EdTech Augmentation for Better Learning Outcomes

A Case Study of Private Schools in Islamabad

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CERTIFICATE

This is to certify that this thesis entitled: **"EdTech Augmentation for Better Learning Outcomes (A Case Study of Private Schools in Islamabad)"** submitted by **Ms. Farzana Parveen Jafferi** is accepted in its present form by the School of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Economics.

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I Farzana Parveen Jafferi hereby state that my MPhil Economics thesis titled Ed Tech Augmentation for Better Learning outcomes A Case Study of Private Schools in Islamabad is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of Development Economics or anywhere else in the country/world.

At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my MPhil degree.

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Farzana Parveen Jafferi

ABSTRACT

This study presents the effect of educational technology (EdTech) on both student learning outcomes and teachers' pedagogical skills in a private high school. Specifically, the research examines the effectiveness of various teaching methodologies employed in the Cambridge Section of Bahria College Islamabad for ninth-grade students in Mathematics and English. The study uses mixed method approach to evaluate both quantitative and qualitative data, targeting to assess the advantages of EdTech and find the challenges faced by teachers in integrating technology into their classrooms. Using a quantitative approach, the study analyzes student test scores from Mathematics and English through multiple linear regression. The results show that students taught with EdTech methods scored, on average, 3.820 points higher in Mathematics and 1.586 points higher in English compared to those taught using traditional teaching methods. The analysis also measured additional variables such as teacher experience, class size, tuition, parental income level, and the number of siblings, which were found to affect the observed score differences. In addition to the quantitative analysis, semi-structured interviews with Mathematics and English teachers were conducted to reveal the problems faced in adopting EdTech in classrooms. The qualitative analysis discovered two major types of barriers: internal barriers, including limited knowledge, competency, skill, and reluctance to change, and external barriers, like insufficient motivation, lack of training, heavy workloads, and inadequate technological infrastructure. The findings of this research present an in-depth information for administrators and policymakers by highlighting the effectiveness of EdTech in enhancing student test scores and recognizing serious aspects for development. These perceptions can guide efforts to overcome barriers and increase the augmentation of educational technology in classrooms to confirm high-quality learning outcomes and prepare students for a successful future.

Keywords: Educational Technology, Private High Schools, Learning Environment, EdTech Content, Pedagogy, Technology Acceptance Model (TAM), Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioral Intention to Use EdTech (BI), Actual System Use

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LIST OF ABBREVIATIONS

β	Beta
BI	Behavioral Intention to Use
EDM	EdTech Teaching Method
EdTech	Education Technology
PD	Professional Development
PEOU	Perceived Ease of Use
PIDE	Pakistan Institute of Development Economics
PU	Perceived Usefulness
TAM	Technology Acceptance Model
TM	Traditional Teaching Method

CHAPTER 1

INTRODUCTION

Education Technology (EdTech) refers to the use of technology to enhance students' learning by innovative teaching tools. This can involve a variety of tools like hardware, software, online resources and several other subject based educational apps. One of the major benefits is that it is more interactive, engaging, and accessible for all levels of students. EdTech make the lessons sparkling, and students get involved in their own learning (Tzenio N., 2020). The use of education technology in the classroom will, certainly, stimulate the teachers to align their tasks to make the learning process interesting for students.

1.1 Background of Study

Education technology plays great role in education system of Pakistan, specifically at high school level when students are focusing at their future career programs. All types of schools in Pakistan aims to improve education . In Pakistan, on average only 34% of households have digital access while only 12% have access to digital tools like laptops (Government of Pakistan, 2021). However digital access is not the only constraint; hence for the present study, we will collect and analyze data (both primary and secondary, and qualitative and the quantitative) related to digital learning in Islamabad. This study will present strategies to optimize the use of EdTech at private schools and help provide a resource for stakeholders like governments, administrators, parents, students and especially the teachers involvement in EdTech use in Pakistan.

Technology is evolving quicker today than ever before with developments like robotics, Internet, cloud computing, Artificial Intelligence (AI), etc., opening many opportunities to our life skills and practices. In both industry and education sectors, importance of technology is growing as a strong means for survival in today's fast-paced and knowledge-driven world. Evidence of its success and impact on teaching and learning has been proved through several research studies (Oyetade K. E., Zuva T. & Harmse , 2020).

EdTech offers both teachers and students access to the latest, up-to-date information of various subjects at a level that a book can never met. Searching the relevant books can be time-consuming, particularly if the book does not contain the information you need. Instead, the EdTech provides a better solution by ensuring the use of internet. Moreover, textbooks can become outdated, sometimes even misleading students into believing that there have been no further changes since the book's publication Teachers must be ready to accept and utilize EdTech as an essential part of their professional skill set to support student learning.

In a global context, EdTech is being adopted by educational institutions to raise quality of education. Therefore, most countries around the globe are working on this task for improvement of educational standards (Noor-Ul-Amin, 2013). Both developed and developing societies appreciated the EdTech tools for their economic development. Technological Leadership Academics are established in every U.S. state administrative office to remain flourish with EdTech development at schools. EdTech has also become vital to successful technology education plans in India. It has absorbed in the society to the extent of becoming vital for its routine tasks, and it has merged in education for teaching and learning purposes .

The aptitude of teachers is the most important factor to produce a good learning environment for their students. The educational sector of Pakistan has a diverse style of education system in the form of government, private schools along with, madrassa education system, but still suffers from the problem of different pedagogical approaches in these different educational systems. Due to this, Pakistan needs to augment EdTech in these institutions to modernize and upgrade the education systems. (Ahamad et al., 2013).

The structure of school education in Pakistan has different levels as shown in the figure. These levels start from pre-primary, middle, high, and higher secondary school. If we want to integrate the EdTech, we need to specify level of student as an experimental group who could learn more with any

harm. The best level for EdTech implementation is high level. The students here grasp the concept and focused on prospects. Pakistani educational institutions are presented in Table 1.1 below.

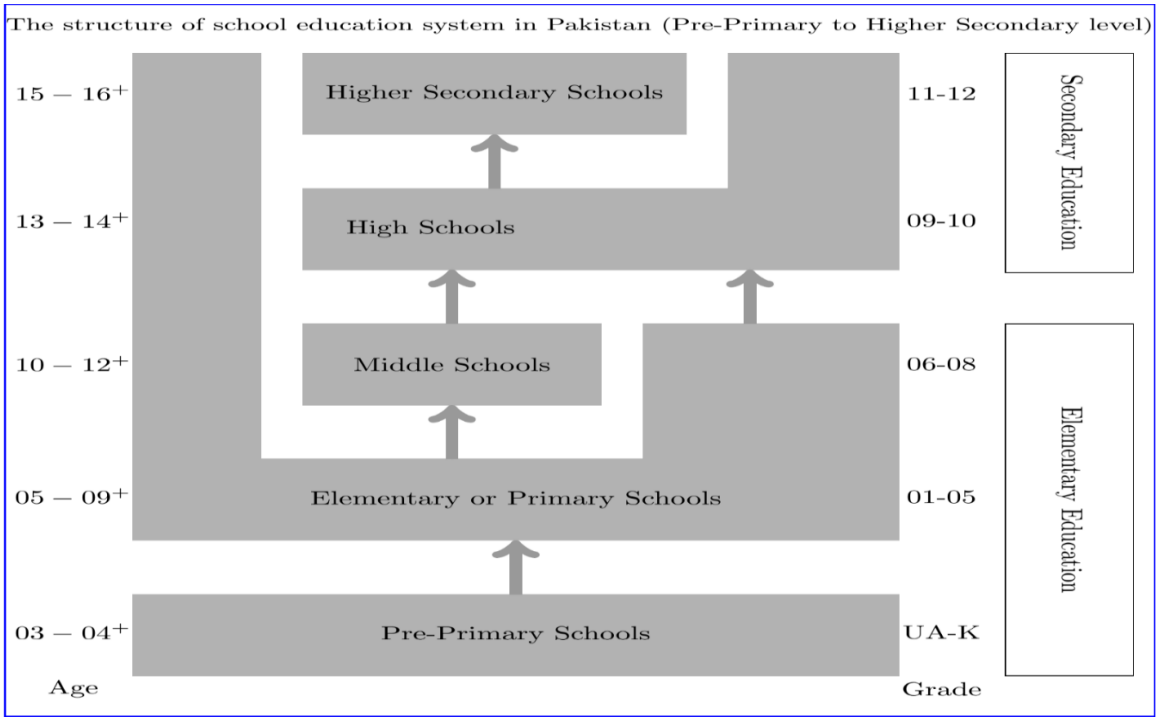


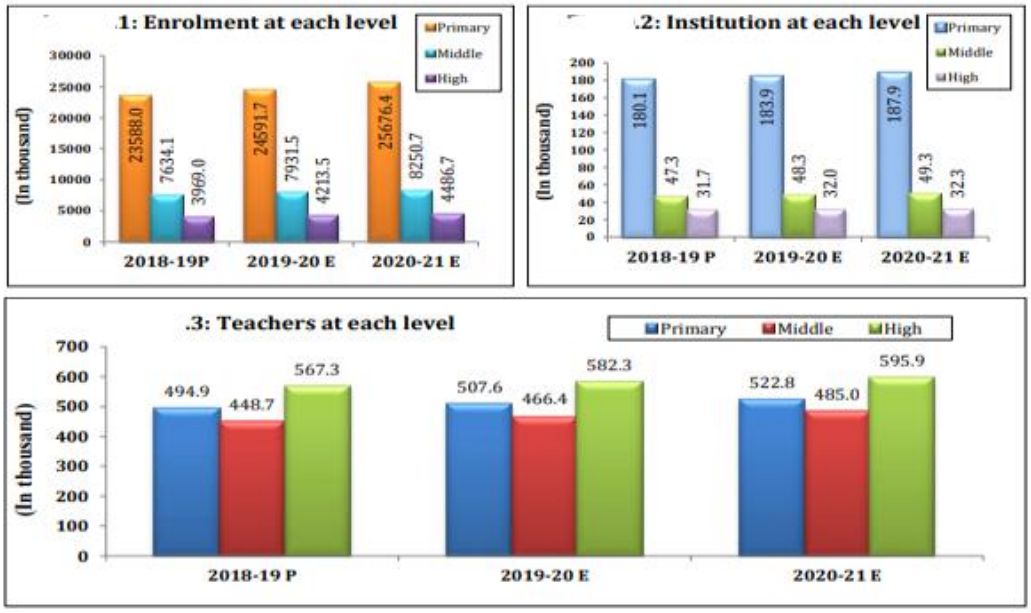
Fig 1.1 *The Structure of School Systems in Pakistan*

Pakistan educational institutions offer different types of educations, including the two main streams: British Curriculum and Matriculation Curriculum at high level schools, these are followed by both private and public schools.

According to Pakistan Bureau of Statistics ,Pakistan Social and Living Standard Measurement Survey PSLM 2019-2020, it is recommended to government to give highest priority for ensuring high quality, equitable and accessible education.It has been realised that education sector should adopt EdTech to achieve the desired goals.

In the 2019-20 academic year, there were a total of 32,000 high schools were working in the country, with a verified number of 582,300 teachers. Nationwide, secondary school enrolment saw a 6.2 percent increase, rising from 4.0 million in 2018-19 to 4.2 million in 2019-20. It is expected that enrolment will grow by an additional 6.5 percent, reaching an estimated 4.5 million in 2020-21.

Key indicators of the overall education situation, such as enrolment numbers, institutional presence, and teacher counts, have shown substantial improvement. Enrolments grew from 53.1 million in 2018-19 to 55.7 million in 2019-20, marking a 4.9 percent increase. This number is expected to rise to 58.5 million in 2020-21. The number of institutions also increased from 271,800 in 2018-19 to 277,500 in 2019-20, with a forecasted rise to 283,700 in 2020-21. Additionally, the teaching workforce expanded from 1.79 million in the previous year to 1.83 million in 2019-20, with an anticipated increase to 1.89 million in 2020-21.



