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COMPARATIVE EFFECT OF PQ4R METHOD AND ADAPTIVE LEARNING PLATFORM OF ARTIFICIAL INTELLIGENCE ON STUDENTS' COGNITIVE ABILITIES AT UNIVERSITY LEVEL

Irsa Tayyab irsatayyab019@gmail.com	MPhil Scholar, Department of Education, University of Gujrat, Gujrat, Punjab, Pakistan.
Assad Naveed assadnaveed@gmail.com	MPhil Scholar, Department of Education, University of Gujrat, Gujrat, Punjab, Pakistan.
Moneeza Aslam moneezyaslam@gmail.com	MPhil Scholar, Department of Education, University of Gujrat, Gujrat, Punjab, Pakistan.

Abstract

The current research is to resolve a great concern about artificial intelligence in today's race of instructional technology. Artificial intelligence is assisting the human being to solve their issues and numerous platforms are employed in this context. However, in an educational context, it is doubtful to examine the impact of adaptive learning platform as an instrument of artificial intelligence on students' cognitive skills. True experimental design will be employed to provide the answer to this question. Study population will be comprised of all undergraduate students of public colleges of Punjab. A single public sector college of district Gujrat will be chosen for this study. Two equal groups; experimental group and control group be drawn through random assignment based on pre-test. Test for assessing students' cognitive skills will be developed in accordance with the sub-levels of cognitive domain. Test will be validated and administered to both groups. Experimental group students will be instructed using adaptive learning platforms whereas control group students will be instructed through PQ4R process. Post-test will be conducted on both groups after treatment manipulation for 21 days and data thus obtained will be analyzed using t-test.

Keywords: *Adaptive Learning Platform*, *Cognitive Abilities*, *PQ4R Method*, *True Experimental*

Corresponding Author: Irsa Tayyab (MPhil Scholar, Department of Education, University of Gujrat, Gujrat, Punjab, Pakistan).
Email: irsatayyab019@gmail.com

1.Introduction

Artificial intelligence (AI) is a new technology with transformative power in almost every aspect of human life, including education. Over the past few years, AI has brought innovative solutions to learning and teaching, especially through intelligent systems that facilitate flexible, self-directed, and collaborative learning environments (Chassagne et al., 2018). One of the impressive benefits of AI in education is its application in computer-supported collaborative learning, particularly in asynchronous learning environments where students participate in learning activities and discussions without being in the same location. This makes it possible for students to have access to educational materials at their convenience and own pace, and this fosters autonomy and inclusion in learning (Perivacuolar, 2019).

Of all AI-driven approaches, adaptive learning platforms have emerged as prominent strategies for their power to customize learning experiences. They employ machine learning algorithms to adjust instruction according to individual learners' needs, performance, and interests, thus boosting engagement and learning outcomes (Gupta, 2023). Adaptive learning is extensively implemented in educational institutions and corporate organizations using digital means such as learning management systems (LMS) and intelligent learning portals. These systems not only dynamically adjust content delivery but also aid learning and development teams in curating and evaluating learning experiences efficiently. In addition, AI-powered platforms help teachers by automating mundane administrative tasks, enabling them to concentrate more on student support and differentiated instruction.

Conversely, conventional teaching approaches like the PQ4R (Preview, Question, Read, Reflect, Recite, Review) technique remain relevant in fostering student comprehension and intellectual growth. The PQ4R technique improves students' skills in reading, understanding, and applying acquired knowledge in real-life situations (Fitriani & Suhardi, 2019). The current research is contextualized within Bloom's taxonomy, with emphasis on the three lower-order cognitive categories: knowledge, comprehension, and application. It is designed to compare the efficacy of two instructional approaches—AI-based adaptive learning systems and the PQ4R approach—on the cognitive capacity of undergraduate students. Through the evaluation and comparison of pre- and post-intervention data, the research aims to establish whether adaptive learning technologies

yield a quantifiable benefit over conventional approaches in developing students' cognitive development.

