International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 7, November-December 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Levels of Conceptual Understanding and Problem-Solving Skills of Physics Teachers in Kinematics

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ABSTRACT

The study aimed to determine the level of conceptual understanding and problem-solving skills of Physics teachers in Kinematics. The study utilized a convergent-parallel mixed-method research design to collect quantitative and qualitative data. A validated researcher-made tool was used in conducting the study. The study was administered to 44 public high school Science teachers in Toledo City, Cebu, Philippines, that are teaching Science at any grade level regardless of their field of specialization.

Based on the findings of the study, most of the Physics teachers were female, General Science majors, and have 1 to 5 years of Science teaching experience. The overall level of conceptual understanding among Physics teachers was Developing, while their level of problem-solving skills was Approaching Proficiency. The relationship between the level of conceptual understanding and the level of problem-solving skills revealed a significant correlation. Moreover, teachers encountered difficulties in understanding and teaching Kinematics, applying mathematical skills, developing students' interests in Physics, and time allotment. Physics content knowledge is crucial in understanding Kinematics while integrating concepts with problems. This supported Lee Shulman's Content Knowledge theory and Jerome Bruner's Constructivism theory which emphasized the teachers' quality of teaching such as possessing a higher conceptual understanding and problem-solving skills in Kinematics as it affects the teacher's quality of instructions and students' performances in Physics.

The researcher recommended that curriculum specialists and school administrators shall provide training for teachers, especially non-Physics majors, to enhance their conceptual and mathematical skills in Kinematics. Further studies may be conducted for out-of-field Physics teaching and students' conceptual understanding and problem-solving skills in Kinematics or other Science-related concepts.

How to cite this paper: Apple Kae R. Lumantao "Levels of Conceptual Understanding and Problem-Solving Skills of Physics Teachers in Kinematics" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-7, December 2022, pp.1295-1322, URL: www.ijtsrd.com/papers/ijtsrd52589.pdf

IJTSRD52589

KEYWORDS: *Kinematics, Physics, Physics teachers, Conceptual understanding, Problem-solving skills, Physics Education*

1. THE PROBLEM AND ITS SCOPE

Rationale

Science education has paved the way to lifelong and meaningful learning with the ultimate goal of scientific conception through fostering scientific values and interests among students and teachers (Daud et al., 2015). According to Reddy and Panacharoensawad (2017), Physics has been a difficult subject due to its dominant problem-solving nature. Moreover, though Physics concepts today are mostly done through mathematical rigors, concepts are at the backbone of it all.

Kinematics, a subchapter of Mechanics in Physics, is a prerequisite to Dynamics, making it a fundamental concept before constructing a more advanced concept in various branches of Physics (Ayop and Ismail, 2019; Murdani and Sumarli, 2020). In the context of Philippine education, the concept of motion is introduced from Grade 3 up to Grade 10 with increasing level of complexity (K-12 Curriculum guide in Science, 2016). Students in the said curriculum experienced extensive context-based learning addressing the main objective of the Philippine Science education.

With this, Physics teaching requires continuing experience as it has been described as a challenging pursuit of scientific comprehension due to its difficulty. New knowledge can be retained longer and reinforced when teachers establish a strong foundation among students (Hairan et al., 2018). However, various studies reported that students' incorrect Physics conceptions still exist even after applying varying approaches to correcting them. Antwi et al. (2016) asserted that an adequate understanding of fundamental concepts is necessary for expert problem-solving. As defined by Sutarno et al. (2017), problem-solving skills are the ability to process information to develop a solution. Therefore, to avoid misleading students, teachers must have excellent competence and comprehension (Kornalia, 2020).

The demand for content knowledge among teachers may look like a truism, but Kuczmann (2017) argued that there are noticeable gaps in their knowledge. These varies by teachers despite various claims that middle school physical Sciences is readily understood by teachers. According to Robinsons (2017), ineffective Physics teaching and students' poor performance in Physics can be attributed to teachers' inadequate Physics content knowledge. Furthermore, Kirschner (2016) stated that Physics teachers' conceptual knowledge should be assessed as an avenue toward professional knowledge enhancement. However, several studies have been conducted on conceptual understanding but predominantly focused on students' conceptions of Science and only minimal studies evaluate teachers' Physics knowledge.

Lack of content knowledge, and mathematical skills in Kinematics among Physics teachers handling the subject, can impede the quality of instructions of the concept despite utilizing various teaching strategies and approaches. This prompted the researcher to investigate Physics teachers' conceptual understanding and problem-solving skills on Kinematics concepts as empirical studies of these two factors of quality teaching are scarce.

Statement of the Problem:

This study determined and correlated the Physics teachers' conceptual understanding and problem-solving skills in Kinematics concepts. Specifically, this study aimed to answer the following questions:

1. What is the profile of the respondents in terms of:
1.1. sex;
1.2. field of specialization and
1.3. number of years in teaching Science?

2. What is the level of conceptual understanding of the Physics teachers in Kinematics in terms of:
2.1. field of specialization and;
2.2. number of years in teaching Science?

3. What is the level of problem-solving skill of the Physics teachers in Kinematics in terms of:
3.1. field of specialization and;
3.2. number of years in teaching Science?

4. Is there a significant correlation between the level of understanding and level of problem-solving skills of the Physics teachers in Kinematics?

5. What difficulties were encountered by the Physics teachers in teaching Kinematics?

6. How did the Physics teachers address the difficulties they encountered in teaching Kinematics?

Statement of Null Hypothesis

In the conduct of the study, the following hypotheses will be tested:

H_{01}: There is no significant correlation between teachers' level of conceptual understanding to the level of teachers' problem-solving skills in Kinematics

Theoretical Background

Related Theories

Conceptual Understanding Theories

Lee Shulman (1986) Content Knowledge Theory proposed that content knowledge, described as a teacher's organization of knowledge, is categorized into three domains: subject-matter content knowledge, pedagogical content knowledge, and curricular knowledge. Subject-matter content knowledge which is the interest of the present study, emphasized that teachers should not just teach facts, definitions, and theories of a particular subject but must also explain the causes of a particular phenomenon, such as why and how information was constructed. This categorization of teachers' content knowledge has been utilized in various studies to measure the quality of teaching. Furthermore, conceptual understanding is described as the reconstruction of ideas by connecting those that an individual already knows. The process of acquiring conceptual understanding is associated with the constructivist theory of learning.

On the other hand, Jerome Bruner (1961), one of the early proponents of Constructivism, claimed that an individual constructs new concepts based on their current or past knowledge (Ilyas and Saeed, 2018; Widiyatmoko and Shimizu, 2017). Without the appropriate background knowledge, an individual cannot learn new knowledge, and develop new skills, such as problem-solving (Lucas and Corpuz, 2014). The constructivist theory describes learning as connecting new knowledge with prior knowledge affected by an individual's beliefs and attitudes (Olusegun, 2015). Based on Bruner's argument on the importance of background knowledge, understanding concepts or knowledge is a prerequisite to dealing with problems. This theory described how teachers develop and link various motion concepts and how they integrate these concepts to solving related problems.

Problem-solving Theories

Gestalt theory is one of the foundations of cognitive perspectives in learning. Max Wertheimer (1925), Wolfgang Kohler (1947), and Kurt Koffka (1935) viewed learners as active individuals simultaneously and continuously organizing and restructuring data in order to grasp an understanding of it. The theory stressed that the problem-solving process includes novel ways of achieving the expected solution, emphasizing the solver's behavior toward the problem. One way of representing a problem is by restructuring in which a problem is examined and analyzed. Laurillard (1997) stated that Gestalt psychology is directed at how an individual makes sense of the problem presented in front of him. Gestalt theory characterized teachers as problem solvers that do not only solve for the unknown but also understand the whole concept of the problem.

Furthermore, a famous problem-solving model is by Polya (1945), as stated by Erlina, Jatmiko, and Wicaksono (2017). This model was used in describing teachers' problem solving ability while undergoing the four stages of the model which are:

A. Understanding the problems. Students cannot understand the problem completely or even partially, which leads Polya to suggest questions that teachers should ask: *Do you understand all the words used to describe the problem? What are you asked to find or show? Can you restate the problem in your own words? Can you think of a picture or diagram that might help you understand the problem? Is there enough information to enable you to find a solution?*

B. Plan Solutions. The skill of choosing an appropriate strategy is best learned by solving many problems. Some of these are: *Guess and check; Look for a pattern; Make an orderly list; Draw a picture; Eliminate possibilities; Solve a simpler problem; Use symmetry; Use a model; Consider special cases; Work backward; Use direct reasoning; Use a formula; Solve an equation and Be ingenious.*

C. Solve the problem according to the plan. Persist with the plan that is chosen. If it continues not to work, discard it and choose another. Do not be misled; this is how mathematics is done, even by professionals.

D. Look back. Polya mentions that much is gained through reflecting and process-output assessment. Doing this will enable the individual to predict what strategy to use to solve future problems.

Related Literature

Kinematics

Mastery of motion is crucial to survival and success as a species, from the primordial track of antelopes across Savanna to the pursuit of satellites in space. Mechanics, a branch of Physics, describes the relationship between the motion of objects and the force exerted on them. It is divided into two main units, namely: Kinematics and Dynamics. Kinematics, the interest of the study, describes the motion of any object without regard to the forces that cause it. (Serway and Vuille, 2017).

Physical quantities such as displacement, velocity and acceleration are used in describing one-dimensional Kinematics. In two-dimensional Kinematics, an object is simultaneously observed as it moves along the x and y direction under the influence of constant acceleration. The essential characteristic of a projectile motion is the independency of its horizontal and vertical components of motion. Lastly is the concept of relative velocity, in which the velocity is measured using a frame of reference, either stationary or moving.

An understanding of Kinematics is crucial in describing and explaining the motion of real-life objects hence making sense of the world. It is also vital in studying forces that caused the motion of objects. Despite the topic being a basic concept in Physics with problems only requiring introductory algebra and sometimes basic trigonometry, developing an adequate understanding is difficult and calculations can still be confusing.

Physics Teacher's Content Knowledge

Scientific Literacy is described by PISA (2018) as being capable of understanding scientific concepts, presenting a scientific explanation in terms of its underlying scientific concepts, and applying scientific procedures. Students and teachers must practice synthesis and communication of Science content knowledge to help them improve their Scientific literacy (Victoria Department of Education and Training, 2019).

According to Ramma (2017), content knowledge is vital for Physics effective teaching, but Physics teachers who are meant to teach Kinematics did not understand its underlying concepts. A Physics teacher may be able to define Physics variables but lacks on conceptual understanding of how these variables are related which is due to their misconceptions in Kinematics. This imposed a tremendous challenge for Physics teachers to teach effectively since insufficient understanding of basic Physics concepts among Physics teachers could lead to inadequate learning among students.

