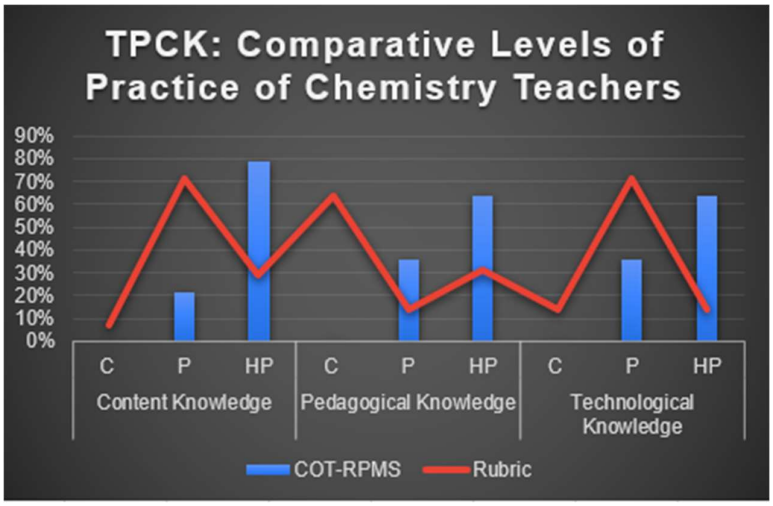

FIGURE 2. The comparative levels of practice of the content, pedagogical and technological knowledge of chemistry teachers

As Johnson et al., (2013) put it, a teacher's desire for their students to learn effectively drives classroom instruction, and if current lesson plans meet the needs of students, there is very little motivation for the teacher to alter them. Educators spend countless hours creating lesson plans that will hold attention and make learning exciting. Revising them means several hours of additional work for the teacher, which is problematic given an already demanding schedule.

Significant Difference in the Levels of Practice of TPCK of Chemistry Teachers Between their COT-RPMS and Rubric-analyzed Lesson Plan Ratings.

Table 1. Results of Wilcoxon Signed Rank Test for Significant Difference Between Ratings in COT-RPMS and Rubric-analyzed Lesson Plan

Indicators		Z value	p-value	Interpretation	Decision
Content	COT-RPMS Rubric	-2.236	0.025*	Significant	Reject H_0
Pedagogy	COT-RPMS Rubric	-2.486	0.013*	Significant	Reject H_0
Technology	COT-RPMS Rubric	-.2714	0.007*	Significant	Reject H_0

Results of the Wilcoxon Signed Rank Tests (Table 1) for significant difference between COT-RPMS and rubric ratings were significant in terms of Content knowledge (Z = -2.236, p = 0.025*);* Pedagogical knowledge (Z = -2.486, p = 0.013); and Technological Knowledge (Z = -2.714, p = 0.007). It can be glimpsed that the instructional plans when

evaluated using the analytic rubric designed in this research showed lower levels of practice for these three areas compared to the COT-RPMS ratings.

Sawchuk (2013), emphasizes that "teacher evaluation is central both to the teacher and to those holding them accountable" because the "quality of education system cannot exceed the quality of its teachers (Barber & Mourshed, 2007). The Quality of teacher evaluation therefore requires a thorough process to ensure the truth of the data.

Implications for Teacher Evaluation

The study opens up to questions of whether the well-researched and well-established standard COT-RPMS tool used to gauge teachers' content, pedagogical and content knowledge is in fact truthfully used in the field. The researcher considers the tool as appropriate and standard, but suggests a deeper investigation on the pedagogical aspect of the chemistry teachers' instruction in the field, otherwise why would national research institutions such as the UP NISMED find a staggering percentage of basic education graduates confronted with difficulty in the general college chemistry? There must be a way around to truthfully measure the depth of content instruction, variety and appropriateness of the instructional strategies used, and the applicability and practicability of the educational technologies employed in the teaching and learning situations.

