Qualitative study on difficulties of non-physics majors teaching physics: basis for competency enhancement for teaching STEM

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Abstract. This study, which aimed to investigate qualitatively the factors that contribute to the difficulties encountered by non-Physics majors teaching Physics, serves as the basis for competency enhancement for teaching STEM. The study was limited to thirty (30) non-Physics major teachers teaching Physics from nine (9) public and private schools in the coastal areas of Iligan City. Grounded Theory Methodology and Thematic Analysis were used in analyzing the data. The study found out that there are five (5) factors that contribute to the difficulties encountered by non-Physics majors in teaching Physics. These are: Facilities and Equipment; Sufficiency of Learning Materials and References; Teachers Readiness and Attitude towards teaching Physics; Learners' Readiness and Attitude towards Physics; and Curriculum. Based on the findings, Reasons of Difficulty Theory was formulated. Non-Physics majors had difficulties in teaching Physics due to some factors which are embodied in the three (3) elements of this theory. These are Readiness, Resources, and Curriculum.

1. The Problem and Its Scope

1.1. Introduction

The Science Curriculum Guide asserted that Science education aims to develop scientific literacy among learners that will prepare them to be informed and participative citizens who are able to make judgments and decisions regarding applications of scientific knowledge that may have social, health, or environmental impacts. The science curriculum recognizes the place of science and technology in everyday human affairs. It integrates science and technology in the social, economic, personal and ethical aspects of life. The K-12 science curriculum is learner-centered and inquiry-based, emphasizing the use of evidence in constructing explanations. Concepts and skills in Life Sciences, Physics, Chemistry, and Earth Sciences are presented with increasing levels of complexity from one grade level to another in spiral progression, thus paving the way to a deeper understanding of core concepts. The integration across science topics and other disciplines will lead to a meaningful understanding of concepts and its application to real-life situations.

This change in curriculum consequently requires the Science teachers to teach four different areas in Science. This means that Science teachers should be able to handle multiple disciplines. This would come as a challenge for teachers because Science teachers are usually specialized in one field. Consequently, this requires non-Physics majors to teach Physics. Physics courses generally cover topics which are difficult to understand by students. These courses have both difficult concepts and complex mathematical background information. Therefore, students develop attitudes towards Physics courses mainly due to such complexity and difficulty of them. In teaching Physics, it is very important that the method you use during the discussion or instruction is appealing to the students...
because Physics is perceived to be a complicated and boring subject but for the most part, this well-known reputation or perception is undeserved [1].

1.2. Objective of the Study
This study aimed to investigate qualitatively the factors that contribute to the difficulties encountered by non-Physics majors teaching Physics. It sought to obtain information about their negative experiences in teaching Physics together with other co-teachers.

1.3. Scope and Limitation of the Study
This study was limited to thirty (30) non-Physics majors teaching Physics from nine (9) schools in the coastal areas in Iligan City. The participants of this study were from the different public and private high schools in Iligan City Division namely: Iligan City National High School, Iligan Capitol College, Kiwalan National High School, Saint Peter’s College, Iligan Medical Center College- BED, and Iligan City National High School- Tambacan Annex, Dalipuga National High School, Saint Michaels College-BED, and Iligan City National High School- Palao Annex.

The researchers only involved those non-Physics majors teaching Physics in the junior high school. These teachers have at least a year experience in teaching Physics. Also, they are employed during the school year 2017-2018 in any of the schools mentioned.

1.4. Statement of the Problem
This study aimed to inspect the following:
1. The positive and negative experiences in teaching Physics,
2. The factors that can impede teaching Physics,
3. The interventions that the government could provide in order to improve the effectiveness of teaching Physics, and
4. The comments and recommendations of participants to improve their effectiveness in teaching Physics.

2. Related Literature and Studies
Teachers, who are inseparable elements of education as implementers of the curriculum, are one of the most important factors ensuring qualified teaching and training of individuals who would contribute and guide the society [2]. Being the prime movers in the teaching-learning process, teachers must possess the essential skills that will make learning more effective and efficient. Teachers play one of the most important role in the classroom and he must be well-equipped with the necessary features in order to manage every classroom pattern.

A professional teacher must have a sense of efficacy, mastery of the subject, and pedagogical knowledge [3]. The preparation of a professional teacher starts from the will and call within the teacher itself.