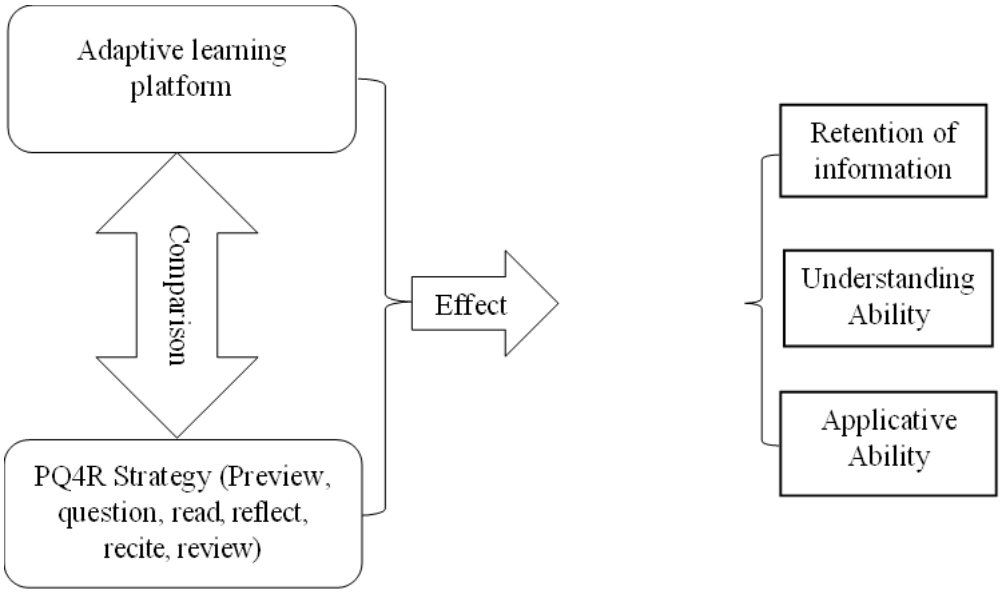

Figure 1: *Conceptual Framework of the Study*

1.1. Statement of the Problem

This present age is the age of technology. Technology is intermixed in every aspect of life. Likewise, artificial intelligence has made way to sort out educational issues but an issue comes into consideration that if the students are solving their issues through artificial intelligence then what about their cognitive skills. Whether their cognitive skills are impacted positively or negatively through the utilization of artificial intelligence. In addition, literature confirms that PQ4R technique has its importance in building retention of students' knowledge, understanding and using the material. The research work is an attempt to identify difference in impacts of adaptive learning platform and PQ4R technique on cognitive skills of University of Gujrat students.

1.2. Objectives of the Study

The following will be the purpose of the study.

1. To determine impact of adaptive learning platform as artificial intelligence tool on students' lower order cognitive skills at university level.
2. To determine impact of PQ4R teaching method on students' lower order cognitive skills at university level.

3. To determine difference between the impacts of students taught by adaptive learning platforms and PQ4R method on students' higher order cognitive skills at university level.

1.3. Hypotheses of the Study

Following hypotheses will be tested to attain the study objectives.

H01: There is no significant difference between mean gain score on pre-test and post-test of students who are taught using adaptive learning platform across their rate of retention information during under graduate studies.

H02: There is no significant difference between mean gain score on post-test and pre-test of students instructed by adaptive learning platform over their knowledge of the course material during undergraduate studies.

H03: There is no significant difference between mean gain score on post-test and pre-test of students instructed by adaptive learning platform over their applicative skills during undergraduate studies.

H04: There is no significant difference between mean gain score on pre-test and post-test of students instructed by PQ4R method across their rate of retaining information during under graduate studies.

H05: There is no significant difference between mean gain score on pre-test and post-test of students instructed by PQ4R method across their comprehension of the study material during under graduate studies.

H06: There is no substantial difference between mean gain score on post-test and pre-test of students educated using PQ4R method across their applicative skills during undergraduate studies.

H07: There is no substantial difference between mean gain score of students' cognitive abilities educated using adaptive learning platform and PQ4R method during undergraduate studies.

1.4. Significance of the Study

This study will be significant like an effort to introduce the modern technology being used in education. Furthermore, this study will determine the impacts of adaptive learning platform as an artificial intelligence tool and another variable PQ4R on students' cognitive skills which will serve as proof regarding the effectiveness of both methods. If students' cognitive development level will increase then it can be suggested to include part of the syllabus at university level. Otherwise, it will be doomed to utilize in the future for particular purposes. Additionally, this research will give an evidence of impact of PQ4R

method and its comparison with the impact of adaptive learning platform on students' cognitive skills. This research is also an attempt to get attention of the stakeholders regarding the use of artificial intelligence. The students can use this technology to get their problems solved and teachers can guide the students to make them proficient in the use of technology.