4. Conclusion

The result of this study has shown another way around to evaluate chemistry teachers' content, pedagogical and technological knowledge using an analytic rubric. The comparative analysis of the COT-RPMS and rubric measured levels of practice of chemistry teachers' content, pedagogical and technological knowledge were significantly different. Rubric analysis showed at least a step lower levels of practice compared to the COT-RPMS rated levels of practice. The findings of the study do not necessarily discount the process of teacher evaluation using the COT-RPMS tool by the academic or school heads. However, it is the hope of this paper to provide current field data on the levels of practice in these areas from the perspectives of the research conducted.

5. Declaration of Competing Interest

The author declares no competing interests that could have otherwise influenced the work reported in this paper.

6. Acknowledgement

The researcher whole-heartedly expresses deep appreciation to all the Kalibo II district chemistry teachers, their respective school heads and Mrs. Arlyn I. Regalado, PDSD-Kalibo II for the opportunity to work with them in the fulfillment of this research. Heartfelt gratitude is also expressed to the researcher's school head, Mrs. Merlyn S. Carrillo, and colleague-Mr. Noel L. Solidum for the constant support and encouragement. Endless appreciation is deeply felt by the author for the following people: Dr. Edna Nabua, research mentor at MSU-IIT, Dr. Darren N. Naelgas of DepEd Aklan-External Evaluator, Dr. Mary Cherry Lyn M. Tabernilla, Dr. Thelma Antonio and Dr. Griselda C. Quintana for the expert validation of the rubric used in this research, my family for the love and inspiration, and above all, to the almighty God for the wisdom and strength He provides.

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Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 194-201, Sep. – Dec. 2023

Developing Guidelines of STEAM Education for Primary School Students' Learning on Designing Floral Craftsmanship based on Thai Royal Court

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Received: 2 Nov 2023 Revised: 19 Dec 2023 Accepted: 30 Dec 2023

Abstract. An important goal of effective primary school education in the modern world is to pave the way for learner's creativity. However, how to use the floral craftsmanship on enhancing learners' creativity at early stages of education has not been focused on current pedagogical literatures. In the context of Thailand, the floral craftsmanship based on the royal court is an exquisite art and a valuable national heritage. This study aimed to develop guidelines of STEAM education for primary school students' learning on designing floral craftsmanship based on Thai Royal court. The guidelines were developed through Nakhon Phanom University Demonstration School Professional Learning Community (NPU PLC). Methodology regarded qualitative research. The developing guidelines were categorized based on NPU PLC planning about the learning activities of STEAM education. The findings revealed that the possible guidelines of activities that could engage students to build physical, social, emotional and intellectual potential primary school students through project-based learning management approaches; aware of occupational and technology for future careers; and build up creativity of designing floral craftmanship based on valuable national heritage. These activities may allow students to practice knowledge about science (e.g., materials) and mathematics (e.g., floral pattern) based on ethical significance (e.g., virtue of nation, religion and the monarchy) and aesthetics and beauty in form of flower arrangement.

Keywords: STEAM Education, virtue, floral craftsmanship, designing

1. Introduction

The children of the twenty-first century are increasingly prepared to bring knowledge and abilities to solve issues, make sense of information, and know how to acquire and assess evidence to make judgments." Improving such skills is central to STEM and STEAM education (Sutaphan & Yuenyong, 2019; Sutaphan and Yuenyong, 2023; Williams, 2011). To equip kids with the skills and knowledge they will need to be successful innovators in a 21st century job; there is an increasing emphasis on STEAM — the educational discipline that engages students in the fields of Science, Technology, Engineering, the Arts, and Math (Sohsomboon and Yuenyong, 2021).

Discussion of technology and/or engineering philosophy may provide a better understanding of incorporating other information into STEM/STEAM integration. According to Sutaphan and Yuenyong (2019), T-technology provides a strong link between science and society (including the arts). According to the four modes (object, knowledge, activity, and volition) of technology philosophy (de Vries, 2017), students' learning in STEM/STEAM education involves creative thinking skills. The ability to think creatively is essential for designers to achieve the fit between physical and functional nature, and for consumers to discover new ways to use technology (Nugraheni and Yuenyong, 2022; Suparee and Yuenyong, 2021). Literatures (Koes-H et.al., 2021; Phan et.al., 2021) suggested how to practice technology based on four modes of technology into STEM/STEAM education.

