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Instructional Practices Linked With Constructivism Used By Teachers In Physics Classes

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ABSTRACT

The study examined the constructivist-related teaching practices employed by teachers in teaching Physics. To better understand constructivist-related instructional practices in the teaching of Physics at the secondary, 78 teachers teaching Physics were asked to respond to survey questions using a descriptive normative research design. Cognitively challenging and active learning were used to categorize the constructivism-related teaching methods. The physics teachers used constructivist teaching strategies in their classes. Teachers used cognitively challenging instructional practices in their Physics classes more than active learning. In particular, problem-solving and group work were the most frequently used cognitively challenging and active learning practices, respectively. They used these constructivist instructional techniques when presenting new material, utilizing learning activities, and evaluating students' progress in Physics.

Keywords: instructional practices, constructivism, cognitively challenging, active learning.

1. Introduction

The development of the teaching-learning process is the primary goal of instruction. The attainment of this goal needs the commitment of both the teachers and the students. However, the burden lies more on the shoulders of the teachers. The teachers should focus on mastering the subject matter and effectively imparting this knowledge to the students.

Teachers are always searching for instructional practices to best enhance students' learning. No matter how complex a subject, learning may still be achieved if teachers teach effectively. Many teachers still rely on the traditional method of teaching. With the proliferation of the internet, students come to class armed with different conceptions, experiences, and interests. The traditional teaching method rarely addresses these concerns because this method makes students passive learners.

Instructional strategies that address the development of analytical thinking are based on the theory of constructivism.

Constructivism is a teaching method that asserts that learning is a product of mental construction, where new information is integrated with existing knowledge (Bada, 2015). Learners construct knowledge through an active mental process of development. They become involved by using their prior learning and practical experience, developing their ability to hypothesize, test their theories, and draw conclusions from their findings (Bada, 2015). Meaning and knowledge are built and created by the learners.

Constructivism is a learning theory or epistemology that explains the nature of knowledge and how people learn. According to Driscoll (2000), as cited by Bada (2015), the constructivist theory holds that knowledge can only exist in a person's mind and need not correspond to any external reality. The goal of learning is for students to continuously try to create their own mental models of the real world based on how they perceive it. Learners continuously alter their mental representations of the world as they experience each new thing, creating their own reality-based theories in the process. Active engagement, inquiry, problem-solving, and collaboration are the characteristics of learning activities in constructivist environments. The teacher encourages students to challenge and develop their ideas, opinions, and conclusions rather than imparting knowledge. Instead, the teacher acts as a mentor, facilitator, and co-investigator. Single interpretations and "correct" responses are downplayed.

Constructivism can be examined as a teaching strategy for what it is and for what it is not. It contests what Oldfather et al. (1994) refer to as the empirical/reductionist approach to teaching and learning as the default mode in education. They cite Freire, who views this strategy as a "banking" model in which the teacher provides the students with deposits of what is thought to be true knowledge, which the students then preserve until they are needed.

According to Ravitz et al. (2000), a constructivist teaching strategy emphasizes self-directed, individual-responsive, and socially mediated learning, prioritizing student motivation and effort over acquired knowledge or information, making it a crucial aspect of education. This method encourages students to define their own problems and issues, rather than having predetermined questions. They choose how to investigate issues or solve problems, reflect on their experiences, and interact with peers by presenting their solutions, outlining the process, and receiving feedback. This approach fosters a more personalized learning environment.

Within the constructivism learning theory, the role of the teacher is crucial. According to this theory, teachers serve as facilitators whose job is to help the students come to their own understanding rather than lecturing. This theory places a strong emphasis on how students learn. The learning theory requires a different approach to traditional teaching, focusing on asking rather than telling, and requires a different set of resources and lesson plans. The facilitator should encourage students to make their own conclusions rather than relying solely on curriculum-aligned questions. Also, teachers continuously engage with students, adapting their learning experience to suit their needs as they progress. The constructivist teacher simply guides the learner to develop an understanding of the content or subject matter as he or she discovers it through experimentation and exchange of ideas with others. The constructivist teacher's key objective is to assist the student in developing effective thinking skills. This is possible if the teacher assumes various roles, such as consultant, coach, and guide (Adom et al., 2016).