2. Review Of Related Literature

Artificial intelligence is a general term used to describe the application of a computer to mimic intelligent behavior with minimal or no human intervention. Artificial intelligence is now considered to be an engineering discipline that uses new ideas and solutions to solve complex problems. Computers could eventually be as smart as humans if developments in electrical speed, capacity, and software design continue. The role of contemporary cybernetics in developing artificial intelligence cannot be overemphasized. Developing robots has sometimes been viewed as the origin of artificial intelligence. The origin of the word robata is based on the Czech term for biosynthetic devices used as coerced labor (Hamet & Tremblay, 2017). Karel Capek's 1921 play "R.U. R" (Rossum's Universal Robots) established the term robot, or robot in Czech, in the literature. It was a factory in which biosynthetic devices were used as slave labor. In the middle of the twentieth century, Isaac Asimov immortalized the word "robot" in a series of contemporary science-fiction short stories. However, the first reference of a humanoid automaton may be found in the third century in China, when a mechanical engineer, Yan Shi, presented to Emperor Mu of Zhou a human-shaped figure of mechanical craftsmanship fashioned of leather, wood, and artificial organs (Theophilus's et al., 2015). In the 12th century, al-Jazari, a Muslim golden era philosopher, polymath, inventor, and mechanical engineer, developed a humanoid robot capable of striking cymbals.

Throughout the past two decades, much development occurred in the area of Artificial Intelligence in Education. The introduction of 21st century skills (Trilling & Fadel, 2009) and Next Generation Science Standards (NGSS, 2013) brought forth an important role of general learning capabilities like metacognition, critical thinking, and cooperation. Consequently, contemporary educational settings and concepts try to integrate true practices within collaborative environments utilizing big challenges. Artificial intelligence has to change to fit these advances in order to continue being relevant and having some impact. These learning changes offer a chance as well: contemporary theories of learning call for more agency and tailoring (Collins & Halverson, 2010). Most traditional classroom designs, nonetheless, are inadequate to involve students in "big" issues (Kirschner et al., 2006; Tobias & Duffy, 2009) or offer students choices

(Collins & Halverson, 2010). Students and teachers both need more individualized support.

Artificial intelligence is applied in various educational areas. Based on Chassagne et al. (2018), artificial intelligence is generally advantageous in curriculum development and content personalization, instruction and instructional methods, assessment, and student-teacher communication. Perivacuolar (2019) found that the inclusion of artificial intelligence enhances learners' learning experiences since they utilize machine learning algorithms and provide students with content based on students' learning needs and abilities. Likewise, the artificial intelligence is being used mainly by students and the learners, and it could assist in medical science and in crime investigation but in educational sphere whether it will be beneficial to the students or not with extra emphasis on cognitive skills of students. In contrast PQ4R method is beneficial for the students to learn effectively. The PQ4R method is a learning approach that can help students think, remember, and understand a learning topic (Fitriani & Suhardi, 2019). The PQ4R method is among the approaches that can enhance memory performance in learning modules (Gardenia et al., 2019). Thus, this research is intended to determine comparison of the impact of adaptive learning platform and PQ4R teaching method on students' cognitive skills.

3.Research Design

This research will be experimental in type. There are three variables in this research altogether. Two of them are independent in type. The first one is adaptive learning platforms as an instrument of artificial intelligence and experimental group students will be taught through it. Second variable is PQ4R teaching method, control group students will be taught using this method. Both the independent variables will have effect on dependent variable; students' cognitive abilities. Furthermore, comparison of both the variables' effect will also be researched in this study. True experimental group will be utilized in conducting this study. Out of true experimental group designs, randomize pre-test post-test control group design will be utilized in conducting this study. In this experimental setup two equivalent groups shall be chosen by random assignment based on pre-test. Both shall be labeled as experimental and control group. Experimental group students shall be taught using adaptive learning platform and control group students shall be taught using PQ4R method. Pre-test shall be given to both group of students prior to the manipulation of the treatment. In the same way, Post-test will also be given to both group students to identify the difference in the cognitive abilities of students after manipulation. Research design is depicted from the following figure.

Experimental Group	Pre-test	Manipulation of adaptive learning platform (IV)	Post-test
Control Group	Pre-test	Manipulation of PQ4R (IV)	Post-test

Figure-3.1: *Randomized Pre-test Post-test Control Group Design*

3.1. Population of the Study

Undergraduate public sector college students enrolled in session 2023-2027 will form the population of the research.