According to the Framework for Philippine Science Teacher Education (2011), the qualities of effective Science teachers are deeply rooted in mastery of content knowledge, pedagogy, and attitude. It means having an adequate conceptual understanding in order to teach it in a comprehensible manner to the students. When conceptual understanding is weak, Science teachers cannot deal with students' confusion. The development of student's conceptual understanding of Physics is integral to a good problem-solving technique which means that teacher's content knowledge and problem-solving skills are considered important in the success of any Physics topics.

Moreover, there are no easy steps in Physics problems. There are three important stages in problem-solving that facilitate attaining the solution to the problem: strategy, solution, and significance. The strategy stage is understanding the problem and developing ways of solving it while the solution stage is applying mathematical knowledge to find the unknown from the known variables. Lastly is the significance stage, which refers to evaluating whether the process makes sense (OpenStax, 2022).

This is supported by Orgoványi-Gajdos (2016), who described problem-solving skills as a necessary competency a teacher must possess because teachers often encounter problems in teaching. It is directly linked to perception and representation of the problem, reasoning, data collection, analysis, finding solutions, decision making, planning, reflection, and evaluation which are generally coined as cognitive and metacognitive processes. Thus, problem-solving skill is vital in the teaching profession, not just in a specific subject but across all subjects and teaching competencies.

According to Patterson (1986), working with Physics problems is time-consuming. Rather than analyzing the problem and its underlying ideas and application, physics teachers tend to skip the problem unresolved and move to another problem. Apart from that, teachers were also distanced from dealing with Physics problems due to non-teaching related work.

Physics Education in the Philippines

The development and advancement of scientific literacy among students is the central aim of Science education in the Philippines. The K to 12 Science curriculum was carefully crafted and significantly linked to its content and skills since the lack of content hinders students from acquiring Science process skills of the context. (K-12 Science Curriculum Guide, 2016).

In the Philippine K to 12 Science curriculum (2016), Physics concepts, particularly Kinematics, are introduced with increasing difficulty starting from third to tenth grade. In Grade 3, students observe the movement of the things around them. In the following Level-Grade 4, students understood that an object's motion, size, and shape could be affected by the amount of force, including the forces that magnets exert. In Grade 5, students quantitatively measure how much an object changes its movement. Their conceptions widened by introducing the concept of gravity and friction as factors affecting the object's motion in the Grade 6 level.

By the time students reach junior high school education, students in the 7th-grade level become acquainted with the scientific description of motion in one dimension. In Grade 8, students learn Newton's laws of motion to explain an object's state. Students in the Grade 9 level deepen their understanding of motion as applied in two dimensions. In the last level of junior high school force and motion progression, Grade 10 students expand their comprehension of forces by understanding how the movement and stability of an object are affected by balanced and unbalanced forces.

Previous grade-level knowledge in Physics is essential to construct new understanding. Science content knowledge should be carefully imparted to the students through varied teaching instruction. Thus, teachers must possess accurate scientific knowledge and a deeper understanding of how this knowledge is interrelated and applied to different situations.

Out-of-field Physics teaching

An editorial published by Luft (2020) stated that content knowledge is essential in teaching. The central problem of out-of-field Science teaching is mastery of the concepts. This concern was lacking in research and underreported, thus often overlooked by educational institutions making the public continuously assume that teachers have sufficient content knowledge and are assigned appropriately (Luft et al., 2020).

In some countries, adhering to the continuous demand for highly qualified teachers is challenging. Vacancies of Science teachers are a significant concern and could affect the quality of education due to a shortage of teachers specializing in Science (Luft et al., 2020). In this regard, out-of-field Science teaching arises to reach the teacher-student ratio in the classroom with teachers having insufficient qualifications in teaching the subject. Ironically, Science education has been pursuing its goal of producing STEM professionals and modifying teaching knowledge standards, forcing non-Science major teachers to teach Science even though it is beyond their area of expertise.

Based on the 2011 framework for Philippine Science Teacher Education, many schools in the Philippines were forced to assign out-of-field teachers to teach Science subjects due to a lack of qualified Science teachers. Furthermore, the following are qualified Science teachers described by Garcia and Tan (2004) as stated in Project RISE (Rescue Initiatives in Science Education).

1. Those who have specialization in any Science discipline (e.g., biology, chemistry, Physics, and general Science) in their undergraduate degrees;
2. Those who have undergone in-service training programs in the varied Science disciplines equivalent to a major or minor; and
3. Those with degrees in Science-related professions (e.g., engineers, pharmacists, nutritionists, and nurses) who opted to teach at the basic education level took 18 units of foundation education subjects and passed the licensure examination for teachers.

Despite these broad categories, qualified Science teachers are still lacking in the country. This is supported by the University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED), as mentioned in the framework, which reported that most teachers handling Science subjects are non-Science majors.

Related Studies

The following relevant studies were reviewed to give more substance to the study.

Kinematics

A study by Ayop and Ismail (2019), reviewed reported research on assessments, difficulties, and teaching strategies on Kinematics. The study presented that understanding the concepts of velocity, acceleration, and displacement of objects in motion are the critical conceptual difficulty in Kinematics. These difficulties are significant concerns in Science education, motivating teachers to seek new approaches toward a scientific understanding of Kinematics concepts. It is also noted that PhysPort, an online platform of Physics teaching resources has assessments listed for Mechanics but only 5 out of 15 research-based assessments are related to Kinematics. Despite being a fundamental Physics concept, Kinematics is still viewed as difficult to understand, mainly when applied to problem-solving.

In the study conducted by Taqwa and Rivaldo (2018), 48 physics education students were examined in their ability to determine the distance traveled, average speed, and acceleration of position functions which are basic concepts in Kinematics. The study showed that students have difficulties in solving problems and explaining concepts in Kinematics such as distance, average speed, and acceleration of the position equation as a function of time which is due to their lack of understanding of vector concepts.

Physics teachers' content knowledge

The prime substance and basis of education is knowledge. It plays an essential role in improving and modifying the Physics curriculum.

The study of Sun (2019) aimed to expose the implications of Physics teachers' knowledge since the quality of teaching depends on it. The study suggested that this knowledge should be composed of four components: knowledge of Physics subjects, pedagogy subjects, knowledge of relevant subjects, and technology. The researcher showed that Physics teachers must have high conceptual understanding on the basic Physics knowledge to avoid teaching students with inaccurate information. This knowledge is a continuous and unending pursuit of understanding and skills improvement by the teacher in the teaching-learning process to align students to the standards set by the education goal.

Sadler and Sonnert (2016) investigated the Science teachers' subject-matter knowledge and their knowledge of students' misconceptions and measured their relationship to student learning. It showed that sufficient knowledge on middle school physical Science teachers is evident but is inadequate and sometimes incorrect. Hence, teachers lacking this factor may deliver lessons incorrectly, leading to students' inaccurate conceptions of Science. Another finding showed that teachers who perceived students' misconceptions as an important area of concern are more likely to find ways to improve and change these misconceptions than teachers who do not.

In the study by Liu and Sun (2021), the critical competencies of middle school Physics teachers were analyzed and explicated relative to the teachers' professional development. These key physics teaching competencies are physics knowledge, scientific knowledge, teaching knowledge, humanistic knowledge, information knowledge, and lifelong learning skills. The key competencies demand Physics teachers to teach Physics along with its real-life application. The study also suggested that in order to effectively teach Physics, teachers should have mastery of conceptual understanding, problem-solving skill and scientific communication while incorporating across interdisciplinary knowledge.

In line with this, a study was conducted by Pedersen et al. (2018) to six Nebraska high school Physics teachers. It identified the teachers perceived impact of participating in a collaborative scientific research program that builds on fundamental high school physics concepts. The authors revealed that Physics being a difficult subject, teaching it requires ongoing learning. Physics teachers' awareness and perception on their content knowledge, learning experience and professional development needs should be given attention, if the goal is to improve the way physics is learned and taught at the secondary level. The study also indicated in the results that Physics teachers should be good at teaching the subject requiring them to use various strategies to help students understand the concepts.

Eraikhuemen and Ogumogu (2014) examined high school Physics teachers' conceptual understanding of forces and motion based on the premise that misconceptions still exist among students even after instruction. The study showed that 73% of the Physics teacher participants did not have a conceptual understanding of forces and motion even though these concepts basic foundations of Physics concepts. The study also revealed that qualifications, specializations, and teaching experiences did not significantly impact the Physics teachers' conceptual understanding of forces and motion.

Kirschner et al. (2016) developed an instrument with three dimensions, namely, content knowledge (CK), pedagogical content knowledge (PCK), and pedagogical knowledge (PK). The findings showed that Physics teachers' CK, PCK, and PK are important distinctions of teachers' overall professional knowledge. It impacts teaching and learning outcomes; hence, identifying the contents taught by Physics teachers is necessary, especially when conducting teaching education programs.

Teachers' professional knowledge is crucial in every aspect of education as it is one of the factors of effective teaching. It demands assessments to enhance teachers' educational goals across the globe since there are limited studies that quantitatively assess Physics teachers' professional knowledge.

According to the study conducted by Mohammed and Andrew (2021) which sought to identify common patterns in interactions among orientations and knowledge bases of pedagogical content knowledge of teachers (PCK). The study showed that students' difficulties in understanding Physics concepts were attributed to teachers' poor understanding of Physics concepts. Moreover, how these components are utilized to help teachers translate instructions from content knowledge was not clearly investigated, leaving a gap in how Physics teachers' knowledge should be assessed.

Physics Teachers' Problem-solving skills

Another factor that significantly impacts the quality of teaching Kinematics concepts is the problem-solving skills of Physics teachers. Problem-solving is one of the 21st-century skills that every educational institution must be developed to help students become more competent in Science.

A study by Sutarno et al. (2017) explored the skills of 76 pre-service Physics teachers in applying the stage of problem-solving strategies. The research determined that the pre-service teachers' problem-solving skills were still low although they already acquired the necessary Physics courses and the problems are only based on the fundamental concepts of Physics. It also showed that pre-service teachers failed to relate the known concepts with the unknown variables. The authors attributed the results to the lack of problem-solving skills in applying the steps. Preservice physics teachers being skill poor at solving problems could impact how they teach in the field.

A study by Çıldır (2019) aimed at providing awareness and skill to the preservice Physics teachers in the areas problem posing and problem solving. The study showed that pre-service Physics teachers had difficulty posing problems and no specific steps and techniques were utilized. Additionally, some of these teachers were unable to evaluate and reflect on their solved problems. However, the study inferred that these prospective teachers wanted to use their problem posing and solving skills in their professional lives in order to reinforce the subject and to increase the motivation.

