

The Peer Instruction's Effectiveness as Teaching Pedagogy: Research Reviews

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Abstract: The effectiveness of PI as a research-based teaching pedagogy was the focus of this review. The authors reviewed nine research studies from 2010 to 2017 and different countries of the world taken from various academic journals. Juxtaposing the findings of these studies indicated that PI is a useful teaching pedagogy. Peer Instruction was developed in 1991 at Harvard University to address poor understanding of conceptual and problem-solving skill of introductory physics students. PI is a research-based pedagogy for teaching sizeable introductory science courses. Lectures in PI consist of some short presentations on critical points, each followed by short conceptual questions called *Concept Test*, posed in a multiple-choice format, on the subject under discussion. PI is a teaching pedagogy that is not common in schools in African countries. Several countries have adopted the pedagogy in science education with the evidence of its effectiveness. This paper reviewed a few of these research studies to spur Nigerian teachers to the adoption of PI as a better pedagogy. The article considered many reasons it is essential to adopt PI in Nigerian schools. The conclusion was made by suggesting PI adoption by all teachers in Nigerian schools.

Keywords: Peer instruction, pedagogy, conceptual, problem-solving, ConcepTest.

INTRODUCTION

Peer Instruction (PI) is a research-based pedagogy for teaching sizeable introductory science courses [1]. It is a pedagogical technique to increase engagement in lectures [2]. It is a method created to help make lectures more interactive and to get students intellectually engaged with what is going on. PI is a simple but effective technique any teacher can use to make lectures more interactive, more engaging, and make learning experiences more active [3]. Many classes have tested it and found to be useful for improving students' performance and also used to identify difficult student areas. Many countries have used PI in different subjects. Peer Instruction is still a new teaching method to some teachers in many countries because of its unique feature of *ConceptTest*.

Peer Instruction is an instructional strategy that engages students during class through a structured questioning process involving every student [4]. It is an instructional approach that students used to construct their understanding of concepts [5]. PI provides a structured environment for students to speak out their ideas and address misunderstandings by talking with their peers [6].

Peer Instruction is a cooperative learning technique for promoting critical thinking, problem-solving, and decision-making skills [7]. Research shows talking to peers helped them to organize their thoughts and reminded them of difficult concepts they have challenges recalling on their own [16]. Peer Instruction is an interactive approach that was designed to improve the learning process [8]. It is a method that has the

advantage of making the student more active in the class and also makes the lecture more fascinating to the students. It has the tremendous importance of giving the lecturers important feedback about the students and their learning progress.

PI is more effective at developing students' conceptual understanding than traditional lecture-based instruction [9]. According to [4], PI increases student mastery of both conceptual reasoning and quantitative problem-solving. PI increase conceptual learning and traditional problem-solving skills [9]. PI encourages students to take responsibility for their learning and emphasize understanding [6]. Peer Instruction increased student conceptual learning and performance on quantitative problem-solving questions. PI is not a rejection of the lecture paradigm, but a supplement that is helping students to engage in a range of learning styles [8].

Given this background, it is essential to review a few empirical studies within the last two decades to establish its effectiveness as a teaching pedagogy. The conceptual framework below is critical to the understanding of the PI for both the experts and the neophyte teachers.

Conceptual Framework

The use of PI involves the instructor starting with a brief presentation or summary of the material to teach. After that, the instructor poses a *ConceptTest* and asks students to think about the question and related concepts. A *ConceptTest* is a conceptual question that is presented with one correct answer and other incorrect

answers in a multiple-choice format [10]. The instructor then allows 1–2 minutes for students to think and come up with an individual answer. This may be through clickers, flashcards, a simple raising of hands, or writing down the answer on a piece of paper.

The instructor may revisit the concepts using a lecture or try a different ConcepTest if there are too few correct responses from the students. If the majority of the students' responses are correct, the instructor will then give a brief explanation and move on to the next topic or ConcepTest. In a situation where 30–70% of the students answer the concepts correctly, the instructor asks the students to turn to their neighbours

and discuss their answers. The students talk in pairs or small groups and are encouraged to find someone with a different answer. The teacher moves around the room to encourage productive discussions and guide student thinking. After several minutes, the students answer the same concepts the second time, and the instructor then explains the correct answer. The instructor can pose other related ConcepTest questions or proceed to a different topic or concept depending on the student's answers.