Cognizant of the dearth of research on constructivism in the country, particularly in physics teaching, the researcher, being a Physics trainer, conducted a study on constructivist instructional practices as reported by the Physics teachers. It aimed to determine the constructivist-based instructional practices commonly used in physics classes. It likewise looked into the frequency of use of these instructional practices and when they are commonly used in physics classes.

The findings of the study could be an input for the divisions covered in the study to develop a training design focusing on constructivist-based instructional practices not only in Physics but for all the science subjects in secondary schools. The findings could serve as input for the university's adopt-a-school extension program and for the graduate enrichment of the curriculum for the graduate education programs.

Research Objectives

This study is aimed to determine to determine the instructional practices linked with constructivism among teachers teaching Physics in the secondary schools in Ilocos Sur, Philippines, focusing on cognitively challenging and active learning practices. Moreover, it looked into how often these instructional practices were used in their classes and in what aspect of the teaching-learning process.

2. Methodology

This study employed the descriptive method of research. The 78 teaching Physics in three divisions of Ilocos Sur, Philippines served as the respondents of the study. They were mostly middle-aged, female, married, and had adequate years of experience in teaching and teaching Physics. The data for the study were collected using a part of the questionnaire by Ravitz et al. (2000). The questionnaire consists of items that measure constructivist practices, particularly cognitively challenging and active learning. Data gathered using the questionnaire was supplemented by personal interviews with the Physics teachers. Responses culled from the survey questionnaires and interviews were interpreted and analyzed to examine the instructional practices of the teachers directly linked with constructivism and those that are indicative of a constructivist practice. Mean, frequency, and percentage were used to analyze the data. Responses to the interview and open-ended questions were tallied, analyzed, and interpreted. Ethical principles were considered in the study.

3. Results and Discussions

Data on the constructivist-instructional practices as reported by the Physics teachers are presented as follows:

3.1. Physics Teachers' Constructivists-Related Instructional Practices and Frequency of Use

In this study, constructivist instructional practices include the theory of constructivism and those indicative of a constructivist practice. The practices directly linked to constructivism are considered cognitively challenging because these include student intellectual engagement. On the other hand, the practices indicative of constructivist practices use active learning strategies.

Cognitively Challenging Practices. Cognitively challenging practices include meaningful thinking and problem-solving.

Meaningful Thinking Two meaningful practices were considered in the study: deep thinking and probing questions, and reflective writing.

Along with deep thinking and probing questions, on average, 83.33 percent of the teacher-respondents claimed that they used this practice in their physics classes. Probing works well for both whole-class conversations and one-on-one interventions. All of the students' attention should be captured by well-managed, effective probing, allowing the teacher to steer the conversation from one student to the next and develop concepts through repeated exchanges and deeper thought. (Sherrington, 2017)

One of the deep-thinking practices is asking students to make conjectures about issues when introducing a unit. According to the National Center for Excellence in Teaching Mathematics, the purpose of making a conjecture is to test it on special cases, partly to see why it might be true or where it might need modifying. This is all part of specializing and generalizing.

(https://www.ncetm.org.uk/mathemapedia/Conjecture). Making conjectures was practiced by almost all the teachers; however, this was only “sometimes” used.

The practice of asking questions whose answers the teacher did not know when introducing a unit was reported to have been used by many (88.2%) teachers. Almost all (95.9%) teachers practiced asking questions to elicit students’ ideas and opinions. The practice of asking questions to get students to justify/explain their reasoning and to have them relate what they were working on to their experience was used by a significant majority (96.1%) of the teachers who used it weekly in their Physics classes.

Another deep-thinking practice used by almost all (92.5%) the Physics teachers was providing tasks for students to suggest or help plan classroom activities. Similarly, the practice of giving tasks to students to debate and argue about scientific views was used by many teachers, but the majority of them used this only once a month. Likewise, the practice of giving tasks to enable students to present the same idea or relationship in more than one way was reported to have been used by most of the teachers, but this was only used once a week by most of the teachers. The least commonly used deep thinking and probing question practice was providing students with tasks or problems for which there was no correct answer. This practice was used by less than one-half of the teachers.

Among the deep thinking practices, asking questions to elicit students’ ideas and opinions was the most common, followed by asking questions to justify or explain one’s reasoning. The least common was providing tasks for students to work on with no indisputably correct answer.

