Comparative Analysis of EdPuzzle and Plickers for Measuring Student's Perception, Engagement, and Learning Outcome

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Approval

It is certified that the contents and form of the thesis entitled "Comparative Analysis of EdPuzzle and Plickers for Measuring Student's Perception, Engagement, and Learning Outcome" submitted by Rida Abbas Ch have been found satisfactory for the requirement of the degree.

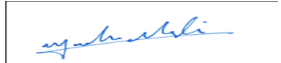Advisor: Dr. Tahira Anwar Lashari

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THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of MS/MPhil thesis written by Ms Rida Abbas Ch, (Registration No 318211), of SEECS has been vetted by undersigned, found complete in all respects as per NUST Statutes/Regulations, is free of plagiarism, errors and mistakes and is accepted as partial fulfillment for award of MS/M Phil degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the said thesis.

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Dedication

Dedicated to my parents for their unconditional love, prayers and support throughout my life; my siblings, especially my brother whose support and help in everything makes life easier.

Acknowledgement

First and foremost, praises and thanks to the Almighty Allah, for His showers of blessings throughout my life.

I would like to thank my research supervisor Dr. Tahira Anwar Lashari for her guidance throughout my research and helping me whenever I was lost.

I am extremely grateful to my parents for their love, prayers, caring and sacrifices for educating and preparing me for my future. Also, I express my thanks to my sisters, and brother for their support and valuable prayers. My special thanks goes to my brother Muhammad Abdullah Chaudhry for his support and help in my research work.

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Abstract

This study aimed to analyze the impact of assessment tools and techniques, particularly EdPuzzle and Plickers, on students' learning, engagement, performance, and overall learning outcomes. The study was developed based on the quantitative research design. The targeted audience was the students in the ninth grade of the school in Rawalpindi. The study collected pre-test data from 60 students to provide the baseline for how well these students performed in their English grammar and comprehension tests. In order to evaluate the performance of students on tests, the effect of different parameters on student performance, and to analyze the differences in perceptions among the three groups, SPSS was used. The findings indicated that students who received instruction via EdPuzzle had the best performance, and student's perceptions of the technology and their learning outcomes were also most significant. The findings have indicated that EdPuzzle was a better learning and instruction approach than Plickers and traditional learning techniques. The experiment was conducted in a single school with a very small sample size; thus, there might be problems in generalization. The study provides awareness to educators and policymakers to make informed decisions for implementing technology in education.

Keywords – EdPuzzle, Plickers, learning, student engagement, learning outcomes, Pakistan.

1: Introduction

Assessment is the process of evaluating or measuring the knowledge, skills, abilities, or performance of an individual or group against predefined criteria or standards. It can be used to determine the level of understanding or proficiency of a particular subject, identify areas of strength and weakness, and provide feedback for improvement. Assessment can be taken formally or informally. Formal assessment includes tests, quizzes, and observations, whereas informal assessment includes observations, oral presentations, interviews, and self-evaluations, and it is commonly used in educational, professional, and personal settings. Effective assessment requires clear objectives, reliable and valid methods, and accurate interpretation of results.

A person's education is greatly influenced by assessment as it can guide the curriculum and teaching method. It can inform teachers about what topics and skills need more attention and what teaching strategies are effective. It is regarded as the main part of the educational process. Assessment is crucial to the learning process since it shows whether learning objectives are being accomplished. It offers data on the development of students from several angles.

1.1. Background of Study

Financial constraints, accessibility, and connectivity problems have made it extremely difficult for developing countries like Pakistan to embrace online education. Only individuals with prior e-learning, blended learning, and ICT tool expertise have adjusted to this transition (Adnan & Anwar, 2020; Crawford et al., 2020; Kalloo et al., 2020; Louis-Jean & Cenat, 2020). Since the Covid-19 pandemic was proclaimed in March 2020, multimedia technologies with video have been

used to establish distance learning and instruction hastily. Teachers, however, cannot confirm if their students are truly watching the instructional videos. As a result, it has been necessary to monitor and inspire student engagement with videos using technological tools. Mobile technologies promise to advance education and evaluation in the 21st century (Nikou & Economides, 2018). Because of how the internet and contemporary information technologies have changed education, children may benefit much from the World Wide Web. Due to this, online learning opportunities have increased recently, providing new learning opportunities that weren't previously available. Due to technological improvements, online education has emerged as a potential replacement or addition to traditional methods of teaching (Waits, 2003). According to (Johnson et al., 2000), online learning is becoming increasingly common in higher education and gives the chance to deliver a whole education online. Through online courses, universities may now provide distance learning to all students, including full-time, part-time, conventional, non-traditional, and foreign. According to (Bartley & Golek, 2004), this is especially advantageous for people with limited access to further education possibilities. (Crawford et al., 2020) contend that learning is a fundamental human need since it helps people develop important life skills. The ways that people learn have changed in the twenty-first century, and traditional or in-person learning has given way to blended or online learning. Online learning is sometimes called e-learning (Ajmal & Hafeez, 2021).
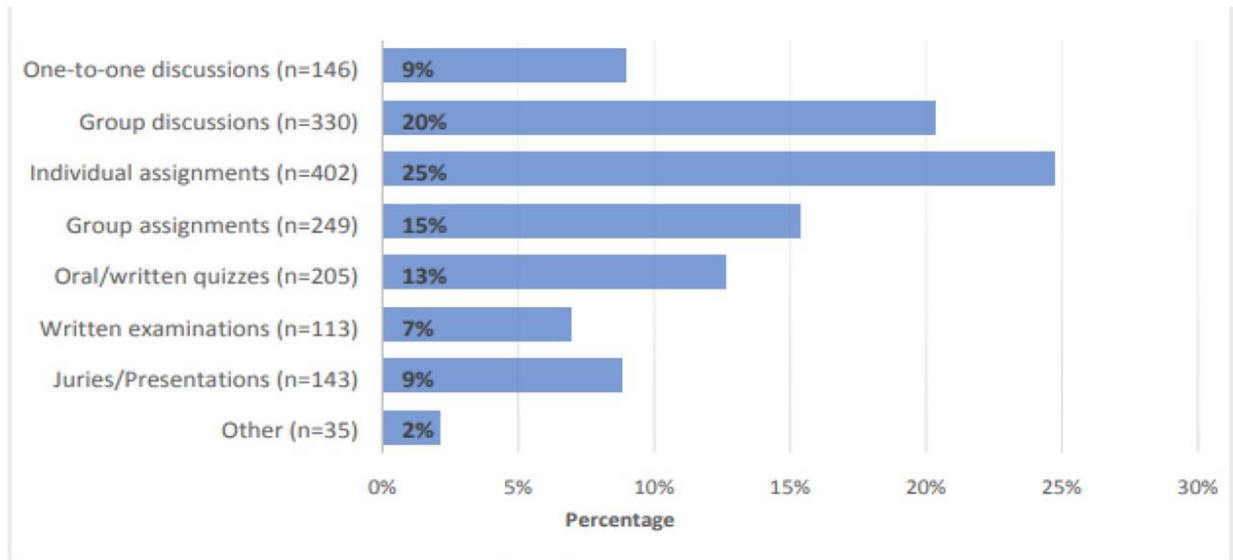
Figure 1: Types of Assessment Methods Source (Iqbal et al., 2022)

The methods of teaching and learning in educational institutions, including schools, colleges, and universities, have radically transformed with the advent of Covid-19 in China in 2019. Due to this, several colleges now provide online education instead of face-to-face instruction (Hafeez et al., 2022). Due to the inclusion of many web-based learning resources, e-learning has become a more effective instruction method in various academic contexts. ICT is used in both the teaching and learning process to increase the effectiveness of the teaching and learning process in e-learning (Ananga & Biney, 2017). Higher education has benefited from the emergence of innovative and engaging teaching and learning techniques that combine or replace traditional face-to-face training (Paudel, 2021). Many studies have been conducted in Pakistan to examine the difficulties and opportunities of online learning in a setting where conventional learning, education, and the inclusion of E-learning procedures were uncommon (Fareed et al., 2016). Only a few national educational institutions used this technology before the Covid-19 epidemic. Previous studies from Pakistan have shown promising outcomes for online learning. The relationship between professors

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and online students is positive, the curriculum is well-designed and up-to-date, and the instructors are committed, competent, and knowledgeable about their fields (Ali & Ahmad, 2011).

1.2. Problem Statement

The prospect of online learning has been made possible by the quick advancement of information and technology. Students taking courses online may easily access a computer network from any location. Online learning, according to (Acosta-Tello, 2015), uses innovative, internet-based tools that are student-centered to offer contemporary, flexible learning experiences in an asynchronous context (Yang & Li, 2018). Recent technology developments have shown promise for improving university teaching methods by facilitating communication, knowledge exchange, and information transmission. The suggestion to incorporate these materials into the training process resulted from this (Valente, 2014). Technology is increasingly being used to improve teaching and the standard of student learning experiences. By utilizing innovative technological tools in educational institutions, teachers want to assess and enhance the efficacy of their teaching strategies. This moves towards using technology as a facilitator in the educational process forces us to reconsider and acknowledge the importance of teaching (Fagundes et al., 1999; Garcia-Ramirez, 2012; Juanes et al., 2018). The development of educational tools (Suárez Guerrero, 2010; Tsay & Brady, 2010) that support the concept given forward in this study of encouraging student performance via the use of resources and technology applications is the consequence of the development of various technological methods. Student assessments are carried out via platforms like Plickers and EdPuzzle.

However, learning happens due to two activities with the same goal. First and first, the teacher's effective use of interactive and engaging technology, and second, the crucial effort was given up

by students. Thus, while the institutional and social context contributes to successful learning, these two components are essential. Several techniques are accessible for evaluating students swiftly, conveniently, pleasantly, and in original ways. Edmodo, Socrative, Kahoot, Plickers, EdPuzzle, and Google Forms are a few of these tools. In this case, the emphasis is on Plickers and EdPuzzle. This user-friendly and uncomplicated program provides the tools for evaluating students' real-life skills and abilities from an interesting and innovative perspective. This study compares the effectiveness of two educational technology tools, EdPuzzle and Plickers, for measuring students' perception, engagement, and learning outcomes.

1.3. Research Questions and Hypothesis

The research has the following Questions and Hypotheses:

- How do the selection and purpose of assessment tools affect students' enjoyment?

- How the choice of assessment tool impacts students' engagement?

- What different options for assessment tools and techniques influence students' learning outcomes?

- How the choice of assessment tool impacts students' performance?

- What different options for assessment tools and the perception of students regarding them?

- What is the impact of Student engagement on student performance?

- What is the impact of Student fun learning on student performance?

- What is the impact of Learning outcomes on student performance?

- What is the impact of Student perceptions on student performance?

1.4. Research Objectives

The study aimed to assess the impact of assessment tools and techniques on various aspects of the learning experience, including enjoyment, engagement, performance, perception, and learning outcomes. Specifically, the study had the following objectives:

- To investigate how the selection and purpose of assessment tools affect students' enjoyment.
- To analyze how the choice of assessment tool impacts students' engagement.
- To explore how different options for assessment tools and techniques influence students' learning outcomes.
- To analyze how the choice of assessment tool impacts students' performance.
- To explore different options for assessment tools and students' perceptions of them.
- To identify the role of Student engagement in student performance.
- To find out the impact of Student fun learning on student performance.
- To evaluate the significance and impact of Learning outcomes on student performance.
- To evaluate the impact of Student perceptions on student performance.

1.5. Definitions of Terminology

1.5.1. Student Engagement

Student engagement is the term used to describe both the time and effort students invest in activities connected to desired college outcomes, as well as the steps institutions take to promote involvement in these activities. Engagement was defined as a broad concept (Coates, 2007) that

includes academic and non-academic facets of the student experience, such as active learning, involvement in demanding academic activities, communication with faculty members, engagement in enriching educational experiences, and university learning communities' support.

1.5.2.Fun during learning

Fun during learning refers to integrating enjoyable and engaging activities into the educational experience to promote interest, motivation, and retention of knowledge or skills. It involves creating an environment that encourages active participation, exploration, and experimentation. This can include using games, puzzles, simulations, role-playing, and other interactive activities that challenge and stimulate students positively. Fun during learning is enjoyable and can lead to improved cognitive processing, better memory retention, and increased engagement with the subject matter. It can also help reduce stress and anxiety, which can positively impact learning outcomes. Educators can create a more dynamic and effective learning experience that engages and inspires students by incorporating fun into the learning process.

1.5.3.Student Perception

Student perception refers to students' subjective experiences, beliefs, attitudes, and opinions about various aspects of their educational environment, such as the curriculum, teaching methods, classroom climate, and social interactions. Student perception encompasses a wide range of factors, including their emotional reactions to learning, sense of belonging and engagement in the classroom, confidence in their ability to succeed, and motivation and interest in the subject matter. Understanding student perception is important because it can provide insights into how students

experience their education, what factors motivate or hinder their learning, and how teachers and schools can improve their instructional practices to support student success.