The study by Ince (2018) presented an overview of problem-solving studies in physics education. It was revealed that one of the factors that affected problem-solving performance was conceptual knowledge. It was also revealed that there are two types of problem solvers which are the experts and the novice. Expert problem solvers seek the underlying concepts of the problem before solving it. On the other hand, novice problem solvers solve problems by first using mathematical expressions without establishing relationships between concepts. It was also ascertained that how teachers teach problem-solving plays a vital role in Physics education as this is where students always encounter difficulty.

Reddy and Panacharoensawad (2017) evaluated the problem-solving skills and the factors that influence the problem-solving difficulties in Physics among 303 high school students. The results of the study revealed that students' poor understanding of Physics concepts and equations resulted in a high failure rate in the subject. The study proposed that teachers need to be highly qualified to provide students the assistance needed in acing Physics problems.

Teachers as a factor for Student Misconceptions

Misconceptions arise when previous knowledge acquired from experiences outside and inside the classroom does not align with accurate scientific concepts. In Physics, these misconceptions hinder conceptual understanding among teachers and students, making the subject more complex and less interesting as misconceptions become more challenging to change the longer it is used or applied.

In the study of Sadler and Sonnert (2016), teachers mostly encounter common high school misconceptions about Science even after acquiring higher-level courses in college, especially those majoring in Science subjects. The study also revealed that teachers and students chose the same incorrect answer to items considered misconceptions. Hence, teachers' ability to identify misconceptions is weak.

In the study conducted by Ekici (2016), a valid and reliable instrument was developed to assess why Physics courses are perceived as one of the most difficult courses among high school students and to investigate the reasons why students have difficulty learning physics through this scale. The results showed that students mainly attributed their difficulties to the teachers, the content, and their abilities. The researcher suggested that in weakening the perception of Physics as a difficult subject, teachers are compelled to acquire and develop adequate understanding of content knowledge so that identification of students' misconceptions can be readily done. However, if teachers also have misconceptions similar or not to the students, then the ultimate aim of transferring content knowledge is highly at stake.

Accordingly, Ilyas and Saeed (2018) stated that misconceptions among students are greatly influenced by teachers, which led them to conduct a study on chemistry teachers' awareness of students' misconceptions. Based on the findings, teachers ignore teaching as a source of misconceptions. Interventions for misconceptions should be done. The study also affirmed that what teachers teach to the students is what they understand. If teachers cannot identify misconceptions, they might also have the same understanding as the students.

Out-of-field Physics teaching

Qualified teachers in all schools are the most significant factor in improving student achievement. Non-Physics major teachers teaching the subject presented a problem in Science education as they are prevalent in rural communities.

Abella et al. (2021) examined the lived experiences of Senior High School out-of-field Science teachers in one of the public high schools in the Philippines. The study revealed that one challenge that Science teachers encounter is inadequate subject matter knowledge (SMK) and pedagogical content knowledge (PCK). According to the teachers, choosing the appropriate teaching strategies, making activities, time allotment in teaching, and discussing the lesson are challenges that made them less confident and less creative in the classroom.

The researchers also added that it posed attention to conduct more content knowledge training as there is a shortage of subject teachers. In addition, factors such as workloads and learning competencies that every student must achieve placed Physics teachers under pressure making the problem difficult to address. In constructing the educational system, the availability of competent teachers is vital since it directly impacts the quality of education.

In the study conducted by Ingersoll (2002), an exploratory analysis was done focusing on the problem of out-of-field teaching. The study presented that teachers were assigned to subjects out of their fields despite that they hold the basic qualifications. This problem was due to the administration and organization of schools and not because of hiring difficulties. It was also identified that it is the inability of schools to adequately staff classrooms with qualified teachers that affects the quality of teaching and inadequate student achievements.

Physics Teacher in the Philippines

In the context of Philippine education, Diate and Mordeno (2021) investigated specific challenges that Physics teachers encounter in teaching Physics. The study was anchored on the results of the previous 2018 and 2019 Trends in International Mathematics and Science Study (TIMSS) with the DepEd's desire to evaluate the effectiveness of the K to 12 enhanced basic education curriculum, which consistently showed unfavorable results even with the recent curricular revision. The study exposed the challenges that Physics teachers were in terms of literacy, numeracy, physical facilities, and real-life application which could significantly impact the quality of Science education in the country.

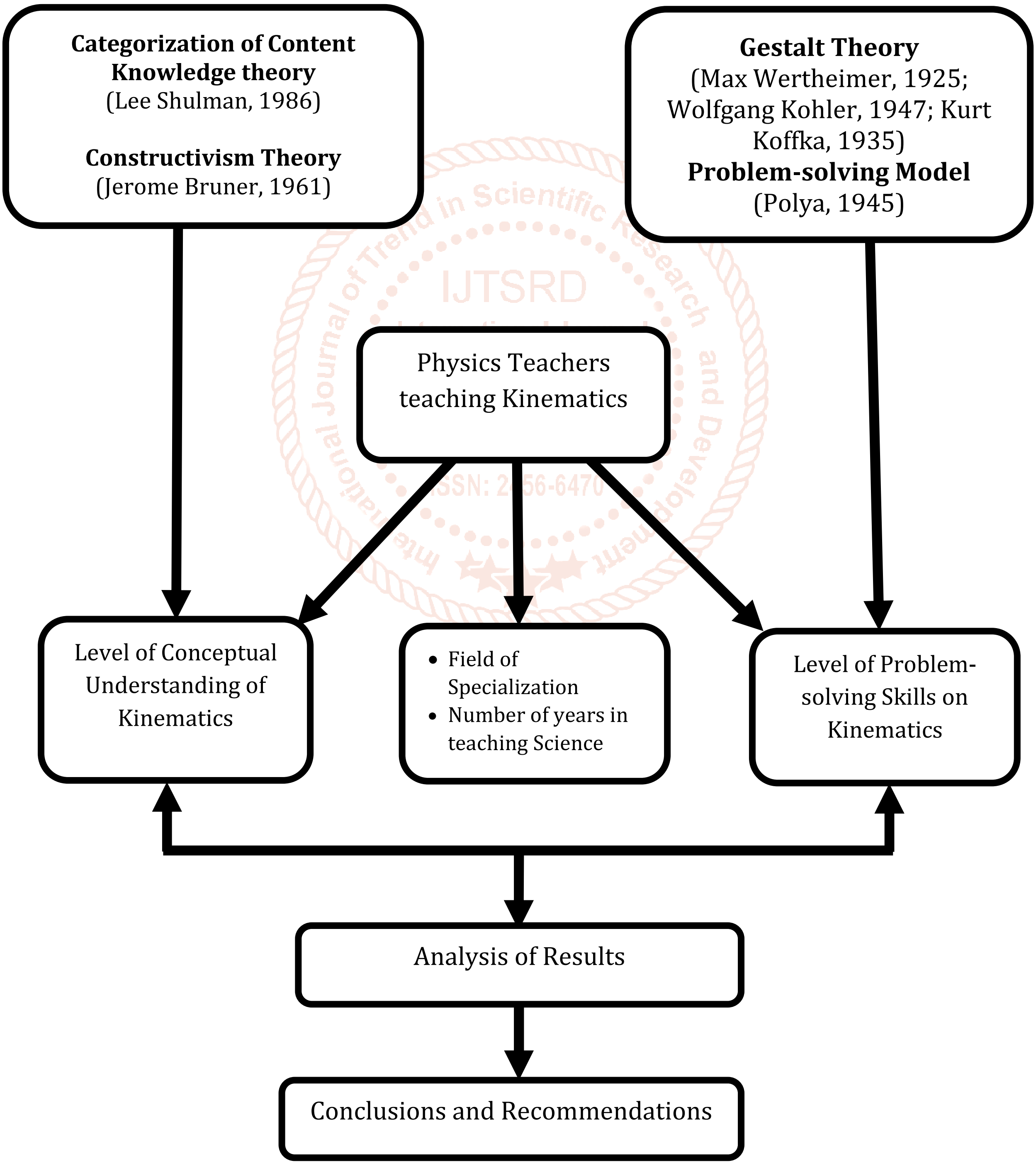
Unexpectedly, Diate and Mordeno (2021) presented that despite teachers' awareness of the set of skills needed by the student in learning Physics, they also have difficulty improving these skills. The authors also noted that the quality of Science education in the country will continue to decline if these challenges are left unaddressed.

Various studies have mentioned that one of the factors influencing the difficulty in understanding Kinematics problems is the teacher. Based on the literature mentioned above and related studies or bearings on the study, the theoretical-conceptual framework is presented on the next page. The theoretical-conceptual framework of this study is presented on the next page.

Theoretical-Conceptual Framework

The Theoretical-Conceptual Framework of the study is shown in the figure below.

Figure 1 Theoretical-Conceptual Framework of the study



Significance of the Study

The results of this study would benefit the following: The **teachers** could be made aware of their content knowledge and problem-solving skill thereby enhancement of this knowledge and skills could be made. **Students** could be taught with correct science concepts and improved their performance in Physics through teachers' adequate content knowledge and skills;

the **school administrators** could be provided with data on what requires improvement among teachers, such as modified training and seminars enhancing teachers' conceptual understanding and problem-solving skills on Kinematics;

the **curriculum specialists** could be provided with a basis for constructing guidelines and training matrix on teacher's content knowledge and problem-solving skills, especially those out-of-field Physics teachers and;

future researchers could use the study's results when conducting further studies on the relationship between conceptual understanding and problem-solving of Kinematics concepts.

Scope and Delimitations of the Study

This study was conducted on forty-four (44) public high school teachers teaching Science in the Division of Toledo City, Cebu, Philippines. Teachers handling Science subjects were selected from the 12 public high schools in the city. Respondents were assessed using a 40-item multiple choice questionnaire and ten items problem-solving using a researcher-made tool related to Kinematics concepts to assess their conceptual understanding and problem-solving skills. A set of interview questions regarding teachers' encountered difficulties and how they address them in teaching Kinematics were attached to the questionnaire. The assessment tool was physically given to them with strict compliance with the social distancing protocols of the pandemic. The respondents were given a printed copy of the questionnaire instead of sending it electronically due to intermittent internet connectivity issues at the schools' locations. The study was conducted from April to July 2022. This study only accounts for two factors of quality teaching of Kinematics concepts: teachers' conceptual understanding and problem-solving skills and how these two variables relate to one another.

Definition of Terms

In this study, the following terms were described operationally.

Science Concepts. It refers to the laws and theories in the form of systematic mental representations of why and how a natural event or process occurs (Kostas Kampourakis, 2018). It also refers to the Science content knowledge that teachers possess and teach to the students.