The conceptual framework of the Peer Instruction process is represented using the figure-1 below.

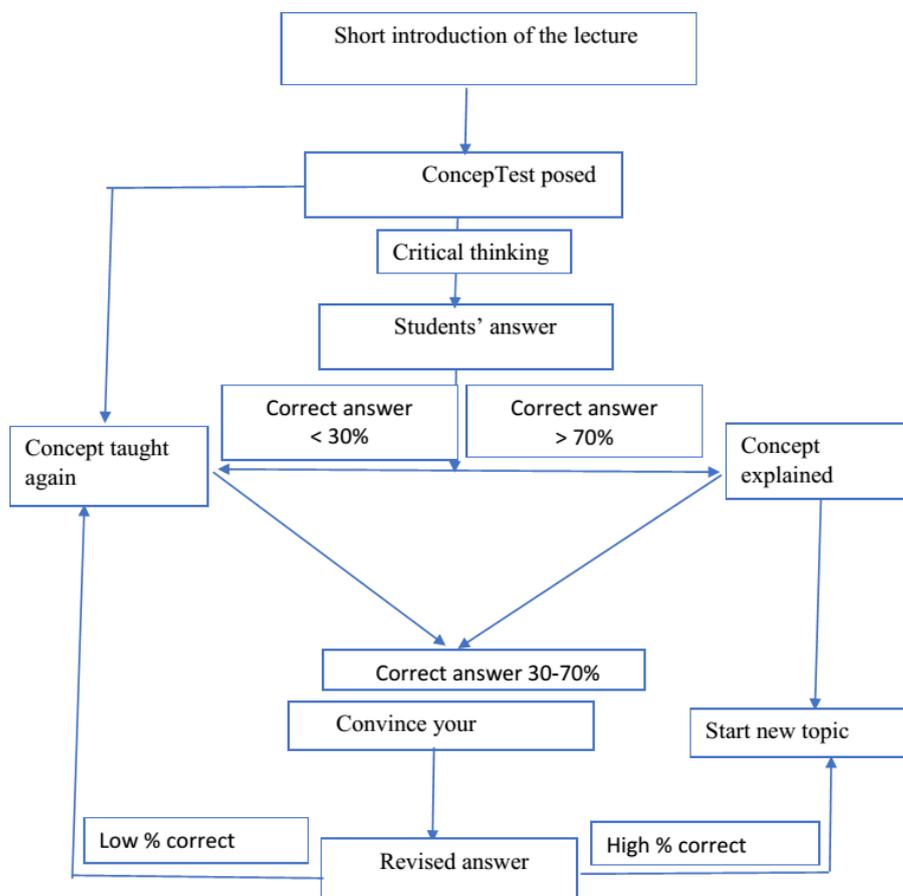


Fig-1: Conceptual framework of Peer Instruction process

The Effectiveness: Research Results

Evidence from [11] research titled “A comparison of students’ performance, skill and confidence with peer instruction and formal education” show that PI is effective in increasing students’ problem-solving skill. The study consisted of 98 students from two different groups enrolled in a physics course in Turkey. The research was pre-post-test quasi-experimental design. The research instrument employed was the Physics Achievement Test developed by the researcher and the Problem-Solving Confidence Questionnaire. The statistical analysis used was Analysis of Variance (ANOVA). The research

concluded with the result that PI increases the performance, skill, and confidence in students’ problem-solving in physics.

[12] researched in “Peer Instruction as a Way of Promoting Spontaneous Use of Diagrams When Solving Math Word Problems.” Fifty-seven grades of grade 8 students participated in the study. A randomized block design method which grouped students according to their achievement was used. The Math Word Problem Assessment and Basic Skills Assessment were used to collect data. The finding of

this study shows that PI help students use diagrams for solving word problems in mathematics.

[13] on the title “Peer Instruction versus class-wide discussion in large classes: a comparison of two interaction methods in the wired classroom” shows the effect of PI on learning. Thirty students participated in the study were interviewed, a survey and a critical incident used the questionnaire as a research method among engineering students. This research summarized that PI increase students’ conceptual understanding.