1.5.4.Student Performance

Student performance refers to a student's academic achievement and progress in a specific subject or across different subjects. It is typically measured by grades, test scores, and other assessments that evaluate a student's understanding of the material and ability to apply it to real-world situations. Student performance can also refer to non-academic factors such as attendance, behavior, and participation in extracurricular activities. In general, student performance reflects their knowledge, skills, and competencies about the learning objectives and expectations set by their school or educational institution.

1.5.5.Learning Outcome

Learning outcome refers to the measurable knowledge, skills, abilities, and attitudes students acquire because of their educational experiences. Learning outcomes may be specific to a particular subject or course, or they may be broader and more general, reflecting the overall goals of an educational program. They may be cognitive (knowledge-based), psychomotor (skill-based), or affective (attitude-based), and they can be assessed through a variety of methods such as tests, projects, and performance evaluations. Learning outcomes are typically aligned with specific learning objectives, which provide a clear and measurable statement of what students are expected to achieve. By focusing on learning outcomes, educators can ensure that their instructional strategies and assessments are aligned with their goals for student learning and can assess the effectiveness of their educational programs in achieving those goals.

1.5.6.Plickers

Plickers is an innovative educational technology tool that facilitates the administration of formative assessments in the classroom through the utilization of paper cards and a mobile device. This tool is designed to enable teachers to gauge the level of understanding of their students in real-time, thereby enhancing the quality of instruction and learning outcomes. Each Plickers card has a unique code corresponding to a specific student and answer choice. The teacher displays a question on a screen, and students respond by holding up their Plickers card with the answer choice they have selected. The teacher then scans the room with a mobile device, and the Plickers app records each student's responses in real-time. Plickers can be used for a wide range of formative assessment activities, including quizzes, polls, and exit tickets, and it provides immediate feedback to teachers on student understanding and progress.

1.5.7.EdPuzzle

EdPuzzle is a creative educational technology platform that enables educators to generate engaging videos for students. EdPuzzle is a web-based platform that enables educators to incorporate multimedia content from diverse sources, such as YouTube, into their instructional materials. Through this platform, teachers can personalize the videos by embedding interactive features, such as questions and comments, to enhance student engagement and comprehension. The instructional videos can be viewed by students at their individualized pace, with accompanying questions to be answered in real-time. Educators are able to monitor student advancement and furnish constructive feedback regarding their comprehension of the subject matter. EdPuzzle also provides teachers with grading and assessment tools, integrating with learning management systems (LMS) like

Google Classroom and Canvas. Overall, EdPuzzle is designed to help teachers create engaging and interactive video-based lessons that support student learning and engagement.

1.6. Conceptual Framework

The conceptual framework offers a structured approach to compare the efficiency of EdPuzzle and Plickers in evaluating students' perspectives, engagement, and learning results. This study will add to the body of knowledge regarding using educational technology tools in the classroom while offering teachers and other education suggestions on how to enhance student learning outcomes by utilizing those tools. This study will show how student engagement, student fun learning, learning outcomes, and student perceptions impact student performance. Figure 2 shows the conceptual framework for this study.
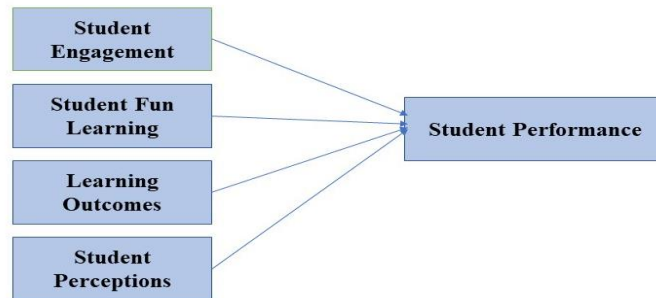
Figure 2: Conceptual Framework

1.7. Significance of study

The present study holds significant value and will contribute on theoretical and practical grounds. This study Contributes to the body of knowledge on how assessment methods and instruments affect various facets of the learning process. The results of this study will increase knowledge of

how students' satisfaction, engagement, performance, perception, and learning outcomes are influenced by the choice and purpose of assessment tools. This will assist in developing a theoretical framework that will direct future study and guide educational practice. The results of this study will have consequences for teachers and educational institutions. It will be easier for teachers to choose and use the appropriate assessment tool when provided with information from the research's analysis of how various alternatives for assessment tools and procedures affect students' learning outcomes.

Additionally, the study's research on how selecting an assessment tool affects students' performance and perception will help teachers pinpoint areas in which their teaching and learning procedures need improvement. Additionally, the study's assessment of how fun learning experiences and student engagement affect student performance may give teachers helpful insights into how to design pleasurable learning opportunities that can positively influence students' performance. Education professionals will better understand how student attitudes and beliefs about assessment tools might affect their learning outcomes by evaluating the impact of student perceptions on student performance.

1.8. Thesis outline

The basic outline of the study is based on five chapters which are discussed as follows:

- Chapter One is the introductory section of the study. It is comprised of the background of the study. This chapter also includes the problem, key definitions, and conceptual framework. Finally, the significance of the study is also presented in this chapter.

- The second chapter presents an overview of the literature on EdPuzzle, Plickers, student perception, engagement, and learning outcomes. The chapter covers the empirical data from previous studies and provides an effective theoretical framework. The connections between fun student learning, perception, engagement, and learning outcomes with student performance develop hypotheses.

- The study's research methodology is discussed in Chapter 3. The research approach, sampling techniques, and research design are all explained. Techniques for data analysis and data collection are also discussed.

- Chapter 4 of the study discusses the study's results. As it presents the findings and analysis of the study, this chapter is important. Based on the data collected, the outcomes are presented in this chapter.

- The results are discussed in Chapter 5, followed by the study's conclusion. This chapter also emphasized the study's implications and identified limits, which are useful for making recommendations for future studies.

2: Literature Review

2.1. Introduction

This literature review aims to analyze and define different variables that influence students' performance in Pakistan and Asia. The first section of this review involves the theoretical background and the conceptual framework used as evidence for supporting our literature review. The next section comprises the application of alternative methods and tools for education in Pakistan and Asia, followed by the individual literature on all the variables affecting student performance in Pakistan and Asia. These variables include student engagement, student fun learning, learning outcomes, and student perceptions and significantly influence students' performance in educational institutes. The next half of the literature review elaborates on the impact of all these variables on students' performance in the educational institutes of Pakistan and Asia. A summary of the chapter as the last section of this literature review follows.

2.2. Theoretical Framework

Students' success, concern, and passion for their studies are the main focus of the educational institutes in Pakistan and Asia, as students are an asset to the nation. To understand the theoretical basis for the success of students in the educational institutes of Pakistan, we have drawn a *"Transition Theory"* which proposes that the engagement of students individually toward their studies depends upon the dynamic practices and convenience provided by the educational institutes to their students respectively (Kahu & Nelson, 2018). According to this theory, the educational framework of various educational institutions is a crucial component that impacts students'

dynamic, complex, and individual nature to tackle their psychological situations while learning. It also highlights all the mechanisms and alternative measures that are responsible for engaging the students, leading to a successful and outstanding performance of students throughout their academic period (Kahu et al., 2015).

2.3. Applications of Alternative Methods for Education in Pakistan and Asia

The most common and innovative learning method in education involves using information and communication technologies in various countries, which refers to e-learning technologies (Asad et al., 2021). From the last ten years of education and schooling in Pakistan, it has been an innovation to integrate various communication technologies within the classrooms. Students and teachers are guided properly to incorporate information and communication technologies in their classrooms.

Information and communication technologies are effective for students as they allow the learners to focus on their learning process and engage themselves so that they can perform better in their academic period (John, 2015). Moreover, teaching and learning in Pakistan is thought to be the toughest job. Still, due to the incorporation of information and communication technologies in various educational institutes, teachers can easily deliver lectures in their classes. Also, the students show more focus and engagement toward the lectures, thus delivered in the form of audio, videos, and graphics.

Ed puzzle is another innovation that should be brought to Pakistan and Asia's schools and higher education institutes. This app comprises four tasks for the students, including videos and quizzes

regarding the parts of the videos (Silverajah & Govindaraj, 2018). Moreover, it has also been found that teachers have given positive perceptions regarding the use of Ed Puzzle as it is the best and most effective tool for enhancing the learning outcomes of low learners in various classrooms of schools and higher educational institutes, which is an ultimate way toward the success and better performance of all the students specifically the slow learners of the class. This is because the Ed puzzle comprises the capability to allow the low achievers of the class in a self-regulated environment and help them to enhance their academic performance.

Plickers is an app that offers a quick and easy way for teachers to assess student understanding in real-time without spending hours grading paper assignments or quizzes. Using Plickers, the app quickly scans the cards, and the teacher can see the results on their device, providing immediate feedback to both the teacher and the student (Ullah & Anwar, 2020). This immediate feedback allows for quick interventions as needed, helping students stay on track and progress. Plickers also engage students with interactive learning, making them active participants in the assessment process, which enhances their learning experience (Bin Mubayrik, 2020). Additionally, Plickers provides data analysis of student responses, which helps teachers understand individual student needs and make data-driven decisions. Overall, Plickers is an innovative tool that offers many benefits for teachers and students in the assessment process. The teacher can use the Plickers data to inform instruction, adjust teaching strategies, and plan for future lessons (Al-Habsi et al., 2021).

The integration of information and communication technologies in the educational institutes of Pakistan and Asia has changed the learning pedagogies because the initial way of teaching involved the verbal delivery of lectures, and students were almost paused (Farahani et al., 2015). This way of learning was quite tedious for the students as the teachers passed the knowledge. Still, this innovation has provided the students with a more efficient way of delivering knowledge where

they can play a crucial role during the class and are found to be more dedicated toward the process of learning, which ultimately leads to the formation of successful learners in schools and higher educational institutes of Pakistan (Goh & Sigala, 2020). However, the efficacy of various alternative methods and tools for education thus incorporated in Pakistan and Asia's schools and higher educational institutions is yet to be researched and studied in detail.

2.4. Student Engagement

Student engagement has become increasingly important in education settings, schools, and higher education institutions. Student engagement refers to the involvement of students in school matters that affect them, including decisions on teaching, learning, assessment, and course organization (Robinson, 2012). This involvement is often facilitated through student voice, which allows students to express their opinions and concerns. Additionally, student participation is crucial, as it emphasizes the importance of students being active contributors to the school community rather than merely passive recipients of information or policies (Vuori, 2014). It relates to students being actively and directly involved in school matters at some level.

Empirical evidence links engagement to academic performance. Early and later involvement patterns can identify students at risk of failing or dropping out. Engagement habits can promote student success and attainment (Groccia, 2018).

Learning effort	**The behavior adapted by learners during and after the class by focusing on their tasks and learning them then and there.**

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Participation in class	Actively participating in class activities involving attendance, assessments, asking questions, and answering questions.
Interaction	It refers to the relationship between the professor and student regarding any help for the lecture thus delivered by the professor.
Cognitive task solving	It refers to the students' internal cognitive processes, including knowledge formation, understanding, and memorization.
Sense of belonging	It refers to interacting with friends and people participating in a learning community.
Learning passion	It is defined as the activeness and willingness of the learner to learn the lecture by having an active mindset so that the learner can actively face the challenges during the learning process.

Table 1: Behaviors identified as indicators of student engagement (Lee et al., 2019)

Recent research (Park & Yun, 2018) has explained eight effective strategies to promote student engagement. Firstly, it is important to enhance students' self-belief, which can help them to feel more confident in their abilities. Secondly, students should be able to work autonomously, enjoy learning relationships with others, and feel competent to achieve their objectives. Third, it is important to recognize that teaching and teachers are central to engagement and provide support

and guidance to students and teachers. Fourth, creating active, collaborative learning that fosters learning relationships can also help promote engagement. Fifth, educators should work to establish learning opportunities for pupils that stretch their academic potential and are enriching and demanding. Sixthly, ensuring that institutional cultures are welcoming to students from diverse backgrounds is crucial to promoting engagement. Seventhly, educators should adapt to changing student expectations, including using new technologies or teaching methods. Finally, enabling students to become active citizens can also promote engagement, as it allows them to become more involved in their communities and feel a sense of ownership over their learning. However, the relationship between student engagement and student performance is a field to be researched regarding Pakistan and Asia schools and higher educational institutes.

Enhance the self-belief of students to make them feel confident.

Enable students to to work autonomously so that they can feel their competency.

Recognize the importance of teachers and provide support to both teachers and students.

Create collaborative learning to promote student engagement in education.

Create challenging and enriching learning experiences for students to extend their capabilities.

Make sure that all the students even from diverse backgrounds are warmly welcomed to the schools.

Educators should adapt new technologies and teaching methods in their classes to enhance student engagement.

Enable the students to become active citizens to enhance student engagement.