An out-of-field teaching assignment is prevalent due to the low supply of qualified teachers. Out-of-field teaching is generally defined as assigning a teacher to a subject outside of his/her academic training. Evidence has shown that this action has measurable consequences on students and teachers alike [4]. Although out-of-field teachers may have good pedagogical knowledge, the teacher still lack in subject matter training. So in order to teach their subject effectively, the teacher needs additional training for the subject matter [5].

A study conducted found out that many teachers handling science subjects are non-science majors. Lacking in confidence to teach science subjects, teachers tend to focus or linger on topics they are familiar with and leave out the difficult ones. One probable effect of this practice is the low performance of students in international and national assessment studies [6].
3. Methodology

3.1. Subjects of the Study
The participants of the study were the non-Physics majors teaching Physics in Junior High School. There was a total of 30 participants with more than 12 months of experience in teaching Physics. These teachers are officially employed in secondary schools of Iligan City during the school year 2017-2018.

3.2. Research Design
An in-depth study with real school environment examined the difficulties encountered by non-Physics majors teaching Physics. Guided with Grounded Theory, the researchers looked into how non-Physics major teachers viewed and perceived teaching Physics. Open-ended questionnaires were then administered and interviews and focus-group discussion were conducted to gather data.

Grounded Theory is a research method that is inductive in nature. It is a set of rigorous research procedures leading to the emergence of conceptual categories. Grounded theory enables to develop a theory which offers an explanation about the main concern of the population of the substantive area and how the concern resolved or processed [7].

3.3. Instruments Used
There were two (2) instruments used in this study. The first was PDF or Personal Data Form that was used to get the profile of the participants. The second was an open-ended questionnaire that was used in the interview and the same questionnaire that was used during the focus group discussion. This questionnaire was adapted and modified from the study entitled Taxonomy of Reasons why Teachers are Reluctant in Implementation of K-12 Program [8].

3.4. Data Gathering Procedure
Prior to the conduct of this study, permission was sought from the School Division Superintendent (SDS). Upon approval to conduct the study, another written request was hand-carried to the principals of selected schools then a schedule for the conduct of the research was prepared.

The data were obtained through open-ended questionnaires, interviews, and focus-group discussions (FGDs). Those who opted to answer through the open-ended questionnaire were given enough time to write down their responses and answers in the language that they are most comfortable with. On the other hand, the interviews were done individually and some in small group of most 5. Participants who were interviewed were also made to answer in the language that they want.

Interview was used to gather data for this study because each participant had specific and unique experiences with the teaching of Physics. Prior to the conduct of interview, administering an open-ended questionnaire and a personal data form was also done to gather data. The use of open-ended questionnaires in qualitative research can give more contexts to enrich data. It can also help or personalize some of the trends the researchers are tracking, helping them see the data in a different light. Open-ended questions asked participants to provide answers in their own words and are designed to elicit more information than is possible in a multiple choice or closed-ended format [9]. Moreover, focus group discussion (FGD) was done in gathering information from participants. FGD is a good way to gather together people from similar backgrounds or experiences to discuss a specific topic of interest. FGDs are used to explore the meanings of survey findings that cannot be explained statistically, the range of the opinions/views on a topic interest and to collect a wide variety of local terms [10]. In this study, the researchers need non-Physics teachers’ experiences in teaching Physics and FGD is appropriate to gather these kind of data.

Before starting the FGD, the researchers made a brief orientation and introduced themselves to the participants then explained the objective of the study. The participants were requested to speak the language they are comfortable with and told that everyone’s ideas are valuable. The researchers asked permission to record the FGD using a recorder to make sure that all ideas would be recorded.
All the responses from the open-ended questionnaires, interviews and FGDs were transcribed by
the researchers and answers which were written and spoken in Cebuano and Filipino language
were translated in English if necessary.
Responses from the open-ended questionnaires were translated if they were in Cebuano or
Filipino and those from interviews were transcribed first before being translated if necessary.
Thematic Analysis was used in analyzing the available data. The purpose of Thematic Analysis
is to identify patterns of meaning across a dataset that provided an answer to the research
question being addressed.