Source: Pakistan Economic Survey Year 2020-2021

Fig1.2: *Student enrollments ,Institution and teachers of Pakistan at different levels*

The private schools are attempting to use EdTech for providing standardized education. Private educational institutes use more EdTech as compared to government institutions. The arrangement of google classes, zoom and WhatsApp groups during Covid-19 to provide home-based education was more rapidly in the private sector (GPE, 2020). Over 300,000 schools were closed since March, but education continued just because of EdTech. In reality, the internet systems are low and getting home wideband is also not affordable. According to Pakistan Telecommunication Authority, only a million children have

access to bandwidth and digital devices, and the penetration of smartphones is only 51 percent in 2020(GPE, 2020).

1.2 Statement of Problem

The study on Education Technology showed that students mostly answer better when EdTech tools are being used in the classrooms (Walkington C.A., 2013). Still, some research state negative results, often because the EdTech was not selected or applied according to the students' exact needs. The use of Education Technology (EdTech) has greatly improved the students' learning by making teachings more communicating and modified. Though, in private high schools, particularly in subjects like English and Mathematics, using EdTech efficiently is often a difficult task.

Teachers must confront with several problems when they try to use EdTech in their classrooms. These problems include very limited amount of technology, rare chances of getting enough technology-based trainings, fear to use the technology ,internet access and stress to align this technology with their teaching practices. Therefore, the potential benefits of EdTech are not understood, which shows that student learning outcomes are not as good as they could be.

My thesis will discover how EdTech can be well used in private high schools to improve student learning outcomes and their performance in examinations. It will precisely focus on the difficulties English and Math teachers confront in using these EdTech tools and will also recommend ways to overcome these Barriers. The purpose is to discover hands-on solutions to make EdTech more effective and help students achieve better scores.

Though many studies have been presented at how Education Technology (EdTech) can be used around the globe, there isn't sufficient research done about its use in private high schools in Pakistan. Much research concentrates on government schools or higher education, which will not solve the barriers faced by private high schools in Pakistan.

This study aims to fill this gap by focusing on how EdTech can be effectively used in private high schools in Pakistan, addressing the unique problems teachers face, and finding solutions that work best for this context. So, , I am narrowing my research problem into; ‘ Does EdTech augmentation lead to better teaching and learning outcomes? And if it does then what are the constraints faced by private school teachers in their use?’ By doing a case Study of a Private School[1] in Islamabad‘’ and have operationalized my topic into following research questions and objectives.

1.3 Research Questions

This research conducts a comparative case study of a private school where teachers use different methodology of teaching to explore the following research questions:

1. How adaptability of EdTech in private schools affect teaching and student learning outcomes?
2. What are the main barriers faced by private school teachers in adopting EdTech tools?

1.4 Research Objectives

The broad objective of this study is to analyze how augmenting the Education Technology (EdTech) can lead to better learning outcomes through comparing student scores along with identifying the main barrier faced by private school teachers in using EdTech tools.

1.5 Explanation of the Key Terms

Education Technology : technological tools that help to gain knowledge ,its development and exchange. In my study, it can include laptops, multimedia, iPads, and softboards etc.

Learning environment: the sum of the internal and external conditions that surrounds and affects a person's learning.

Pedagogy : refers to method and practice of teaching

Private High Schools : A secondary school not owned by the Government .

Ideally it should be for private schools with Cambridge System and Pakistani System but given time and resource constraints only private schools are evaluated. Furthermore, private schools have lesser resource problem, so the issue of affordability is neutralized to an extent .

Technology Acceptance Model (TAM) : a framework used to identify key factors that influence a person's decision to accept or reject education technology.

Perceived Usefulness (PU) : The extent to which a teacher believes that using EdTech in the classroom would improve their students 'learning and performance

Perceived Ease of Use (PEOU) : The extent to which a teacher believes that integrating EdTech as a teaching method would be comfortable

Behavioral Intention to Use (BI): It refers to the extent to which a person intends to use the technology

Actual System Use: This is the result, giving the actual usage of the education technology

Stakeholders : Anyone who has interest in the success of educational system . In our study, students, teachers, administrators, and the parent are included

EdTech Content : The combined use of computer hardware and software to facilitate students' learning .

1.6 Scope and Significance of Study

This study finds how Education Technology (EdTech) can be used in private high schools to improve teaching methods and learning outcomes in two subjects i.e. English and Mathematics. It will cover several main features including use of different types of EdTech tools , problems faced by the teachers in trying to align these EdTech tools with curriculum's specific demand. The research will also assess how effective use of EdTech can improve student involvement and performance in English and Math. Finally, the thesis will propose practical results to overcome these barriers and improve the integration of EdTech, aiming to increase student learning outcomes.

This research is important for several reasons as it identifies the specific challenges teachers face with EdTech, the study will help develop solutions that clarifies the special needs of private schools in Pakistan. This research will also fill a gap by focusing on EdTech issues in Pakistani private high schools, providing insights that can guide future educational policies and practices. The results will give valued evidence for policymakers, school managements, and teachers to make better choices about EdTech

investments and use. In general, this study follows to link technology with current teaching to boost student learning and support both teachers and students in private schools in Pakistan.

Summary

This chapter presents a study aimed at enhancing educational technology (EdTech) in private high schools. It observes how digital learning tools can boost student performance in subjects like Mathematics and English. The study has two main goals: to see if EdTech improves test scores and academic outcomes for ninth-grade students, and to identify issues like insufficient training and resources that hinder teachers from using EdTech effectively.

The chapter will give recommendations to address these tasks and improve EdTech use in high schools. It comprises of background information, the problem statement, research questions and objectives, key terms, scope, and the study's importance for private schools in Pakistan. The thesis is divided into six chapters: Introduction, Literature Review, Research Methodology, Data Analysis, Findings and Discussions, and Conclusion, along with Policy Recommendations and Limitations.

CHAPTER 2

LITERATURE REVIEW

Chapter two provided literature on Educational Technology (EdTech) that it is presenting new opportunities for enhancing students' learning in high school education. For O-Level Mathematics and English, that are central subjects currently, the augmenting of EdTech tools is very significant. This literature review discovers current developments and results related to the use of EdTech in high schools, particularly in these subjects, assessing how these technologies helped to improved learning outcomes.

The section included here gives literature on Methodologies and the theories related to EdTech Augmentation , and the summary of literature view.

2.1 Methodologies in EdTech Augmentation for students' Improved Learning in High Schools for Mathematics and English

The use of Educational Technology (EdTech) in secondary schools, particularly for Mathematics and English, has got universal importance. Methodologies for using EdTech tools successfully into educational practice are vital for enhancing learning outcomes. This literature review focuses on current methodological approaches to applying EdTech in these subjects, highlighting strategies, models, and frameworks that have been discovered in new research.

2.1.1 Methodologies related to EdTech for Mathematics Education

2.1.1.1 Integrated Learning Model

Integrated learning, which combines both traditional teaching with EdTech resources, has become a widespread method in Mathematics education. Research shows that this method can improve student understanding and scores. For example, (Hart T.L ,2024) describe that using platforms like Khan Academy in a blended learning situation provides students with instructional movies/videos and complete

exam practices both in class and at home. This mixture of online tools with traditional teaching led to better learning skills and remarkable test results among students.

2.1.1.2 Flipped Classroom Model

In this model, the students read the content at home before doing it in the class and the class time is used for understanding and discussion , this method has proven effective in Mathematics. (Saunders J. M., 2014) realized that this approach aids students to review the topic at their own and then discuss it during class. This model presents higher student involvement and a better grip of mathematical ideas.

2.1.1.3 Game-based Model

Game-based learning is a new methodology that prefers game mechanics to augment learning. Studies led by (Engelhardt M. R., 2024) discovered how mixing games such as Prodigy Math into the syllabus can encourage students and expand their scores. The use of game-based learning approach has led to improved attention and better understanding of mathematical concepts.

2.1.2 Methodologies related to EdTech for English Language Education

2.1.2.1 Collaborative Learning Resources

Google Docs and Padlet promotes peer interaction during writing tasks (Pratiwi V. U., 2020).By encourage these resources improves students' writing skills by making teams and groups on projects, sharing peer advice, and involving in debates. These tools led to critical thinking and writing skills.

2.1.2.2 Multimedia Projects and Digital Storytelling

Multimedia projects and Digital storytelling are methods help to improve language. EdTech resources like Story bird help students to generate digital stories on their own, which can advance narrative skills and creativity. (Syafryadin H & Salniwati A, 2019) presented that student involved in

digital storytelling projects revealed upgraded writing and speaking aptitudes and more interest in English language .

2.2 Theoretical Framework of EdTech Augmentation and Learning Outcomes in Mathematics and English

Educational Technology (EdTech) in high schools is imposed by many theories that explain its usefulness. This study also emphasizes current theories relevant EdTech usage in GCE Mathematics and English. Following these theories, we can comprehend how EdTech influences teaching methodologies and students' learning and helps these implications to be followed practically by the schools.

2.2.1 Theories for Mathematics

2.2.1.1 Constructivist Theory

Constructivist theory, by (Major T. E. & Mangope B.,2012) suggests that learning occurs enthusiastically as students understand concepts of Mathematics through relating with their surroundings. Latest EdTech tools, like interactive simulations and problem-solving platforms like GeoGebra and Desmos, proved this fact .

2.2.2. Theoretical Perspectives on EdTech in English Language Education

2.2.2.1 Socio-Cultural Theory

Socio-Cultural Theory (Dickfors E., 2015) focuses the worth of social and cultural interactions using EdTech tools in language learning. In English language, this theory uses digital storytelling tools like Google Docs and Story bird. These tools assist with language development by peer feedback and writing, producing social dealings as valuable learning method.

2.3 Integrative Theoretical Frameworks

2.3.1 TPACK Framework

The Technological Pedagogical Content Knowledge (TPACK) framework connects EdTech with teaching methodology and subject knowledge and the content. This framework helps the way to use EdTech successfully in high schools. By augmenting the education technology, teaching method, and subject knowledge and proficiency, teachers can make both teaching and learning, an effective process. Latest studies in Mathematics and English education reveal that using the TPACK framework resourcefully can cause a better learning by combining education technology with teaching methodology and subject content (Istiningsih, I., 2022).

2.3.2 SAMR Model

The SAMR Model (Substitution, Augmentation, Modification, Redefinition) also presents the impacts of EdTech on teaching , student learning and their performance. It has transformed the teaching experiences from simple and traditional teaching into innovative and convenient teaching styles. In most of latest research, the SAMR Model has been used to incorporate tools like interactive simulations in Mathematics and multimedia projects in English to boost learning by replacing traditional teaching methods (Peters, 2024).

2.3.3 Technology Acceptance Model (TAM)

The **Technology Acceptance Model (TAM)**, developed by (Davis, 1989), provides a theoretical framework to explain how teachers identify the convenience of teaching and get ready to use EdTech in their classrooms for best students' learning. TAM posits that perceived usefulness (PU) and perceived ease of use (PEOU) influence teachers' behavioral aims to accept technology (Davis, 1989). In the context of EdTech, this model helps explain how students' perceptions of the benefits and ease of EdTech tools affect their learning outcomes. TAM is used to Understand teachers' and students' acceptance of educational technologies through better performance and result scores.

2.3.4 Theoretical Framework of using EdTech

Theoretical frameworks present that EdTech tools can enhance learning outcomes in high schools for O-Level Mathematics and English. Theories like constructivism, cognitive load theory, self-determination theory, socio-cultural theory, and the communicative approach support this vision. Frameworks like TPACK, the SAMR Model, and the TAM Model provide real direction on how to use EdTech successfully. By using these theories and frameworks, teachers can best comprehend and augment technology to their productive teaching and enhanced students' learning through exam performance.