Figure 3: Strategies to enhance student engagement (Source: Author generated)

2.5. Fun during Learning

Learning and fun can go hand in hand, and incorporating fun activities into the learning process can have several benefits. It can be an effective way to increase engagement and motivation among students. When learning is fun, students are more likely to be engaged and invested (Qazi et al., 2020). Incorporating fun into learning can have many benefits, and there are several ways to achieve these benefits. Games can engage students and help them learn new concepts (Chiazzese et al., 2018). Hands-on activities can also be effective in making learning more fun and interactive. Experiments, art projects, and simulations can help students connect with the material and retain information. Technology can be used to make learning more innovative and engaging. Interactive whiteboards, tablets, and educational apps can provide students with a fun and interactive way to learn. Humor can also be incorporated into the learning process, creating a more relaxed and enjoyable environment. Humorous examples and jokes can help students to remember information and reduce stress. Finally, field trips can be a fun and educational way to learn outside the classroom. Visiting museums, parks, and historical sites can help to bring learning to life and make it more interesting (Ha et al., 2019). In addition to incorporating fun activities, creating a positive and supportive classroom environment that fosters a sense of community and belonging is also important. This can be achieved through classroom discussions, group projects, and other collaborative activities promoting student interaction and connection (Stearns et al., 2019).

Fun Activities that should be promoted in schools in Pakistan and Asia
1. Games to engage students
2. Hands-on activities such as experiments and art projects

3.	Technology such as interactive whiteboards, tablets, and educational apps
4.	Humorous examples and jokes for students so they can learn comfortably without stress.
5.	Field trips include visiting parks, museums, and historical sites.

Table 2: Key fun activities promoted in the Pakistani education system (Source: Author generated)

The importance of fun during learning can be seen in the study's results on the game. Narrative versions of the game were more engaging, exciting, and less frustrating than the puzzles (Lee et al., 2018). Including a simple narrative and off-screen character helped set a context for the learning experience that felt integrated with the gameplay, preserving the immersiveness of the gaming experience. The player's emotional attachment to the child character who requires their help may also contribute to the learning outcomes (Brooker, 2020). Additionally, using an off-screen character as a partner or assistant provides opportunities for meaningful responses to the player's actions, encouragement, and reflection on learning. Overall, using fun and engaging game elements in learning can improve the effectiveness of educational games and make the learning experience more enjoyable for students.

2.6. Learning Outcome

Learning outcomes help define what a student should understand after completing a particular course or program (Hartikainen et al., 2019). This text focuses on authentic evaluation and the importance of designing assessments that accurately measure students' abilities and skills in real-

world situations. By defining learning outcomes in terms of specific skills and expectations and establishing clear criteria for measuring student performance, educators can ensure that their teaching methods and assessments are effective and meaningful (Nortvig et al., 2018). Learning outcomes also help students understand what they are expected to learn and achieve and can motivate and guide them in their studies. Ultimately, by aligning teaching and assessment with clear learning outcomes, educators can help students to develop the knowledge, skills, and attitudes they need to thrive in a rapidly changing and demanding world (Marzano & Miranda, 2021).

4C Learning Model for better learning outcomes (Constructive, critical, Creative, collaborative)
The 4C model requires the students to collaborate while discussing their viewpoints regarding the class inside or outside the classrooms to enhance critical thinking about various topics and creativity for understanding and applying various creative skills in their classrooms. This 4C model had a very powerful impact on the student's learning outcomes, and it should be promoted in various schools and higher educational institutions in Pakistan and Asia.

Table 3: Importance of the 4C model for enhancing the learning outcomes of students (Supena et al., 2021).

Learning outcomes offer several advantages that benefit diverse stakeholders, such as course designers, quality assurance and standards bodies, learners, and employers (Sun et al., 2022). For course designers, explicit learning outcome statements can help guarantee consistency of delivery, aid in curriculum design, determine the purpose of a course, clarify areas of overlap, and facilitate learning progression. By highlighting the relationship between teaching, learning, and assessment, learning outcomes can also promote in-depth reflection on assessment and the introduction of effective and varied assessment types (Lerang et al., 2019). Learning outcomes of the students in various schools in Pakistan and Asia can also be enhanced and developed by making professional

learning communities for teachers of the educational institutes and also for the students studying in different schools (Doğan & Adams, 2018). Moreover, the professional learning communities will facilitate the teachers to deliver effective lectures, and well-trained teachers can deliver an effective lecture by making it interesting for them to avoid any tediousness in classrooms, which ultimately flourishes students' learning outcomes.

For learners, learning outcomes provide a comprehensive set of statements that clarify precisely what they can achieve after successful study, leading to more effective learning. Students can use learning outcomes to select the module, unit, program, and qualification that aligns with their interests and aspirations, leading to more informed choices (Karacabey et al., 2022). Furthermore, a clear articulation of the achievement associated with specific qualifications can benefit employers, higher education institutions, and civil society in general. By highlighting the competencies and skills important in the workplace, employers become familiar with the learning outcomes, value them more, and appreciate their utility.

2.7. Student Perception

The way teachers behave is important for student achievement. Personal and environmental factors influence teaching effectiveness. According to recent research (Burroughs et al., 2019), teachers are the main asset of any educational institution, and an effective teacher is the assurance of having successful students. Newly trained teachers often need guidance and support to learn effective practices. Experienced teachers also benefit from collaboration and reflection to maintain and develop their skills. Identifying areas for improvement can help teachers be more effective. Research has shown that teacher behavior predicts student outcomes, but there is a need to identify

explanatory variables for teaching quality. Teacher evaluation can help bridge the gap between learning and practice, allowing for progress (García & Weiss, 2019).

Experience	It is defined as the number of years that a teacher has worked in the classroom of any particular educational institute.
Professional Knowledge	A teacher's Professional knowledge is defined as the subject-based and influential knowledge of teachers generally based on their undergraduate or postgraduate degrees. Moreover, it also refers to the number of opportunities a teacher provides throughout their professional career in various educational institutes.
Teacher's behavior and Opportunity to learn	It is related to the teacher's behavior in the classroom which significantly influences the student's capabilities to grab different learning opportunities inside and outside the classroom.

Table 4: Constructs necessary for effective teaching and influencing student's perceptions (Hackmann et al., 2018)

Students' perceptions about their learning and assessment are crucial for academic success. Research (Mucherah et al., 2018) points out that students' learning approaches significantly impact their understanding and the quality of their outcomes. Students' perceptions of assessment requirements also influence their approach to studying, as they tend to adopt strategies that will help them fulfill task requirements or achieve the highest possible grades. Educators play a critical role in guiding students towards a deeper approach to learning, but the task is not without its

challenges. Appropriateness of assessment methods is also a key factor, and students' perceived unfairness or inappropriateness of the assessment can lead to a surface approach to learning.

Moreover, student perception is an important element in analyzing a student's success during the academic career. Therefore, understanding and addressing students' perceptions of learning and assessment is vital for students' effective education and success (Uiboleht et al., 2019). Therefore, research is needed to be done regarding student perceptions and their relationship with the success of the students learning in the educational system of Pakistan and Asia.

2.8. Student Performance

Studies on school-based incentives have shown mixed results, with some reporting increases in student pass rates or test scores but with concerns about short-term manipulation or spurious correlations due to unobserved school quality (Feng et al., 2018). The lack of direct information on schools' personnel practices in large data sets has also contributed to the limited understanding of the relationship between teacher performance incentives and student performance. It is also important to note that intrinsically motivated students tend to perform better than extrinsically motivated students. Intrinsic motivation comes from a student's interest in the subject matter or desire to learn, while extrinsic motivation comes from outside factors like grades or rewards (Moore, 2019). Teachers can foster intrinsic motivation by tapping into student interests, offering relevant and challenging material, providing autonomy and choice in learning, and giving meaningful feedback.

In contrast, relying solely on extrinsic motivators can lead to a dependence on rewards and a lack of true engagement in the learning process. Student performance is a crucial aspect of educational

success, and it is affected by numerous factors, such as individual and school-wide, and policy interventions. In this regard, several studies have highlighted the importance of interventions that enhance student performance. Several factors can impact student performance in school.

Factors that can influence student performance
1. Individual factors, e.g., learning styles, abilities, and interests
2. Home environment refers to parent involvement, family income, and access to resources like books and technology.
3. Quality of the school environment, such as teaching effectiveness, school facilities, and extracurricular activities.
4. Peers can help to enhance student performance with positive peer pressure.
5. The physical, mental, and emotional well-being of the student.
6. Students from lower socioeconomic backgrounds may face limited access to resources, high-stress levels, and limited opportunities.
7. Teaching methods and the curriculum followed in the school may also affect student performance.

Table 5: Factors impacting student performance in schools (Iglesias-Pradas et al., 2021)

Understanding these various factors can help educators and parents better support students in achieving academic success. Student performance is crucially important for achieving the goals set out by standards-based reform. Student performance is crucial for ensuring effective learning outcomes and the success of standards-based reform (Rahman et al., 2021). Student performance is crucial to their educational success, and assessments play a vital role in monitoring progress and identifying areas of improvement. While standardized tests are often used to measure student

achievement, typically, they are administered only once a year, and the results come back too late for teachers to use them to make instructional adjustments. On the other hand, tests intended for instructional guidance, typically administered by classroom teachers, offer a greater depth of knowledge assessment and are given relatively frequently, allowing for timely feedback and adjustments to improve student learning outcomes. Understanding student performance is crucial for educators to tailor their instructional programs to meet individual student needs, and assessments that provide reliable and relevant data are a key component of this process.

2.9. Related Work

2.9.1.Student Engagement and student performance

Research has consistently shown that certain aspects of engagement, such as involvement, time spent on tasks, and quality of effort, are associated with positive outcomes in higher education (Payne, 2019). Multiple studies have examined the relationship between engagement and positive outcomes regarding the performance and success of students. Seven effective undergraduate teaching and learning practices are student-staff contact, active learning, prompt feedback, time on task, high expectations, respect for diverse learning styles, and student cooperation (Lockman & Schirmer, 2020). Institutions can help students develop their social and cultural capital by creating opportunities for them to engage with diverse peers, interact with experienced and successful professionals, engage in volunteer work or community service, participate in study abroad programs, and attend cultural events and workshops (Garcia & Ramirez, 2018). All these practices are responsible for engaging the students in their classrooms and significantly influence

the performance of students in various educational institutes. Therefore, it is necessary to analyze and interpret the impact of these practices in schools in Pakistan and Asia as well.

Student performance is positively influenced by student engagement regarding technological innovations (Baragash & Al-Samarraie, 2018). Additionally, institutions should actively address and remove barriers to engagement that may disproportionately affect certain groups of students, such as financial barriers, lack of access to resources or technology, and discriminatory practices or attitudes (Shams et al., 2020) because these barriers will prove to be an obstacle in the way of the success of students. Therefore, the educational institutes of Pakistan should remove these barriers toward student engagement so that the student's success can be promoted in Pakistan. By fostering the development of social and cultural capital in all students, institutions can help create a more inclusive and engaged educational community that values and benefits from the diverse experiences and perspectives of its members. Moreover, student engagement in their academics has a significant influence on the performance of students in Pakistan and Asia.

H1: Hence, proposed that student engagement significantly impacts student performance.

2.9.2. Fun during Learning and student performance

Incorporating fun into learning can be highly beneficial for students. It can increase engagement as students tend to be more interested and focused when learning is enjoyable (Arif et al., 2022). This increases engagement and can lead to better retention of information and a greater motivation to learn. Fun and carefree activities can help reduce stress in students who may find learning a stressful experience and significantly enhance the performance of students in Pakistan. By creating

a relaxed learning environment, educators can help students feel more at ease and comfortable in the classroom (Calver & Michael-Fox, 2021).

Moreover, the gaming processes should be applied in the school systems of Pakistan because it creates fun for the learners and significantly contributes to flourishing student performance in their academic careers (Felszeghy et al., 2019). Fun activities can improve memory retention by creating a positive emotional association with the material (Xu et al., 2021). This can lead to better recall and retrieval of information and ultimately enhance students' performance. Fun activities can encourage students to think creatively and develop critical thinking skills. Furthermore, encouraging students to think outside the box can give them a deeper understanding of the material. Therefore, it is necessary to understand the application of fun-based software in the education system of Pakistan to promote student outcomes and performance as well.

Interactive and collaborative learning activities can help students develop important social skills such as communication, cooperation, and empathy. Finally, when students enjoy learning, they are more likely to have a positive attitude toward education and lifelong learning, which also positively influences their performance (Göksün & Gürsoy, 2019). By incorporating fun into the classroom, educators can help students develop a love for learning and a positive outlook on education. Incorporating fun can create a more positive and engaging learning environment that promotes student success and well-being. By making learning enjoyable and entertaining, educators can help to foster a love of learning and promote academic achievement for the learners learning in the Pakistani school system.

H2: Hence, it proposed that student performance is significantly impacted by fun during learning.