3.5. Statistical Analysis
Thematic Analysis (TA) is one of the most common forms of analysis in qualitative research and
is considered as a basic method for qualitative analysis. TA is an approach for extraction of
meanings and concepts from data and includes pinpointing, examining, and recording patterns or
themes. TA is a method for detection, analysis and reporting the themes in data. It is the minimum
organization and description of set of data that is widely used in a qualitative data analysis. A
good TA can help in both reflecting and clarifying the reality [11]. The researchers underwent
several phases/processes in thematic analysis.

3.5.1. Phase 1: Generating Initial Codes
This phase has two sub-phases, transcribing and coding. The first step is to transcribe the raw data from
the recorded and written interview and translate the data, if needed.
After transcribing and translating comes coding of the data. This phase involves the initial production
of codes from the data, a theorizing activity that requires the researchers to keep revisiting the data.
Qualitative coding is a process of reflection and a way of interacting with and thinking about data
[12]. During coding, researchers identify important sections of text and attach labels to index them
as they relate to a theme or issue in the data [13].
Codes are names or labels assigned to specific units or segments of related meaning identified
within the field notes and transcripts. A “good code” is one that captures the qualitative richness
of the phenomenon. They should be clear and concise, having explicit boundaries. The codes
become the groundwork for the themes that are going to be generated [11].
The researchers worked systematically through each of the transcripts and used line-by-line
coding to take note of themes and phenomena on the margins the extract experiences significant
to the interviewee by assigning a conceptual label, known as a code. The codes were not strictly
microscopically and some more abstract categories came in to view; some codes were very close
to the interviewees accounts and others were more abstract or conceptual. Similar responses were
place on the same sheet and numbered. As more and more interviews were coded, this sheet
started looking less like a random collection of the labelled notes but more like a brain storm
map or a tree where branches of through grew from certain categories. Sections of text can be
coded in as many different themes as they fit, being uncoded, coded once, or coded as many
times as deemed relevant by the researcher [11]. Hierarchical coding allows the researcher to
analyze texts at varying levels of specificity with broad higher order codes providing an overview
and detailed lower order codes allowing for distinctions to be made within and between cases
[13].

3.5.2. Phase 2: Code Validation
To ensure the integrity of the codes, the researchers read and reread the data, double-checking the
codes for consistency and validation. The codes were reviewed by more than one person, including
the three (3) researchers, thesis and adviser and five (5) students to avoid biases and
misinterpretation. The integration of the codes from the data becomes the basis from which themes
emerge.
3.5.3. Phase 3: Searching for Themes

This phase involves sorting and collating all the potentially relevant coded data extracts into themes. Initial codes may begin to form main themes, and others may form subthemes. Codes that may have been much related or may have been considered the same aspect within the data were combined. Codes that might be relevant to answering the research questions were incorporated into a theme [11]. According to a study, “A theme is an abstract entity that brings meaning and identity to a recurrent experience and its variant manifestations. As such, a theme captures and unifies the nature or basis of the experience into a meaningful whole”. Once identified, themes appear to be significant concepts that link substantial portions of the data together [14].

3.5.4. Phase 4: Defining and Naming Themes

Once a clear idea of the various themes and how they fitted together emerged, the researchers finalized the name of each theme. At this stage, the researchers considered how each theme fits into the overall story about the entire data set in relation to the research question. Each theme were defined and accompanied by a detailed analysis. Considerations were made as to how relationships are formed between themes and how these are related to the overall story that was evident within the data. The themes were finalized after all data have been read through and the coding was analyzed twice. It was highly important to develop short but impactful names that conveyed an immediate indication of the theme. The themes that were developed are the following: 1) Facilities and Equipment; 2) Sufficiency of Learning Materials and References, 3) Teachers Readiness and Attitude towards Teaching Physics, 4) Learners’ Readiness and Attitude towards Physics and 5) the Curriculum.

4. Results and Discussions

The focus of this study was to investigate the factors why non-Physics major have difficulties in teaching Physics. The data for this study were structured to five factors namely Facilities and Equipment, Sufficiency of Learning Materials and References, Teachers’ Readiness and Attitude towards Teaching Physics, Learners’ Readiness and Attitude towards Physics and Curriculum (Spiraling).

