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Developing Preservice Teachers' Scientific Problem-Solving Skills Using a Pragmatic Approach to Physics: The Case of Gbewaa College of Education

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Abstract

This research aimed at developing preservice-teachers' scientific problem-solving skills after taking part in active learning in an introductory science lesson in semester two of the 2020/2021 academic year. The researchers engaged 150 level hundred preservice-teachers for five (5) weeks. Pre-test and post-test designs were employed to collect data for both quantitative and qualitative analyses. Ten active learning practices were performed throughout the semester. The problem-solving assessment used was T-TEL and rubrics were used to develop the research instrument to evaluate preservice teachers' problem-solving skills. A Sample group interview was conducted to obtain qualitative data on preservice teachers' opinions of active learning activities. A sample t-test was used to compare problem-solving pre-test and post-test scores in the class. The data collected and content analysis was used to summarize preservice teachers' opinions. The results revealed their problem-solving skills were highly improved after taking part in active learning processes at 0.05 confident levels. Preservice teachers expressed their opinions positively toward active learning processes and showed a willingness to participate actively in the next lesson using the same learning approach.

Keywords

Active Learning, Problem-Solving Skills, Preservice, Teachers, T-TEL, Think-Pair-Share, National Teachers' Standard (NTS)

1. Introduction

Science education in the 21st century is driven by technology and self-directed learning (Institute for Promoting Science and Technology, 2016). Active learning is an eminent approach to which students' problem-solving skills are paramount. Students' learning style is directed toward active participation in their class activities on their own (Kara Mustafa Oglu, 2009). According to Meyers and Jones (1993), active learning consists of three factors that include basic elements, learning strategies, and teaching resources. Bonwell and Eison (1991) summarized the literature on active learning and concluded that it led to better students' attitudes and improvements in students thinking and writing. To buttress Sivan et al.'s (2000) research, students who received education through active learning and students centred on learning had developed scientific problem-solving skills as well as critical thinking abilities. Kalem and Fer (2003) studied the effects of a model designed for active learning on University Students They found that University students agreed that, this teaching method had positive effects in the view of their learning, teaching, and communication. Preservice teachers' attitudes and success were increased after using an active learning approach in the lesson in the second week during the activities processes. Many research studies revealed that active learning techniques are effective in science teaching as much research is still needed (N.T.S., 2017). The covid-19 era had introduced new ways of tackling problem-solving skills using online platforms such as zoom, Microsoft team, telegram, What App, etc. which are significant to both students and teachers in lesson delivery. Scientific studies serve as an important base for description in all ICT platforms for teaching students how to develop scientific problem-solving skills (Heller & Holla Baugh, 1992).

The main purpose of this study is to assist preservice teachers to develop scientific problem-solving skills in basic physics learning using an active learning approach. The study was conducted at Gbewaa College of Education, Ghana.

2. Theoretical Framework

Active learning in basics Physics is defined as instructional pedagogy that engages student-teachers in the complex learning process (Tientongdee, 2018). The major ingredients of active learning are students' activity and engagement in the learning process (Tientongdee, 2018). For the teaching and learning of manipulative skills to be effective, it is necessary to determine what is being assessed. Lack of reliable assessment has resulted in the neglect of experimental work in most schools (Abrahams, 2020). The assessment of students' practical work in science laboratories is important because learning science is intrinsically linked to the evidence collected and analyzed in laboratory settings. According to Jonson (2007), assessment is gathering evidence to understand students' acquisition and performance in process skills. In countries such as Ghana, direct assessment of students' practical skills is limited (Docktor et al., 2016). Thus, there is less inclination amongst teachers to devote precious time and effort to developing students' practical skills (Fadzil & Saat, 2013).

The researcher adopted the 4 characteristics of active learning instructional methods in Physics for this study based on Meltzer and Thornton's (2012) recommendations.

- Instruction to specific learning difficulties related to particular science concepts and knowledge elements;
- Engage students in a variety of scientific problem-solving activities during the lesson period;
- Engage students in small groups and allow them to work together;
- Problems are posed in a wide variety of contexts and representations.

3. Methodology

The researchers adopted quantitative and qualitative research approaches in this study. The design used was a one-group pre-test and post-test design to compare preservice teachers' problem-solving skills. The researchers engaged 100 level three hundred (300) preservice teachers who were basic physics elective students at Gbewaa College of Education for 5-week periods in the 2021/2022 academic year. Preservice teachers' written problem solutions rubrics based on T-TEL were employed to assess their problem-solving skills. This T-TEL assessment form focused on preservice teachers' performance in solving problems chronologically. (add more) The study centered on group interviews to collect the qualitative data on preservice teachers' opinions. The study was guided by the following research questions:

1) What was the significant difference between preservice teachers' problem-solving skills before and after learning to use the pragmatic approach in basic physics?