2.9.3. Learning Outcomes and student performance

Learning outcomes play a crucial role in developing the student's performance in the education system because a better outcome will lead to a successful academic career for various students studying in the educational institute of any particular country. According to research (Law et al., 2019), learning outcomes and student choice of learning significantly influence student performance. It can be evidenced by a study (Shea et al., 2012) where the student's choice regarding their learning perspectives has been elaborated. The research was conducted on the outcomes of blended learning which incorporated the face-to-face and the online learning system for higher educational institutes and their learners. In addition, it had been observed that student choice toward various forms of learning elaborates the learning outcomes of the students and the students who chose the online learning system were found to be better in showing their learning outcomes and this was an ultimatum for the success and better performance of the learners in their academics. However, the implication of various learning outcomes regarding the choice of learning platform has yet to be researched in the context of the school system of Pakistan and Asia.

It can be said that learning outcomes positively impact the performance of learners studying in different educational institutes. Innovations should be introduced in the Pakistani education system to enhance students' learning outcomes because learning outcomes are crucial in interpreting students' performance. Many recent studies (Yu et al., 2021) have elaborated the introduction of game-based learning, which involve some serious games regarding the course or lecture thus delivered to increase the communicative ability of the learners, which will pave the way to approach better understanding and learning outcomes of all the students including the low-achievers of the class, So, it can be concluded that innovative technologies should be promoted in

the Pakistani schools because the better the learning outcomes of the learners in any educational institute the better will be the performance of the students in their academic courses.

H3: Hence, proposed that learning outcomes significantly influence student performance.

2.9.4.Student Perceptions and student performance

The relationship between student perception and the performance of the students can be determined by measuring the DREEM score of student perceptions, with higher scores indicating a more positive perception of the educational environment (Stormon et al., 2019). Although all three phases of medical education fell into the "more positive than negative" category, scores significantly increased from Phase 1 to Phase 3. This improvement was attributed to the curriculum's emphasis on student participation and engagement in clinical settings. Interestingly, there was no significant difference in subjective happiness levels between the phases, with social self-perception having the strongest correlation (Yoo & Kim, 2019). Aiming for higher academic achievement alone may not lead to increased happiness and social relationships, and support should also be prioritized in education to attain better student performance.

Student perception plays a significant role in influencing student outcomes. Positive perceptions of students regarding their academic teaching methods, assessments, and questionnaires, thus taken during their academic career, are very important to analyze the students' performance (Mushtaq & Mash'hadi, 2021). Moreover, innovative learning technologies have positively changed students' perceptions, which has a major influence on the success and performance of students in Pakistan and Asia.

Students' perceptions about their learning and assessment are crucial for academic success. Research points out that students' learning approaches significantly impact their understanding and the quality of their outcomes (Mphahlele, 2022). Students' perceptions of assessment requirements also influence their approach to studying, as they tend to adopt strategies that will help them fulfill task requirements or achieve the highest possible grades. Educators play a critical role in guiding students towards a deeper approach to learning, but the task is not without its challenges. Appropriateness of assessment methods is also a key factor, and students' perceived unfairness or inappropriateness of the assessment can lead to a surface approach to learning. Therefore, understanding and addressing students' perceptions of learning and assessment is vital for the effective education and success of students in the education system of Pakistan and Asia.

H4: Hence, proposed that student perception significantly impacts student performance.

2.10. Chapter Summary

This literature review has analyzed how student engagement, learning outcomes, fun during learning, and student perception have influenced the performance of all the students, including the low-achievers, thus studying in various educational institutions, by providing evidence from past studies and research. Different studies assume student performance is effectively impacted by the variables discussed in the chapter literature review. Moreover, the applications of various communication technologies in schools and higher educational institutes in Pakistan and Asia have been explained in the chapter by supporting the effectiveness of Ed Puzzle and Plickers for learners' success in different schools. According to the chapter, these alternative technologies play a key role in flourishing the engagement, fun, learning outcomes, and perceptions of the learners, which will pave the way for students toward academic success compared to the traditional way of

delivering face-to-face lectures. This chapter emphasizes the strong influence of variables, as discussed above, in terms of innovative education tools on students' performance in educational institutes.

3: Methodology

3.1. Introduction

As the title indicates, this chapter provides a methodology for this study. It provides an overview of this study's research design, approach, and strategy. The chapter examines the sources used for the quasi-experimental approach, the strategy for selecting samples, and the techniques for collecting data, such as surveys and tests for language and grammar. The paired sample t-test, regression analysis, and ANOVA are just a few of the data analysis methods and research tools used in this study. The chapter concludes with a discussion of research ethics and an overview of the research study's methodology.

3.2. Research Design

The research design refers to the broad analytical approach and strategy selected to rationally and consistently integrate various study components and thoroughly examine the research question (Bloomfield & Fisher, 2019). Correlation, review, descriptive, and experimental research designs are among the numerous research designs. Descriptive research consists of case studies, surveys, and naturalistic observation, whereas experimental research designs include quasi-experiments, field experiments, and controlled experiments (Veling & McGinn, 2021). This study is based on the pragmatism philosophy, which employs a mixed-method approach. In the present study, the quasi-experimental approach was used. This study employed a quasi-experimental research design, an approach that does not entail assigning participants to groups at random. The researchers chose the quasi-experimental approach because it enables them to assess the efficiency of different

methods or tools in assessing student perceptions, engagement, and learning results. There are three different kinds of quasi-experimental research designs: non-equivalent groups, pre-test and post-test, and interrupted time series (Paul C. Price, 2015). The dependent variable is measured once before the treatment is provided and once more after the treatment has been administered in a pre-test and post-test design. To evaluate the results, this study used a pre- and post-testing design. The pre-test assesses students' initial perceptions, levels of engagement, and levels of learning, whereas the post-test gauge these same factors after the use of the three assessment tools. This makes it easier to compare how well technologies improve students' perspective, engagement, and learning outcomes.

3.2.1.Research Approach

The research approach, which outlines the whole process of data collecting and information analysis necessary for the research, is referred to as the master plan for any research. Additionally, it selects the analytical techniques to confirm the study's findings (Maher et al., 2018). An inductive, deductive, and abductive study approach are three categories of research approaches. The deductive approach is applied when a theory or hypothesis is developed based on the literature and then tested through empirical observation and data analysis. Based on previous research and current literature, this study's research questions and hypotheses were developed to enhance students' perception, engagement, performance, and learning outcomes. The researchers aimed to determine whether various assessment tools affected students' perspective, engagement, performance, and learning outcomes; hence a deductive approach was suitable for this study. Pre- and post-testing was used to collect data for the study's quasi-experimental design, which allowed the researchers to compare the findings and analyze the efficacy of various assessment methods.

The deductive approach was appropriate for this study because it allowed the researchers to evaluate their hypotheses using actual data and compare the findings to past research.

3.2.2.Research method

The research method is one of the most important components of a research methodology since it outlines the procedure for collecting the essential data, which is subsequently analyzed to fulfill the stated study objectives (Yiu et al., 2020). Methods can be classified as either qualitative, quantitative, or mixed. The huge sample size for data collection was supported by the quantitative method, and the data obtained from the sample was afterward converted into results in numerical form. To collect data for this study, the researchers used a quantitative approach and technique in the form of a survey. Using a quantitative approach is necessary to collect numerical data that can be statistically analyzed to test hypotheses and provide answers to research questions.

Additionally, quantitative research offers a structured and standardized method for gathering data, which may reduce biases and increase the accuracy of the results. Because it enables the researchers to collect data from a significant number of participants in a relatively short time, a survey is the best method for this study. Surveys are important for gauging student involvement, perception, and learning outcomes since they may gather information on various factors, such as attitudes, perceptions, and behaviors. Surveys are also practical for researchers and participants as they can be sent and collected electronically at little cost. Overall, the use of a quantitative method together with a survey strategy was an effective method to collect data for this study and provide answers to the research questions and hypotheses.

3.2.3. Research Strategy

A research strategy refers to a preconceived approach employed in the exploration and resolution of research inquiries (Zuniawan et al., 2020). The four most commonly employed methods in business research are case studies, action research techniques, interviews, and questionnaires (Oliva's, 2019). While quantitative studies rely on experiments and surveys to demonstrate causal relationships between variables, qualitative studies frequently use case studies and interviews to understand participants' perspectives. The pre-test data of 60 students were collected as part of the research strategy for this study to provide a baseline for how well they performed on English grammar tests. The researcher then conducted an intervention with three different assessment tools with each group of 20 students. Traditional methods (without any modifications), Plicker, and EdPuzzle were the three tools for assessment utilized. After the intervention, post-test data were collected to gauge each student's best performance.

3.3. Sampling technique

3.3.1. Population

In most cases, the population is seen as a group with at least one common characteristic. Similarly, the word "population" in a research study refers to people who share particular traits about the planned research objectives (Mukhopadhyay & Wang, 2020). Thus, the population of a research study is selected based on the developed research questions or objectives. For the current research, the population for this study is the students of some schools in Rawalpindi, Pakistan. In contrast, 60 students from the 9th standard have been taken.

3.3.2.Sampling

Sampling techniques are necessary to choose an appropriate sample size for the collection of the necessary data. Probability and non-probability sampling techniques are typically employed as sample methods in scientific and business research. Every component or study population member has an equal chance of being chosen when using probability sampling techniques; however, this is not the case when using non-probability sampling techniques (Stratton & Medicine, 2021). The students were later selected through purposive non-probability sampling, and a Likert-style questionnaire was used. The study and its objectives were made public in the final lecture after we had conducted the study. The study was conducted on 60 students divided into 3 groups, the Plickers group with 20 students, the paper-based quiz with 20 students, and the EdPuzzle group with 20 students. The Plickers group consists of students aged 13-15 years 12 were girls, and 8 were boys. The paper-based quiz group and EdPuzzle group also consisted of 20 students each, aged between the ages of 13-15 years, 8 were boys, and 12 were girls. The students were informed that their participation in this experiment would not affect their grades, and they could also share their responses to make the learning process more efficient.

3.3.3.Data Collection Process

The procedure for collecting data is crucial to the success of a research project since it produces the desired outcomes. Primary and secondary data are just two of the several forms of data targeted in scientific studies. As opposed to secondary data obtained by someone else, primary data is information the researcher has personally collected. Personal interviews, experiments, observations, survey techniques, and others are a few of the ways to acquire data. Survey techniques are thus most frequently utilized in quantitative research investigations to get the

necessary data. There were two stages to the data-collecting process used in this study. Pre- and post-tests were given to students in phase 1 to assess their proficiency in English grammar. Traditional, Plickers, and EdPuzzle were used for the pre-test, and traditional, Plickers, and EdPuzzle were used for the post-test, which was used to gauge the efficacy of each method. A purposeful non-probability sampling approach was adopted to choose 60 students from the ninth standard for the study. Twenty students were assigned to each group. Phase 2 involved surveying to gather information on student perceptions, engagement, and learning results related to the three instructional approaches. Students' opinions of the teaching strategies, how much fun they had while learning, their level of engagement, and their overall learning results were evaluated using a Likert-style questionnaire. Following the end of the study, the survey was given to all 60 students, and the data collected were analyzed to ascertain the efficacy of each method. The study was done in a controlled environment to guarantee the validity and reliability of the data obtained, and all participants were made aware that their participation would not impact their grades. To improve the effectiveness of the learning process, the research's objectives and methods were made public at the final lecture. The data obtained were statistically analyzed to evaluate the positive aspects of each approach and get insights into student perspectives, engagement, and learning results.

3.4. Instrumentation

3.4.1.Student Engagement

The effective use of technology may significantly impact student engagement. In educational psychology, student involvement is very important. The four-item Likert scale questionnaire will gauge student engagement in the activity. Respondents indicate their degree of agreement with a

sequence of statements on a scale of 1 to 4 (e.g., strongly agree, agree, disagree, strongly disagree). After collecting the replies, an overall indicator of student engagement is calculated.

3.4.2.Fun During Learning

Learning and fun can go hand in hand, and incorporating fun activities into the learning process can have several benefits. It can be an effective way to increase engagement and motivation among students. The Likert scale questionnaire of three items will be used to gauge how much fun students did during learning.

3.4.3.Learning Outcome

The specific information, skills, capabilities, or attitudes students are expected to have by completing a learning experience or program of study are known as student learning outcomes. After completing the task, the student's learning outcomes will be evaluated using an eleven-item Likert scale questionnaire.

3.4.4.Student Performance

Student achievement in a variety of academic topics is measured by academic performance. Teachers frequently use standardized test scores, graduation rates, and classroom performance to gauge students' achievement.

3.4.5. Student Perception

Student perception is an important area of study for educators, as it can provide insight into how students engage with learning and make sense of their experiences. The Likert scale questionnaire of ten items will be used to get the student's perception regarding Plickers.