2.4 Barriers faced by Teachers in using EdTech

2.4.1 Internal Barriers faced by teachers augmenting EdTech

Internal barriers (also known as second-order barriers) refer to those obstacles that are intrinsic to teachers, which include knowledge, skills, and teacher Competency (beliefs)(Wang, 2017).

2.4.1.1 Lack of teachers EdTech competency, reluctance, knowledge, and skill

According to (Pelgrum, 2001) who categorizes the obstacles into two types: material and non-material. Material cases are the availability of a smaller number of EdTech tools and software while non-material problems encompass teachers' lacking the EdTech knowledge and skills, the challenges of integrating ICT into instruction, and their rigidity .

According to one of the fixed mindset characteristics, participants tend to easily give up. This propensity to give up was acknowledged by them as they are reluctant to augment EdTech that would give both perceived usefulness and ease of use. As the reluctance to change is being proved by (Ertmer, 2009) who presented second-order barriers to be intrinsic and encompass beliefs about teaching, attitudes toward computers, established classroom practices, and resistance to change.

From the literature we find that (Balanskat et al., 2006) describes that limited ICT knowledge among teachers causes anxiety about using technology in the classroom, resulting in a lack of confidence in incorporating it into their teaching.

In the literature, (Harris, 2000) observed that technology has the potential to significantly reshape 21st-century education. Educators must undergo a paradigm shift in their perception of technology's role and reconsider their beliefs regarding learning processes. (Harris, 2000) recognized that, *"The technological revolution has the capacity to redefine the educational experience itself, as the traditional barriers of time and place no longer constrain students."*

2.4.2 External Barriers faced by Teachers in augmenting EdTech

External barriers (first-order barriers) refer to those obstacles that are extrinsic to teachers. These barriers often involve *the lack of resources* (e.g., access internet, instructional software, and educational digital resources), *the lack of support* (e.g., availability of technical support and opportunities for professional development), and to *the lack of institutional strategies* e.g., administrator's priority, school's visions, and plans; (Kopcha, 2012).

2.4.2.1 Lack of Teachers' Motivation, Training, Time, and Infrastructure

As per literature about the motivation of teachers to embrace technology plays a crucial role in its integration into education. (Amin, Saeed, Lodhi, & Iqbal, 2013) examined the effects of training on employee performance and motivation within Pakistan's education sector, showing that effective teacher training enhances a stronger commitment to integration of technology. Pakistan's education sector requires the hiring and selection of qualified workers and the use of innovative technologies to assure the delivery of high-quality education. The International Society for Technology in Education (ISTE) developed a set of technology standards formulated to enhance teaching and learning across different subjects, promoting digital literacy and technological skills (Kereluik et al., 2016)

As per literature, (Wenglinsky, 1998) found that , fourth and eighth grade students whose teachers had received professional development in computers, achieved higher scores on the NAEP math test compared to students whose teachers had not undergone such training. In fourth grade, students whose teachers received technology-focused professional development scored approximately 0.09 of a grade higher (equivalent to five weeks) than students whose teachers did not receive such training. Similarly, eighth grade students taught by teachers who received professional development showed gains of approximately 0.42 of a grade (equivalent to 13 weeks) over students whose teachers did not receive such training.

According to(Lee, 2007), California teachers who regularly incorporated computer activities into their lessons had established classroom management strategies to ensure adequate student access to EdTech. These teachers often assigned tasks that required higher order thinking skills, viewing technology use as providing distinct learning opportunities. They invested more of their preparation time in utilizing technology and expressed greater comfort with its integration. In contrast, teachers who assigned computer activities less frequently tended to prioritize other classroom tasks over technology-based activities. Despite varying frequencies and complexities of computer assignments, most teachers identified limited time and equipment constraints as significant barriers to implementing such programs.

(Ertmer, 2010) argue that there should be effectively integrated technology for enhancing student learning, teachers need the expertise to select technologies that align with curriculum goals and cater to student needs. Moreover, they must be able to adopt and utilize appropriate technologies to tackle challenges in their professional development and instructional practices .

Chapter Summary

The literature review shows that EdTech can greatly improve student learning and teaching practices. Different theories and models help explain what affects the use of EdTech, and research

confirms that these tools are helpful in Mathematics and English. Recent studies focus that using EdTech in high schools can significantly increase learning for O-Level Mathematics and English. Tools like interactive simulations, adaptive learning platforms, and collaborative writing apps increase engagement and personalize learning. Strategies like blended learning and gamification boost motivation and understanding in Mathematics, while digital storytelling and intelligent tutoring systems enhance language skills in English. However, challenges such as ensuring sufficient accessibility, proper teacher training, and data privacy need to be addressed to fully realize these benefits.

CHAPTER 3

RESEARCH METHODOLOGY

This methodology section outlines the research design, data collection methods, and analytical techniques used to achieve the study's objectives.

3.1 Research Strategy

The Impact of Augmenting Educational Technology (EdTech) on Teaching and Student Learning Outcomes in O-Level Mathematics and English Subjects , focusing on both student performance and teaching strategies utilized by teachers , at Bahria College Islamabad. The combined focus will offer a deep understanding of how education technology affects both student achievement and teaching practices in secondary education. This study uses a mixed-methods approach, combining quantitative and qualitative methods to measure the effectiveness of EdTech tools and identify challenges teachers face in their use. Quantitative Component measures the impact of EdTech tools on student performance and teaching effectiveness using statistical methods. Here, assessment test scores in Mathematics and English using EdTech teaching and Traditional teaching method is measured to see the difference in student performance. Multiple linear regression run to analyze student scores taught through different methods. While qualitative Component **e**xplores teachers' experiences and challenges with EdTech through detailed feedback and observations. Here, semi-structured interviews were conducted with selected teachers to gather insight of their experience using EdTech. Interviews examined to identify common themes related to EdTech usage.

3.2 Quantitative Components

For the first research question, quantitative research has been done using **positivist approach** based on scientific evidence as collection of data and the figures is prerequisite to test and expand the theory based on Technology Acceptance Model (TAM). The use of a positive approach directly informs the methodology of this study. It necessitates the collection of objective data, such as test scores, survey

responses, and usage statistics of educational technology tools, hardware e.g., laptops and software programs Grammarly to measure student learning outcomes. The analysis is focused on identifying patterns and correlations, which will allow the research to draw conclusions based on evidence, rather than theoretical or normative assumptions. The outcomes will be framed as descriptive insights into how EdTech influences learning outcomes in O-level Mathematics and English, without presuming any value judgment on whether this influence is inherently positive or negative.

3.2.1 Research Design

This study uses a positivist approach, which prioritizes objectivity and relies on measurable data to answer the research questions (Goddard & Melville, 2011). The research design is structured to ensure that data collection, analysis, and interpretation are systematic and free from bias. The focus is on providing reliable, factual knowledge based on students' test scores, which will be used to assess the effectiveness of EdTech tools in improving student performance.

The study targets ninth-grade students from selected classes following same curriculum to ensure a representative and equitable sample. The data, consisting of test scores, will be analyzed using multiple linear regression to examine the relationship between EdTech usage and student performance, controlling for other factors that may influence outcomes. To maintain objectivity, the direct data collection was refrained, ensuring that personal opinions or biases did not influence the results. The analysis will provide factual insights into how EdTech tools impact student learning outcomes in Mathematics and English, without making normative judgments about whether the effects are desirable.

3.2.2 Population

The population comprises of students studying these two subjects, with a total of 91 students. The other factors include the students' age group (14 to 16 years old) of both genders (male and female) in the Cambridge section.

3.2.3 Sample Size and Sampling Technique

A **purposive sampling** technique was used to ensures that the sample consists of students who have been taught using both EdTech and traditional teaching methods. The study's sample comprises 91 students from each of four sections at ninth grade. Out of two boys' sections, one taught using technology and the other through traditional method for both selected subjects. Likewise, out of two girls' sections, one was taught using EdTech but the other taught in traditional method by the participant teachers mentioned in Table 4.6. This sample size is adequate for performing multiple linear regression analysis and allows for meaningful comparisons between the two groups. It is an ideal approach to small school size. At this O Level grade, number of subjects offered are 14 out of which a minimum 8 subjects are compulsory for each student as per directions of Inter Board Chairmen of Committee (IBCC) to issue Equivalency certificate for admissions to undergraduate universities in Pakistan. Out of 14 varied subjects, two core subjects Mathematics and English are selected as they are mandatory for all students and are the part of SAT-1,IELTS and GRE tests. The selected students seriously peruse for external board examinations.

3.2.4 Research Hypothesis:

1. **Teaching Method**

Null Hypothesis (H_0): no significant relationship between Teaching Method and Better Test Scores.

Alternative Hypothesis (H_1): Different Teaching Methods significantly influence Better Test Scores

2. **Teacher Experience**

Null Hypothesis (H_0): Teacher Experience does not significantly affect Better Test Scores.

Alternative Hypothesis (H_1): Teacher Experience has a significant indirect effect on Better Test Scores

3. **Class Size**

Null Hypothesis (H_0): Class Size does not significantly impact Better Test Scores.

Alternative Hypothesis (H_1): Class Size affects Better Test Scores

4. **Parent Income Level**

Null Hypothesis (H_0): Parent Income Level has no significant relationship with Better Test Scores.

Alternative Hypothesis (H_1): Parent Income Level Influences Better Test Scores

5. **Number of Siblings**

Null Hypothesis (H_0): Number of Siblings does not significantly affect Better Test Scores.

Alternative Hypothesis (H_1): Number of Siblings affects Better Test Scores

These hypotheses advocate that each independent variable (Teaching Method, Teacher Experience, Class Size, Parent Income Level, Number of Siblings) potentially impacts Better Test Scores through the pathway of perceived usefulness, ease of use, behavioral intention, and actual usage of educational technology.

3.2.5 Variables

The students' test scores for core subjects' mathematics and English are dependent variables while the Teaching Method, Teacher Experience ,Class Size **,** Parent Income Level and Number of Siblings are independent variables.

Table 3.1 Description of Both Dependent and Independent Variables

Variable Type	Variable Name	Definition	Measurement Method
Independent Variable	Teaching method	Taught either by traditional or using EdTech	1 is using EdTech and 0 is traditional method (dummy variable)
Independent variable	Teacher Experience	Number of years a teacher has been teaching	Measured by the total number of years the teacher has taught
Independent Variable	Class Size	The number of students in a class	Count of students enrolled in each class
Independent Variable	Parent Income Level	The financial status of the student's parents	Measured through Pak Rupees per month
Independent Variable	Number of Siblings	The number of siblings a student has	Count of siblings in the family
Dependent Variable	Test Scores	Academic performance in Mathematics and English	Measured by marks by each student out of 30 marks in respective subject

3.2.6 Tools for Data Collection

Student test scores were collected from the academic records of Bahria College Islamabad for the academic year 2023-24. Scores data was collected from ninth-grade students in the Cambridge section for Mathematics and English through assessment tests based on academic records to address validity and reliability concerns, while primary data on teachers' experience, class size, parent income, and number of siblings was also collected through a structured questionnaire.

3.2.7 Units of Data Collection (UDCs)

3.2.7.1 Student Test Scores (UDC-1)

Scores have been selected from Mathematics and English tests for ninth-grade students used to measure the effectiveness of EdTech methods vs. traditional methods.

3.2.7.2 Additional Variables (UDC-2)

Variables have been used including data on teaching method, teacher experience, student attendance, class size, parental income, and number of siblings to evaluate factors influencing test score differences. The data is collected from students' personal files and the class wise lists from class teachers.