2) What were preservice teachers' opinions toward pragmatics learning in basic physics course?

The researchers used 12 active learning activities which consisted of topics in mechanics; one-dimension motion, two-dimension motion, force, application of newton's law of motion, momentum, mechanical energy, and rotation of the rigid body. Obtaining feedback and a small group project to solve basic physics problems were used as a variety of problem-solving activities learning-based.

Two examples of questions were given to preservice teachers to write down their answers.

- If you want to walk from lecture hall 1 to lecture hall 2 with minimum time, what is the best way to do it and why?
- If you have two equivalent sandbags and you want to lift them from level 1 to 2. What can you do to get the least work done by yourself and why?

The researchers adopted a 4-step approach according to the T-TEL learning domain to evaluate preservice teachers' problem-solving skills.

1) Understand the problem

2) Discussion on how to solve the problem

3) Solve the problem

4) Look back and check

In each step, rubrics criteria were used to assess preservice teachers on a scale of 1 - 5.

Step 1 rubrics scores are as follows;

- Preservice teacher does not understand the problem at all;
- Preservice teacher shows little understanding of the problem;
- Preservice teacher shows fair understanding of the problem;
- Preservice teacher shows the evidence of understanding most of the problem;
- Preservice teacher shows a full understanding of the problem.

4. Results

All the 100 preservice teachers taking basic physics were evaluated on problem-solving skills based on 4 steps with 5 rubrics scores before and after the class. The scores totaling 20, and the results of their problem-solving scores from pre-test and post-test are shown in **Table 1**. There is an indication that their problem-solving skills are significantly higher at a 0.05 confidence level after participating actively in basic physics class. Some part of the results also revealed no significant difference between male and female preservice teachers' scores on the problem-solving.

In the focus group interview, 20 preservice teachers participated in answering the 5 questions on what their opinions were. 40 minutes was scheduled for each group for the interview and this was transient to the end of the semester. Content analysis was used and the results indicated that most preservice teachers had a strong positive feeling about active learning activities in basic physics lessons. This is shown in **Table 2**. Female preservice teachers were more appreciated in participating while working as a team than their male counterparts since it helped them feel more confident to share and speak out their minds.

5. Discussion and Conclusion

Basic physics course at the college level is characterized by pragmatics learning for preservice teachers in semester one of the 2021/2022 academic year. This learning approach helped preservice teachers to have a greater problem-solving skill in physics as well as a positive opinion of learning basic physics courses.

This approach creates a learning environment in which preservice teachers enjoy learning physics. The main reason behind these satisfactions is their roles as owners of their learning and seeing how physics knowledge can be useful.

The results showed that preservice teachers' problem-solving skills have improved after learning through active learning activities which is confirmed by the

Table 1. Preservice teachers' problem-solving scores.

Test	Mean	SD	*Df*	t	*P*-value
Pretest	7.83	0.91			
Post-test	16.07	0.73	100	72.28	$P < 0.05$

Source: Research Data, 2022. N = 100.

Table 2. Preservice teachers' Opinions on using active learning basic physics and problem-solving skills.

Question	Summary
1. What do you think about active learning before taking physics as a course?	1. All preservice teachers agreed that they are not sure what is active learning and how it would be taught in physics lessons
2. What was your thinking of your problem-solving skills before considering physics as a course?	2. 95% of preservice teachers think that their problem-solving skills are not good and others were not sure of how to define this skill
3. What was your thinking about active learning activities?	3. All preservice teachers think that active learning activities are good and useful, it gives them room to work on their own and, think pair and share
4. What do you think of your problem-solving skills after you finish the physics course?	4. 99% of preservice teachers think that their problem-solving consisting of 4 steps, is better due to them learning using an active learning approach. 1% of preservice teachers think that most likely their problem-solving skills have improved because of both their interest in physics and the pragmatics learning style.
5. Would you recommend active learning in basic physics to others? If yes why?	5. All preservice teachers would recommend using active learning in other physics lessons because they feel more enjoyable and safe in their classrooms.

findings of Sivan (2004) who did similar research. (what is he say?) The preservice teachers' opinion of active learning activities which allows them to discuss can improve their communication skill and their positive feeling toward physics lectures as shown in the study of Kalem and Fer (2003).

6. Conclusion

This study led to conclusion that can significantly improve the quality of physics teaching, preservice teachers interested in physics as an undergraduate course and can also increase their problem solving skills and physics-related careers, especially in teaching careers.

The researchers concluded that potentially, there are useful recommendations for both teachers and researchers and these are:

Active learning as the new basic physics teaching approach in this paper is relevant to assist preservice teachers to develop problem-solving skills as well as better feelings toward basic physics learning.

It is recommendable to allow preservice teachers in the class to discuss, think pair share which will improve their understanding and also serve as a motivational vehicle to tackle future challenges they will encounter as far as learning physics is concerned.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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