3.5. Ethical Consideration

The study, which was conducted anonymously, was conducted as a teaching-learning activity to improve the students' learning opportunities. Participants were made aware of the research's goals, methods, possible risks, and advantages. Additionally, it's important to let them know that participating in the study is completely up to them and respect their choice to withdraw at any moment. The participants in this situation were made aware that completing the online survey constitutes their agreement to participate in the anonymous survey. At the beginning of the teaching-learning activity, students were informed that their voluntary completion of the online questionnaire represented their consent to participate in the anonymous survey. It was crucial to make sure that the participants' privacy and identity were maintained. The researchers maintained the confidentiality and security of the data acquired. The researchers in this study processed the data under strict confidentiality and ensured no participant-identifying information appeared in the study's reporting. Participants identifying information was not included in the study's reporting, and anonymity was always safeguarded by processing the data with stringent secrecy. Research participants were not harmed in any way, including physically, emotionally, psychologically, or socially. According to the researchers, the questionnaire in this study was not to be obtrusive, insulting, or inconsiderate. Participants in the research were not singled out for discrimination

based on their gender, race, ethnicity, religion, sexual orientation, or any other personal trait. The participants in this study were chosen at random and to represent a variety of people. The study's funding sources, potential conflicts of interest, and interpretation of the findings were all disclosed. Additionally, participants were aware of the study's limits and the degree of ambiguity around its findings.

3.6. Data analysis procedure

3.6.1.T-test and Regression Analysis:

The effectiveness of the three different teaching strategies was evaluated using pre-and post-testing. The data were analyzed using a paired sample t-test. In this situation, the pre-and post-test scores and the paired sample t-test assist in determining if there is a significant difference between the two sets of scores. This study was conducted in SPSS, and the data were analyzed to determine whether there had been any appreciable shift in student performance as a result of the various methods of instruction. Regression analysis was carried out to assess the causal relationship between learning predictors (student perceptions, fun during learning, engagement of students, and learning outcomes) and student performance. Regression analysis is a statistical technique that helps establish the link between two or more variables. It was applied in this case to determine how the learning predictors affected student performance, and the findings were evaluated to ascertain whether learning predictors significantly influenced student performance.

3.6.2.Reliability

The reliability of the entire instrument was evaluated to ensure that the survey questions were accurate and consistent. The reliability analysis was carried out by using Cronbach's alpha coefficient. This test evaluates a group of questions or objects' internal consistency. The data was analyzed to see if the tool was accurate and consistent in gauging student views, enjoyment of the learning process, student participation, and learning outcomes.

3.6.3.Descriptive and Correlation Analysis:

The properties of the collected data, such as the mean, standard deviation, and frequency, were summarized and described using descriptive statistics. This analysis was done to comprehend how the data were distributed and to find any patterns or trends. The association between the variables was also examined using a correlation analysis. If a link exists between two or more variables, the correlation analysis might assist in showing it. To find patterns or trends in the data, these tests were run using SPSS, and the results were then analyzed.

3.6.4.ANOVA:

An analysis of variance (ANOVA) was performed to examine the efficiency of the three methods of instruction (traditional, Plicker, and EdPuzzle). The statistical technique, ANOVA, is used to compare the means of two or more groups. In this instance, it was utilized to compare the three groups' averages for student perceptions, enjoyment of the learning process, student participation, and performance. SPSS and Excel were mainly used. After analyzing the results, it has been shown

that students' perceptions, performance, fun learning, and engagement were significant through EdPuzzle.

3.7. Summary

The study's methodology and research design are the main topics of this chapter. Beginning with a definition of research design, the chapter describes several research design types, including correlation, review, descriptive, and experimental research designs. Based on the pragmatism philosophy, which combines classical positivism and a quasi-experimental method, the study uses a quasi-experimental research design. The research methodology, which describes the procedure for gathering data and analyzing information needed for the study, is also covered in this chapter. The study used a deductive methodology since its research questions, and hypotheses were formed using data from earlier studies and recent literature. Research methods are also addressed, and the study uses a quantitative approach and survey to collect data. The study employs pre- and post-testing to collect data to analyze the effectiveness of various assessment methods, which is covered along with the research strategy. The sampling method is covered in the chapter's conclusion. The students of a school in Rawalpindi, Pakistan, make up the study's population, and the sample of 60 children was chosen using purposeful non-probability sampling. Overall, the chapter offers a thorough review of the research methodology and design utilized in the study, highlighting the many methods and strategies applied for collecting and analyzing data.

4: Results

4.1 Introduction

This section of the research explains and discusses the statistical analysis findings. For evaluating the research objectives, the researcher adopted various statistical tools. Firstly, the difference in student performance before and after introducing the three tools in teaching, EdPuzzle, Plicker, and traditional method, is observed through paired t-tests. In addition, regression and ANOVA methods are adopted using SPSS to evaluate hypotheses.

4.2 Pre and Post-test Differences for Student Performance

In the present investigation, the researcher intended to examine the effect of the intervention of three tools, EdPuzzle, Plicker, and the traditional method. Using the same group of individuals, before and after measurements were taken, a paired t-test was utilized to determine whether a significant difference in student performance was found (Kim, 2015). Paired sample t-test allowed the researcher to determine and compare the mean of two measurements taken before and after applying each learning tool (Ross et al., 2017). Paired sample statistics are displayed in Table 1. A total of 20 respondents in each group were included in the experiment, as shown by the N value. The first pair represents Plicker, where the post-test mean value implies improving students' performance. This improvement is depicted by the increase in the mean score from 4.43 to 7.06. Hence, the mean score was enhanced by 2.63 points. The second pair represents EdPuzzle, where the pre-test mean is 5.30. Student performance improvement is observed as the post-test mean increases to 8.66. Hence, an increase of 3.36 points in the mean score was detected. Lastly,

traditional instructions are shown by Pair 3. The pre-test mean value was 4.81, and a slight increase

of 0.84 was observed in the post-test mean. The post-test mean was 5.65. Therefore, to summarize

the results in Table 1, pre and post-test mean values verify that students' performance improved

by the three methods. However, the traditional method resulted in the lowest increase, whereas

EdPuzzle was found to have the largest difference among the three methods.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PLICKER2	7.0600	20	.76530	.17113
	PLICKER1	4.4300	20	.68756	.15374
Pair 2	EDPUZZLE2	8.6600	20	.49033	.10964
	EDPUZZLE1	5.3000	20	.63743	.14253
Pair 3	TRAD2	5.6500	20	.81531	.18231
	TRAD1	4.8100	20	.48330	.10807

Table 6: Paired Samples Statistics

Table 2 represents the paired samples test evaluated at a 95% confidence interval. The difference

observed is said to be significant when the significance value is lower than 0.05. The results of

the paired sample t-test confirm that implementing Plicker effectively improved students'

performance ($p = 0.000$). With a p-value of 0.000, students' performance improved after adopting

the EdPuzzle method. Lastly, students' performance was improved using the traditional method

with a p-value of 0.001.

		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference		t	Df	Sig (2-tailed)
					Lower	Upper			
Pair 1	PLICKER2 - PLICKER1	2.630	.80857	.18080	2.25158	3.00842	14.546	19	.000
Pair 2	EDPUZZLE2 - EDPUZZLE1	3.360	.87684	.19607	2.94963	3.77037	17.137	19	.000
Pair 3	TRAD2 - TRAD1	.8400	.92589	.20703	.40667	1.27333	4.057	19	.001

Table 7: Paired Samples Test

4.3   Regression Analysis

Descriptive statistics were used to display the characteristics of the data (George & Mallery, 2018). Table 3 shows the mean, standard deviation, skewness, and kurtosis values. Student fun learning has a mean value of 2.0, followed by student engagement with a mean of 2.2. The mean value of learning outcome is 2.31, whereas students' perception has a value of 2.33. Lastly, student performance has a mean of 7.12. Skewness and kurtosis values are utilized to establish the univariate normal distribution of data. As per the standard thresholds, skewness must range between -2 and +2, whereas the range for Kurtosis is between -7 and +7 (Hair et al., 2010). The

values in the table below confirm that all the variables have achieved the criteria as values are within the mentioned ranges.

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Fun	60	1.00	3.71	2.0071	.79493	1.136	.309	-.211	.608
ENG	60	1.00	3.75	2.2000	.91919	.450	.309	-1.517	.608
LO	60	1.22	3.78	2.3130	.96160	.494	.309	-1.648	.608
PCP	60	1.20	3.90	2.3317	.94250	.374	.309	-1.697	.608
PERF	60	4.60	9.40	7.1233	1.42048	-.109	.309	-1.195	.608
Valid N (listwise)	60								

Table 8: Descriptive Summary

Fun= Student fun learning, ENG= Student engagement, LO= Learning outcome, PCP= Student perception, PERF= Student performance

The reliability of an instrument is a crucial part of any research study, demonstrating the scale's ability to measure the intended construct consistently (Taber, 2018). A widely utilized measure of reliability is Cronbach's coefficient alpha. With a range from 0 to 1, it is used in assessing the consistency of scales with multiple items. A reliable instrument implies high internal consistency,

which shows that the items utilized to measure a construct accurately do so. Therefore, the reliability test is concerned with the interrelatedness of the items. According to the established criteria, values above 0.9 have great internal consistency, whereas values below 0.6 are unacceptable (Taber, 2018). Table 4 shows the results of the reliability test. Student fun learning was measured with a set of seven items with a value of 0.942, and the scale is highly consistent and reliable. Four items measured the variable student engagement. The Cronbach alpha value of 0.930 verifies the reliability of the scale. Similarly, the learning outcome was measured with eleven items and a high degree of internal consistency is present as the value is 0.977. With ten items, the scale for student perception was also revealed to be consistent and reliable as Cronbach's alpha value exceeded 0.9.

VAR	ITEMS	α
FUN	7	.942
ENG	4	.930
LO	11	.977
PCP	10	.966

Table 9: Reliability Test

Fun= Student fun learning, ENG= Student engagement, LO= Learning outcome, PCP= Student perception, PERF= Student performance

The researcher assessed the adequacy of the sample and suitability for proceeding with factor analysis. For this purpose, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were employed. Both these tests allow researchers to determine whether the data meet the specified requirements for conducting factor analysis (Yong & Pearce, 2013). The KMO test was performed to measure the proportion of variance among the data, which helps to determine whether the data is suited for factor analysis. Bartlett's test was used to ascertain that sufficient correlations exist in data which is a requirement for factor analysis (Yong & Pearce, 2013). The results are demonstrated in Table 5. The benchmark for KMO is 0.6, where values below the cut-off indicate poor sample adequacy (Yong & Pearce, 2013). Table 5 shows that the value is 0.867, which exceeds the cut-off value; hence, the researcher was able to certify sample adequacy in the research. Secondly, Bartlett's test presumes that an identity matrix exists, implying that the variables are not correlated and factors cannot be generated (Yong & Pearce, 2013). According to the test results, the null hypothesis of the identity matrix cannot be supported at a significance level of 5%. Therefore, the sample is sufficient, and enough correlations are present in the data.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.867
Bartlett's Test of Sphericity	Approx. Chi-Square	2408.660
	df	496
	Sig.	.000

Table 10: KMO and Bartlett's Test

Once the researcher established that the sample was adequate, the researcher carried out factor analysis with contains factor loadings, as shown in Table 6. In exploratory factor analysis, the rotated component matrix represents the correlation between variables and the rotated factors (Kline, 2014). A rotated component matrix allows an understanding of the factor structure. The item loadings for each construct are shown in the table. The researcher intended to examine the rotated component matrix based on two criteria. Firstly, it is critical to ensure that there are no cross-loadings in the data which means that all the items of the construct must only be present in their respective column, i.e., load onto the factor it is presumed to measure. Researchers have to delete items in the presence of cross-loadings (Chan & Idris, 2017). Secondly, factor loadings must be above the assigned threshold of 0.4, as values less than 0.4 are considered low factor loadings, and items are dropped. According to the factor loadings for fun learning shown in Table 6, the factor loadings were significant as all the items acquired loadings above 0.7. There are no cross-loadings, and all the seven items associated with fun student learning are loaded onto the third column. The second variable, student engagement, is loaded onto the first column with its four items. All the associated items have values above 0.5. The ten items of learning outcome appeared in the second component of the matrix, and it can be verified that no factor loading is below the threshold of 0.4. The ten items of student perception loaded onto the fourth component, and all items satisfied the criteria of 0.4. In addition, no cross-loadings for any factor were detected.