3.2.8 Data Analysis

Multiple Linear Regression was used to analyze the test scores of students. It comprises of descriptive statistics (frequency of using the EdTech in teaching class ninth); correlation analysis (examining the relationship between EdTech use and the student test scores in Math's and English) and regression analysis (exploring the impact of EdTech use, teacher experience, class size , parent income and number of siblings). The model was estimated using statistical software(SPSS).

3.3 Empirical Evidence of EdTech

The study has shown that EdTech can certainly affect student learning outcomes in various subjects. For example, in our case it affects Mathematics and English test scores as follows:

Mathematics Learning:

A meta-analysis by (Cheung & Slavin , 2013) create that technology-enhanced instruction improved students' mathematics achievement. Their study proved that educational technologies like interactive simulations and online practice exercises were effective in enhancing students' mathematical skills.

3.3.1 Empirical Equation Form for Mathematics' Test Score Results

Based on the coefficients provided in the Math Model-2 findings, we can formulate the mathematical model for the dependent variable (Student Mathematics result) as follows:

Let:

Y_i denote the mathematics test result (dependent variable) for student i

$X1_i$ denote Education method for student i (independent variable)

$X2_i$ denote Math teacher experience for student i (independent variable)

$X3_i$ denote class size for student i (independent variable)

$X4_i$ denote No. of siblings for student i (independent variable)

$X5_i$ denote Parent income level for student i (independent variable)

The model can be written as :

$$Y_i = \beta0 + \beta1(X1_i) + \beta2(X2_i) + \beta3(X3_i) + \beta4(X4_i) + \beta5(X5_i) + \varepsilon_i$$

Math Test Result =intercept + β1(Education Method) +β2(Math Teacher Experience) + β3(class size) + β4 (No. of Siblings) + β5(Parent Income Level) + Error Term for student i

Where:

β0 is the constant (intercept)

β1, β2, β3, β4, β5 are the coefficients for each independent variable

X1 , X2 , X3 , X4 , X5 explanatory variables respectively

ε_i is the error term for student i

From the Math model 1 findings, the coefficients are:

β1= (education method)

β2= (Math teacher experience)

β3=(class size)

β4= (no. of siblings)

β5= (income level)

3.3.2 Empirical Equation Form for English's Score

Let

Y_i denote the English test result (dependent variable) for student i

$X1_i$ denote Education method for student i (independent variable)

$X2_i$ denote English teacher experience for student i (independent variable)

$X3_i$ denote class size for student i (independent variable)

$X4_i$ denote No. of siblings for student i (independent variable)

$X5_i$ denote Parent income level for student i (independent variable)

The model can be written as :

$$Y_i = \beta0 + \beta1(X1_i) + \beta2(X2_i) + \beta3(X3_i) + \beta4(X4_i) + \beta5(X5_i) + \varepsilon_i$$

English Score =intercept + β1(Education Method) +β2(English Teacher Experience) + β3(class size) + β4 (No. of Siblings) + β5(Parent Income Level) + Error Term

Where:

β0 is the constant (intercept)

β1, β2, β3, β4, β5 are the coefficients for each independent variable

X1 , X2 , X3 , X4 , X5 explanatory variables

ε_i is the error term for student i

From the English model 2 findings, the coefficients are:

β1= (education method)

β2= (english teacher experience)

β3=(class size)

β4= (no. of siblings)

β5= (income level)

3.4 Qualitative Components

Qualitative research has been done through **Interpretive approach** that is based on questioning and observation to discover a deep understanding of the phenomenon being investigated in relatively limited context.(Guba, 1990).This approach enables us to figure out hidden differences while interpreting the private school teachers' perceptions towards EdTech.

The qualitative aspect involves **thematic analysis** of semi-structured interviews conducted with high school teachers to identify the barriers they face in adopting EdTech. This approach seeks to uncover both internal and external challenges affecting the integration of technology in teaching practices.

3.4.1 Research Design

This study is built on social interaction with the participants teachers, so an interpretive approach is being used. Interviews were conducted to get knowledge and better understanding of education technology acceptance by the private high school teachers. In our case study approach, we have selected embedded design as it involves several individuals as to analyze how different teachers at schools might response and be engaged in using EdTech.(Ellinger et al, 2005).

3.4.2 Population

The number of Mathematics and English teachers in Cambridge Section is 6 and 5 respectively.

3.4.3 Sample Size and Sampling Technique

Purposive sampling was used to select teachers who have experience with both EdTech tools and traditional teaching methods. This technique ensures that the interviewees have relevant experience and can provide valuable insights into the challenges of EdTech integration.
Five teachers were chosen based on their experience and willingness to participate in the study. This sample size is sufficient for conducting thematic analysis and uncovering diverse perspectives.

3.4.4 Data Collection Tools

Semi-structured interviews are used in data collection process in qualitative approach as they enabled the study to get different types of information from targeted participants. Interviews are the most effective phenomenon of data collection for the qualitative research.(Marshall & Rossman, 1999).The important concern is to keep in mind the values , ethics, and perception of the teachers towards EdTech use in the private schools. The questions designed for the teachers revealed the experience of using EdTech . They were asked to share their feeling of using the EdTech and without EdTech teaching. They were encouraged to contribute their successes and failures related to EdTech .These interviews are based on specific themes and were conducted in a certain time limit. The method of this interview is in ‘ conversation’ form instead of ‘one-way dialogue’(Yin, 2009).

3.4.5 Units of Data Collection

3.4.5.1 Semi-structured Teacher Interviews (UDC-3)

The third UDCs includes Interviews with teachers using EdTech or traditional methods in their classrooms to explore challenges and barriers in EdTech adoption.

3.4.5.2 Thematic Analysis of Interview Data (UDC-4)

Different themes have been analyzed from interviews to identify internal and external barriers to EdTech augmentation by the teachers.

3.4.6 Data Analysis

Thematic Analysis was used to identify and analyze patterns or themes related to the barriers faced by teachers in integrating EdTech. The interviews were transcribed verbatim (the words were exactly captured as were spoken by the interviewee),data was assigned some identification),themes were developed (related to internal and external barriers faced by teachers during EdTech augmentation in classrooms).The thematic framework helped to analyse internal barriers (e.g., limited knowledge, skills) and external barriers (e.g., lack of training, technological infrastructure).

3.5 Integration of Findings (Triangulation)

Combine quantitative findings (e.g., correlations and regression results) with qualitative insights (e.g., thematic analysis) through TAM model to provide a comprehensive understanding of how EdTech integration and teaching strategies (PEOU) influence student scores(PU) in Mathematics and English .

3.6 Conceptual Framework

To create a theoretical framework for the Technology Acceptance Model (TAM) that shows the augmentation of EdTech in private high schools with better test scores as the dependent variable, teaching method, teacher experience, class size, parent income level, and number of siblings were incorporated as independent variables. There are two mediating variables : one is perceived usefulness (PU) and another is perceived ease of use (PEOU) of EdTech. The outcome variable comprises of behavioral intention to use EdTech (BI) and actual use of EdTech. This framework will illustrate how these factors influence the acceptance and use of EdTech, ultimately affecting student test scores.

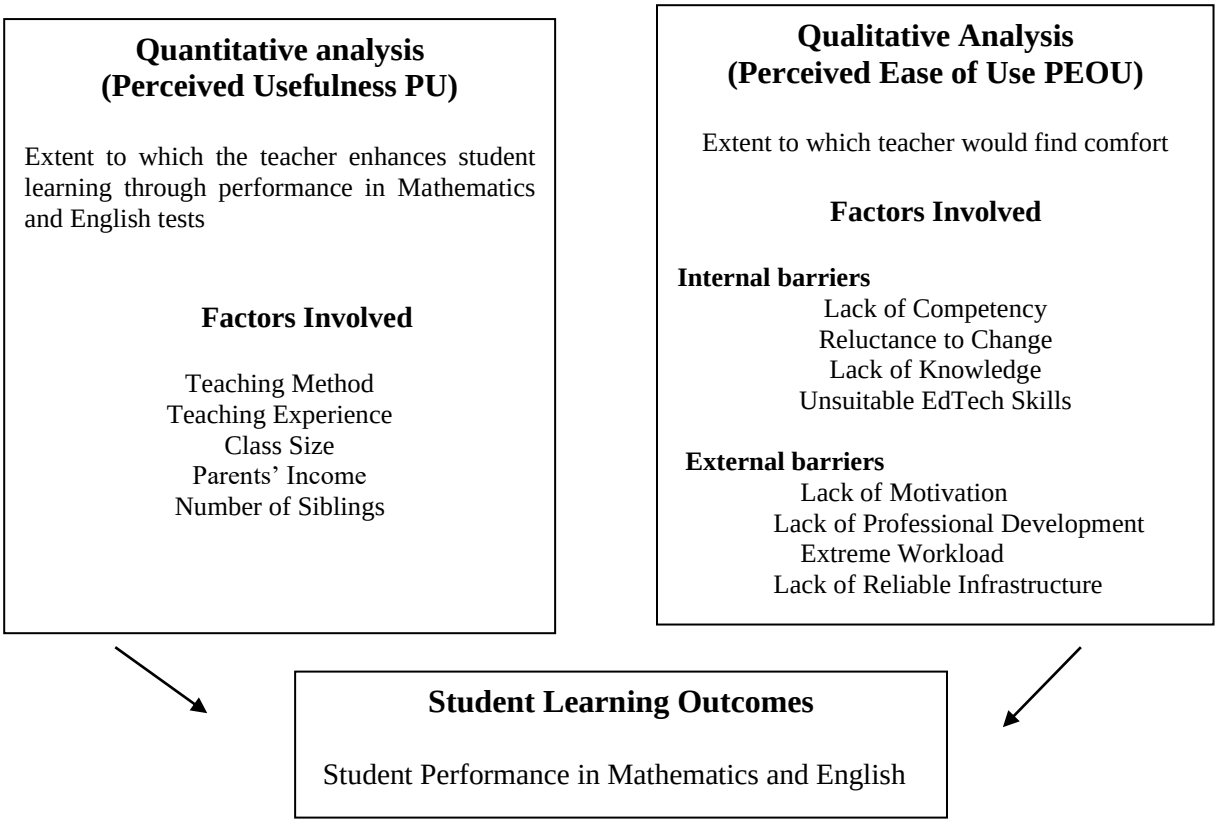


Fig 3.5 : *Conceptual Framework*

3.7 Informing Participants

While choosing the school to participate in study, school vice principal and the mentor was given a brief detail about the research objective and methodology .In order to save the time bound research, a short presentation was arranged for the faculty to explain the nature of the research. Participants were assured that data collected will be used for academic purpose and may be published in future journal.

3.8 Ethical Concerns

Research ethics have been kept in mind as they are important when an educational institute along with lots of teachers is involved. The PIDE Economics Department gives a clear guidance and limits the research work towards betterment of society and some realistic contribution in the welfare of the institution that one works for .This valued approach resulted to bring forward a relevant detail during the data collection process.

3.9 Respecting Participants' Privacy

This research promises to keep in mind , the confidentiality, respect, dignity and the rights of potential participants teachers and other staff members.(Council, 2019). Participants and the school are assigned Pseudonyms for conducting meaningful name during the thesis .For example, phrases had been used like participant teachers 1,2,3,4 ,5 and 6 to keep their privacy concerns.

3.10 Limitations of this Study

There is a time limit for the research so it could not be expanded beyond the assigned period .Therefore, the personal institute was selected to get accessible data as per course requirements and it stands among the well renowned schools of Islamabad .It consists of a comprehensive picture as it is a mixed culture towards the use of EdTech . However, a choice had been made that could paint a broader image of the existing scenarios . All this data is collected in a time limit and resources constraint and used a sample school which is diverse enough and manageable for the researcher .