The infrequent use of deep-thinking practices in physics classes, particularly at the secondary level, may lead to only partial understanding of Physics concepts. The teaching of Physics should not focus on memorization and following procedures. Physics learning is not based on ‘cookbook’ lab exercises, where students follow a recipe to a pre-determined end. It should focus more on understanding how things work and providing students with many opportunities to devise ways to work on a task based on available resources. Additionally, there should be more opportunities for students to reflect on how Physics is taught and to think like scientists. Actively demonstrating to students how you arrive at a hypothesis or the solution to a question is one way to model "being a scientist" for them. Students should be encouraged to ask questions in lectures, even questions whose answers the teacher does not know. The teacher should be ready to accept that he does not know the answer, and he should be happy to learn something new.

Reflective writing is a very effective practice to develop meaningful intellectual engagement. It develops the students' critical thinking and analytical abilities and contributes to their cognitive development. It promotes creativity and enables them to make unique connections between disparate sets of information. It also provides new perspectives on science and technological issues. As Bartsch (2001) stressed, writing a reflective prose or academic essay requires students to regurgitate information they have memorized and to express independent ideas generated through focused reflection on the subject matter.

There were three forms of reflective writing considered in the study: namely, journal writing, writing reflective essays, and writing analysis of the quality of work. The most reported among the three was writing analysis of the quality of work, as reported by 92.8 percent of the teachers. Around three-quarters (62.8%) of the respondents reported that they engaged their students in reflective writing activities, and 89.2 percent of the respondents claimed to let their students write essays explaining their opinions, while only around one-third (37.1%) reported engaging their students in writing a journal. With regards to the practice of letting students write an essay about an assessment of work, the teachers sometimes used this.

<u>Problem Solving</u>. This practice is also a cognitively challenging activity that enhances meaningful thinking.

Almost all (98.7%) teacher-respondents used problem-solving in their Physics classes. Among the problem-solving practices considered in the study, letting students decide on their procedure to solve complex problems was the most commonly reported. Findings show that over three-quarters (82.1%) of the teacher-respondents claimed requiring their students to solve complex problems. Meanwhile, more than three-fourths (79.7%) of the teachers claimed letting students take part in working on problems with no obvious solution.

Active Learning Practices. Active learning covers instructional strategies not directly linked with constructivism but indicative of a constructivist practice. These include project-based, use of group work, and skills-oriented (reversed) teaching practice.

<u>Project Based</u>. These are not practices where students complete a Physics project by group and come up with a finished product, but these focus on cognitively challenging instruction. The teacher designs tasks that are meaningful to the students, i.e., they work collaboratively in completing the project. Many teacher-respondents professed using project-based strategies in their physics classes. An analysis of the problem-solving indicators reveals that all the teachers required their students to do hands-on or laboratory activities. This practice was expected in Physics classes where laboratory activities emphasize developing the students' process skills. The teachers claimed that they equired their students to do projects that lasted for weeks or more and require their students to make a product that others could use. These products could be improvised materials or learning resource materials that students in other sections could use. Most of the teachers averred to have used this once per grading period. However, only very few teachers require their students to present their outputs in public, inside and outside the school. Grossman, et al. (2019) emphasized that understanding what teachers must do to be successful in a project-based classroom is crucial for project-based teaching to succeed. Educators who use projects effectively encourage subject-area learning, provide pertinent experiences, nurture a culture of production, feedback, reflection, and revision in

the classroom, and increase student agency in learning communities.

Group Work. This instructional practice refers to students working collaboratively in completing a task. Almost all the teachers claimed to have used group work in teaching Physics. There are lots of activities in Physics classes that require group cooperation and collaboration in classroom and environment settings, like exercising, solving a problem, doing investigatory projects, and laboratory activities in a classroom and laboratory environment. Many teacher-respondents averred that they let their students do collaborative work in discussing a topic, and work in small groups to develop a joint solution to a problem or task.

Lapp, Flood, and Thrope (1989) cited many educators who have found that grouping can be successful in secondary science classrooms just as it is effective in elementary classrooms. As Gok and Silay (2010) cited, cooperative group problem-solving is performed for two reasons. Cooperative group problem-solving allows students to practice the strategy because it is more practical. Complex problems can be solved more easily by groups rather than individuals. Furthermore, students' achievement, perseverance, and attitudes toward science have increased in groups where students collaborate to accomplish common learning objectives. Group work encourages students to share their reasoning, leading to cognitive restructuring and learning. It provides formative assessment and feedback, fostering diverse viewpoints and developing communication and teamwork skills. This is particularly beneficial in scientific collaboration and professional fields, fostering cognitive restructuring and critical thinking. (Wilson et al., 2018)

Transmission-Oriented (Reverse) Teaching Practice. There are more teachers who used transmission-oriented activities in teaching Physics. Of the transmission-oriented activities surveyed, one widespread practice involved is using drills on skills and facts when introducing a science concept. This practice was reported to have never been used by most teachers but was used by 30 percent, and only rarely, i.e., once per quarter or grading period.