Regarding technology concepts, it suggests that other disciplines such as arts need to be included in creatively designing. We must define "sense of arts"; arts in the postmodern paradigm or in STEAM education do not focus solely on the beauty of painting; sense of arts here could refer to any of the arts. Yakman (2008) clarified arts into categories including language arts, fine arts, physical arts, manual arts, and liberal arts. At the start of teaching STEAM, teachers must consider teaching topics that include arts. Some teachers may focus primarily on the arts component while designing prototypes, with the response STEAM. There is nothing wrong with that notion, but it may be too restrictive for the arts definition, which focuses solely on fine arts. We may look at it via the liberal arts perspective (Sohsomboon and Yuenyong, 2021). For example, Maneelam et.al. (2023) express arts in her STEAM approach education as an ethical problem story through the issue of plastic awareness. Maneelam taught not only about plastic, but also about its ethical, moral, and value issues. This plastic awareness gives meaning to students' ethics, and it has the potential to provide beauty to society. In this stage of STEAM, ethnography could inspire ethical consciousness by telling a tale about their society's propensity of utilizing plastic. So, at this point, teachers do not need to worry about how to incorporate arts into STEAM activities because the arts are already mentioned in the title.

Regarding Thai context, this study brings the issue of royal floral arrangement as the moral and ethical value in Thai context to engage students to practice STEAM integration knowledge. The Royal Floral Arrangement of the Thai Royal Court in the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great generates the moral and ethical value because it showed the gratitude towards the King. This event made palace people be gathered, exchange their belief, show goodwill, share, and encourage each other, in which it builds up friendship among people in the society (Chanthanaphalin, 1989). As you can see from the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great that courtiers and people offered their best work making the floral work with their full effort. The decoration of the Royal Crematorium displayed the valuably exquisite craftmanship to other people so that the participants can involve with inheriting the valuable tradition, belief, ritual, exquisite craftsmanship, and artwork of the Royal Court Tradition further. With the remembrance and realization in the gratitude of His Majesty King Bhumibol Adulyadej the Great for his hard working in improving live living of Thai citizens, the people who offered the Royal Floral Arrangement including Princess Maha Chakri Sirindhorn who visited at the Boromraj Sthitya Maholan Hall and knitted the crown flower net decorated with red ixora and shiny golden lace, which used in decorating the Ninth Floor of the Royal Crematorium. It emphasized that the Royal Floral Arrangement of the Royal Court Tradition has moral and ethical value and needs to be conserved for the next generation.

Put the arts in term of aesthetics value, the Royal Floral Arrangement of the Thai Royal Court in the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great generates the aesthetics value because its beauty in the exquisite craftmanship was displayed and being widely accepted by all people. Chanthanaphalin (1985) described the

floral work that affects the people's emotions and feelings after seeing, smelling, touching. They will feel gentleness, soothes, and tenderness because of its well-crafted Royal Floral Arrangement. The good smell was up in the air, and it made the people refreshed and want to know who created it. It is a good combination of beauty (Bunnak, 2017). The beauty of the Royal Floral Arrangement of the Thai Royal Court in the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great illustrated the Royal Court Tradition by using the artwork composition generating the exquisite craftmanship. The aesthetic value means to derive the senses though over the six entries which are ears, eyes, nose, tongue, and mind. The aesthetics value can be perceived from watching beautiful artwork and being pleasure and like the artwork using the mentioned entries. Plus, the floral artwork made the creator and the participants learned how to appreciate the beauty of the nature that is a mind-healing. In additions, people, especially foreigners, who saw the Royal Floral Arrangement felt amazed and appreciated the aesthetics value.