It was a very challenging task to communicate with the teachers as it assured about their availability along with heavy workload and several tasks assigned as an Economics HOD, conducting classes, examinations, and lots of other job-related duties like Mod Duties. It was unfortunate to know that many teachers hesitate to use the technology-based lesson plans being more comfortable with their tradition teaching methods .In this research , all participants teachers were encouraged to express their own teaching methods. The results cannot represent the education system of the whole country but at least to understand a comparative situation for upgrading the whole education system starting from a local school in Islamabad.

3.11 SUMMARY

This chapter focuses on conducting controlled and not controlled experiments to evaluate the impact of EdTech incorporation in a private high school using mixed method approach. To assess the impact of EdTech augmentation on student test scores who were taught using technology in the class, we used quantitative approach of multiple regression and interpreted our data .Different variables such as teaching methods, teacher experience, class size, parent income level, and number of siblings are carefully considered to assess how they influence the outcomes of the student test scores in our research whether positively or negatively (Botha et al., 2005).To ensure the success of this research, careful planning was essential for both teachers and students involved in the study.

On the other hand, qualitative method used to analyze data collected through semi structured interviews related to teacher perception about EdTech was examined. It justifies teachers' attitudes towards technology, identifying the factors that either encourage or hinder their effective utilization of education technology. The aim was to help teachers overcome potential barriers and facilitate their transition to 21st-century teaching through purposeful integration of technology in their classrooms. The next step was to confirm the data reliability and the barriers face by teachers in augmenting the EdTech .The ethical concerns were kept in mind during the meaningful conduct of this research.

CHAPTER 4

DATA ANALYSIS

This chapter presents quantitative approach using multiple linear regression method and the qualitative approach is used by conducting semi-structured interviews of relevant teachers to interpret certain themes for further analysis.

4.1 Quantitative Analysis

It comprises of descriptive analysis (frequency of using the EdTech in teaching class ninth); correlation analysis (examining the relationship between EdTech use and the student test scores in Math's and English) and regression analysis (exploring the impact of EdTech use, teacher experience, class size , parent income and number of siblings).

4.1.1 Descriptive Analysis

The data has been gathered on 'Augmentation of EdTech in Private High Schools for better learning outcomes' with the focus on ninth grade students' better performance in test scores in Mathematics and English by using the EdTech method to report the regression results .Here, data is presented through regression tables:

Regression Table

In this research, multiple linear regression is used to simply discuss the most significant variables during the presentation while dropping some explanatory variables to improve the precision of the regression's fit to data.

Table 4.1 : Descriptive Statistics of Mathematics and English Test Scores

Descriptive Statistics					
Explanatory Variables	**Observations**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Education Method	91	0	1	0.4505495	0.5003052
Math Scores	91	0	30	21.68	6.674
English Scores	91	8	29	19.05	3.801
Math Teacher Experience	91	10	16	12.49	2.094
English Teacher Experience	91	10	15	12.15	2.314
Class Size	91	17	31	24.03	5.604
Family Size	91	3	8	4.78	1.008
Income Level	91	80000	500000	198736.3	83837.1
Father Education Level	91	14	22	15.52	1.311
Mother Education Level	91	14	18	15.21	1.070
No. of Siblings	91	0	5	1.82	1.028
Student Age	91	13	16	14.65	.656

This table offers a snap of the descriptive statistics for numerous variables related to student performance, teacher experience, class size, family background, and income levels in a private school setting. The data describes key characteristics and variations within the sample, which can be useful for further analysis of the impact of using EdTech in classes on student results. For instance, the moderate differences in scores and teacher experience, significant variation in parents' income levels, and relatively consistent education levels of both parents are important factors to consider when examining the efficacy of EdTech in enhancing educational outcomes.

This table mentions a detailed summary of various variables collected from a sample of 91 observations. These variables are essential in understanding the educational framework and the possible impact of educational technology (EdTech) on student performance in private secondary schools. Below is a detailed explanation of each variable.

4.1.1 Interpretation of Descriptive Statistics

The mathematics test results of ninth grade students (Male and Female) ranges from 0 to 30, with an average test score of 21.68. The standard deviation of 6.676 illustrate that there is a moderate variation in mathematics results among the ninth-grade students. The average mathematics score is comparatively high, and the standard deviation lays down significant variability in student test result. This suggests that while some students outclass, others may be struggling, stressing a potential area where EdTech could provide individual support to improve the student scores. English test scores vary between 8 and 29, with a mean score of 19.05. The standard deviation of 3.801 depicts that English test results are less variable compared to math test results. English results are slightly lower on average than math results, with little variability. It justifies those English results are more reliable across students, but there may still be needed to improve, mainly for students at the lower end of the band.

Mathematics teacher experience vary from min 10 to max 16 years, with an average of 12.49 years. The standard deviation of 2.094 shows a reasonable level of variation in teacher experience. The average mathematics teacher has significant experience, which probably adds up positively to student test performance. But the reasonable variability mentions that much experienced teachers might impact the usefulness of EdTech integration, contingent to teachers' association with education technology. English teacher experience ranges from 10 to 15 years, with a mean of 12.15 years. The standard deviation of 2.314 portrays approximate variation in experience between English teachers. Like mathematics teachers, English teachers also have great teaching experience. There is minutely higher standard deviation as

related to math teachers and it gives a great range of experience levels, that impacts the teachers' skill to integrate EdTech tools into their pedagogical technique.

Class sizes varies from 17 to 31 students, with an average class size of 24.03. The standard deviation of 5.604 means a significant variation in class sizes. The average class size is reasonable which shows that some classes are quite large (strength 31) as compared to others (Student strength 17). We can say that it reflects that larger class sizes can get more advantages from augmenting EdTech solutions as they give modified learning opportunities and can meet different types of student needs.

Family sizes varies from 3 to 8 family members, with an average size of 4.78 members. The standard deviation of 1.008 directs a moderate difference of these family sizes. The average family size is around 5 persons, with moderate variation. Bigger families may have less resources and time, that will surely impact students' performance to involve with EdTech tools outside the classrooms ,specifically at homes.

Parent income levels ranges from 80,000 to 500,000 units of our currency's Pak rupees, with an average income level of 198,736.26. The high standard deviation of 83,837.122 proves a wide difference in income levels among the students' families. The varied range and high standard deviation in parent income levels gives significant economic diversity among families. This would impact accessibility to EdTech resources at home, with lower-income families theoretically facing problems to use these EdTech tools successfully.

Fathers' education levels range from 14 to 22years, with a mean of 15.52 years. The standard deviation of 1.311 proves a relatively low variation in fathers' education levels. Fathers mostly with high level of academics correlated with a more stress on educational accomplishments and provision for EdTech usage at home. Mothers' education levels change from 14 to 18 years, with an average of 15.21 years. The standard deviation of 1.070 depicts a low variation in mothers' academic levels. Like fathers,

mothers also have a more level of education, contributing towards helpful in provision of EdTech tools at home and better performance of their children.

The number of siblings ranges from 0 to 5, with an average of 1.82 siblings. The standard deviation of 1.028 gives a moderate variation in the number of siblings. The average number of siblings is relatively low, suggesting that student may receive more intensive care at home, that could develop the use of EdTech tools for individual learning.

Student ages range from 13 to 16 years, with a mean age of 14.65 years. The standard deviation of 0.656 shows a relatively low difference in student ages. Students are naturally in their mid-teens, an age group that is generally tech-savvy and may be more receptive to EdTech based learning methodologies.

4.1.2 Correlation Analysis

The correlation analysis shows the relationships between EdTech use as a teaching tool and student test results in two core subjects: Mathematics and English. According to Pearson correlation coefficient = 0.68, there is a moderately positive correlation between the frequency of EdTech use and Math test results and Pearson correlation coefficient = 0.05 means there is also a moderate positive correlation between the frequency of EdTech use and English results.

These correlations depict the higher frequencies of EdTech augmentation in teaching that are linked to higher student test results in both Mathematics and English.

4.1.3 Regression Analysis

Table 4.2 Regression Analysis of Math Score with and without Control Variables

	(Without Control) Math Score	(With Control Variables) Math Score
Education Method	3.82*	0.843
	(2.82)	(0.6)
Class Size		-0.56**
		(-4.39)
Family Size		-0.215
		(-0.35)
Income Level		-5.15
		(-.69)
_cons	19.96*	36.813***
	(21.94)	(8.50)
N	91	91
adj. R^2	0.071	.237
F	7.95	7.99
df_	90	90

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < .01$

In the Mathematics score regression, Education Method has a significant positive effect, showing that certain educational approaches boost Math performance (Coefficient = 3.82, p = 0.006). However, when additional variables like Class Size and Family Size are included, only Class Size proves impactful, with a negative coefficient (-0.56, p = 0.0), indicating that larger class sizes may hinder Math achievement by reducing individualized attention.

Table 4.3: Regression Analysis of English Score with and without Control Variables

	(Without Control) English Score	(With Control Variables) English Score
Education Method	1.586*	2.671**
	(2.01)	(3.05)
Class Size		.228**
		(2.90)
Family Size		.319
		(.84)
Income Level		-6.04
		(-.1.31)
_cons	18.34	12.038
	(34.69)	(4.50)
N	91	91
adj. R^2	.032	.104
F	4.06	3.61
df_	90	90

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < .01$

In contrast, the English score regression shows a smaller but still significant effect of Education Method (Coefficient = 1.586, p = 0.047), signifying a general positive impact of the method on English performance. Unlike Math, Class Size has a positive effect on English scores (Coefficient = 0.228, p = 0.005), possibly because larger classes foster diverse linguistic exchanges that benefit English learning. Family Size and Income Level remain insignificant in both regressions, indicating limited influence on scores for either of these subjects.

4.2 Qualitative analysis

To conduct a detailed qualitative analysis of the main barriers faced by private school teachers in adopting EdTech tools, we can categorize the barriers into major themes and sub-themes. This thematic framework helps organize and analyze the data effectively.

4.2.1 Thematic Analysis

The research holds a descriptive approach, gathering information within a controlled environment of a private high school where no adjustments were introduced to influence participant teachers' responses.(Maree, 2016) explains descriptive case studies as those which describe interventions or process within their authentic contexts. This method was carefully chosen to signify how various subject teachers'(Mathematics and English) respond toward education technology acceptance where classroom EdTech use varies remarkably, even under same environmental conditions. As participant teachers depicting the conditions of this research were already present so convenience sampling was implemented. This method was advantageous because it gave a convenient contact to participants who were already acquainted with the subjects (Mathematics and English) under study.

Five teachers including one section head from the Cambridge Section of the school participated voluntarily in this study. These participant teachers were selected to represent other teaching members as well taking several subjects, though they constitute a small sample out of population . One section has been selected to review and analyses the Cambridge section administration. Four teachers were female and had tenure at the school ranging from 10 to 16 years and the male teacher with 15 years. Their ages varied significantly: two were in their thirties, one in her forties, one in her mid-fifties and the male in his fifties. They perform their teaching , including many other duties being assigned to them. Almost every teacher had access to a personal laptop and internet connection at the school, for tasks such as lesson planning, tests, assessment, and exams preparation, including research for teaching lessons.

The themes derived from the interview data revealed pertinent and occasionally concerning concepts. However, it is crucial to note that the interview questions were directly aligned with the research investigations before discussing the specifics of the interview data.

4.2.1.1 How is technology being used in participant school?

Based on the interview data, it became obvious that participants were involved in two categories of technology use i.e. For their personal use (PEOU) and for their teaching purpose (PU).

4.3 Barriers impacting participants' Perception on EdTech Augmentation

During the interviews, participants discussed many factors that impact their attitude toward education technology augmentation. This section broadly defines each factor mentioned by participants in their interviews. Some factors were explicitly mentioned while others were inferred by the researcher from participants' responses during these interviews. These factors are divided into two groups: Internal and External barriers. Internal barriers include participants' own perceptions, belief systems, attitudes, and behaviors. External barriers affect participants from outside environment like lack of technology access, financial constraints, time etc. The list of teachers being selected is given in the table 4.1 along with certain details about them .Their names have been changed to protect their secrecy .The pseudonyms have no pattern to be followed while naming them.