Kinematics. It deals with the description of motion without regard to what causes it. In the study, Kinematics is the focused Science concept due to its importance and progressing level of knowledge in the K to 12 curriculum.

Conceptual Understanding. In Science, it refers to the ability to relate and apply correct scientific concepts to everyday life phenomena, thus making sense of the word (Widiyatmoko and Shimizu 2017). The study pertains to the comprehension of Kinematics concepts concerning a given phenomenon in one and two dimensions.

Problems. It refers to a task, situation, or person with which an individual is encountering difficulty. It is a question that seeks a solution (Seel, 2012). In the study, problems are situations related to the motion of an object presented in a situation that requires a conceptual understanding of Kinematics concepts and problem-solving skills in arriving at a solution.

Problem-solving Skills. It refers to the skill of determining the problem source and finding ways of solving it. In the study, it is defined as the skill in applying conceptual understanding to the problem and the needed mathematical skills to solve problems on Kinematics.

Physics Teachers. In this study, it refers to any teacher who teaches Physics regardless of their academic background in twelve (12) public high schools in Toledo City.

2. RESEARCH METHODOLOGY

This chapter presents the study's research methodology, including research design, research environment, research respondents, research and data gathering procedures, research sampling, research instrument, research ethics and data management plan, and statistical treatment.

Research Design

The study used a Mixed Method Research Design to collect quantitative and qualitative data to analyze the research problem. Specifically, Convergent parallel design, a mixed-method design, was employed in which the quantitative and qualitative data were collected concurrently and analyzed separately. A combination-relation of two databases was done during the interpretation and discussion of results, thereby drawing an overall conclusion. Furthermore, a correlational research design was used to obtain quantitative data through determining the relationship between levels of conceptual understanding and problem-solving skills. For the qualitative data, a descriptive survey research design was used to identify the difficulties encountered by Physics teachers in teaching Kinematics concepts and describe how Physics teachers address these challenges.

Research Environment

The study was administered at twelve public high schools in Toledo City, Cebu, Philippines. These schools are classified into clusters 1, 2, and 3, in each cluster is composed of four secondary schools. The division superintendent arranged the clustering of these schools. These public high schools of the city were designated as **A, B, C, D, E, F, G, H, I, J, K, and L** in this study. Cluster 1 has schools A, B, C, and D; cluster 2 comprises schools E, F, G, H, and I, J, K, and L for the third cluster. Moreover, each school environment was identified as **C1-A,** denoting that the school is under **cluster 1.**

C1-A offers both Junior and Senior High Schools and has approximately 80 teachers. It is located along the national highway. The school is one of the three public high schools in the city that offers Science, Technology, Engineering, and Mathematics (STEM) strand to Senior High Schools.

C1-B has 44 teaching personnel, both offering Junior and Senior High School. The school is located along the national highway.

C1-C also offers both Junior and Senior High schools with 64 teaching personnel. The school was categorized as a big school due to the large population of students and is 300 meters from the national road.

C1-D is composed of 65 teachers and also offers both Junior and Senior High Schools. The school specializes in technical and vocational training and is located along the national highway. The school is also considered a big school.

C2-E is located approximately 1.7 kilometers from the national highway, with 18 teachers. The school also has both Junior and Senior High Schools.

C2-F has 32 teachers, offering both Junior and Senior High School. It is also 1.7 km from the national highway.

C2-G is situated 170 meters from the national highway, where 143 teachers are stationed. The school offers both Junior and Senior High Schools and is therefore considered a big type of school. The second public high school offers a STEM strand for Senior High School.

C2-H is considered the farthest school, approximately 12 kilometers from the national highway. The school has 56 teachers and offers both Junior and Senior High Schools.

C3-I comprises 46 teaching personnel and offers both Junior and Senior High schools. The school is situated 2.6 km from the national highway.

C3-J is also considered a big type of school, offering both Junior and Senior High Schools with 169 teaching personnel.

C3-K has 21 teachers and also offers both Junior and Senior High Schools. The school is also located along the national highway.

C3-L is located at the top of a mountain, 400 meters from the national highway. It has only 20 teachers and offers both Junior and Senior High Schools and specializes in Science and Mathematics and is the third public high school that offers STEM education in Senior High Schools.

Research Respondents

The study was conducted on a forty-four (44) respondents stationed in the twelve public high schools in Toledo City. Teacher respondents in the study must have a Science teaching load at any grade level regardless of the field of specialization and are identified as Physics teachers considering that they taught Physics in a particular quarter throughout the school year. Teacher respondents were identified according to the cluster number and school represented by numbers **1, 2, 3, and 4.** The number of respondents from each cluster varied depending on the number of Science teachers in that particular school. Hence, a respondent with a label **C1-A.1** indicates that Teacher 1 is from a school labeled “A” under a district cluster 1 labeled “C1”.

The respondents’ educational background and years of service, assessment results on conceptual understanding, problem-solving, and responses to interview questions were collected in the study. Due to intermittent internet connectivity in these twelve schools, data collection was done physically with proper social distancing health protocols. Teacher respondents were asked for their consent to participate in the study and approval from the school head. Furthermore, they can request the results of their assessments.

Research and Data Gathering Procedures

The study underwent four phases which are the following: (1) permission to conduct the research; (2) Validation of the Research Instrument; (3) Pilot-testing of the Research Instrument; (4) Assessment of Physics teachers regarding their education and teaching background, conceptual understanding and problem-solving skills on Kinematic concepts, and interview questions on their difficulties in teaching Kinematics.

Before gathering the data, permission to conduct the study was addressed to the Schools Division Superintendent and School Heads. Subsequently, the Research Ethics Review Committee reviewed the research instrument used in the study since it involved human participants. The committee also reviewed the consent and consent-assent form. These forms were given and carefully explained to the research participants. Moreover, after accomplishing the necessary documents and approval of the committee, the researcher started conducting the study.

The data gathering procedures were done physically with strict compliance to the social distancing health protocols considering the ongoing COVID-19 pandemic. The respondents were given a week to complete the assessment. The teachers' profile was answered first, followed by the assessment on conceptual understanding and problem-solving skills, then the interview questions were the last. Furthermore, these instruments were validated and pilot-tested before administering it to the study participants. The assessment responses were retrieved one week after the assessments were given.

Research Sampling

This study utilized a non-probability sampling method in selecting respondents from the population and employed a homogenous purposive sampling technique which denoted that the research problem is specific to the characteristics of the groups of interests. Hence, only teachers handling Science from grades 7 to 12 had the chance to be selected as participants in the study. They were selected according to the purpose of the study, which was to identify the Physics teacher's level of conceptual understanding and problem-solving skill of Kinematics concepts. This means that these teachers were eligible and have taught Kinematics concepts in every Physics learning area for any grade level at a particular quarter.

Research Instrument

A researcher-made assessment was utilized in conducting the study (See Appendix E). The instrument has three parts, namely, (part A) Teachers' educational background and teaching experience; (part B) a test for conceptual understanding and problem-solving skill of Kinematics concepts; and (part C) interview questions on the difficulties encountered by the teachers in teaching Kinematic concepts and how they address them.

For part B, 40-item multiple-choice questions were given covering motion in both one and two dimensions, with twenty (20) items for each dimension. Additionally, 6-item Kinematics problems were administered equally divided for one- and two-dimensional motion. These questions are aligned with high school Physics learning competencies in the K-12 curriculum. Solutions to the problems were scored using the Minnesota Assessment for Problem-solving (MAPS) standardized rubric (See Appendix F). Questions were taken from standardized assessments such as Force and Motion Conceptual Evaluation (FMCE-v99-en), Force Concept Inventory (FCI-v95), Mechanics Baseline Test (MBT-v97), Force, Velocity, Acceleration Test (FVA-v3.2.3a), Test of Understanding Graphs in Kinematics (TUG-K v4.0) and Inventory of Basic Conceptions-Mechanics (IBC-M-vF06). Some items were also taken from books, mainly Conceptual Physics, College Physics, University Physics, and Physics Principles and Problems (Teachers Annotated Edition).

Furthermore, Physics experts validated the accuracy of Part B, and pilot testing was conducted before the data collection to measure the instrument's reliability. The instrument's reliability was measured with a reliability score of 0.7 and higher as an acceptable level of consistency. The alpha coefficient for the Conceptual Understanding assessment was 0.85, and the Problem-solving assessment was 0.76, suggesting that the instrument has a good and acceptable internal consistency, respectively.

A series of interview questions were also given as part C of the instrument. Teachers were asked about the challenges of teaching Kinematics concepts in terms of content knowledge, problem-solving skill, teaching strategies, resources, time allotment, students' behavior and interests, and other non-teaching related factors.

Research Ethics and Data Management Plan

The researcher had an ethical obligation to protect the confidentiality of personal information provided by research participants. The study requested a research ethics review from the University Research Ethics Committee. A documented consent form was given to the participants of the study. The consent form included the purpose of the study, procedures, risks, and benefits, and most importantly, the consent emphasized that participation in the study was voluntary. Participants in the study indicated in the consent form that they understood the study's purpose and allowed anonymized data-sharing upon agreement. Anonymized research data refers to the general results and findings of the study and does not directly point out the individual participant.

Personal data included the names, ages, educational backgrounds, teaching experience, and years of service of the participants, while individual scores of the participants are classified as confidential data. All personal and confidential data of the respondents were protected and not shared. Personal data collected from the respondents were destroyed since these were no longer needed, and the study participants were informed about it. Furthermore, the data gathered in the study were only used for academic purposes and kept at the utmost level of confidentiality.

The collected anonymized data and the research instruments were stored on the University premises, and digital access was done through authorized persons with University accounts. After completion of the study, anonymized data was preserved indefinitely and made available to others for further studies with a controlled access policy. Personal and confidential data was held longer than necessary and was subjected to periodic reviews to evaluate whether to retain or destroy it. A consent form was also retained as long as personal and confidential data were preserved. When the researcher left the university, the research adviser gave authority to hold the research data with provisions and agreements upon transfer of authority.

Statistical Treatment

The study utilized the following statistical tools to analyze the data collected.

1 To determine the Physics Teachers' Profile, a percentage statistic was utilized. Percentage was calculated by dividing the frequency in the category by the total number of participants and multiplying by 100%.

$$\% = \frac{f}{n} \times 100$$

where,
f = frequency of responses
n = total number of respondents

2 To determine the level of conceptual understanding of Physics teachers on Kinematics concepts in terms of their field of specialization and years of experiences, a weighted mean was calculated. A separate computation for the mean was done for one-dimensional and two-dimensional Kinematics items. A frequency distribution was done on each item.