Designing the royal floral arrangement would also provide students the value of innovation. In the globalization era, new generation people have grown as known in, "Gen C people". There are a lot of changes in terms of facilities, advanced technologies, and beliefs compared with the past in Baby Bloomers Generation (Tanthichuwet, 2017). Anyhow, adults can also use and access technology because society keeps changing all the time. People are eventually learning to adapt themselves in the new context (Tanthichuwet, 2017). The Royal Floral Arrangement is one of many customs that have been passing on from the past until the present. In the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great, it is found that innovation, new methods, and materials were adapted with the traditional Royal Cremation appropriately, effectively, and fashionably. The artisans also needed to adapt themselves and develop their innovative thinking to conform with the current society. Consequently, their artwork was not out-of-date and is still valuable according to the Royal Court Tradition.

The Royal Floral Arrangement according to the Royal Court Tradition in the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great reflects Thai belief, tradition, ritual, and history passing on from generation to generation for ages. To cooperatively making the Royal Floral Arrangement, the citizens and relevant sectors showed their fealty to the Royal Family, their love and harmony, and the unity of the Royal Artisans in creating the floral artwork by combining the tradition with the innovation appropriately nowadays. The generating of the excellent artwork, in which it is widely accepted. With an ability to manage the resources well, the Royal Floral Arrangement had been done perfectly with the utmost respect displaying the most valuable Thai Royal Floral Arrangement to both Thai and other nations to be able to sense the proudness of Thai people.

2.Methodology

This study aimed to develop guidelines of STEAM education for primary school students' learning on designing floral craftsmanship based on Thai Royal court. The guidelines were developed through Nakhon Phanom University Demonstration School Professional Learning Community (NPU PLC). Methodology regarded qualitative research.

2.1 Participants

Participants in this study included members of NPU professional learning community addressing in the part of planning the design thinking of STEM lesson plan. The members included five expert panel committees. The five STEAM education experts included (1) male expert who has been working as science educator at Faculty of Education, Khon Kaen University for about 20 years, (2) male expert who has been working as physics lecturer at Faculty of Education, Rajabhat Mahasarakham University for 10 years, and (3)

three female experts who has been working as primary school educator at Faculty of Education, Nakhon Phanom University for more than 8 years.

2.2 Method of inquiry

The developing guidelines of STEAM education for primary school students' learning on designing floral craftsmanship based on Thai Royal court were categorized based on NPU PLC planning about the learning activities of STEAM education. The first draft ideas of designing floral craftsmanship STEAM education were developed by a primary school teacher who was working at Nakhon Phanom University Demonstration school. Then, the PLC member meeting was organized two times to improve the appropriate guidelines. The issues of revising STEAM education lesson plan were collected through the report of expert suggestion on expert panel discussion. The suggestion then was categorized to develop assumptions for further revising guidelines of STEAM education for primary school students' learning on designing floral craftsmanship based on Thai Royal court.

3. Findings

The findings revealed that the possible guidelines of activities that could engage students to build physical, social, emotional and intellectual potential primary school students through project-based learning management approaches; aware of occupational and technology for future careers; and build up creativity of designing floral craftmanship based on valuable national heritage. The guidelines were concluded into three issues including 1) arts as core content of valuable national heritage for blending into STEAM projects, 2) principles of integrating arts about royal floral arrangement into STEAM projects, and 3) strategies for organizing the royal flower craftsmanship.

3.1 Arts as core content of valuable national heritage for blending into STEAM project

The valuable national heritage could be provided as core content for designing floral arrangements. The royal flower craftsmanship is a valuable cultural cost of Thailand, a perfect blend of cultures, beliefs, traditions, and arts through exquisite craftsmanship. Therefore, this valuable cultural cost is a very important social cost that should be preserved continuing to create sustainability in the future. The guidelines for inheriting the value of the royal flower craftsmanship could be shown through the history as following.