	Component			
	1	2	3	4
FUN1			.765	

FUN2			.821
FUN3			.875
FUN4			.844
FUN5			.879
FUN6			.862
FUN7			.829
ENG1	.658		
ENG2	.663		
ENG3	.591		
ENG4	.572		
LO1		.802	
LO2		.816	
LO3		.804	
LO4		.755	
LO5		.777	
LO6		.784	

LO7	.886	
LO8	.845	
LO9	.808	
LO10	.804	
LO11	.761	
PCP1		.711
PCP2		.731
PCP3		.611
PCP4		.731
PCP5		.700
PCP6		.732
PCP7		.374
PCP8		.702
PCP9		.759
PCP10		.797

Table 11: Rotated Component Matrix

Fun= Student fun learning, ENG= Student engagement, LO= Learning outcome, PCP= Student perception, PERF= Student performance

The "Pearson Correlation" technique is the most frequently used for evaluating the association between variables (Piaw, 2013). Table 7 presents the correlation matrix, which was utilized for assessing the linear correlation between the variables (Piaw, 2013). The measure ranges from -1 to 1, where a perfectly positive correlation is represented by a value of 1, and a -1 value depicts a total negative correlation. Pearson correlation measure is useful in inspecting whether the association between variables is significant (Piaw, 2013). Table 7 shows that student fun learning positively and significantly correlates with student engagement, learning outcome, and perception. Furthermore, student perception strongly correlates positively with learning outcomes (r=.846) and student engagement (r=0.811).

		fun	ENG	LO	PCP	PERF
Fun	Pearson Correlation	1	.436**			
	Sig. (2-tailed)		.000			
	N	60	60			
ENG	Pearson Correlation	.436**	1			
	Sig. (2-tailed)	.000				
	N	60	60			
LO	Pearson Correlation	.404**	.869**	1		

	Sig. (2-tailed)	.001	.000			
	N	60	60	60		
PCP	Pearson Correlation	.402**	.811**	.846**	1	
	Sig. (2-tailed)	.001	.000	.000		
	N	60	60	60	60	
PER F	Pearson Correlation	.074	.436**	.454**	.679**	1
	Sig. (2-tailed)	.575	.001	.000	.000	
	N	60	60	60	60	60

Table 12: Correlation Matrix

Fun= Student fun learning, ENG= Student engagement, LO= Learning outcome, PCP= Student perception, PERF= Student performance

An important part of the regression analysis is analyzing the model summary, which shows the R square value and test statistic for autocorrelation. Table 8 summarizes R, R-square, and adjusted R-square values. Researchers mainly rely on adjusted R-square value as it considers the number of predictors in the model and uses it relative to the observations (Miles, 2005). The table below shows that the adjusted R square value is 0.517. This indicates that 51.7% of the movement in the dependent variable is accounted for by the predictors, student perception, student fun learning, learning outcome, and student engagement. Adjusted R-square values above 50% are acceptable (Moore et al., 2015). In addition, the researcher tested serial autocorrelation in the data using the

Durbin-Watson (DW) statistic. It is crucial to ensure no autocorrelation as it is one of the fundamental assumptions of regression (Chatterjee & Simonoff, 2013). The DW value ranges between 0 and 4, where values closer to 2 verify no autocorrelation issue. The value in the table is 1.136, which means that positive autocorrelation exists in the data. Autocorrelation in the present research may be due to the small sample size.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.742[a]	.550	.517	.98671	1.136

Table 13: Model Summary

At this stage, the ANOVA depicts the model's variability and showcases the overall model's significance. With a p-value less than 0.05, it can be verified that the model estimation is significant and observed differences between the means are statistically significant.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	65.500	4	16.375	16.819	.000b
	Residual	53.547	55	.974		
	Total	119.047	59			

Table 14: ANOVA

The table of coefficients is displayed below, giving information about the linear regression model coefficients. The researcher examined the impact of fun student learning on student performance, and it was found that it negatively impacted student performance in the present study with a β value of -.201. This indicates that increasing student fun learning does not improve student performance. The association is considered significant at a 90% confidence interval. Moreover, student engagement was also revealed to negatively influence students' performance with a β value of -.104. Students' performance did not improve with student engagement. However, the relationship was insignificant, with a p-value of 0.592. The results showed that learning outcome was negatively associated with students' performance with a β value of -.311.

Nevertheless, the p-value of .144 resulted in the rejection of the hypothesis. Student perception was found to have a significant impact on student performance at a 99% confidence interval. Furthermore, student perception was positively associated with students' performance.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.368	.407		13.182	.000		
	fun	-.358	.180	-.201	-1.986	.052	.803	1.246
	ENG	-.161	.299	-.104	-.540	.592	.219	4.571
	LO	-.459	.310	-.311	-1.483	.144	.186	5.375

PCP	1.669	.268	1.107	6.234	.000	.259	3.857

Table 15: Coefficients

Collinearity statistics are also mentioned in Table 10. These statistics allow researchers to verify the absence of collinearity, as collinearity issues can cause potential problems in the data, such as inflated variance and estimations (Midi et al., 2010). Collinearity can also cause associations to be insignificant; hence, the researcher utilized the variance inflation factor (VIF) to ensure no collinearity issue exists in the present study. The assigned threshold of 10 is regarded as high and indicates multicollinearity problems in the data. As VIF values are below 10, the researcher concluded that multicollinearity has no problem.

Figures 4 to 8 represent the regression scatterplot used to examine the relationship between independent and dependent variables by controlling for the effect of other variables.
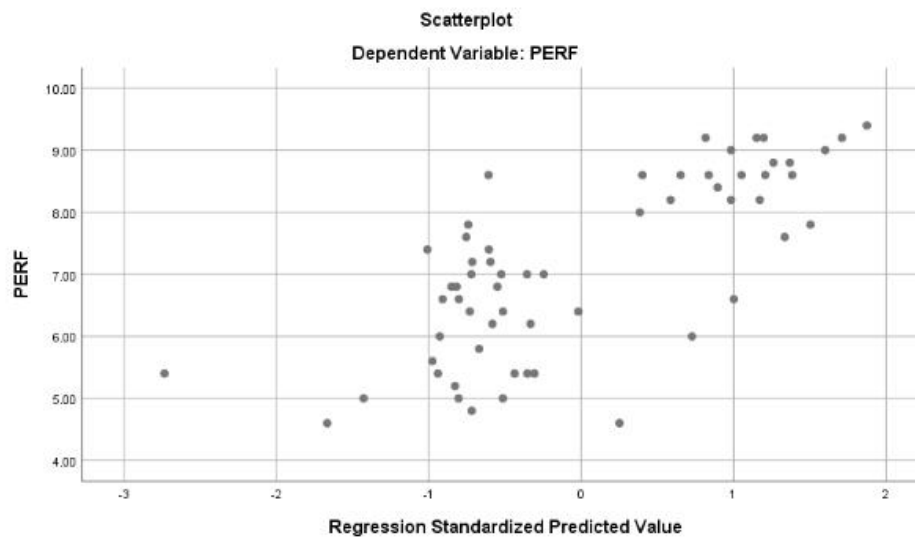
Figure 4: Scatterplot

Figure 5 shows the impact of adding student fun learning in the model and the nature of the association between student fun learning and student performance.
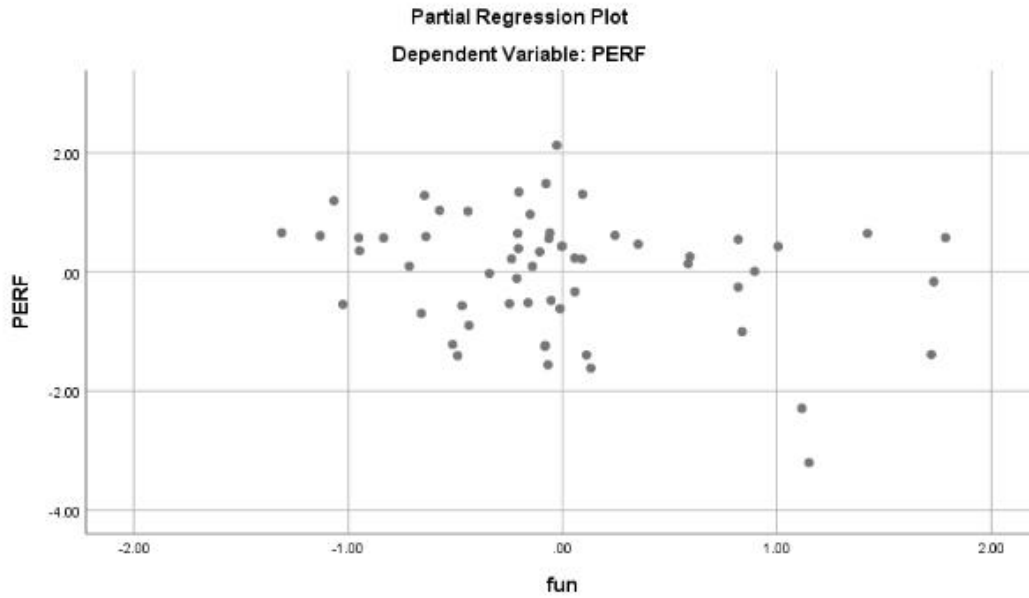
Figure 5: Partial Regression Plot (FUN)

Figure 6 represents the association between student engagement and student performance, and the residuals are largely centered around zero.
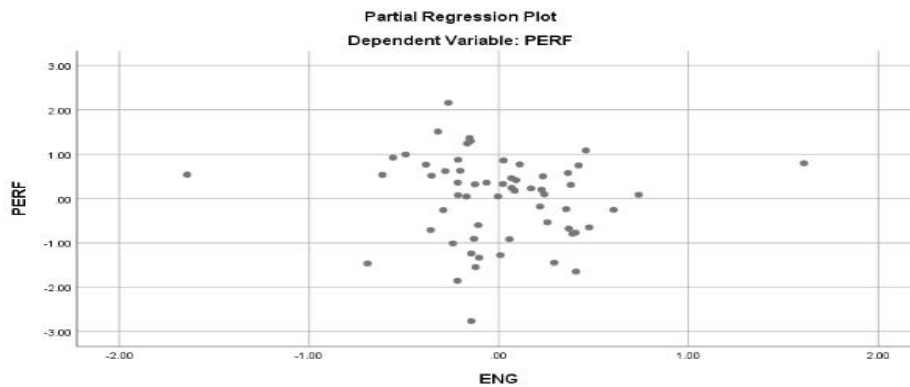
Figure 6: Partial Regression Plot (ENG)

The impact of student perception is shown in Figure 7, and the residuals' distribution indicates a positive relationship.
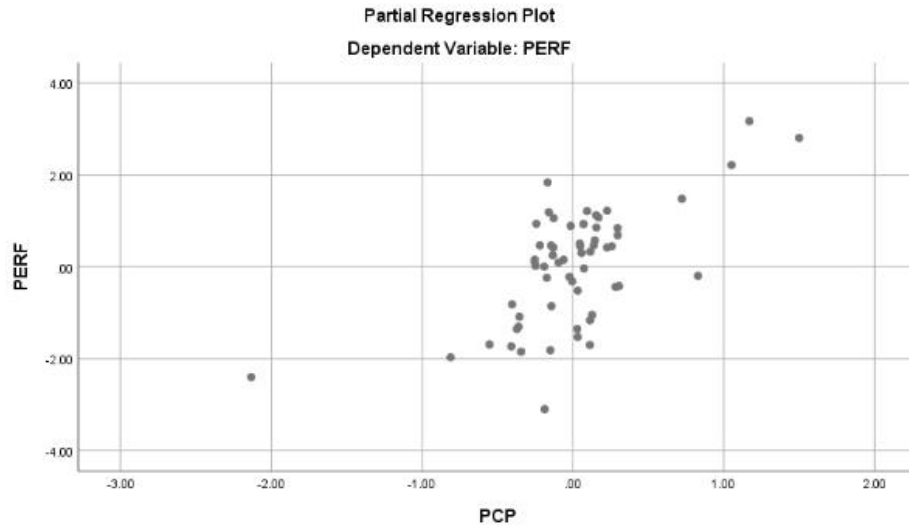
Figure 7: Partial Regression Plot (PCP)

Lastly, Figure 8 shows the nature of the association between learning out and student performance. The regression scatterplots verify the presence of linearity.
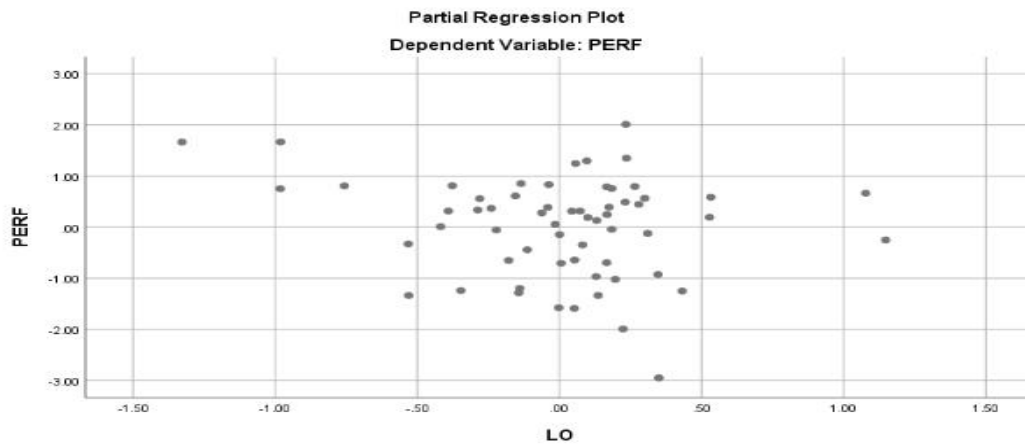
Figure 8: Partial Regression Plot (LO)

4.4 ANOVA

The "Analysis of Variance (ANOVA)" was adopted to test and analyze whether the group means are the same (Tabachnick & Fidell, 2007). The researcher conducted ANOVA as it is an effective method for evaluating experimental data with several factors. Lastly, Table 11 shows the analysis of ANOVA, which was conducted to analyze whether there is a significant difference between the means of the three assessment tools by examining the variation between and within the groups (Tabachnick & Fidell, 2007). The results showed no significant effect of Plickers, EdPuzzle, and traditional methods on fun learning ($p > 0.05$). However, the amount of variation between groups is greater for EdPuzzle. Furthermore, there is a lack of significant effect of the three assessment tools regarding student engagement. For student perception, an insignificant effect of Plickers, EdPuzzle, and traditional learning methods exists ($p > 0.05$). Hence, the results do not support the hypotheses formulated, and group means were found to be equal.