Table 4.4 Profile of the Participants High School Teachers

Code	Designation	Pseudonym	Age	Experience in Years	Interview Date
Cambridge Section					
T1	Mathematics (TM)	Participant 1	35	10	06-04-24
T2	Mathematics (EDM)	Participant 2	45	13	08-04-24
T3	English (TM)	Participant 3	47	16	11-04-24
T4	English (EDM)	Participant 4	50	12	12-04-24
T5	Mathematics(EDM)	Participant 5	40	15	08-04-24
H1	Administration	Participant 6	48	13	06-05-24

Interpretation of the Data on Participant Teachers

The table gives facts of participant teachers from the Cambridge Section, comprising their tasks, ages, years of experience, and interview dates. There are three Mathematics teachers and two English teachers, with ages ranging from 35 to 50 years and experience between 10 to 16 years. Moreover, one administrative participant, aged 48 with 13 years of experience, was also interviewed. Interviews were conducted from early April to early May 2024, while Mathematics and English teachers interviewed over a week, and the administrative participant interviewed a month later.

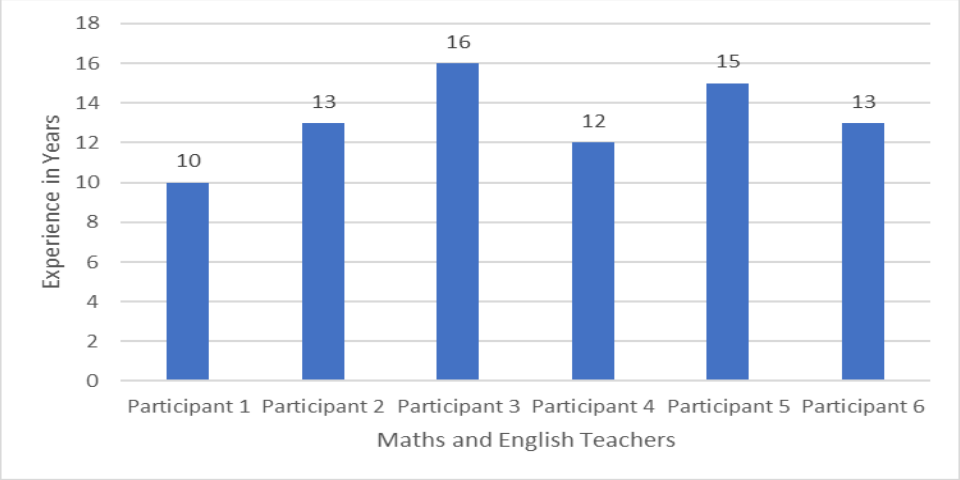


Fig 4.1: *Experience of Maths and English Teacher in Years*

4.3.1 Internal Barriers

4.3.1.1 Lack of Competency

One of the respondents, Participants 1 (TM) ,teaching Mathematics specified as *" I cannot present the concepts of the subject as if I fail to do it in front of my students, they might lose their confidence in me despite of the strong command on my subject matter."* According to another respondent, *" Agar students satisfied hein tou kya zarorat hei key khud ko mushkil mein dalein"* Participant 3 is of the view that *" although I tried to seek support from IT teacher assigned to help, but I feel myself very weak*

asking her again and again the same concepts related to EdTech use in computer lab and in the class. "As per participant 5,he says "we are providing EdTech tools gradually in our senior classes but there is a frequent innovation in using this software .If teachers do not cope with the pace, then they might not be able to cover their syllabus in time."

This means Participant 1 reflects a feeling of losing self-esteem just due to fear of failure and nothing else. She scares to take a start that could give her long lasting reputation among her students and much unexplored convenience especially for those topics that needed to be performed by using EdTech tools incorporation especially in Mathematics. She further says that if she fails in classroom activity in front of students, she might lose control over her students and become a school gossip. Participant 3 seems to grow professionally in her use of EdTech classroom environment, but she is afraid of her professional outstanding in front of colleagues. Once discussed with the IT participant, this problem was also mentioned by her that we are ready to help them but either they lack interest or refuse to work on technical side like use of excel sheets, spreadsheet software etc. Participant 5 says "we train our teachers to use different software to integrate them into their lessons but there is gradual updating in the programs like MS Office with new features and we find it difficult to reschedule frequent training sessions for our teachers and students. Every time things become obsolete resulting in loss of time, finances, and energy.

According to (Pelgrum, 2001) who categorizes the obstacles into two types: material and non-material. Material cases are the availability of a smaller number of EdTech tools and software non-material problems encompass teachers' lacking the EdTech knowledge and skills, the challenges of integrating ICT into instruction, and limited teacher .

4.3.1.2 Reluctance to change

One of the respondents during in-depth interview particularly, participant 6, the section head of Cambridge school specifies with various traits like teachers who give up easily and feel burden when

asked to use EdTech in their classrooms. "*She says' the idea of augmenting is fruitless until staff intends to avoid challenges and remain in comfort zone".* She encounters her observation that new teachers want changes in the existing environment to bring innovations, but senior staff feels more comfort in following the traditional teaching methodologies. Participant 3,the English teacher, presents an example of reluctance to change as she has a long experience of teaching linguistics, so "she states that *even many language teachers do not know that how to teach the language. It is not just teaching but constructing the language . It needs to be taught without partiality* ." It shows that she avoids the constructive criticism to her professional practice. She thinks use of EdTech to teach English language is a time-consuming process. Participant 1, the mathematics teacher, replies that use of EdTech is not suitable because as per "her statement, *I have a long experience of teaching these concepts and they are at my fingertips .I feel it worthless to invest more time just on transmitted my physical data on to my laptop. Moreover, I have additional duties so prefer my notes to use in the class."* While Participant 5,Mathematics HOD, believes in online resources and designed programs for teaching Mathematics concepts but as there are frequent load shedding and internet connectivity issues, many teachers are discouraged to integrate the build in tools for teaching Mathematics. He adds " *I am a certified examiner of the Cambridge university on behalf of Bahria College Islamabad, and they are interested to make our institution ,the registered center for conducting CIE exams and other tests like IELTS but our institution refuses to share the school data due to location of safe zone with the Cambridge Centre."*

This shows that head does not want any confrontation from her staff as they are producing excellent result of examination classes . She ,in fact, do not want these teachers to adverse situation until planned implementation as most of these senior teachers have the links in the market so she simple worth the comfort of the senior staff members at our school .She is directed to keep these teachers in line as per directions of the headquarters. Participant 3 , want to refer to library books, her notes, and other materials instead of using EdTech in her class. Participant 1, ,demonstrates that her educational qualification is

enough, and it assures the success of the mathematics students in their exams. She believes that EdTech tools should be on teacher choice as she is playing her role efficiently.

According to one of the fixed mindset characteristics, participants tend to easily give up. This propensity to give up was acknowledged by them as they are reluctant to augment EdTech that would give both perceived usefulness and ease of use. As the reluctance to change is being proved by (Ertmer, 2009) who presented second-order barriers to be intrinsic and encompass beliefs about teaching, attitudes toward computers, established classroom practices, and resistance to change.

4.3.1.3 Lack of Knowledge

As per one respondent, participant 6 suggests *"the only solution to upgrade our teachers lies in the practice of staying ahead of technological innovations."* She believes that it demands hands on experiences rather than traditional teaching methodologies. Participant 5 claims that *"implementing Edtech is not a one- or two-days task, instead it requires a proper plan where we need to a high level of pedagogical training including content knowledge through technological application."* Participant 4 says that *"instead of using lengthy books and other printing materials, we should shift the content to newer technology versions to replace the outdated content."*

This shows that the need is for a sustainable solution to augment EdTech into teaching practice. Bookish knowledge is now becoming obsolete and latest techniques are being introduced to update the learning methods.

From the literature we find that (Balanskat et al., 2006) describes that limited ICT knowledge among teachers causes anxiety about using technology in the classroom, resulting in a lack of confidence in incorporating it into their teaching.

4.3.1.4 Unsuitable EdTech Skills

One of the respondent participant 4 expresses that *"I found the using of EdTech to be tedious process until we get full command on it."* She believes and adds that " *developing the 21st century skills in student learning process are not a short-term practice. Initially this practice might lead to disappointment and frustration among the teachers and the learners but consistency in this regard will lead to success."* Participant 6 recalls *" when I started using EdTech to English classes in the lab ,students' reaction was shocking as they were unfamiliar with the methodology as I have introduced it for the first time as an English teacher. I also faced lots of criticism from my colleagues, and the administration. Despite the use of EdTech ,students could not get satisfactory scores in class test in the language. Then, I identified that English being a language has different demands .It needs blended teaching methodology as certain areas needs practice on hands like thinking and imagination .EdTech would work on listening and reading skills."* Participant 2 states that *"I cannot get instant test results in my students but might be this incorporation of technology would lead to life-time learning."*

It reveals that to grasp new century skills, much consistency, patience, and devotion required to use EdTech being imperative and should be adopted strategically .

In the literature, (Harris, 2000) observed that technology has the potential to significantly reshape 21st-century education. Educators must undergo a paradigm shift in their perception of technology's role and reconsider their beliefs regarding learning processes. (Harris , 2000) recognized that, *"The technological revolution has the capacity to redefine the educational experience itself, as the traditional barriers of time and place no longer constrain students."*

Table 4.5 Frequency of Internal barriers faced by Participants

Internal Barrier	Frequency
Lack of Competency	3
Reluctance to Change	4
Lack of Knowledge	3
Unsuitable EdTech Skills	3

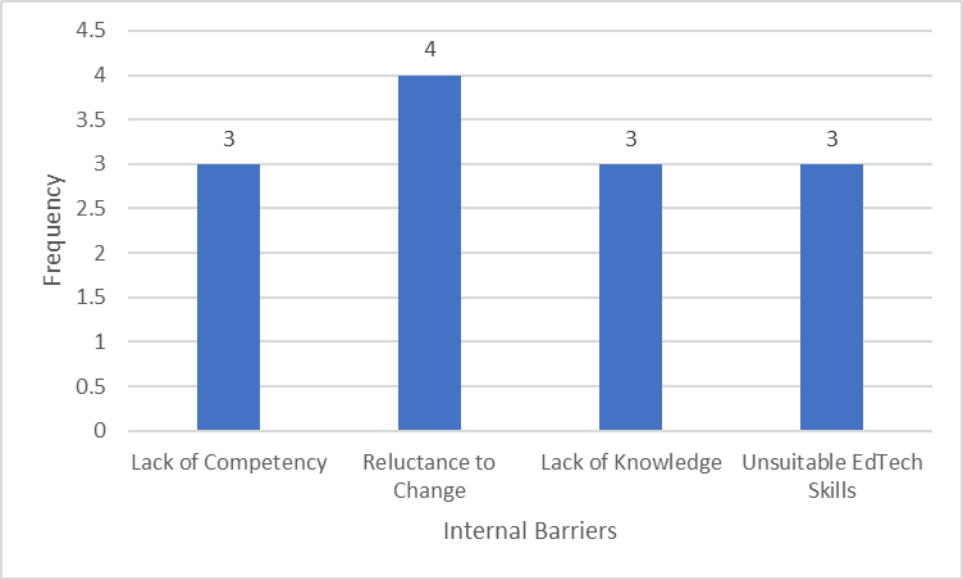


Fig 4.2 : *Frequency of Internal Barriers faced by Participants*

The bar chart depicts that Reluctance to Change is the frequent barrier faced by participants, happening 4 times, showing an extreme resistance to augmenting new technologies into teaching methods. Lack of Competency**,** Lack of Knowledge, and Unsuitable EdTech Skills seem 3 times, confirming significant problem in these areas. Lack of Competency gives concerns about teachers' will and flexibility with technology. Lack of Knowledge reminds for better training and understanding of EdTech tools. Unsuitable EdTech Skills present hardship in efficiently using and augmenting EdTech tools. In short, while reluctance to change is the major barrier, enhancing competency, knowledge, and technical skills is also critical for improving EdTech use in classrooms.