The Royal Floral Arrangement of the Thai Royal Court in the Royal Cremation of His Majesty King Bhumibol Adulyadej the Great used the artisans who has been inherited its Royal Craftsmanship from Sukhothai era until Ratanakosin Era, specially in the King Rama V era. All royalties paid interested in developing craftmanship in the courtiers , especially Sri Bajarindra. She had a skill in the Royal Floral Arrangement, and the uniqueness of her floral work was "exquisite", in which it reflected the way of how high class people made the floral artwork (Bunnak, 2017). This is correspondence to the studying of Thotong (2012) that mentioned an artisan means the person who handcrafted and created the beautiful artwork for a special occasion, festival, and rituals. The Royal Floral Arrangement, for example, requires the high skilled artisans and a lot of practice and preparation. They had a floor to present the masterpiece to Thai people and the global in mutually inheriting Thai tradition and culture for good.

3.2 Principles of integrating arts about royal floral arrangement into STEAM project

Principles of integrating arts about royal floral arrangement into STEAM project related to the great King Rama IX on the principle of exploding from the inside. It is believed that any action will be sustainable and successful, it must be developed from the inside before it can go outside. In another word, the community development dimension, the community must be developed to be ready to support inside first before the

development from outside can be implemented. The development of operations in the manner of cultural inheritance should be provided starting from raising awareness of the value. And the benefits of that culture from within the person's self will support the development and inheritance of such culture outside. Therefore, setting a framework for driving the development of human resources of the country to realize the importance of and can create added value to extend the valuable wisdom. In this case, it is floral arrangement.

The main objective of the floral arrangement STEAM education is to create human resources of the country that recognizes the importance ready to develop and continue creatively in the cultural cost of fresh flower wisdom. The value of cultural heritage could be classified into three aspects. Firstly, it could be creating Thai identity. The creation of the Thai identity integrates the beautiful beliefs, culture, history, traditions, religions, and practices of Thailand that have been passed down for a long time. It is the root of being Thai. Second is creative value of raising awareness. Creating value is to raise awareness and see the importance of cultural costs in the field of fresh royal flowers to be ready for conservation, continuation, and creativity to create sustainability in society. Third is to create a career for people. Career building is to create a career for people who are skilled and interested in career building. Because the royal flower craftsmanship is a high-class craftsmanship with a long history There are intricacies and stories that are of great value in the general public perception, so in such craftsmanship is that there is a story that is the process of creating added value to the product. If it is promoted and marketed at an economic upper level, it is an opportunity to create a new career that can build stability both at the individual and local level. Elevate your flower work from normal craftsmanship to highly skilled craftsmen.

3.3 Strategies for organizing the royal flower craftsmanship

Strategies for organizing the royal flower craftsmanship will be clarified through the succession of the royal flower craftsmen called the MALAI Model for creating sustainability. The goal of learning about the Model of the garland (MALAI Model) included building yourself, creating value and building careers. The MALAI Model was organized regarding on 5-component strategy including creating sustainability through creation, creating sustainability through the preservation of Thai identity, and creating sustainability through education.

3.3.1 Creating sustainability through creation.

Creating sustainability through the creation of new occupations to create career opportunities. To build income security for those who are interested and have the skills to be able to rely on themselves. And gives rise to the intention of continuing this cultural work Including finding suitable marketing channels and marketing research to develop knowledge Laid on a cultural foundation that has a long inheritance.

3.3.2 Creating sustainability through the preservation of Thai identity.

Creating sustainability through the preservation of Thai identity Is to raise public awareness and see the importance of the cultural heritage of Thailand. Build awareness and correct understanding of the wisdom that has been accumulated and transmitted through valuable fresh flower making work that is different from other normal craftsmanship.