		Sum of Squares	df	Mean Square	F	Sig.
FUN1	Between Groups	.125	2	.063	.071	.932
	Within Groups	15.022	17	.884		
	Total	15.147	19			
FUN2	Between Groups	1.145	2	.572	.644	.537
	Within Groups	15.096	17	.888		
	Total	16.241	19			

		Sum of Squares	df	Mean Square	F	Sig.
FUN3	Between Groups	.206	2	.103	.710	.506
	Within Groups	2.466	17	.145		
	Total	2.672	19			
ENG1	Between Groups	.505	2	.253	.401	.676
	Within Groups	10.695	17	.629		
	Total	11.200	19			
ENG2	Between Groups	.496	2	.248	.426	.660
	Within Groups	9.879	17	.581		
	Total	10.375	19			
ENG3	Between Groups	.371	2	.186	.405	.674
	Within Groups	7.804	17	.459		
	Total	8.175	19			
LO1	Between Groups	1.026	2	.513	.732	.496
	Within Groups	11.924	17	.701		
	Total	12.950	19			
LO2	Between Groups	.081	2	.040	.057	.945
	Within Groups	12.025	17	.707		
	Total	12.106	19			

LO3	Between Groups	.131	2	.065	.281	.759
	Within Groups	3.966	17	.233		
	Total	4.097	19			
PCP1	Between Groups	1.027	2	.513	1.075	.364
	Within Groups	8.123	17	.478		
	Total	9.150	19			
PCP2	Between Groups	.047	2	.023	.292	.750
	Within Groups	1.363	17	.080		
	Total	1.410	19			
PCP3	Between Groups	.079	2	.040	.182	.835
	Within Groups	3.690	17	.217		
	Total	3.770	19			

Table 16: ANOVA

Multiple comparisons with the LSD method technique were carried out for the study's pairwise comparisons of treatment groups. In ANOVA, Fisher's Least Significant Difference (LSD) method generates confidence intervals for pairwise differences among the means of different factor levels (Williams & Abdi, 2010). It ensures that the individual error rate is controlled at a specified significance level. The LSD procedure compares the expected means of treatment groups and determines whether significant differences are present in the treatments (Midway et al., 2020). Results are summarized in Table 12. This technique is based on the assumption that the variances

of the groups being compared are equal. Results of the analysis demonstrated that no significant

difference was found in student fun learning in favor of the three assessment tools. Similar results

were observed for student engagement, perception, and learning outcome.

Dependent Variable	(I) INSTRUCTION	(J) INSTRUCTION	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
FUN1	PAPER	PLICKER	-.19388	.52298	.715	-1.2973	.9095
		EdPuzzle	-.13265	.52298	.803	-1.2360	.9707
	PLICKER	PAPER	.19388	.52298	.715	-.9095	1.2973
		EdPuzzle	.06122	.50246	.904	-.9989	1.1213
	EdPuzzle	PAPER	.13265	.52298	.803	-.9707	1.2360
		PLICKER	-.06122	.50246	.904	-1.1213	.9989
FUN2	PAPER	PLICKER	-.26531	.52427	.619	-1.3714	.8408
		EdPuzzle	.30612	.52427	.567	-.8000	1.4122
	PLICKER	PAPER	.26531	.52427	.619	-.8408	1.3714
		EdPuzzle	.57143	.50370	.272	-.4913	1.6342
	EdPuzzle	PAPER	-.30612	.52427	.567	-1.4122	.8000
		PLICKER	-.57143	.50370	.272	-1.6342	.4913
FUN3	PAPER	PLICKER	.18367	.21191	.398	-.2634	.6308
		EdPuzzle	.24490	.21191	.264	-.2022	.6920

	PLICKER	PAPER	-.18367	.21191	.398	-.6308	.2634
		EdPuzzle	.06122	.20360	.767	-.3683	.4908
	EdPuzzle	PAPER	-.24490	.21191	.264	-.6920	.2022
		PLICKER	-.06122	.20360	.767	-.4908	.3683
ENG1	PAPER	PLICKER	-.36310	.44128	.422	-1.2941	.5679
		EdPuzzle	-.32738	.44128	.468	-1.2584	.6036
	PLICKER	PAPER	.36310	.44128	.422	-.5679	1.2941
		EdPuzzle	.03571	.42397	.934	-.8588	.9302
	EdPuzzle	PAPER	.32738	.44128	.468	-.6036	1.2584
		PLICKER	-.03571	.42397	.934	-.9302	.8588
ENG2	PAPER	PLICKER	.01786	.42412	.967	-.8770	.9127
		EdPuzzle	.33929	.42412	.435	-.5555	1.2341
	PLICKER	PAPER	-.01786	.42412	.967	-.9127	.8770
		EdPuzzle	.32143	.40748	.441	-.5383	1.1811
	EdPuzzle	PAPER	-.33929	.42412	.435	-1.2341	.5555
		PLICKER	-.32143	.40748	.441	-1.1811	.5383
ENG3	PAPER	PLICKER	.00000	.37694	1.000	-.7953	.7953
		EdPuzzle	.28571	.37694	.459	-.5096	1.0810
	PLICKER	PAPER	.00000	.37694	1.000	-.7953	.7953

		EdPuzzle	.28571	.36215	.441	-.4784	1.0498
	EdPuzzle	PAPER	-.28571	.37694	.459	-1.0810	.5096
		PLICKER	-.28571	.36215	.441	-1.0498	.4784
LO1	PAPER	PLICKER	-.42424	.46594	.375	-1.4073	.5588
		EdPuzzle	-.54113	.46594	.262	-1.5242	.4419
	PLICKER	PAPER	.42424	.46594	.375	-.5588	1.4073
		EdPuzzle	-.11688	.44766	.797	-1.0614	.8276
	EdPuzzle	PAPER	.54113	.46594	.262	-.4419	1.5242
		PLICKER	.11688	.44766	.797	-.8276	1.0614
LO2	PAPER	PLICKER	-.13853	.46792	.771	-1.1257	.8487
		EdPuzzle	-.13853	.46792	.771	-1.1257	.8487
	PLICKER	PAPER	.13853	.46792	.771	-.8487	1.1257
		EdPuzzle	.00000	.44956	1.000	-.9485	.9485
	EdPuzzle	PAPER	.13853	.46792	.771	-.8487	1.1257
		PLICKER	.00000	.44956	1.000	-.9485	.9485
LO3	PAPER	PLICKER	.19913	.26872	.469	-.3678	.7661
		EdPuzzle	.08225	.26872	.763	-.4847	.6492
	PLICKER	PAPER	-.19913	.26872	.469	-.7661	.3678
		EdPuzzle	-.11688	.25818	.656	-.6616	.4278

	EdPuzzle	PAPER	-.08225	.26872	.763	-.6492	.4847
		PLICKER	.11688	.25818	.656	-.4278	.6616
PCP1	PAPER	PLICKER	-.55476	.38457	.167	-1.3661	.2566
		EdPuzzle	-.38333	.38457	.333	-1.1947	.4280
	PLICKER	PAPER	.55476	.38457	.167	-.2566	1.3661
		EdPuzzle	.17143	.36948	.649	-.6081	.9510
	EdPuzzle	PAPER	.38333	.38457	.333	-.4280	1.1947
		PLICKER	-.17143	.36948	.649	-.9510	.6081
PCP2	PAPER	PLICKER	-.08810	.15751	.583	-.4204	.2442
		EdPuzzle	-.11667	.15751	.469	-.4490	.2157
	PLICKER	PAPER	.08810	.15751	.583	-.2442	.4204
		EdPuzzle	-.02857	.15133	.852	-.3479	.2907
	EdPuzzle	PAPER	.11667	.15751	.469	-.2157	.4490
		PLICKER	.02857	.15133	.852	-.2907	.3479
PCP3	PAPER	PLICKER	.05238	.25922	.842	-.4945	.5993
		EdPuzzle	.15238	.25922	.564	-.3945	.6993
	PLICKER	PAPER	-.05238	.25922	.842	-.5993	.4945
		EdPuzzle	.10000	.24905	.693	-.4254	.6254
	EdPuzzle	PAPER	-.15238	.25922	.564	-.6993	.3945

PLICKER	-.10000	.24905	.693	-.6254	.4254

Table 17: LSD Multiple Comparison

5: Discussion and Conclusion

5.1. Summary of previous chapters

The dissertation has been categorized into five chapters. The present research has included nine research objectives formulated in the first chapter. The second chapter included the literature review in which the hypothesis was formulated corresponding to the research objectives. The third chapter discussed methodological choice and in-depth description of the mechanism applied in the present research. Data were analyzed in the fourth chapter with a statement of detailed interpretation. The discussion has been demonstrated in this chapter. The results obtained from the data analysis have been aligned with the past researchers. The acceptance and rejection of the hypothesis have been explained with the reason for separate test levels. Furthermore, the importance of the research in the theoretical, practical, and managerial implications perspective has also been stated in the end. The last part of the dissertation explains limitations and future research indications.

The present study has been conducted to evaluate the comparative analysis of Ed Puzzle, Plickers, and the traditional way of delivering lectures. These techniques measure students' perception, engagement, and learning outcomes. The review of the literature led to the formulation of nine hypotheses. Each of these hypotheses has been tested through the application of statistical techniques. In order to accomplish the research objectives formulated in the introduction section of the dissertation, the analysis conducted in the present research has been divided into three levels. There were three groups of 20 students each, and therefore were 20 observations included in the present research.

5.2. Discussion of Results concerning Pre and Post-test Assessments

The first hypothesis stated that the post-test results of EdPuzzle are better than Plicker and the traditional method. Results indicated that the post-test outcomes for EdPuzzle were significant. According to the research by Orcos Palma et al. (2018), EdPuzzle is an adequate technique for improving different skills among students. Results highlighted that the instruction-giving style through EdPuzzle by integrating technology has yielded the best outcomes. As in traditional lecture delivery methods, it has commonly been observed that students lose interest after a certain point and are distracted. Mayang et al. (2021) suggested that EdPuzzle helps students embrace different concepts more easily and ensures teachers' ability to differentiate their means of teaching, after which students' performance is likely to be improved. The instructors can enable their students to perform better by creating interactive video lessons for students. Instructions delivered through EdPuzzle result in the best outcomes for students. Results also highlighted that Plicker is the second most significant technique of giving instructions, whereas the traditional way of delivering lectures is the least effective. Just like EdPuzzle, Plicker is also a free, easily accessible, and engaging educational technique used by millions of instructors worldwide to evaluate students and gather instant results in the classroom. This is also considered an effective response system as ranked second significant technique in the present research after EdPuzzle. Through Plicker, instructors use their mobile devices to effectively scan the classroom premises to read the student's paper-based voting cards (Wood et al., 2017). As the pre and post-assessment indicated that EdPuzzle is the most significant and Plicker is the second most significant learning technique used

by teachers, so we can relate these results with the technological effectiveness in any sector, whether it is the industrial, academic, or educational sector (Raja & Nagasubramani, 2018).

Similarly, innovation and technological advancements yield practical significance in educational sectors. Teachers these days are more frequently shifting towards innovative and modern means of conveying lectures, such as through EdPuzzle, videos can be uploaded through multiple sources (Joshi et al., 2021; Juanes & Ruisoto, 2018; Kayacan & Ulker, 2020). Students' engagement increases when they seek to answer customized questions, and in this way, they learn on an entirely new level. The literature and benefits insights of EdPuzzle correspond to the results of our study as it has been designed to help instructors by creating and engaging interactive lessons which are video based through which students' performance, learning, engagement, and development are supported.