4.1. Factor 1: Facilities and Equipment

The first factor pertains to the difficulty of the non-Physics major teachers to transmit learning to the students due to lack of facilities and equipment. Many teachers have indicated that in teaching Physics, laboratories and apparatus are important in discussing the lessons in Physics. Some of their comments pertaining to lack of facilities and equipment are as follows:

“We need equipment. It’s hard to visualize something that you have not seen ever since.”

“Especially in public schools, we are waiting for the blessings from the government, we are lacking with laboratory materials and equipment.”

“What I don’t like in Physics now is that when it comes to lights, we can’t properly discuss it since we do not have a dark room. We cannot properly show color combination and separation of white light because we don’t have proper materials and equipment.”

Laboratory activities provide an experimental foundation for the theoretical concepts introduced in the lectures. It is important that students have an opportunity to verify some of the ideas for themselves. Having proper and enough materials will highly help in classroom instruction. A respondent stressed the importance of learning facilities in effectively transmitting learning to the students. He stated, “So, for example as teachers, in order for us to transmit learning to the learners, we use the laboratory. We also have our internet hub. The library is actually open every day. So, in that way, we can be able to effectively teach them through learning-by-doing style.” Numerous studies have shown the significance of having sufficient facilities as well as good facility conditions in the teaching-learning process.
Almost all four have indicated that the lack of laboratories and laboratory equipment and apparatuses as factors that could impede in teaching Physics. Physics teacher is likely to feel frustrated without his laboratory. Either his teaching have a tendency to become entirely theoretical or he spends time for various kinds of improvisation instead of improving his teaching. In other words, his teaching becomes ineffective. The participants suggested that the government should provide adequate laboratory equipment and apparatuses in order for the students to achieve optimum learning [15].

4.2. Factor 2: Insufficiency of Learning Materials and References
Non-Physics majors have difficulties in teaching Physics due to insufficient learning materials and references. Classrooms lack basic materials that the teachers needed such as books, textbooks and modules. Because of this, teachers have difficulties in delivering the lessons. Some of their negative experiences in teaching Physics are:

“We lack books and manuals. Sometimes the book is not fitted to the students’ learnings and it’s very lengthy.”
“We don’t have enough learning materials”
“We have books but they are limited. And we also need differentiated learning materials.”

Participants also indicated that lack of references contribute to their difficulty in teaching Physics. They stated that, “We lack references or other learning material where we could verify what we understood from our textbooks. Since we self-study, we need other references.”

The importance of appropriate textbooks in improving the quality of education has been increasingly highlighted since the 1990s [16]. When there is an inadequate resources, the teaching approach tends to be teacher-centered. Students remain passive participants in class, expected to listen and observe only. Consequently, the teacher will be the only source of knowledge for the learner. This can be risky because the teacher might be inadequately informed on the subject. A teacher-centered approach is bad for teaching and learning science and soon kills the interest of students in the subject [17].

4.3. Factor 3: Teachers’ Readiness and Attitude towards Teaching Physics
The third factor pertains to the readiness of the non-Physics major to teach Physics. It also pertains to the attitude of non-Physics major towards teaching Physics. Most participants have stated that they lack knowledge of Physics concepts. For instance:

“’We are not equipped with the knowledge in Physics.”
“What we know [about Physics] is very limited.”
“For me, I lack knowledge in Physics that’s why my students lack as well.”
“I can’t explain some contents or theories especially those topics that I did not encounter during my college days.”

Participants have shown concern about teaching Physics when it is not their field of specialization: “For me, teaching Physics is really stressful. I have to stay up late for so many nights because I have to study the lessons since I have not mastered them yet.”

Most participants have indicated the need to undergo seminars on Physics concepts and trainings on pedagogy for teaching Physics.

“The division should offer seminars and trainings on the different teaching and learning strategies in Physics for non-Physics major teaching Physics.”
“We need seminars that would teach us procedures on how to explain the topics in Physics.”

Teachers are the prime movers of the educational wheel. Therefore, playing a vital role in the learning process of the students [3]. The National Competency-Based Teacher Standards states that a teacher should demonstrate mastery of the subject. They should be able to deliver accurate and updated content knowledge using appropriate methodologies, approaches and strategies. With this, the
participants suggest that the government provide proper trainings for teachers in order for them to transmit learnings to the students.

4.4. Factor 4: Learners’ Readiness and Attitude towards Physics
Another factor structured in this study why non-Physics majors have difficulty in teaching Physics is the learners’ readiness and attitude towards Physics. Participants have expressed how the learners are not ready to cope with the demands of the subject. Students have little basic knowledge that they need in order for them to understand the lesson.