Another transmission-oriented activity is asking questions to see if students know the correct answer. This is a traditional practice because it does not emphasize thinking, understanding, and reasoning. It does not allow the students to construct their knowledge. These were the teachers who used theory constructivism in their Physics classes. There are also many teachers who let their students work individually in answering questions in the textbook or on a worksheet. This suggests that the teachers often used this traditional transmission-oriented strategy in Physics, indicating that the theory of constructivism was rarely used in this specific practice.

Based on Table 1, among the six constructivist-related instructional practices considered in the study, problem-solving was the most commonly reported practice. This was followed by deep thinking and probe questioning, and groupwork ranked third. The last commonly reported was the transmission-oriented (reversed) practice, which suggests that the teachers still used the traditional transmission-oriented teaching practices.

Table 1. Percentage of Teachers Using the Constructivist-Related Instructional Practices

Constructivist-Related Instructional Practices	**f**	**%**
Cognitively Challenging		
Deep Thinking and Probing Questions	65	83.3
Reflective Writing	49	62.8
Problem-Solving	77	98.7
Active Learning		
Project-Based	58	74.4
Group Work	62	79.5
Reversed-Transmission Oriented	35	44.9

Table 2 reveals the extent of use of constructivist-based instructional practices surveyed among the Physics teachers. The teachers often practiced deep thinking and probing questions, problem-solving, and group work in teaching concepts in Physics at the secondary level. Conversely, reflective writing and project-based teaching were sometimes practiced, while transmission-oriented (reversed) was rarely practiced.

Table 2. Extent of Use of Constructivist-Related Instructional Practices

Constructivist-Related Instructional Practices	Mean	Extent of Use
Cognitively Challenging	**3.18**	**Sometimes**
Deep Thinking and Probing Questions	3.50	Often
Reflective Writing	2.62	Sometimes
Problem Solving	3.42	Often
Active Learning	**2.93**	**Sometimes**
Project-Based	2.80	Sometimes
Group Work	3.56	Often
Reversed-Transmission Oriented	2.42	Rarely
Overall	**3.05**	**Sometimes**

3.2 When are Constructivist-Related Instructional Practices Mostly Used in Physics Classes?

This study also determined in what part of the science teaching constructivist practices were used and to what extent these were used in the Physics classroom. Table 3 shows that constructivist instructional practices were mainly used when presenting new information and sometimes used in learning activities and assessing students' learning.

Table 3. Part of Teaching Constructivist-Instructional Practices are Used

Part of Physics Teaching	Mean	Extent of Use
Introducing New Information	3.57	Often
Using Learning Activities	2.81	Sometimes
Assessing Learning	2.72	Sometimes

In introducing new concepts in Physics, the teachers claimed that they let their students explore the concept and discuss topics for better understanding, model the scientific method, and give examples and situations related to the topic. They prepare their students to solve problems. In using learning activities, the teachers averred that they let their students work cooperatively in discussing gathered data, drawing conclusions, and solving problems. Likewise, they let their students explore questions generated from their own experiences, use information from different sources, and use “think aloud” in solving problems. Moreover, the teachers claimed to have allowed the students to select and evaluate research articles on topics they were interested in and required written reports about the topic.

In assessing learning, the teachers reported using alternative assessment techniques, like giving portfolios and presentations to check how well the students understood new ideas, using questions to know if students used logical thinking, and giving quizzes and paper and pencil tests and different assessment techniques to determine students’ mastery of ideas taught.

The above findings show that deep thinking and probing questions were commonly used when presenting a new concept in Physics. Problem solving, project-based and group work, and deep thinking were commonly used in learning activities. On the other hand, problem-solving and probing questions were commonly used in assessing learning. The transmission-oriented (reversed) practice was not much used; instead, the traditional transmission-oriented practices were more commonly used.