4.3.2 External Barriers

4.3.2.1 Lack of Motivation

As per respondent participant 5, *"I have no doubt in saying that our teachers know less as compared to what is prevailing in the market. They are lagging behind in EdTech augmentation except for few skills like paper making or giving some presentations to the students .In fact , there are so many designed programs in Mathematics that with just a little effort, they will get the ease for life."* Respondent

6 mentions that *"we have a quick plan to develop the Language labs to assist the English student to remain focused without any distortion from the surroundings."*

All this depicts that augmenting the EdTech to teaching practices requires the guidance from the experienced mentors who will encourage the existing and the new teachers to incorporate technology to their daily practice. Creativity and the innovation only come through the proper guidance.

As per literature about the motivation of teachers to embrace technology plays a crucial role in its integration into education.(Amin, Saeed, Lodhi, & Iqbal, 2013) examined the effects of training on employee performance and motivation within Pakistan's education sector, emphasizing that effective teacher training fosters a stronger commitment to inclusive teaching practices and the integration of technology. Addressing the challenges in Pakistan's education sector requires the recruitment of qualified personnel and the implementation of innovative technologies to ensure the delivery of high-quality education. The International Society for Technology in Education (ISTE) developed a set of technology standards designed to enhance teaching and learning across various subjects, promoting digital literacy and technological proficiency (Kereluik et al., 2016)

4.3.2.2 Lack of Professional Development

As per response of participant 2, she describes *"I have a broad exposure of training and development sessions from previous organizations. Therefore, I feel the basic content used in our training sessions here is irrelevant and needs to be modified .We should be given opportunity of recent trainings from around the globe to encompass us with latest EdTech updates in our relevant subjects."* Participant 3 is categorized as beginner in relation to technology as when she was asked about taking EdTech training she simply replied, *" I need to take the basic training session to learn from the basic ideas about EdTech successful incorporation."*

This proves that participants want more professional development as the existing sessions is irrelevant and ineffective. The participants articulated their frustration and dissatisfaction when asked about their experience .They expressed their opinion about training to be conducted in a practical manner so they could enhance their EdTech skills for both perceived usefulness as well as their own ease of use.

As per literature, (Wenglinsky, 1998) found that , fourth and eighth grade students whose teachers had received professional development in computers, achieved higher scores on the NAEP math test compared to students whose teachers had not undergone such training. In fourth grade, students whose teachers received technology-focused professional development scored approximately 0.09 higher (equivalent to five weeks) than students whose teachers did not receive such training. Similarly, eighth grade students taught by teachers who received professional development showed gains of approximately 0.42 of a level (equivalent to 13 weeks) over students whose teachers did not receive such training.

4.3.2.3 Extreme Workload

One of the respondents, participant 1 is of the view that *"when should I learn about EdTech when I lack time during school hours?"* Another participant 5 says that *" I am managing all my possible lessons per week in teaching, taking substitutions, workshop arrangement and other administrative tasks."* Participant 3 is also overburdened being involved in arrangement of different events, stage decors, break time duties, uniform checking, and late stays .She says that *" I have to prepare the students for debating contests and other inter department competitions, so it is hard to use EdTech effectively until I prepare my lesson plans for EdTech classes."*

It shows that when these participants are left with less available time due to co-curricular and non-co-curricular activities, then any question raised about their pedagogical innovations points towards the lack of free time during the school hours .It also becomes difficult for many teachers to use their own

time as teachers have responsibility towards their families and evening jobs too, to meet the inflationary pressures.

According to (Lee, 2007), California teachers who regularly incorporated computer activities into their lessons had established classroom management strategies to ensure adequate student access to EdTech. These teachers often assigned tasks that required higher order thinking skills, viewing technology use as providing distinct learning opportunities. They invested more of their preparation time in utilizing technology and expressed greater comfort with its integration. In contrast, teachers who assigned computer activities less frequently tended to prioritize other classroom tasks over technology-based activities. Despite varying frequencies and complexities of computer assignments, most teachers identified limited time and equipment constraints as significant barriers to implementing such programs.

4.3.2.4 Lack of Reliable Infrastructure

As per response of participant 3 ,she adds that *"I found limited access to available EdTech support, so it is difficult for me to use it effectively in the class for better learning of the students."* Participant 4 concludes *"I am unable to use EdTech at the pace ,I like to just because of outdated software and hardware used in some classes ."* Participant 5 encourages the removal of EdTech glitch that might happen during the lesson. He adds *"I Think teachers are reluctant to use the EdTech due to occurrence of technical glitch otherwise they will be entertained and more peaceful after one time effort."*

This reveals that participants have a positive perception towards using the EdTech in these private schools but only these difficulties outweigh their use of EdTech.

(Cennamo, Ross, & Ertmer, 2010) argue that there should be effectively integrated technology for enhancing student learning, teachers need the expertise to select technologies that align with curriculum goals and cater to student needs. Moreover, they must be able to adopt and utilize appropriate technologies to tackle challenges in their professional development and instructional practices .

Table 4.6 Frequency of External Barriers faced by Participants

External Barriers	Frequency
Lack of Motivation	2
Lack of Professional Development	2
Extreme Workload	3
Lack of Reliable Infrastructure	3

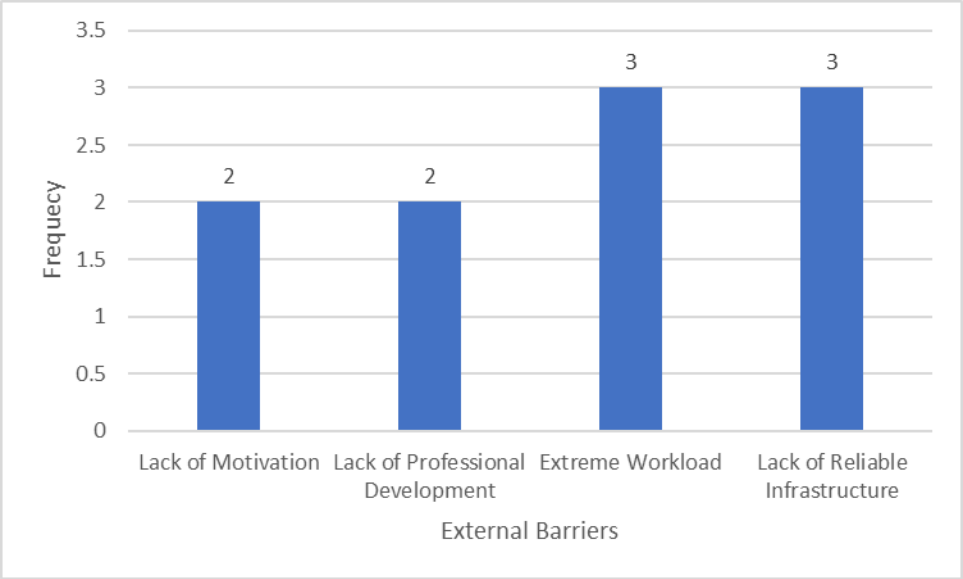


Fig4.3 *Frequency of External barriers faced by participants*

The bar chart specifies that Extreme Workload and Lack of Reliable Infrastructure are the maximum frequent stated external barriers, with a frequency of 3. It submits that participants are mainly confronted by the irresistible sum of workload and insufficient infrastructure, which deters their skill to successfully use EdTech in the classrooms. Lack of Motivation and Lack of Professional Development too are substantial problems, each happening twice, mentions the problems with scarce training and low interest for adapting latest education technologies. In short, handling these issues, particularly the workload and infrastructure matters, is central for encouraging the augmentation of EdTech in high school setup.

4.4 Interpretation of Thematic Analysis

When examined through the TAM model, the thematic analysis of the study reveals that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are essential elements affecting teachers' acceptance and use of EdTech. Internal obstacles, including a lack of competency, reluctance to embrace change, insufficient knowledge, and inadequate EdTech skills, contribute to perceptions that technology is less useful and harder to use. External challenges such as insufficient motivation, ineffective professional development, excessive workloads, and unreliable infrastructure further aggravate these issues.

In case of this study, the most important internal barrier is the 'reluctance to change' as it comprises of two internal beliefs of a teacher that represent emotion-driven aspects making it a great challenge to augment the EdTech in classrooms. One is 'ability belief' and the other is 'value belief'. 'Ability belief' refers to teacher's belief in their ability to effectively handle the task of using EdTech for better students' learning, so it justifies perceived ease of use(PEOU) of TAM. On the other hand, 'value belief 'refers to teachers' belief that they can meet the needs of students for better learning so it represents perceived usefulness (PU).Similarly, external barriers also impact the teachers' perception in several ways but as per this research, it is proved that a less work-load and reliable infrastructure can impact teachers' competencies more including ability and value beliefs to use EdTech in their classrooms (Bowman et al., 2020).

Summary

This chapter combines both quantitative and qualitative approaches to comprehensively analyze the multifaceted factors influencing the augmentation of EdTech in private school settings. This analysis was done to assess the impact of using EdTech by the teachers on the results of nine class students for Mathematics and English. It provides valuable insights into challenges and opportunities for improving educational outcomes through effective use of technology. On one side, this chapter investigates into

quantitative methods to assess the impact of EdTech in private schools. This process includes three types of data analysis: descriptive analysis examines the quantitative data to describe the current state of EdTech augmentation with summarizing key descriptive statistics and the trends of observed data. The correlation analysis investigates the relationship between Dependent variables(Student test scores of Mathematics and English) and independent variables(Teaching methodology, teacher experience, class size, tuition/academy ,number of siblings and the parent income level .Finally, the regression analysis is done to interpret the Mathematics and English test score findings to draw conclusion.

On the other side, the qualitative analysis employs different methods to explore deeper view of EdTech augmentation in private high schools by the teachers and the barriers faced by them in its acceptance. The analysis and interpretation done through one-site case study which means different teachers working in a single environment . The interpretation identifies the themes and patterns in how much EdTech is utilized effectively within the private schools. It further inculcates various internal and external factors that are the obstacles faced by the teachers in the effective implementation of EdTech at schools. The internal factors identified include lack of competency ,reluctance to change, lack of knowledge and inappropriate EdTech skills while the external factors include lack of motivation ,lack of training, extreme workload, and lack of reliable infrastructure and resources.

CHAPTER 5

Findings and Discussion

5.1 Impact of EdTech on Student Learning Outcomes

5.1.1 Impact of EdTech on Mathematics Learning

The study indicates that the use of Educational Technology (EdTech) at Bahria College in Islamabad has had a positive impact on student learning outcomes in Mathematics. Specifically, tools such as interactive simulations and adaptive learning platforms played a key role in improving student performance in O-Level Mathematics. Students who engaged with these EdTech tools demonstrated enhanced problem-solving abilities and achieved higher test scores compared to those who relied solely on traditional teaching methods. Notably, tools like Dr Austin Maths , GeoGebra and Desmos were particularly effective, as they provided collaborative forums and immediate feedback, which helped students grasp and apply mathematical concepts more efficiently. Regression analysis further supports these findings, showing that the educational method used (which includes EdTech) had a significant positive effect on Mathematics performance (Coefficient = 3.82, $p = 0.006$). However, when considering other variables like class size and family size, the data reveals that larger class sizes negatively impacted Math achievement (Coefficient = -0.56, $p = 0.0$), likely due to reduced opportunities for individualized attention.