"The students don’t have basic foundation when it comes to basic Physics concepts."

"It takes up so much time because I have to go back to the basics so that they will understand the calculations."

"Students have difficulty in English. There are some words in the experiment that they don’t understand."

"Students are slow in Math, they have a hard time in calculations."

Participants have also indicated students’ lack of retention as a difficulty in Physics instruction.

"One factor also, is the students’ lack retention. Students have the tendency to forget the lesson right away."

"Students do not retain the lesson. They forget it right away. When you ask them what your lesson was yesterday, they can’t answer. They have to look at their notebooks so they could remember. And even then, they can’t explain anything about the topic. It’s like they haven’t learned anything."

"Yes, that’s true. The students lack retention. It may be because they don’t have any interest with the subject. They hardly remember our lesson yesterday. What more when they move to the next grade level. You really have to go back to the lessons in the previous grade level, not just as a review or else your new lesson will be for nothing."

The students’ attitude towards Physics is also a factor of teaching difficulty. Most participants stated:

"Some students don’t participate in hands-on activities"

"Students are lazy especially when it comes to conversion of measurements and calculations."

"The students find the lesson boring since they have a difficult time in understanding the topic."

The learners’ readiness and attitude contribute to the difficulties encountered by non-Physics majors teaching Physics. When students have a hard time understanding even the simple concepts and equations, then, chances are, teachers will get stressed out. The teachers have to find ways to make the lessons simpler which is a difficult task for them since they are not experts in the field. They cannot expound the lessons well. The learners’ willingness to learn affects the learning process. Students’ interest towards learning the topic produces big impact to their learning. When students are interested with the lesson then it makes learning pleasure instead of a task.

4.5. Factor 5: Spiral Curriculum
The last factor denotes the current curriculum, the K to 12 Science curriculum. The lessons in the curriculum present increasing levels of complexity from one grade to another in a spiraling progression. One of the reasons why non-Physics majors hesitate with the new curriculum is because many students will get left behind. Participants have stated that students fail to grasp or master the material in the first pass and moves on to the next grade level without achieving progress. As a result, in the next year, the teacher will have to cover the same material.

"The spiral nature pushes the students into various topics without giving enough time to master each one."

"We need to discuss all the lessons in a given time. So there are times that the student will get left behind."

"It’s better if we teach our own Field of Specialization because we can expound the lessons well."
Many participants complain that the lessons are long or lengthy and that there is no sufficient time to cover all the topics adequately. So what happens is that the last few topics will not be elaborated since they have to finish discussing all the topics. This will in turn cause problem for the next-level Physics since the learners haven’t really learned the required basic concepts to understand the following lessons.

“The lessons in Physics are also lengthy. If you look at the module the Physics has many topics.”

“That’s true. You don’t just discuss the concepts, you also have to try solving many problems so that the students can grasp the lesson. So if we do that, we can focus on the first few lessons but for the last lessons sometimes we can’t discuss them well with problem solving since we lack time. And the exam is centralized so we really should finish all the lessons.”

“Another thing also, if we can’t cover all the lessons, then the teacher in the next grade level will have a problem. She will have to discuss lessons that are supposed to be discussed in the previous grade level.”

Understanding the previous lessons are vital to make sense of the next lesson. The implementation of the K-12 curriculum requires so much of the teachers’ effort and work. Moreover, the participants asked that the curriculum be looked into and be revised instead of implementing half-baked curriculum.

5. Conclusion
It could be concluded that non-Physics majors have difficulties in teaching Physics due to some factors. Based on the findings, Reasons of Difficulty Theory is formulated. Non-Physics majors have difficulties in teaching Physics due to some factors which are embodied in the three (3) elements of this theory. These are Readiness, Resources, and Curriculum. Readiness refers to the readiness of the non-Physics majors teaching Physics and their students. They are the two vital elements in the teaching and learning process. Resources refers to the facilities, equipment, and learning materials. Without these teaching would be ineffective. Lastly, Curriculum refers to the current curriculum which utilizes spiral approach to teaching. This approach to teaching contributes to the difficulty of Science teachers because they are forced to teach subjects that are not their field of specialization.

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