5.3. Discussion of Results concerning regression analysis

After analyzing the pre-test and post-test performance of students, the regression analysis was performed to assess whether the fun during learning, student engagement, learning outcomes, and perceptions regarding the method of delivering instruction influences students' performance. The second hypothesis stated that "fun learning significantly affects student performance." Fun is a key element in learning, the deficiency of which generates boredom and a lack of student interest. Results indicated that fun during learning significantly impacts student performance. Research by Tisza (2021) explains that more than 65% of students are visual learners, and 95% watch YouTube regularly. Aligning the learning technique and process of delivering lectures with students' interests positively affects their performance. Gaining lecturers through traditional methods generates a feeling of boredom among students, thereby increasing the chance of their distracted

attention. Suppose the fun element is inculcated in learning and delivering lectures. In that case, it strengthens the student's interest in the sessions they are attending, thereby contributing to the student's betterment and effective performance. Researchers suggest that including fun activities in the classroom entails several benefits (Mandasari, 2020; Mandasari & Aminatun, 2020). The most important of which is "increased student engagement." When new ways of learning concepts are applied using digitalized mediums and the usage of technology results in better performance of students, retaining students' focus and attention is integral for any researcher because, in the absence of fun activities, boredom can strike the students. They can lose interest in learning and listen to the instructors (Bond, 2020). Different activities such as discussion sessions with friends in group settings, innovative open-book quizzes, and art activities can refresh students' minds by conveying a sense of fun learning. Instructors these days also prefer to throw random jokes so that stress among the students reduces and they actively learn new concepts. Study tours are also increasing as a medium of fun learning in different academic institutions. This technique also assists in student's increased interest in learning and reducing educational stress thereby improving their performance.

The third hypothesis being tested stated, "Student engagement significantly impacts the student's performance." The results indicated an insignificant association between the two. According to Qureshi et al. (2021), multiple factors contribute to student performance. The instructor's ability to incorporate their focus in lectures strengthens the probability of students' better performance. Lack of interest in lecture delivery and grasping the main concepts leads to diminished student performance. Their learning skills strongly influence student academic performance, the background of their parents, peer influence, teacher quality, and the effective learning infrastructure. Paul and Jefferson (2019) highlighted that family support, preparedness for

academics, life competencies, and skills, and students' problem-solving skills enhance their learning. Better student engagement can be achieved when the right infrastructure prevails, resulting in effective performance. Therefore, it can be assumed that one factor cannot ensure adequate student performance, as student engagement is one of those factors. Researchers have highlighted that student performance is a major responsibility of any teacher. But numerous factors matter in paving the way for better student performance (Yansyah, 2022). As highlighted, creative activities increase students' performance because most students dislike consecutive or boring lectures. Therefore, their performance increases when instructors try various mechanisms to provide learning.

The fourth hypothesis stated that "learning outcome significantly impacts the student's performance." Results indicated an insignificant association between the learning outcome and student performance. The learning outcomes only aid in defining the extent to which a student can understand after completing any course or class session. A vast amount of literature is available on the importance of learning outcomes as it generates a sense of clarity and focuses on students regarding what they can learn in coming sessions. But merely defining learning outcomes cannot ensure a student's guaranteed progress. Students' focus on achieving those learning outcomes is more important to ensure better performance. Learning techniques are far more important than learning outcomes to attain adequate performance of students in their educational setting. With the increased trend of digital media, teachers are also shifting towards blended learning modes (Bahri & Corebima, 2015; Brooks et al., 2014). Therefore, defining learning outcomes remains no longer a goal for any teacher. Including fun during learning through creative activities can ensure better performance. The infrastructure and quality of teachers are also important in attaining better student performance. Through critical and innovative mediums, multiple learning techniques are

encouraged by different academic institutions so that they can achieve a competitive advantage along with increased and satisfied student performance (Nortvig et al., 2018).

The fifth hypothesis stated that "perceptions of students significantly impact the student's performance." After testing this hypothesis, results indicated a significant impact of students' perception on performance". Keller and Cernerud (2002) stated that the learning environment is important and integral in shaping students' performance. It includes the social, physical, educational, and psychological context in which the students are observed as immersed. These factors play a crucial role in their personal and professional development. Student perception is, therefore, a leading element in attaining student performance. As results indicated, these factors are significant and closely impact each other (Hill et al., 2003). According to Bakhshialiabad et al. (2015) and Patil and Chaudhari (2016), DREEM is an effective measure to consider and diagnose deficiencies in the current learning environment. This technique compares different groups related to the educational environment with an expected or ideal one in a similar group. Kossioni et al. (2012) explained that through DREEM perception of students is aligned with what they expect. Different academic institutions consider the importance of students' perceptions and their impact on performance. Through this aspect, authorities of educational sectors can know about the learning environment and provide solutions to educational problems by improving educational efficiency. Students with greater and positive academic achievements have adequate perceptions of their education, whereas low-achieving students illustrate a greater negative perception of education. Students tend to learn better when they positively perceive the learning environment in the class. A positive learning environment refers to the psychological, social, and pedagogical contexts of learning. As learning methods have transformed from traditional methods towards innovative and digitalized mechanisms, students' perceptions and expectations have now been

revolutionized at another level (Matuk & Linn, 2023; McLean & Attardi, 2023). They perceive higher and expect greater. A positive perception of such students results in better educational performance.

5.4. Discussion of results concerning the ANOVA test

After analyzing the pre and post-test assessment results and regression analysis, the ANOVA test compared the four independent variables: student engagement, fun learning, learning outcome, and perception of students across the groups. The results demonstrated through the test of multiple comparisons used to test homogeneity illustrate that the results are insignificant and there is no homogeneity. These groups were labeled as one, two, and three to demonstrate which level provides the best outcome for student performance. Results indicated that mean differences were significant between the traditional and educational technologies. In contrast, the mean of EdPuzzle was higher than Plicker, through which it can be demonstrated that students are responsive toward adopting educational technologies, particularly the more interactive ones. Educational technology holds greater significance when it is interactive for students to a great extent. The technologies help teachers integrate new tools and procedures into the classroom. Students demonstrate greater responsiveness toward these technologies (Ngwacho, 2020; Oke & Fernandes, 2020). Through innovative technologies, teachers can upgrade and improve their classrooms' learner-centeredness. Students engage in innovative, unique, and equitable techniques through these integrated technologies. Students tend to perform better when they receive instructions other than the traditional modes of lectures. According to Cesare et al. (2021), students tend to be more responsive when information is digitalized.

EdPuzzle is thus considered a supreme and formative assessment tool for instructors. This helps the instructors incorporate student engagement and tends to improve their performance. Those instructors who utilize digitalized assessment tools or run a flipped classroom along with assigning videos for homework are more likely to bring a greater student performance. Technological advancements have molded the way of teaching for instructors as they want to encourage asynchronous communication. According to Guzey et al. (2022), EdPuzzle is also helpful as it aids in illustrating whether or not the students achieve the targeted goals at the end of their semesters. This is because students prefer innovation and creativity in their academic learning. Although after hypothesis testing, it was observed that student engagement, fun during learning, learning outcome, and student perception insignificantly impacts the student's performance. According to the study by Bessa et al. (2020) student engagement is not merely the obligation of the instructor but it is the entire atmosphere of school and culture of institution which contributes in student's engagement. Teachers must analyze the fact that technology is for the betterment and benefit of a person. If applied adequately even in educational sector yields greater student' productivity and performance. Numerous factors contribute to enhancing student performance; technology can be assumed to be one of those leading factors due to its capacity to increase student responsiveness. Due to the fact that the sample in the present study was really small and the researcher approached only 20 groups of students to study the differences. This was the reason behind the insignificant results, as the last test considered one-way ANOVA; other than that, other repetitive techniques or multiple ANOVA can be used along with a huge sample size as an alternative or varied statistical approach to test the present hypothesis.

5.5. Conclusion

With the increased change and advancements in academic institutions, the learning mechanisms have also been changed on an entirely new level. Attaining progressive and positive student performance is believed as the obligation of teachers. Online learning mediums have made it easier for teachers to deliver lectures productively and efficiently. The key advantage of the modern learning mechanism is that it improves students' performance, thereby ensuring their engagement and effective learning. Many instructors are adopting the technique of EdPuzzle and Plicker to deliver lectures. Apart from these techniques, traditional lecture delivery methods have also been adopted widely in Pakistan. But there is an emerging need to assess the fluctuation among these three techniques relative to the student's academic performance. After reviewing the literature, 9 hypotheses were formulated that corresponded to the accomplishment of research objectives. In the present research, the quantitative research method has been applied to draw results. A survey mechanism was used for the data collection. For this purpose, the data was collected by disseminating questionnaires to the 9th-grade students of a school based in Rawalpindi, Pakistan. SPSS was used to analyze the data. Analysis was performed in three sections. The researcher targeted 60 students, categorized into three groups, the Plicker, EdPuzzle, and traditional groups, having 20 students each. So, the researcher used paired sample t-test, regression analysis, and the ANOVA test to analyze the data. Results indicated that for pre and post-test assessments of the three mentioned groups, EdPuzzle was among the most significant techniques for impacting student's performance, Plicker was the second and the traditional was the third most significant mechanism for impacting student performance. The regression analysis results indicated that fun learning and perceptions of students significantly impacted students' performance. Whereas student engagement and learning outcomes insignificantly affected the student's performance.

5.6. Implications of the study

The present research study aims to analyze the impact of EdPuzzle and Plickers on the student's perception, engagement, and learning outcomes. This study is significant regarding theory, practice, and policy at the managerial level.

5.6.1. Theoretical implications

The present study supports the existing literature on the impact of EdPuzzle and Plickers on the student's perception, engagement, and learning outcomes. This study adds to the current literature on this topic, particularly in developing countries like Pakistan, a developing economy, i.e., lower-middle income. This study supports the existing literature that there is a need to change instruction design and that teachers should change their assisting methods, adapt to the latest technologies, and implement them. It also supports the developing literature on the application and significance of technology in education. This study provides fresh insight into the underlying topic at the secondary level of education, particularly in Pakistan; therefore, this study is of higher theoretical importance in this region.

5.6.2. Practical Implications

This study has solidified the impact of blended learning and assisted learning methods such as EdPuzzle and Plickers. In neighboring countries such as China and India, the use of advanced technology in the learning and teaching processes is widely used (Mishra et al., 2020; Shadiev & Yang, 2020), but in Pakistan, technological advancements have yet to be frequently used in learning methods (Asad et al., 2021). Despite the small size of the sample, even though the

researcher has collected data from the students of only one class of a single school, still, the findings of this study support that the usage of technology for assistance and providing instructions to the students in their learning significantly and positively influence the academic performance of the students enhances their engagement, improve their performance and also improves their learning outcomes. Therefore, this study provides a significant application to the management, staff, and teachers of the secondary schools of Pakistan that they should focus on this aspect and improve their learning style by utilizing advanced and improved technologies to improve the student's learning abilities and results. They should change their learning styles as soon as possible because it is high time. This study also highlighted the importance of using digital technologies such as EdPuzzle and Plickers in learning, and this would make education more accessible to every student, no matter their location. This would also assist in promoting remote education and learning in Pakistan because these online learning platforms can be accessed anytime from anywhere. The study is also vital for policymakers, government, and educators. This would help them enhance their awareness about the use of blended and assisting learning methods and the use of technological applications such as EdPuzzle and Plickers and their associated benefits. This would help them make effective education decisions, particularly at the secondary level or generally at any educational level in Pakistan.

5.6.3. Managerial Implications

This study has several managerial implications as well. When the policy makers or managers of the organization or educational institutions or any other stakeholders of school or any other educational institutions may visit the results and findings of this study, it would be approved to them by the conclusions that they need to develop and redeveloped such strategies and educational

policies which ensure the implementation of advanced and improved technologies in the instructional designs of the teachers and these policies should be implemented in the schools and higher educational institutions including colleges and universities. The people who are in managerial positions, such as principals, leads, coordinators, heads of the departments, etc., need to create such an environment by which they facilitate the learning of their employees, i.e., teachers, regarding the technological methods of instruction such as EdPuzzle, Plickers, and many others. Then the teachers should ensure the implementation of these applications in their classroom settings for their students.

5.7. Limitations and future research indications

The study has a few limitations, based on which the researcher has suggested recommendations for future studies. First, the sample size was very small, and the study collected data from the ninth-grade students of a single public limited school, which might restrict the generalisability of the findings; therefore, it is suggested that future researchers use a larger sample size. Also, future studies should collect data from different schools in different cities of Pakistan and then analyze whether the results would still be the same or different by changing the environment, culture, and setting. Another limitation of this study is that the present study has only used the quantitative analysis approaches and did not take and consider the opinions of students and teachers; the study just ran an experiment and made conclusions accordingly, even though the study has employed different methods for data collection, but all of them were quantitative and gathered numerical data only, none of them was qualitative, none of them relied on the opinions, perspectives and the perceptions of the respondents; therefore it is suggested for the future researchers to use a mixed method approach and collect data both qualitatively and quantitatively, to study the perceptions of

students and teachers as well about technological applications in learning. The researchers should conduct a focus group or semi-structured interviews to get their opinions and perspectives about the impact of EdPuzzle and Plickers applications on the student's perception, engagement, and overall learning outcomes. Another limitation of the study is that most respondents were female students so the results could be gender biased. Therefore, it is suggested that future researchers collect data from both genders, i.e., males and females respondents, equally to eliminate the biases in the findings of their studies. The study has also recommended that future researchers analyse the impact of any additional technological applications along with the EdPuzzle and Plickers in their studies and examine their findings.

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