3 To determine the level of problem-solving skills on Kinematics concepts in terms of their field of specialization and years of experiences, the Minnesota Assessment of Problem-solving (MAPS) was utilized. Jennifer Doctor and Ken Heller developed the MAPS rubric to assess students' problem-solving at the University of Minnesota. Each category in the rubric has equivalent points. These points are summarized to get the score for each problem, then added to obtain the overall score of the problem-solving assessment. The weighted mean was calculated by adding up all the scores in the problem-solving assessment and dividing it by the number of respondents in the study.

Formula for sample mean:

$$\bar{x} = \frac{\Sigma x_i}{n}$$

where,
$\bar{x}$ *= weighted mean*
Σx_i *= the sum of all the test scores*
n = number of respondents

The level of conceptual understanding and level of problem-solving skills were based on DepEd Order no. 31, series of 2012 which described the students' proficiency levels (See Appendix G). The said DepEd Order was used to categorize and describe the level of conceptual understanding and problem-solving skills relative to students' level of proficiency. These levels are described as such;

- **Beginning (B)**- The student at this level struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding.
- **Developing (D)**- The student at this level possesses the minimum knowledge and skills, and core understandings but needs help throughout the performance of authentic tasks.
- **Approaching Proficiency (AP)**- The student at this level has developed the fundamental knowledge, skills, and core understandings and, with little guidance from the teacher and/or with some peer assistance, can transfer these understandings through authentic performance tasks.
- **Proficient (P)**- The student at this level has developed the fundamental knowledge, skills, and core understandings and can transfer them independently through authentic performance tasks.
- **Advanced (A)**- The student at this level exceeds the core requirements regarding knowledge, skills, and understanding and can transfer them automatically and flexibly through authentic performance tasks.

4. A Pearson product-moment correlation or Pearson's r correlation was used in determining the relationship between conceptual understanding and problem-solving skills. The correlation coefficient measured the association of the target variables with a number between -1 and +1. A positive coefficient implies a significant relationship, while a negative value indicates a weak correlation between variables. A sample covariance and its sample standard deviation were used in calculating the sample correlation coefficient.

Formula:

$$r_{xy} = \frac{n\Sigma XY - \Sigma X \Sigma Y}{\sqrt{(n\Sigma X^2 - (\Sigma X)^2)(n\Sigma Y^2 - (\Sigma Y)^2}}$$

where,

r_{xy} = *strength of the correlation between variables x and y*

n = *sample size*

X = *each X-variable value*

Y = *each Y-variable value*

ΣX = *summation of X-variable value*

XY = *summation of Y-variable value*

XY = *product of each X-variable value and Y-variable value*

ΣXY = *summation of XY product values*

All statistical tests were done at a 0.05 level of significance.

5. The frequency of responses was determined to determine the overall challenges Physics teachers encountered in teaching Kinematics concepts and their means of addressing them. The data collected underwent content analysis, which was then categorized.

3. PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter presents the data analysis and discusses the results of the study.

Profile of Physics Teachers

Table 1 presents the profile of the Physics teachers as respondents of the study in terms of sex, specialization earned related to Science, and the number of years they have taught Science.

Table 1 Profile of Physics Teachers in terms of sex, degree of specialization earned related to Science teaching, and number of years in teaching Science. (n=44)

Profile Criterion		Frequency	Percentage
Sex	Female	36	82%
	Male	8	18%
Specialization earned related to Science teaching	Physics	5	11%
	Chemistry	4	9%
	Biology	9	20%
	General Science	19	43%
	Math	7	16%
Number of years in teaching Science	1 – 5	23	52%
	6 – 10	7	16%
	11 – 15	7	16%
	16 – 20	2	5%
	21 – 25	1	2%
	26 –30	3	7%
	31 – 35	1	2%

From the Table, most respondents were females (82%), while only 18% were males. Regarding specialization, 43% of the respondents graduated, majoring in General Science, while 52% were almost new to the teaching profession with only 1-5 years of teaching experience.

Level of Physics Teachers' Conceptual Understanding in Kinematics

Table 2 presents the conceptual understanding of Physics teachers in Kinematics according to the field of specialization.

Table 2 Physics teacher's level of Conceptual Understanding in terms of Field of Specialization

Field of Specialization	n	One-Dimensional Motion (20 items)			Two-Dimensional Motion (20 items)			Total (40 items)		
		M	SD	QD*	M	SD	QD*	M	SD	QD*
Physics	5	9.40	4.80	AP	10.00	4.60	AP	19.40	9.37	AP
Chemistry	4	10.00	3.08	AP	11.75	1.92	AP	21.75	4.76	AP
Biology	9	8.00	4.16	D	8.22	4.54	D	16.22	8.65	D
General Science	19	6.79	3.53	D	7.00	3.61	D	13.79	6.90	D
Mathematics	7	5.29	2.43	D	4.14	2.53	B	9.43	4.73	D
Overall	44	7.39	3.97	D	7.57	4.29	D	14.95	8.08	D

for 20 items	for 40 items	*Qualitative Description (QD)
17-20	33-40	Advanced (A)
13-16	25-32	Proficient (P)
9-12	17-24	Approaching Proficiency (AP)
5-8	9-16	Developing (D)
1-4	1-8	Beginning (B)

Table 2 displays the mean (M) and standard deviation (SD) of teachers' scores according to their field of specialization. For items under one-dimensional Kinematics, teachers who are Physics majors and Chemistry majors obtained a mean of 9.40 (SD=4.80) and 10.00 (SD=3.08), respectively, which were both categorized as **Approaching Proficiency**. This level of proficiency, according to DepEd, means that the students at this level have developed the fundamental knowledge, skills, and core understanding with little guidance and assistance from peers and can transfer these understandings through authentic performance tasks (See Appendix G). Similarly, teacher respondents who were on this level only possessed a basic understanding of motion concepts and may limit their teaching to only the basic concepts of motion, which can be implied that their understanding was considered low even though these teachers' majors were Physics and Chemistry.

Furthermore, General Science, Biology, and Mathematics major respondents were classified under the **Developing** level of conceptual understanding. The total mean for one- dimension Kinematics was 7.39 (SD=3.97) and was also **Developing.** This level of proficiency described students as possessing minimum knowledge, skills, and core understandings but still requiring guidance in achieving authentic tasks. When this level is described relative to the teacher respondents, this means that teachers at this level had a minimal understanding of the basic concepts of motion. It implies that teachers have a low level of understanding, although one-dimensional Kinematics is a basic topic. This low level of understanding might also hinder their teaching of the topic.

In two-dimensional Kinematics, Physics and Chemistry major teachers consistently attained a level of **Approaching Proficiency** which have a mean of 10.00 (SD=4.60) and 11.75 (SD=1.92), respectively, while respondents majoring in Mathematics have a mean of 4.14 (SD=2.53) denoting that they are in the **Beginning** level of conceptual understanding. Students struggle to understand prerequisite and fundamental knowledge and skills that have not been acquired or developed at the students' level. Similarly, teacher respondents categorized as Beginning were described as having difficulties in understanding the basic concepts of motion, probably due to their lack of background knowledge of the topic. Moreover, the total mean in two-dimensional Kinematics was 7.57 (SD=4.29), which was classified as under the **Developing** level of conceptual understanding.

In general, the overall conceptual understanding of the respondents was also **Developing.** This level gained by the Physics teachers, which was considered low, can contribute to the students' poor understanding of Physics concepts and misconceptions. The mastery of content knowledge is one of the foundations of the framework for Philippine Science Teacher Education (2011), but the resulting level of conceptual understanding in this study described teachers as having only minimum understanding and skills in Kinematics. According to Rama (2017), this could pose a significant challenge to the quality of Science teaching since low mastery of the underlying concepts among Physics teachers could also lead to students' inadequate learning and misconceptions, as confirmed in this study.

Additionally, non-physics majors teaching Kinematics excluding Chemistry majors possess minimal understanding of the topic categorized as **Developing**. This level among non-physics majors could hinder them from effective teaching and the quality of correct concepts during instruction (Luft, 2020). This present study supported the study conducted by Eraikhuemen and Ogumogu in 2014, which claimed that 73% of the Physics teacher participants did not have an adequate conceptual understanding of forces and motion, although these are basic concepts in Physics. On the other hand, this study also confirmed the study of Sutarno et al. (2017), which claimed that preservice Physics teachers who had already acquired basic courses showed a low level of logical progression and integration of Physics concepts to equations. The results of this study contradicted Reddy and Panacharoensawad (2017), who claimed that to ace Physics problem-solving, Physics teachers need to be highly qualified hence possessing a high level of problem-solving skills in order to provide students the quality of learning Physics as it has been considered a difficult subject due to its mathematical applications.

Table 3 indicates the Physics teachers' level of conceptual understanding in Kinematics in terms of their years of teaching Science.

Table 3 Physics teacher's level of Conceptual Understanding in terms of the number of years in teaching Science

Number of years in teaching Science	n	One-Dimensional Motion (20 items)			Two-Dimensional Motion (20 items)			Total (40 items)		
		M	SD	QD*	M	SD	QD*	M	SD	QD*
1-5	23	6.70	3.25	D	6.78	3.44	D	13.48	6.51	D
6-10	7	10.14	5.08	AP	11.14	5.30	AP	21.29	10.31	AP
11-15	7	5.86	1.96	D	6.00	2.33	D	11.86	3.56	D
16-20	2	13.50	6.36	P	14.50	3.50	P	28.00	8.00	P
21-25	1	4.00	0	B	3.00	0	B	7.00	0	B
26-30	3	8.00	1.41	D	7.33	0.47	D	15.33	1.25	D
31-up	1	4.00	0	B	3.00	0	B	7.00	0	B
Overall	44	7.39	3.97	D	7.57	4.29	D	14.95	8.08	D

Based on Table 3, there are only two Physics teachers who have been teaching for 16 to 20 years and were the only ones categorized as **Proficient** in terms of their conceptual understanding of Kinematics, having a mean of 13.50 (SD=6.36) for one-dimensional Kinematics and a mean of 14.50 (SD=3.50) in two-dimensional Kinematics. Students on this level, according to DepEd, are characterized as having developed the necessary knowledge, skills, and core understanding and can transfer them without any assistance through authentic performance tasks independently. This study means that teacher respondents have acquired an adequate understanding of the Kinematic fundamental concepts and have taught these concepts to the students without difficulty explaining the topic. Notably, there was only one teacher respondent teaching for 25 and 34 years who were both classified as **Beginning** for motions in one and two dimensions. This implies that teachers cannot understand even the basic concepts of motion. As a whole, the total level of conceptual understanding in Kinematics relative to the years of teaching Science among Physics teachers was **Developing**. This implies that teachers might have not develop mastery of Kinematic concepts as their years of teaching Science increased. The resulting level was also considered low for teachers who are expected to have an advanced conceptual understanding of Kinematics.