Investigating peer instruction: How the initial voting Session affects students’ experiences of group discussion by [14] shows that PI is beneficial to learning. The research conducted was in an introductory physics course for preparing engineering students. Seven teachers and over two hundred students participated in the study. The study used another method with the PI for teaching for eight weeks and after that conducted interviews with the students. Analysis of the interview results shows that after the initial voting PI was more beneficial to the students learning.

[15] researched the “PI and the secondary school students’ achievement in vectors” in Kenya using Solomon Four Experimental design. The data collected were analysed using the t-test and the Analysis of Variance (ANCOVA). Four hundred and seventy-nine secondary school students participated in the study. Results show that peer instruction had a positive impact on the students’ achievement in vectors.

Teaching engineering dynamics by the use of peer instruction supported by an audience response system by [16] shows PI increase students’ learning outcome and satisfaction with the learning paradigm. The study was among the 65 university students in Denmark. Both PI and traditional method of teaching were employed, and data collection was by pre-test at the beginning of the semester, the audience response system, final examination in dynamics, final examination in mathematics and questionnaire. The data analysis was by the descriptive statistical tool.

[17] researched the effects of peer instruction on the success, motivation and decision-making styles of primary seventh-grade students. 49 seventh grade students in a public school in Turkey participated in the study. The researcher used Motivation Scale for Science Education and Academic Achievement Test as research instruments. The data collected were analysed using ANCOVA. The study concludes that peer instruction contributes to the students’ academic success and also provides a positive contribution to the motivation for science learning.

[18] in a study on “Using peer instruction (PI) to investigate pre-service physics teachers’ academic

performance in Nigeria” show a significant difference between students taught with PI and those with the traditional lecture method. Additionally, the paper reveals that PI helps the student to get rid of misconceptions in physics. The researcher sampled fifty-two students in a college of education in Nigeria. Two research instruments adopted were Electromagnetism Physics Assessment and the Dialogical Argumentation Questionnaire. Data obtained were analysed using the t-test and the Analysis of Covariance (ANCOVA).

[19] study on the effect of peer instruction method on pre-service teachers’ conceptual comprehension of methodology course shows the Effectiveness of PI female students in Saudi Arabia. The study adopted the quasi-experimental design. Seventy-eight female students participated in the study. The researcher collected data through a pre-post conceptual comprehension methodology test. The t-test, descriptive statistics, and Analysis of Covariance (ANCOVA) were used to analyse the data collected. The result indicated that PI had a positive influence on the students’ learning. The author concludes that peer instruction method was effective in enhancing conceptual comprehension among others.

Having considered the research evidence on PI, it is imperative to discuss two constructs critical and unique to PI. These are ConcepTest and Concept Inventory.

The Uniqueness of the PI

The PI is unique and different from all another interactive learning paradigm because of the ConcepTest. ConcepTest is a short conceptual multiple-choice question created for Peer Instruction. ConcepTests have been observed by [4] to be the cornerstone of PI. Without good ConcepTests, there cannot be any success in PI class. ConcepTest is what makes PI different from all other cooperative learning. There are many qualities of a good ConcepTest that the scope of this paper cannot cover. More importantly, the research document suggests a ConcepTest must not address two concepts at a time, and it must not contain too many words. The ConcepTest help the teacher to know the level of students’ misconception and also give quick feedback to the teacher.

Why the Need for PI?

There is that need for a shift in the paradigm of teaching in Nigeria schools. The traditional lecture method that is common in classes in Nigerian schools is no longer valid because it cannot produce what is called the authentic learning. This method is at best can lead students to rote learning. Most students in Nigeria, today, are unable to connect classroom experience to the real-world problem because they learned by memorization (rote learning). They learned to forget very quickly because they have not actively participated

in the class during the lecture. Authentic learning is the best learning that is appropriate for the present world of science and technology.

Authentic learning focuses on real-world, complex problems and their solutions, problem-based activities, case studies, and the students' participation in the learning tasks [20]. Students are actively working, participating in discussions, seeking for information, and enjoying the process of learning [21].

Authentic learning activities give the students „real-world“ experiences but protect them from the harmful thing which may not support their learning. Authentic learning is learning by doing. It is active learning where students are not passive. It is an inquiry method of learning. Observation shows that this learning is vital for developing critical thinking skills scientific and evolving the contents [22].