3.3.3 Creating sustainability through education.

Creating sustainability through education is important to the operation for sustainability. By creating sustainability through the education system. The Model of the garland (MALAI Model) could provide the spectrum of creating sustainability in STEAM education. These included 1) Building up physical, social, emotional and intellectual potential students, 2) connect to teaching and learning about occupational and technology, 3) career and generate income from creating garland, 4) provide mindset of economic value, and 4) opportunities and create spaces for exchange of knowledge in the community

Building up physical, social, emotional and intellectual potential students

Linking with experience management to build physical, social, emotional and intellectual potential, may be based on activities or project-based learning management approaches. Including learning management in STEAM that allows learners to experiment and integrate knowledge from various areas for learners to practice. Where garlands or fresh flowers may start from hundreds of large materials Which corresponds to the curriculum of early childhood education and standards of early childhood education aimed at developing the use of small groups of learners Especially the small muscles that contribute to writing. Including the creation of Thai identity for students to absorb the value of culture Thai traditions Especially the fresh flowers

Connect to teaching and learning about occupational and technology

Connect to teaching and learning about occupational and technology Which aims to develop students' skill skills and learn to be Thai and raise awareness of the importance through social studies history in addition, if the learners are interested, those involved may have a club activity group or other learner development activity so that learners have the opportunity to develop their potential and abilities in fresh flowers. In order to further expand into the competition

Career and generate income from creating garland

Linking the succession of fresh flowers in the royal court by integrating with academic, basic work, occupation and technology for learners to practice Study details in terms of history, values, and create future conservation action approaches. By aiming for the students to see development opportunities in order to further their career and generate income for themselves Including organizing competitions or creative contests for motivation to develop the skills of interested learners.

Provide mindset of economic value

Develop short- and long-term courses to build a career with specialization. Especially moving towards highly skilled workers. That will result in both self-worth and higher economic value. Aiming to develop research and study in depth in the area of history, history, innovation development approach Business Channel Development opportunities to generate income Which is an academic study to fill and strengthen the body of knowledge in addition, there may be a project-based study to inherit and create a new development approach that is more consistent with the present.

Opportunities and create spaces for exchange of knowledge in the community

Create a lifelong learning system for all ages. Provide opportunities and create spaces for exchange of knowledge in the community. Create a series or short course of learning that facilitates training. Which is the creation of knowledge Basic skills and an awareness of the value of a royal flower fair. And conducting advanced skills development courses to develop new skills Restore the original skills that are suitable and create quality human resources for society. Creating sustainability through skill development Is training for skill

development in both short-term and long-term courses Which in the past there were guidelines for developing the original skills and rejuvenate to add new skills Operated by the Department of Skill Development Ministry of Labor It is the creation of skilled labor skills for creating a career in the future. Building sustainability by connecting people's daily lives. By creating attitudes and perceptions that fresh florist work is something that can be found in daily life and the practice of the daily routine can be a part of the conservation and continuation of the culture of using fresh flowers, such as the selection of fresh flower crafts products according to traditions, cultures, festivals that are appropriate for each period. And campaigning for general recognition that it is a legacy that deserves to be preserved and inherited

4.Conclusion

Guidelines of activities allow students to practice knowledge about science (e.g., materials) and mathematics (e.g., floral pattern) based on ethical significance (e.g., virtue of nation, religion and the monarchy) and aesthetics and beauty in form of flower arrangement. These guidelines may support teachers to focus primarily on the arts component while designing prototypes as STEAM knowledge with cultural heritage. In summary, the royal flower craftsman's work is valuable in both cultural aspects. history That has been accumulated for a long time Therefore, actions should be taken to continue the inheritance of this cultural heritage in the future. And has been developed to be appropriate Consistent with the context Create development and monetization opportunities that are cultural business opportunities. The researcher has therefore proposed a method for the inheritance of the royal flower works. It presents the character of the garland with three objectives: build oneself, create value and create careers. Through five key elements: creating a new career Conserving Thainess Attention to education the development of craftsmanship attitude and adherence to daily life by driving such actions, networks should be created. According to the method of building a ring-type network that integrates operations in a form of strengthening between 7 sectors: government agencies, educational institutions, communities, private sector, mass communication, local government organizations and civil society That all play a role in promoting, preserving, developing, preserving the royal flowers in the royal court for sustainability.

Acknowledgements

This research was financially supports by Faculty of Education, Nakhon Phanom University, Thailand. (Fiscal year 2023). Thank you for your kindness.

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