The results of this study supported the study of Zhang in 2008, whose findings suggested that as the number of years in teaching increases, the student's performance under that teacher becomes increasingly worse, which can be further implied that teachers may not remain effective throughout their whole career even after attaining a higher educational degree. Similarly, the results of the present study did not show a trend on the teachers' level of understanding since teachers who are on the earliest years (1-5 years) in teaching Physics had a lower level of conceptual understanding than those in 6-10, 16-20 and 26-30 years of teaching Science.

Furthermore, this finding did not completely agree with Rice (2010) who claimed that "experience matters, but more is not always better". According to her study, teachers who are in their early years of teaching showed a positive impact on their career and decreased as their years in teaching increased. The results of the present study also negated the study of Ismail et al. (2018) which stated that teachers with more teaching experience are more knowledgeable and more effective in their careers as they have been acquiring and developing knowledge over the years. Moreover, this low level of understanding supported Laurie and Larson (2020) who asserted that teacher burnout, that is losing of interests in one's career due to various forms of stress, negatively impact their teaching quality which includes sustaining higher-order thinking skills.

Level of Physics Teachers' Problem-solving skills in Kinematics

Table 4 presents the level of problem-solving skills of Physics teachers in Kinematics in terms of their field of specialization.

Table 4 Physics teacher's level of Problem-solving skills in terms of Field of Specialization

Field of Specialization	n	One-Dimensional Motion (15 points)			Two-Dimensional Motion (40 points)			Total (55 points)		
		M	SD	QD*	M	SD	QD*	M	SD	QD*
Physics	5	12.84	2.67	A	22.72	12.10	AP	35.56	14.27	P
Chemistry	4	15.00	0	A	35.70	4.19	A	50.70	4.19	A
Biology	9	9.00	3.88	AP	12.20	10.51	D	21.20	13.58	D
General Science	19	10.88	4.36	P	20.94	10.72	AP	31.82	14.56	AP
Mathematics	7	7.11	6.33	AP	13.09	13.61	D	20.20	19.45	D
Overall	44	10.50	4.82	P	19.45	12.78	AP	29.94	17.01	AP

for 15 points	for 40 points	for 55 points	*Qualitative Description (QD)
13-15	33-40	45-55	Advanced (A)
10-12	25-32	34-44	Proficient (P)
7-9	17-24	23-33	Approaching Proficiency (AP)
4-6	9-16	12-22	Developing (D)
1-3	1-8	1-11	Beginning (B)

This implies that teachers with problem-solving backgrounds related to Science could efficiently solve motion problems. For Kinematics in one dimension, no respondents have attained a level below approaching proficiency. The overall mean for one-dimensional Kinematics showed a **Proficient** level of problem-solving skills among Physics teachers. This implies that teachers on this level could solve basic motion problems and apply mathematical knowledge in teaching motion concepts.

In two-dimensional motion, only Chemistry majors have consistently attained the **Advanced** level with a mean of 35.70. Moreover, the levels of problem-solving skills in each field of specialization, excluding Chemistry from one-dimensional motion to two-dimensional motion lowered by one level. This could be due to the fact that concepts in two-dimensional Kinematics involved more complex equations and abstract concepts than in one-dimensional Kinematics. This implies that Chemistry major teachers are better at solving problems in Kinematics than Physics teachers who specialized in the subject. This might be attributed to their knowledge and skills as evidenced in their written responses to the interview in which all Chemistry majors teachers claimed to have sufficient mathematical skills to solve Kinematic problems and they expressed no struggle in teaching Kinematics with problem-solving application. Conversely, 60% of Physics major teachers despite acquiring the necessary courses in Physics claimed that they have insufficient conceptual understanding and problem-solving skills which challenged them in teaching Kinematics. These findings agreed with Bodner and Herron (2022) who stated that individuals who successfully took Chemistry courses were good problem-solvers.

The respondents' overall level of problem-solving skills in two-dimensional Kinematics was **Approaching Proficiency (M=19.45),** and the total resulting mean is 29.94, also categorized as **Approaching Proficiency.** For teacher respondents in this study, this means they possessed the basic mathematical knowledge and skills to solve problems in Kinematics. This level also indicated that Physics teachers did not have higher problem-solving skills. This could also imply that teachers might only teach motion using Kinematic equations and how to manipulate them to solve for the unknown variable without relating the underlying concepts. Teachers who only focused on solving the problem with equations according to Ince (2018) are known as novice problem solvers who could not establish relationships between concepts.

Moreover, problem-solving skills are necessary for successful Physics teaching and learning. According to Orgoványi-Gajdos (2016), this skill must be possessed by teachers as it is directly associated with cognitive and metacognitive processes however, the respondents in the present study did not possess high level of the said skills. The present study supported the study of Taqwa and Rivaldo (2018) which showed that physics education students have difficulties in solving problems and explaining concepts in Kinematics.

Table 5 shows the Physics teachers' level of problem-solving skills in Kinematics in terms of their years of teaching Science

Table 5 Physics teacher's level of Problem-solving skills in terms of the Number of Years in Science Teaching

Number of years in teaching Science	n	One-Dimensional Motion			Two-Dimensional Motion			Total		
		M	SD	QD*	M	SD	QD*	M	SD	QD*
1-5	23	9.59	5.16	AP	17.40	13.79	AP	26.99	18.39	AP
6-10	7	12.80	1.95	P	24.43	9.83	AP	37.23	11.25	P
11-15	7	9.91	6.43	AP	20.14	13.33	AP	30.06	19.61	AP
16-20	2	14.80	0.20	A	27.40	12.60	P	42.20	12.80	P
21-25	1	10.20	0	P	21.80	0	AP	32.00	0	AP
26-30	3	10.73	0.19	P	17.07	6.73	AP	27.80	6.79	AP
31-up	1	10.20	0	P	15.60	0	D	25.80	0	AP
Overall	44	10.50	4.82	P	19.45	12.78	AP	29.94	17.01	AP

In one-dimensional Kinematics, as shown in Table 5, only those teaching Science for 16-20 years have advanced problem-solving skills (M=14.80). This result was consistently high with their level of conceptual understanding of the group range. Remarkably, the lowest level in this category was **Approaching Proficiency**, attained by those teaching for 1-5 years (M=9.59) and 11-15 years (M=9.91). Moreover, the overall level of problem-solving skills in one-dimensional motion was **Proficient,** with a mean of 10.50 (SD=4.82). For Kinematics in two dimensions, only those who have been teaching for 16-20 years have a mean of 27.40, categorized as Proficient, while the majority of the group range has an **Approaching Proficiency** level. The overall level of problem-solving skills for motion in two dimensions was 19.45, classifying the respondents as the **Approaching Proficiency** level**.** It is also noted that the level of problem-solving skills from one dimension to two dimensional motion for most of the group ranged had decreased by one level.

In general, teachers teaching for 6-10 years and 16-20 years were classified as **Proficient** with their resulting mean of 37.23 (SD=11.25) and 42.20 (SD=12.80), respectively. In general, the level of problem-solving skills among Physics teachers in terms of their years in Science teaching was found to be **Approaching Proficiency** level. This implies that Physics teachers were capable of solving basic Kinematics-related problems regardless of how long they have been teaching Science. It can also be inferred that solving problems in two-dimensional Kinematics was more difficult than solving problems in one-dimensional Kinematics since the former was considered a higher concept than the latter.

Correlation between the Physics teachers' level of conceptual understanding and level of problem-solving skills in Kinematics

Table 6 establishes the relationship between the Physics teachers' conceptual understanding and problem-solving skills in Kinematics.

Table 6 Correlation between the level of conceptual understanding and level of problem-solving skills among Physics teachers in Kinematics

Variables	n	Mean	Standard Deviation	Test Statistics		
				Computed r	Computed t-value	p-value
Conceptual understanding	44	14.95	7.98	0.33*	2.27*	0.028*
Problem-solving skills	44	29.94	17.01			

*significant at α = 0.05.

As shown in Table 6, the Physics teachers obtained a mean of 14. 95 (SD=7.98) in conceptual understanding and a mean of 29.94 (SD=17.01) in problem-solving skills. There was a low positive but significant correlation, t (42) = 2.27, p=0.028. H_{o1} was rejected, which means that there was a significant correlation between the teachers' level of conceptual understanding and problem-solving skills. This means that teachers who are good at conceptual understanding are also good at problem-solving skills. Consequently, teachers with low conceptual understanding scores also have low scores in problem-solving skills.

Although the correlation was positively weak, it was nevertheless significant. This implies that the teacher's level of conceptual understanding is associated with their problem-solving ability. This may indicate that respondents with an adequate or higher understanding of concepts may have sufficient or higher skills in solving Physics problems, specifically in Kinematics which may lead to correct conceptual understanding and problem-solving skills among students. The study supported the study of Sadler and Sonnert (2016), which revealed that teachers' understanding of the subject matter was perceived as a necessary predictor of students' knowledge. According to Reddy and Panacharoensawad (2017), physics teachers should be highly skilled to provide the assistance needed in acing Physics problems however this is negated by the findings of the present study. The study also supported the study of Silaban in 2017, which showed a positive correlation between mastery of physics concepts and problem-solving ability among Grade 12 students in the concept of static electricity, a higher concept in Physics.

Difficulties encountered by the Physics teachers in teaching Kinematics

The difficulties encountered by Physics teachers' difficulties encountered were collected through written interviews and are discussed through these themes: conceptual understanding, problem-solving skills, teaching strategies, teaching resources, time allotment, and other difficulties encountered.

Difficulties encountered in terms of conceptual understanding

In this aspect, respondents were asked in a written interview regarding their perception of Kinematics as a major topic in Physics. Most respondents (68%) claimed that Kinematics is difficult, while only 32% of the respondents stated that the content is exciting and manageable (See Appendix J). Here are some notable responses from those who asserted that Kinematics is a tricky subject. They answered as such;

> "It is very difficult and needs thorough discussions for the learners to understand." (C3-J.12, written responses, 2022).

> "Very challenging and it requires analysis." (C3-J.10, written response, 2022).

> "The topic is manageable for me to teach." (C1-A.29, written response, 2022).

> "It is one of the most interesting topic in physics that involves algebra skills to manipulate the equations in Kinematics." (C1-A.30, written response, 2022).

Additionally, 64% claimed to have the insufficient conceptual understanding to teach the concepts correctly. Most of the respondents expressed that it is due to the complexity of the topic requiring them to acquire a deeper understanding to teach it correctly. They also expressed that they were not experts in the subject since they were non-Physics major teachers. Moreover, 77% of the teachers responded "Yes" when asked whether they struggled to understand Kinematics concepts before teaching it or not. Here are some of their responses:

> "yes, sometimes especially on complicated scenarios because some problems do have connections to different concepts in physics" (C3-L.26, written response, 2022).