3.2. Sampling

University students of Gujrat program of a public sector college in city Gujrat will be chosen for experiment. Two equal groups of 30 students each will be created through random assignment on the basis of pre-test. The first group will be referred to as experimental group while another group was referred to as control group. Each student has an equal and independent opportunity of being assigned to experimental or control group (Fraenkel et al., 2018). Sample diagram is provided below.

Sixty students of undergraduate program	***R*** Random assignment of30 students in Experimental Group	***O*** Pretest: Cognitive abilities test (Dependent variable)	**X** Treatment: Adaptive learning platform	***O*** Posttest: Cognitive abilities test (Dependent variable)
	R Random assignment of30 students in Control Group	***O*** Pretest: Cognitive abilities test (Dependent variable)	***C*** Treatment: PQ4R method (preview,	***O*** Posttest: Cognitive abilities test (Dependent variable)

3.3. Instrument of the Study

The research design is Randomized Pre-test Post-test Control Group Design. A 30 marks test containing 30 MCQs will be designed to determine cognitive capabilities of the students. Test will be designed based on three simplest sub-levels of cognitive domain of Bloom's taxonomy (1956). The test will be employed as a pre and post-test for the data collection process.

3.4. Validation of the Instrument

Test will be verified by expert view. Content Validity Index (CVI) of questionnaire will be computed. Weak MCQs will be improved and amendments will be carried out on the basis of the view of experts. Furthermore, test will be piloted and reliability will be assessed.

3.5. Intervention

Experimental group students will be educated by hand-on activities from an adaptive learning platform. Further, students will be given home work. In addition, control group will be instructed by PQ4R approach (preview, question, read, reflect, recite, review). Pre-test will be carried out for both the groups. Then post- test will be carried out for both the groups after treatment to the experimental and control group to identify effect of adaptive learning platforms on the cognitive skills of the students. This treatment will be extended for at least 21 days.

3.6. Data Analysis

Data will be gathered through test and input in SPSS to obtain the results. Descriptive and inferential statistics will be employed to analyze the data. T-test will be employed to test the study hypothesis.

4.RESULTS AND DATA ANALYSIS

Table 1: Descriptive Statistics for Pre-Test and Post-Test Scores of Experimental Group (Adaptive Learning Platform)

Test Type	N	Mean	Standard Deviation	Std. Error Mean
Pre-Test	30	12.30	3.42	0.62
Post-Test	30	20.67	2.98	0.54

Table 2: Paired Sample t-test for Experimental Group (Adaptive Learning Platform)

Test	Mean Difference	t-value	df	p-value(Sig. 2-tailed)
Pre vs. Post	8.37	12.45	29	0.000*

***Significant at p < 0.05**

Table 3: Descriptive Statistics for Pre-Test and Post-Test Scores of Control Group (PQ4R Method)

Test Type	N	Mean	Standard Deviation	Std. Error Mean
Pre-Test	30	12.10	3.50	0.64
Post-Test	30	17.23	3.20	0.58

Table 4: Paired Sample t-test for Control Group (PQ4R Method)

Test	Mean Difference	t-value	df	p-value (Sig. 2-tailed)
Pre vs. Post	5.13	9.32	29	0.000*

***Significant at p < 0.05**

Table 5: Independent Sample t-test for Post-Test Scores Between Experimental and Control Group

Group	N	Mean	Std. Deviation	Std. Error Mean
Experimental	30	20.67	2.98	0.54
Control	30	17.23	3.20	0.58

Table 6: Independent Sample t-test Results

Test	Mean Difference	t-value	df	p-value (Sig. 2-tailed)
Experimental vs Control	3.44	4.57	58	0.000*

***Significant at p < 0.05**

These tables indicate a remarkable improvement in cognitive skills (knowledge, understanding, application) in both groups, with more improvement in the experimental group instructed by adaptive learning platforms.

5. Discussion

The aim of this study was to examine and compare the impact of an adaptive learning platform, as an instrument of artificial intelligence (AI), and the PQ4R approach on undergraduate students' lower-order cognitive skills—i.e., knowledge retention, understanding, and application. The findings of the study show that both teaching methods resulted in considerable improvement in cognitive capacities of the students. The experimental group, though taught through the adaptive learning platform, demonstrated much higher post-test scores compared to the control group instructed through the PQ4R method.

These results are consistent with current studies that affirm the use of AI-driven adaptive learning tools in classrooms. Adaptive learning systems customize instruction according to individual learning pace, preference, and performance, thereby facilitating a customized learning experience that improves student engagement and performance (Chassignol et al., 2018). As seen in this research, the greater individualization through adaptive systems most likely helped improve performance in knowledge retention and understanding.