PI is a research-based pedagogy that was developed purposely to aid the transfer of learning from theory to practice. According to [23], authentic learning can improve students' academic performance and also connect the classroom experience to the real-world situation. Students in the PI class cannot be passive because it is activity-based pedagogy.

No student can be passive in the PI class because the period of peer discussion that is called „convince your neighbor“ is a period of real learning. PI is one of the best teaching pedagogy that is closely related to authentic learning in any subject because retention in traditional lecture is very low after classroom activities. According to [24], a student on the average retains just 42 percent of the material learned through a lecture by the time it ends and only 20% one week later.

PI promotes teacher effectiveness in the class. Teachers who got feedback from the students about his or learning will ultimately be more efficient. According to [25], teacher effectiveness is essential to students' academic performance in any subject [26] has once observed that teachers' teaching pedagogy is a serious factor that influences a teacher's effectiveness. According to [27], teachers' poor method of teaching science greatly contributed to the poor performance and enrollment in science in Nigerian schools. PI can help to increase teacher self-efficacy and also pedagogical content knowledge (PCK). According to [28], self-efficacy and PCK are important constructs that help a teacher to succeed in a teaching profession. It is, therefore, important for Nigerian teachers to adopt a research-based method of teaching such as PI to improve students' academic performance and enrollment; teacher effectiveness; teacher self-efficacy and pedagogical content knowledge.

The critique that students do not learn during peer discussions is a significant issue in PI which integration with the dialogical argumentation resolved. Some believed not much is known about the potential of the peer discussion before students register their answers [29]. According to [5], it is not clear whether a student indeed learned or just copied the correct answer in their groups during PI.

A dialogical argumentation-based classroom is an environment where learners have the opportunity to express their views freely. In this way dialogical argumentation allows learners to construct what may be called Authentic Learning (AL) knowledge and to participate in a socio-cultural milieu of classroom interactive discursive dialogue focussed on conceptual-contextual issues. In this case, students do not accept any scientific information given by the teacher unless such information is subjected to an argument-based classroom interrogation before reaching what may be called harmonious understanding or cognitive harmonization.

Given this, the constructivism theory plays a crucial role in students learning during the PI. Constructivism emphasizes the importance of the knowledge, beliefs, and skills that an individual brings to the experience of learning [30]. Vygotsky, a proponent of social constructivism, argued that learning is a social and collaborative activity by which people constructs meaning as they interact with one another [31]. Students created ideas through interaction with the teacher and other students. Equally essential is the constructive Controversy theory which involves deliberative discussions aimed at creative problem solving [32]. Students are strongly motivated to produce solutions and display high-level reasoning, and more significant mastery and retention of new knowledge gained.

Juxtaposing PI and the conventional teaching strategy reveals that PI is flexible to accommodate social interaction during learning. It also allows students to lend their opinion to learning through logical argument to produce consensus in learning as supported by two theories mentioned above. It is, therefore, apparently clear that Peer instruction is an effective strategy based on the research studies reviewed above.

CONCLUSION AND RECOMMENDATIONS

In conclusion, PI is a research-based pedagogy that promotes classroom interaction that improves conceptual and problem-solving skill. It encourages and supported authentic learning; it gives immediate feedback to the teacher about his or teaching; it helps students to identify troublesome areas of learning, and above all, it improves students' academic performance.

The following recommendations are suggested based on this review:

Since this is a new pedagogy to Nigerian schools and Africa as a whole, there should be seminars, conferences, and workshops on PI for teachers at all levels. The process may look simple, but it is difficult to practice.

There are problems peculiar to PI such as the construction of valid ConcepTest. All teachers must be committed to the process of PI even when it seems the students are not cooperating. For valid ConcepTest teachers must read books and journal articles on PI very well.

This paper suggests PI to all categories of teachers in Nigeria and Africa irrespective of discipline. Teachers had used PI in the different subject even in Philosophy.

Finally, the article suggests that all scholars and researchers in Nigeria and Africa should investigate more on the integrity of the effectiveness of PI. Presently more of the research studies on PI were done in schools outside African countries.

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Conflict of Interest

I declare that there is no conflict of interest.

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