> "I myself can't understand well, so I can't extend my teaching" (C2-F.44, written response, 2022).

> "yes, no proper background of the topic" (C3-J.13, written response, 2022).

Furthermore, specific difficult parts to teach in Kinematics were also asked. Teaching projectile motion, acceleration and deceleration, and free-fall and gravity were the difficulties identified by 45% of the respondents. 23% responded that all parts are challenging to teach, and another 23% of the respondents mentioned that it was understanding problem-solving such as grasping and utilizing Kinematic equations, calculations, and teaching with equations involved. Ten teachers claimed they did not find any content difficult to teach. Kinematics, being a fundamental concept in Physics, has to be correctly taught. Without adequate understanding among those teaching, it could probably lead to poor performance in Physics. Some of the notable responses were quoted as such:

> "all parts are difficult, it is not something I'm confident at" (C3-J.4, written response, 2022).

> "projectile motion; a lot of variables to consider" (C3-J.14, written response, 2022).

> "I struggle in teaching equations involved because the students usually take time to understand and apply them in problems" (C1-A.30, written response, 2022).

It implies that the respondents of the study lacked conceptual understanding of Kinematics which might hinders them to teach the students with correct concepts. This was also evident in their level of conceptual understanding as identified in this study. These findings supported the study of Ramma (2017) which revealed that Physics teachers who are meant to teach Kinematics did not understand its underlying concepts. The results did not agree with the framework of Philippine Science Teacher Education (2011) which emphasized that one of the qualities of an effective Science teachers are deeply rooted in mastery of content knowledge. It means having an adequate conceptual understanding in order to teach it in a comprehensible manner to the students.

Difficulties encountered in terms of problem-solving ability

Problem-solving in Physics has been utilized to quantify and apply concepts learned; hence, mathematical skill is necessary for teaching Physics. Physics teachers were asked about their mathematical skills; only 41% of the respondents claimed to have sufficient mathematical skills to teach problem-solving in Kinematics. Similarly, 34 teacher respondents out of 44 have struggled to teach Kinematic concepts when applied to problem-solving. Respondents revealed that they have insufficient mathematical and conceptual knowledge and that integrating concepts into problem-solving is a struggle. They also attributed this difficulty to the students' lack of basic skills for problem-solving and lack of interest in Kinematics and problem-solving. Some of their reasons were such;

> "yes, with complicated concepts, hard to connect the concept to the problem-solving skills" (C3-J.10, written response, 2022).

> "yes, students lack basic skills for problem solving" (C3-J.3, written response, 2022).

> "yes, I'm not an expert of it" (C3-J.5, written response, 2022).

The respondent's claims agreed with their level of problem-solving skills. Although most of the respondents struggle with problem-solving in Kinematics, they all noted that they included problem-solving in teaching Kinematics. Their reasons vary when asked about including this aspect in Physics. In general, the respondents asserted that including problem-solving improves students' logical and analytical thinking skills and helps them understand the topic. Here are some of their written answers.

> "yes it improves logical and analytical thinking skills of the students" (C3-J.2, written response, 2022).

> "concepts and problem-solving should be given to the students in order for them to understand the topic" (C3-J.11, written response, 2022).

> "yes, this is where learners quantify the concepts taught" (C2-G.21, written response, 2022).

From the responses, it can be implied that Physics teachers might not be able to properly teach the students scientific ways of arriving at solutions to Physics-related problems and explain its underlying concepts. It can also be implied that teachers might just rely on given equations and formulas to solve for the unknown. The findings contradicted the framework for Philippine Science Teacher Education that problem-solving skills are crucial for a successful Physics course and that understanding the concepts of a problem is integral to solving it. These responses supported the study of Sutarno et al. (2017) who attributed the low problem-solving skills of pre-service Physics teachers to their lack of understanding and problem-solving skills.

Difficulties encountered in terms of the teaching strategies used

Teaching strategies enabled teachers to develop students' interests and helped them achieve the lesson. 55% of the respondents agreed that despite using any teaching strategies, teaching Kinematics was still a challenge for them. Teachers repeatedly explained that they possessed inadequate content knowledge; they found it difficult to engage with mathematical applications and; the contents were complex and abstract for them to explain. The following are a few of the responses to support the statement;

> "yes, difficult to explain in ways students can understand" (C3-J.12, written response, 2022)

> "yes, when involved with mathematical computations" (C2-G.12, written response, 2022)

> "yes, because of lesser content background" (C3-L.25, written response, 2022)

> "yes, because of complex or abstract concepts" (C1-C.31, written response, 2022)

Teaching Kinematic concepts relative to the student's perception was difficult, as 82% of the respondents claimed. This large percentage of respondents was probably due to the abstract concepts of Kinematics. As claimed by the teacher respondents, students have poor comprehension of concepts and mathematical skills. Additionally, the low interest among students in Science and their complex perception of the subject also challenged teachers in teaching the topic. Here are some notable responses in the written interview.

> "Yes, because not all students understand kinematics/ they find it difficult" (C3-J.1, written response, 2022)

> "yes, teaching students with a low level of mathematical operations is very difficult" (C3-J.6, written response, 2022)

> "yes, Students are less interested in Science" (C2-G.20, written response, 2022)

From the responses, it can be implied that the quality of Physics teaching might decline. The results supported Ayop &Ismail (2019) who asserted that given all the available teaching strategies, a Physics teacher must also have the ability to learn how students learn to effectively utilize and choose strategies that could cater to the needs and abilities of the students.

Difficulties encountered in terms of teaching resources

Teaching resources can significantly impact the quality of instruction and learning among students. Physics teachers utilized various teaching resources in teaching the subject, especially abstract ones. Responses from the written interview revealed that most teachers (39 out of 44) agreed the use of varied resources in teaching could help students in the process. According to their responses, they utilized videos, books, the internet, simulations, and physics experiments in teaching motion concepts to the students. On the other hand, teachers were asked explicitly regarding the usefulness of DepEd Science books in teaching Kinematic concepts, but 57% of the respondents stated that it is not very useful and informative. The following were a few notable reasons for their responses.

> "need additional sample problem that is applicable in life situations" (C3-J.6, written response, 2022)

> "not so, they need to provide books with greater explanations, not just mere activities" (C1-A.30, written response, 2022)

> "not quite informative, it's limited per unit because of its spiral style of teaching" (C1-C.32, written response, 2022)

> "yes, but some of the signs are not placed properly in the equations" (C3-I.28, written response, 2022)

Difficulties encountered in terms of time allotment

Most of the Physics teacher respondents (75%) claimed to have insufficient time attaining competencies related to Kinematics. They expressed that although the topic requires analysis, there was minimal time to achieve the competencies related to motion which was further challenged by other interrupting school activities. Here are some of their reasons for such a challenge;

> "insufficient, due to interrupting school activities" (C2-G.21, written response, 2022)

> "no, time is too short to teach completely all kinematic competencies" (C2-G.24, written response, 2022)

> "no, because the time allotted for kinematics is so short to discuss deeply the concept with calculations" (C3-L.26, written response, 2022)

> "no, I have to learn the topic and it is so difficult to teach when you are not ready and not well-informed of the topic" (C1-C.34, written response, 2022)

The Physics teachers' responses on time constraints imply that teachers might not be able to attain the specific objectives in Kinematics or Physics as a whole and students' understanding of the topic might be lacking or not scientifically aligned due to the limited time grasping, understanding, and applying of concepts. This is similar to the challenges that teachers encountered in the study of Abella et al. (2021) and Ayop and Ismail (2019) which made them less confident and less creative in the classroom.

Other difficulties encountered by Physics teachers

Modular distance learning was the main mode of delivery during the pandemic in most public high schools since it prohibited face-to-face interaction between teachers and students. This forced students to learn independently and guided their pacing by the modules. In the study, Physics teachers were asked about their experience teaching motion concepts using the self-learning modules, and 93% responded that they have been struggling to teach the concepts. They also perceived students as having difficulties in learning Kinematics (84%) which can be associated with the notion that students usually view Physics as a complicated and abstract subject. Meanwhile, only 45% stated that they also encountered difficulties in developing students' interests in learning Kinematics. This can be connected with the strategies and resources they utilize in delivering learning instructions. This probably means that utilizing varied teaching strategies will motivate the students to learn the topic hence developing their interests. Here are a few of their responses in arriving such;

> "yes students really don't have interest in the topic" (C3-J.3, written response, 2022)

> "yes they perceive physics as already difficult" (C3-J.12, written response, 2022)

> "yes, student's mindset involving mathematical equations are not that positive" (C1-A.30, written response, 2022)

> "not so, it depends on the strategies of the teacher" (C2-H.37, written response, 2022)

Physics teachers also encountered other non-teaching related tasks and how it impacts their quality of teaching. All of them responded that it has dramatically affected their teaching roles. Most respondents claimed that doing tasks like meetings, making reports, and managing school programs have been taking their time in preparing instructional materials for teaching. Here are some of the actual responses;

> "yes, I don't have enough time to prepare for the topic due to a lot of paperwork" (C3-J.3, written response, 2022)

> "yes, because having coordinatorship and other school reports ended me up in choosing something that requires attention once or twice a week. I can ever hardly deny the urge to do something that I USED TO DO compared to other priorities such as coordinatorship" (C3-I.27, written response, 2022)

> "very very much 100%, instead of spending vacant time preparing topics, I spend it on reports so sad" (C1-C.32, written response, 2022)

The difficulties encountered by Physics teachers imply that several improvements are needed to be done to attain the main goal of Physics Literacy. It can also be implied that despite having a high level of conceptual understanding and problem-solving skills in Kinematics, a teacher has to view any learning situations from different aspects, such as teaching strategies and resources, students' behavior and interests, and other factors that may hinder the quality of instructions. These findings supported Diate and Mordeno (2021) who stated that despite teachers' awareness of the set of skills needed by the student in learning Physics, they also have difficulty improving these skills. Facilities and resources were also very limited.

Diate and Mordeno (2021) also noted that the quality of Science education in the Philippines will continue to decline if these challenges are left unaddressed. The difficulties encountered by the teacher respondents supported Djudin (2018) who identified the challenges in teaching and learning Physics such as students' lack of interest, difficulty understanding Physics concepts, and negative perception of the subject. Moreover, these difficulties confirmed the study of Abella et al. (2021) which revealed that constructing learning activities, choosing teaching strategies and time constraints were the factors that caused Physics teachers to become less confident and less creative in the teaching process. Lastly, non-teaching related challenges expressed by the Physics teachers supported David et al. (2019) who exposed that public high school teachers in the Philippines have been experiencing an overworked state not only limited to teaching but also to non-teaching tasks.