4. CONCLUSIONS

The preceding discussions show evidence that constructivist-related instructional practices are used by teachers in the teaching Phyics. There were more teachers who used cognitively challenging instructional practices than active learning. In particular, the most commonly used cognitively challenging practice was problem-solving, and the most commonly used active learning was group work. Furthermore, constructivist instructional practices were generally sometimes used by physics teachers. When presenting new material, utilizing learning activities, and evaluating students' progress in Physics, they used these constructivist instructional techniques.

These constructivist instructional practices were mainly used when presenting new information; a combination of problem-solving, project-base, and group work; deep thinking in using learning activities; and problem-solving and probing questions in assessing learning.

5. RECOMMENDATIONS

Curriculum planners should incorporate the constructivist theory in improving the curriculum. In-service training workshops should be conducted focusing on constructivist-based instructional practices. In addition, subject matter content and teaching process should be given equal emphasis in teaching Physics. There should also be a continuous monitoring of teachers regarding their use of constructivist-based instructional practices, particularly in Physics classes. School administrators should also be properly oriented with the constructivist-based instructional practices so that they can do their functions more effectively in supervising their teachers to use these instructional practices. Teachers should be provided with opportunities to support their pursuit of professional development to become more confident in their teaching.

LITERATURE CITED

Adom, D., Yeboah, A., & Ankrah, A. K. (2016). constructivism philosophical paradigm: Implication for research, teaching, and learning. Global Journal of Arts Humanities and Social Sciences, 4(10), 1-9. Retrieved from https://www.eajournals.org/wp-content/uploads/Constructivism-Philosophical-Paradigm-Implication-for-Research-Teaching-and-Learning.pdf

Bada, S. O. (2015). Constructivism learning theory: A paradigm for teaching and learning. IOSR Journal of Research & Method in Education, 5(6), 66-70. doi: 10.9790/7388-05616670

Batsch, C. (2011) in How to Use Reflective Writing in the ClassrooomHOW.com. http://www.ehow.com/how_7761542_use-reflective - writing-classroom.html#ixzz1Mx7YFqQO

Cannella, G. S., & Reiff, J. C. (1994). Individual constructivist teacher education: Teachers as empowered learners. Teacher Education Quarterly 21(3), 27-38. EJ 498 429.

Ferralis, N. (2007). The Role of Constructivism in Teaching Science. In http://www/olpcnews.com/use_cases/education/constructivism_role_teaching_science.html

Gok, T., & Silay. (2010). The Effects of Problem Solving Strategies on Students' Achievement, Attitude and Motivation. Lat. A, Journal of Physics Education 4(1). In http://journa.lapen.org.mx/jan10/LAJPE_328_Tolga_Gok_preprint_corr_f.pdf

Grossman, P., Dean, C. G. P., Kavanagh, S. S., & Herrmann, Z. (2019). Preparing teachers for project-based teaching. Phi Delta Kappan, 100(7), 43-48. https://doi.org/10.1177/0031721719841338

Kroll, L. R., & LaBosky, V. K. (1996). Practicing what we preach: Constructivism in a teacher education program. Action in Teacher Education 18(2), 63-72. EJ 536 947

Lapp, D., Flood, J., & Theope L. (1989). Cooperative Learning. Enhancing learning in the secondary classroom. The American Biology Teacher 51(2), Feb. 1989. In http://www.jstor.org/pss/4448864

Oldfather, P., Bonds, S., & Bray, T. (1994). Drawing the circle: Collaborative mind mapping as a process for developing a constructivist teacher education program. Teacher Education Quarterly 21(3), 5-13. EJ 492 137

Piaget's Theory of Constructivism. (N.D.). http://www.teach-nology.com/currenttrends/comstructivism/classroom_applications/

Ravitz, J., Becker, H. J., & Wong, Y. T. (2000). Constructivist-Compatible Beliefs and Practices Among U.S Teachers Center for Research on Information Technology and Organizations, University of California, Irvine and University of Minnesota.

Sherrington, T. (2017). The Learning Rainforest. The strategy on K4 probing. John Catt. https://my.chartered.college/research-hub/the-use-of-writing-frames-and-planning-tools-to-improve-structure-and-increase-depth-in-writing/

Wilson, K. J., Brickman, P., & Brame, C. J. (2018). Group work. CBE—Life Sciences Education, 17(1). doi: 10.1187/cbe.17-12-0258.