Past research has also indicated that adaptive learning technologies powered by AI algorithms offer instant feedback and modify the learning process according to students' requirements, ultimately enhancing learning outcomes. For instance, Gupta (2023) points out that adaptive systems improve not just student engagement but also knowledge retention and application in diverse fields, such as higher education. These results are aligned with the present research, where the adaptive learning group showed a higher capacity to utilize learned principles.

Conversely, the PQ4R strategy has been proven to be a successful method in enhancing reading comprehension and memory since a long time ago (Fitriani & Suhardi, 2019). In the current study, the control group students also showed substantial cognitive enhancement in comprehension and retention, verifying the effectiveness of the strategy. Gardenia et al. (2019) also noted that the PQ4R strategy facilitates deeper cognitive processing, consistent with the findings of the current study. Still, compared to AI-driven adaptive learning, the PQ4R approach might not be as responsive and adaptive to real-time individual learning differences.

Additionally, the post-test performance difference between the two groups validates the claim by Pokrivcakova (2019), which stated that AI-based learning environments provide differentiated instruction and respond to student feedback, making it a more effective learning process. This responsiveness probably benefited the experimental group in achieving greater cognitive involvement and abilities.

The results of the present study also align with wider educational trends prioritizing 21st-century learning competencies like personalization, critical thinking, and student agency (Trilling & Fadel, 2009). As learners transition into increasingly digital learning contexts, established methods, although still effective, may have to be supplemented or blended with intelligent systems to ensure maximum impact.

Although both instruction methods promoted substantial cognitive advancement, the dominance of adaptive learning platforms in this research indicates that AI-supported instructional tools have great potential to complement and replace traditional methods in some cognitive areas. Nevertheless, it is important to take into account the context, infrastructure, and teachers' training when incorporating such technology into classrooms.

6. Conclusion

This present study sought to investigate and compare the impact of an adaptive learning platform, a product of artificial intelligence (AI), and the PQ4R strategy on undergraduate students' lower-order cognitive capacities—i.e., knowledge recall, comprehension, and application. The findings showed that although both teaching strategies had a significant positive impact on the cognitive capacity of the students, the experimental group instructed through the adaptive learning platform performed better than the control group instructed using the PQ4R strategy.

These results further support the ability of AI-powered adaptive learning solutions to advance cognitive growth through responsive and tailored learning paths. The ability of adaptive platforms to automatically modify content in response to learners' requirements seems to be an important aspect in promoting increased engagement and enhanced performance, especially in retention and knowledge application. On the other hand, while the PQ4R strategy is still a strong and teacher-directed thinking tool, it is less flexible and in-the-moment responsive compared to AI technology.

The findings of this study have serious implications for contemporary education practices. As digital change gains momentum in the education system, the embedding of AI tools within teaching and learning activities can be a sound strategy to address the varying needs of students and improve academic outcomes. In addition, the study recommends that adaptive learning technologies are explored further and systematically introduced into higher education environments to optimize the learning outcomes of students.

6.1. Recommendations

Based on the conclusion and finding of this research, the following recommendations are made:

6.1.1. Incorporation of Adaptive Learning Platforms in Curriculum

Higher educational institutions, especially at the undergraduate level, should incorporate AI-based adaptive learning platforms into pedagogy. These platforms can be

especially beneficial for core and content-rich subjects in order to enhance students' retention, comprehension, and utilization of knowledge.

6.1.2. Teacher Training on AI-based Tools

To facilitate successful implementation, training sessions must be conducted for teachers to acquaint them with the capabilities, potential, and pedagogical uses of adaptive learning technologies. Teachers are key in directing students' interactions with AI tools and ensuring meaningful learning outcomes.

6.1.3. Blended Learning Approach

A hybrid learning model that mixes conventional methods such as PQ4R with adaptive learning technology might serve a wider variety of students. This mixed model can provide both the scaffolding of known methods and the adaptability of AI systems, resulting in a more balanced and inclusive learning environment.

6.1.4. Additional Research on Long-term Effect

Longitudinal studies must be undertaken to examine the long-term impact of adaptive learning platforms on students' higher-order cognitive skills, including analysis, evaluation, and creation. Future studies may also examine other variables, including motivation, self-regulation, and digital literacy.

6.1.5. Policy Support and Funding

Policymakers in the education sector and stakeholders need to support the adoption of AI tools through specific funding, infrastructure development, and policy making to facilitate equitable access and sustainable usage across institutions.

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