How Physics teachers address the difficulties encountered in teaching Kinematics

Difficulties or challenges encountered during the teaching-learning process, if not addressed, may hinder the quality of Physics instructions. In the study, difficulties were uncovered and discussed in which the Physics teachers also presented ways to cope with such difficulties in teaching Kinematics. These resolutions to their struggles were also categorized into seven aspects.

Conceptual understanding

It was revealed that most of the teacher respondents identified themselves as having inadequate conceptual understanding of Kinematics and that they struggle to comprehend it. When asked how they addressed these difficulties, most of them utilized videos, simulations, the internet, and read books and other resources, while only a few responded that they did some reviews of Kinematic concepts based on their stock knowledge to understand the concepts, especially the abstract ones. Some teachers resolve such challenges by seeking help from colleagues more knowledgeable about the topic. The use of simulations as means of understanding concepts by the Physics teachers further supported the study of Rehman et al. (2021) which revealed that it aided in understanding more abstract concepts while linking it with daily instructions.

Problem-solving

Problem-solving is also essential evidence of applying concepts learned in Kinematics. Most of the respondents perceived themselves as lacking mathematical skills, which is evident with their level of problem-solving skills. Hence, teaching Kinematic concepts with problem-solving was viewed as a struggle among them. It necessitates them to learn and apply such skills considering that it is one of the competencies in Science education. To teach such skills, teachers seek ways to deal with these difficulties. Study, practice, and review were the teachers' strategies to manage such challenges. Apart from that, some teachers answered that teaching problem-solving in Kinematics should be done step by step, starting from the simplest to complex problem-solving. Few teachers claimed that there should be multiple example problems given. Some ways are similar to difficulties in understanding concepts, such as surfing the internet and watching YouTube videos.

The results of the study supported Ince (2018) who indicated that if problem-solving is perceived as a method, one should develop problem-solving skills through practice and a defined strategy. There is no simple step-by-step technique in solving a problem as each problem has different goals. The findings of the study further supported Erdemir (2009) who confirmed that the development of positive attitudes towards solving Physics problems was influenced by the teachers problem-solving strategies taught to the students.

Teaching Strategies

Teaching strategies and methods helped students and teachers achieve a lesson's objectives. In this study, teacher respondents still struggled to teach Kinematics, especially considering the students' level of understanding, despite utilizing various teaching strategies. Some of the means of overcoming this difficulty suggested by the teachers are through peer tutorials or group discussions among students; step-by-step explanation; familiarization of formula and when to use it; understanding of the basic concepts of Kinematics; and using diagrams, videos, and simulations; study and review. Other respondents answered that they unlocked students' misconceptions first and gave Physics problems based on the student's level of understanding. These responses also supported Ayop and Ismail (2019) who claimed that teaching strategies should be varied and specific to every group of students to effectively deliver the instructions. The results also supported Naseerali (2013) who claimed that peer tutoring among students improved their achievements in Physics. Furthermore, it also agreed with the study by Benckert and Pettersson (2008) that group discussions focused at Physics problems led to a more interactive learning of Physics.

Teaching Resources

Teaching resources are necessary for delivering instructions while developing students' interests. These also aid in teacher-student interaction creating an engaging and meaningful learning experience for both teacher and students. It has been revealed that most teachers did not find the current DepEd Science books valuable and informative. This posed another concern among teachers, especially those with minimal resources available. To address this concern, teachers resorted to surfing the internet for additional references and using other books. They also utilized instructional videos and provided more examples other than what is found in the books provided by DepEd. These findings supported Ndihokubwayo et al. (2020) who emphasized that the use of well-designed and diversified instructional too leads to effective Physics teaching.

Time Allotment

The importance of preparation time for teachers is that it helps them effectively plan activities and prepare attainable resources within the given period of instruction. With this, teachers can also maximize instructions during classes, given that they have adequately planned the learning flow while considering the students' behaviors and abilities in the subject matter. Most of the Physics teachers responded that they lacked time to achieve the competencies related to Kinematics. To overcome this challenge, teachers answered that they should have time management. Additionally, few of them responded that careful lessons planning, merging overlapping competencies, simplifying topics, and providing brief examples and problems were their means of addressing the problem. The aspect of time management supported Tamar (2021) who stated that it is an important factor of an effective teacher as it can improve teachers' productivity and quality of instructions they can provide to the students.

Student's behavior, interests, and non-teaching related factors

Students vary in terms of interests, abilities, and behavior, and these differences make them unique individuals. In this study, it was revealed that students' perception of Physics, particularly Kinematics, was challenging, which is probably one of the reasons why Physics teachers encountered difficulties developing students' interests in understanding Kinematics. Respondents of this study answered that to resolve these challenges, they guide the students, provide instructional videos, and give examples with integration to real-life settings, such as relating motion to everyday movement. They also provided differentiated activities, games, and motivations to encourage the students to learn and appreciate Kinematics. These findings supported the study of Cruz and Roleda (2018) which showed that games had significantly improved students' performance in Physics and increased their motivation in the learning process. Additionally, this study also supported Kwarikunda et al. (2020) who claimed that students' motivation is directly related to their interests in learning Physics thereby necessitates teachers to seek ways in enhancing their interests and consequently their performance of the subject.

In the school setting, teachers not only play the role of a teacher that delivers the lesson, but they also plan, manage and report non-teaching related activities inside the school. These non-teaching related factors may include programs that develop, encourage or improve the school environment, social activities, and the student's health and hygiene. According to all the respondents of this study, these programs have an overall positive impact on school improvement if successfully implemented but have a negative effect on the quality of teaching and learning. Physics teachers repeatedly responded that it is a matter of time management. They also expressed that ancillaries such as school program coordinators should be lessened along with paper works while some also said that it should be abolished since they viewed it as unnecessary. Another response from the teachers was that DepEd should hire more non-teaching staff so that teachers will have ample time to prepare and deliver the lessons.

4. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter presents the summary, findings, conclusions, and recommendations of the study.

Summary

This study utilized a Mixed Method Research Design in collecting quantitative and qualitative data. The purpose of this study was to determine the Physics teacher's level of conceptual understanding and level of problem-solving skills in Kinematics and established relationship between these variables. This Mixed Method study focuses on the Physics teachers as respondents. Forty-four teachers were assessed and surveyed. Specifically, this study sought to answer the following questions:

1. What is the profile of the respondents in terms of:

1.1. sex;
1.2. field of specialization and;
1.3. number of years in teaching Science?

2. What is the level of conceptual understanding of the Physics teachers in Kinematics in terms of:

2.1. field of specialization and;
2.2. number of years in teaching Science?

3. What is the level of problem-solving skill of the Physics teachers in Kinematics in terms of:

3.1. field of specialization and;
3.2. number of years in teaching Science?

4. Is there a significant correlation between the level of understanding and level of problem-solving skills of the Physics teachers in Kinematics?
5. What difficulties were encountered by the Physics teachers in teaching Kinematics?
6. How did the Physics teachers address the difficulties they encountered in teaching Kinematics?

Findings of the Study

Based on the results of the study, the following findings were obtained:

1. Most of the Physics teachers were teaching in urban schools; young adults; dominantly female; were General Science majors and had few years of Science teaching experience.
2. Physics and Chemistry majors had the highest level of conceptual understanding, which is **Approaching Proficiency**; those who have been teaching for 16-20 years had the highest level of conceptual understanding, which is **Proficient**. As a whole, the teacher respondents for one-dimensional and two-dimensional Kinematics were categorized as **Developing**.
3. Physics and Chemistry majors had the highest problem-solving skills, namely **Proficient** and **Advanced,** respectively. Those teaching Science for 6-10 and 16-20 years exhibited **Proficient** problem-solving skills. As a whole, the teacher respondents manifested an **Approaching Proficiency** level in problem-solving skills.
4. There was a **significant correlation** between the Physics teachers' conceptual understanding level and problem-solving skills in Kinematics.
5. Physics teachers had encountered difficulties in teaching Kinematics, such as possessing insufficient content knowledge and mathematical skills; difficulty in understanding Kinematic concepts and teaching them with a problem-solving application; teaching Kinematics according to the student's level of understanding using any teaching strategies; DepEd Science books' limited content discussions; insufficient preparation time and allotted time of instructions in covering all competencies; difficulty developing students' interests due to students' negative perception of the subject; and managing school programs negatively affect their quality of teaching in Physics.
6. Physics teachers presented various ways of addressing the challenges they encountered, such as using instructional videos and simulations; surfing the internet for additional information; reading book references and reviewing background knowledge; seeking help from more knowledgeable colleagues; studying and practicing problem-solving; guiding students through step-by-step explanation; peer tutoring; merging of overlapping competencies; simplifying lessons; providing students with differentiated activities and motivations; limiting non-teaching related activities and programs; and time management.

Conclusion:

Teaching Physics necessitates Physics teachers to possess a sufficient understanding and problem-solving skills since the subject has been described as complex and challenging. Understanding concepts in Physics, particularly in Kinematics, is vital in solving problems of the subject. Teachers' Science educational specialization is paramount in understanding concepts and solving problems. Based on the study's findings, the more aligned the teacher's specialization is to the subject he or she is teaching, the higher the level of understanding concepts and skills in solving problems. Physics teachers conceptual understanding and problem-solving skills were interrelated and not influenced by their years in teaching Science. They also encountered difficulties that challenged their quality as a Physics teacher.

The Content Knowledge Theory by Lee Shulman with a domain of subject-matter content knowledge which emphasized the teacher's quality in explaining concepts, specifically why certain phenomena occur and how these concepts are interrelated, and Jerome Bruner's Constructivism theory which stated that conceptual understanding connects new knowledge with prior knowledge were affirmed by the findings on this study. Thus, Physics teachers must possess a higher level of conceptual understanding and problem-solving skills in Kinematics as it affects the teacher's quality of instructions in Physics and students' performances and perceptions of the subject.

Recommendation

Based on the findings of the study, the following recommendations were made, that:

1. teachers who are teaching Physics find ways to enhance their conceptual understanding and problem-solving skills, which may help them in choosing suitable activities and teaching strategies appropriate to the group of students, thus improve students' conceptions and understanding in Kinematics;
2. school administrators utilize the results of the study as a basis for providing the assistance needed among Physics teachers to enhance their content knowledge while addressing the difficulties they encounter;
3. curriculum specialists utilize the study results as a basis for constructing guidelines and training matrices enhancing teachers' conceptual understanding and problem-solving skills, especially those out-of-field Physics teachers; and
4. a follow-up study be made by future researchers on out-of-field Physics teaching and conceptual understanding and problem-solving skills in other Science-related concepts among students.

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