5.1.2 Impact of EdTech on English Learning

In the English subject, the use of EdTech tools such as digital storytelling apps and intelligent tutoring systems also yielded positive outcomes. Platforms like Storybird and Grammarly facilitated collaborative and personalized learning experiences, which helped improve students' writing skills and test scores. The data analysis showed that students using these tools performed better on average in

English, as the tools offered immediate feedback and made learning more engaging. These benefits were reflected in the regression analysis, which showed a significant but smaller positive effect of EdTech on English performance (Coefficient = 1.586, p = 0.047). Additionally, unlike in Mathematics, class size was found to have a positive effect on English test scores (Coefficient = 0.228, p = 0.005), suggesting that larger class sizes might promote more diverse linguistic interactions that benefit language learning. Both family size and income level were found to have no significant impact on English scores, underscoring that EdTech tools played a more prominent role in improving English learning outcomes.

5.1.3 Impact of Additional Variables on Student Test Results

The analysis also considered several additional variables, such as teacher experience, class attendance, class size, and parental income level, to better understand their influence on student performance. While these factors did have some effect, the results clearly indicate that the use of EdTech was the most significant contributor to improved test scores. In particular, the analysis found that class size negatively impacted Mathematics performance, likely due to the reduced ability for teachers to provide individualized support in larger classes. On the other hand, class size had a positive effect on English scores, possibly due to the greater opportunities for peer interactions and linguistic exchanges in larger groups. Family size and parental income level did not show any significant influence on test scores for either subject, emphasizing that the primary driver of improved learning outcomes was the integration of EdTech tools within the educational approach.

5.2 Teacher Perspectives and Challenges in Augmenting EdTech

5.2.1 Teacher Training and Support:

The applicability of EdTech at the college needs proper teacher training and support regarding tools. The subject teachers have realized the importance of EdTech vast scale implementation needs gradual time and encouragement. The need is to train them to augment the tools with great efficiency.

Current technical provision and professional development were also important for making EdTech incorporation in the classroom.

5.2.2 Implementation Barriers:

The research showed different barriers to use EdTech efficiently. These included partial contact to technology in some senior classes of the school, some teachers being reluctant to new change, and a need for additional resources to continue and update education technology. Teachers sensed that EdTech should boost rather than substitute traditional teaching methods. It was decided that merging both technological and traditional methodologies is compulsory for the top educational results.

5.2.2.1 Internal Barriers:

Teachers reported challenges related to insufficient competency, limited knowledge, and reluctance to change**.** Many teachers lacked adequate training in new technologies and felt unprepared to incorporate EdTech tools into their teaching methods. There was also a notable reluctance to shift from traditional teaching methods to new technological approaches.

5.2.2.2 External Barriers:

Teachers faced external barriers like inadequate motivation, scarce training, substantial workloads, and short technological infrastructure**.** Teachers confronted motivational problems due to the deficiency of administrative recognition and encouragement for their hard work to fit in technology. Moreover, there were gaps in EdTech training programs, and many teachers face heavy workloads and partial access to more technological resources.

5.3 Student Engagement and Motivation

5.3.1 Student Engagement Through Technology:

EdTech tools have precisely enhanced student involvement in both Mathematics and English. Collaborative and game-based learning platforms made learning further entertaining and encouraging. For example, game-based Math tools created an interesting, good environment that stimulated more practice. Likewise, digital storytelling and interactive grammar tools in English presented appealing ways to expand language skills.

5.4 Motivation and Performance:

The analysis developed a connection between increased student dedication and better academic performance through best scores. Students sensed more interested and took part more actively in class while using EdTech tools. This lift in inspiration led to higher test scores and a better command on the subject content.

CHAPTER 6

Conclusion, Policy Recommendation and Limitation of the Study

6.1 Conclusion

This thesis, titled *"EdTech Augmentation for Better Learning Outcomes: A Case Study of Private Schools in Islamabad"*, investigates the impact of educational technology (EdTech) on teaching and learning outcomes particularly in Bahria College Islamabad for O-Level Mathematics and English. The research clearly demonstrates that the integration of EdTech tools by teachers in the classroom has a significant positive effect on student performance in both the subjects.

In Mathematics, the use of tools such as Dr Austin Maths, GeoGebra and Desmos enabled students to better understand mathematical concepts and improve their problem-solving abilities. This resulted in measurable improvements in test scores. Similarly, in English, platforms like Storybird and Grammarly provided personalized and engaging learning experiences, leading to enhanced writing skills and better academic performance.

Despite these positive outcomes, the study also recognized several barriers in the effective integration of EdTech. Teachers reported a lack of proper guidance and training on technology, which hindered the full potential of EdTech tools. Additional barriers included limited access to technology, resistance to change, and insufficient resources for maintaining these tools. Nevertheless, the findings suggest that when implemented thoughtfully and with adequate support, EdTech can considerably enhance student learning and engagement.

6.2 Policy Recommendations

Based on the findings, the following policy recommendations are proposed to support the continued and effective use of EdTech in education:

1. **Investment in Teacher Training:** The school should provide ongoing professional development for teachers, equipping them with both the technical skills and pedagogical strategies needed to effectively integrate EdTech into their teaching practices.
2. **Boost Technology Infrastructure:** The schools must invest in upgrading their technology infrastructure, ensuring that every classroom is equipped with the necessary devices and reliable internet connectivity to support EdTech tools.
3. **Encourage a Balanced Teaching Environment:** EdTech should complement traditional teaching methods, not replace them. A blended learning approach, which combines both digital and face-to-face instruction, is essential for maximizing student learning outcomes.
4. **Provide Continuing Technical Support:** The schools should establish in-house technical support teams, including IT staff, to resolve any technical issues promptly and minimize disruptions to the learning process.
5. **Encourage EdTech Adoption:** The school should actively promote the benefits of EdTech to all stakeholders including teachers, students, and parents helping to overcome resistance to new technologies and fostering a culture of innovation.
6. **Monitor and Evaluate EdTech Effectiveness:** The school should regularly assess the impact of EdTech tools on student learning outcomes, using data to refine teaching strategies and ensure that the tools are being used effectively.

6.3 Limitations of the Study

While this study provides valuable insights into the use of EdTech in the classroom at our institute, several limitations should be considered:

1. **Sample Size and Generalizability:** The research was conducted in a single institution, meaning the findings may not be directly applicable to other schools in different regions or educational contexts.

2. **Short-Term Focus:** The study primarily focuses on the short-term effects of EdTech on student learning. Further research is needed to explore the long-term impact of these tools on student performance and knowledge retention.
3. **Potential Bias in Data Collection:** The data collection process, particularly through interviews, may have introduced biases that could affect the reliability of the conclusions. Future studies could benefit from a more diverse range of data collection methods.
4. **Limited Scope of EdTech Tools:** This research focused on specific EdTech tools, such as Dr Austin Maths , GeoGebra, Desmos, Storybird, and Grammarly. The findings may not fully represent the effectiveness of other EdTech tools not included in the study.
5. **External Factors:** The study did not account for external factors, such as family circumstances or socioeconomic status, which could also influence student performance and learning outcomes. These factors should be considered in future research.

In conclusion, this study highlights the potential of EdTech to boost teaching and learning outcomes, particularly in Mathematics and English. However, it also underscores the challenges that must be addressed to ensure that these technologies can be used to their best potential. By investing in teacher training, improving infrastructure, and fostering a supportive atmosphere for EdTech integration, schools can better prepare students for success in an increasingly digital world.

References

Baloch, I., & Taddese, A. (2020). *EdTech in Pakistan: A Rapid Scan* (No. 10). EdTech Hub.

Batool, B., Gardezi, Z., & Policy, M. P. (2020). Differences in Pedagogical Approaches Across Public and Private Schools in Pakistan: Implications for Single National Curriculum. *Pakistan Institutes of Development Economics Islamabad*.

Becker, H. J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *The future of children*, 44-75.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, science, and technology education*, *5*(3), 235-245.

Blazer, C. (2008). Literature Review: Educational Technology. *Research Services, Miami-Dade County Public Schools*.

Costello, R. (2018). Evaluating E-Learning from an End User Perspective. In *Student Engagement and Participation: Concepts, Methodologies, Tools, and Applications* (pp. 818-844). IGI Global.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society*, *13*(4), 63-73.

Chang, I. H., Chin, J. M., & Hsu, C. M. (2008). Teachers' perceptions of the dimensions and implementation of technology leadership of principals in Taiwanese elementary schools. *Journal of Educational Technology & Society*, *11*(4), 229-245.

Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational research review*, *9*, 88-113.

Chugh, R., Turnbull, D., Cowling, M. A., Vanderburg, R., & Vanderburg, M. A. (2023). Implementing educational technology in Higher Education Institutions: A review of technologies, stakeholder perceptions, frameworks, and metrics. *Education and Information Technologies*, 1-27.

Courtney, M., & Wilhoite-Mathews, S. (2015). From distance education to online learning: Practical approaches to information literacy instruction and collaborative learning in online environments. *Journal of library administration*, *55*(4), 261-277.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American educational research journal*, *38*(4), 813-834.

Dayan, I., Roth, H. R., Zhong, A., Harouni, A., Gentili, A., Abidin, A. Z., ... & Li, Q. (2021). Federated learning for predicting clinical outcomes in patients with COVID-19. *Nature medicine*, *27*(10), 1735-1743.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Davies, R. S. (2011). Understanding technology literacy: A framework for evaluating educational technology integration. *TechTrends*, *55*, 45-52.

Delgado, A. J., Wardlow, L., McKnight, K., & O'Malley, K. (2015). Educational technology: A review of the integration, resources, and effectiveness of technology in k-12 classrooms. *Journal of Information Technology Education*, *14*.

Dickfors, E. (2015). Teaching Literature in English at High School Level: A Discussion of the Socio-Cultural Learning Theory vs the Transmission Theory.

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 1-24.

Engelhardt, M. R. (2024). Feedback in Digital Game-Based Learning (DGBL): Influencing Students' Self-Efficacy and Motivation.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational technology research and development*, *53*(4), 25-39.

Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. *Educational technology research and development*, *47*(4), 47-61.

Farsawang, P., & Songkram, N. (2023). Fostering technology integration and adaptability in higher education: Insights from the COVID-19 pandemic. *Contemporary Educational Technology*, *15*(4), ep456.

GPE. (2020). Pakistan: Technology boosts education reform in remote areas | Global Partnership for Education. Retrieved 22 December 2020

GONDREE, E. Pedagogical strategies to find success with computers in the classroom: Benefits, challenges, and tips.

Gray, C. M. (2020). Paradigms of knowledge production in human-computer interaction: Towards a framing for learner experience (LX) design. *M. Schmidt, AA Tawfik, I. Jahnke, & Y. Earnshaw,(2020). Learner and User Experience Research: An Introduction for the Field of Learning Design & Technology. EdTech Books. https://edtechbooks. org/ux*.

Habibu, T. (2012). *A study of difficulties faced by teachers in using ICT in classroom teaching-learning in technical and higher educational Institutions in Uganda* (Doctoral dissertation, Department of Technical and Vocational Education (TVE), Islamic University of Technology (IUT)).

Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. routledge.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale online journal of African studies*, *2*(1), 39-54.

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The substitution augmentation modification redefinition (SAMR) model: A critical review and suggestions for its use. *TechTrends*, *60*, 433-441.

Hart, T. L. (2024). *Supporting Elementary Teachers with Technology Integration Within the Mathematics Curriculum* (Doctoral dissertation, Walden University).

Heaton, L. A., Washington, L. A., & Schoeny, Z. G. (1999). Perceptions and educational technology need of school administrators. In *Society for Information Technology & Teacher Education International Conference* (pp. 456-461). Association for the Advancement of Computing in Education (AACE).

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational technology research and development*, *55*, 223-252.

Higgins, S. (2009). Interpreting the evidence base for the impact of digital technologies on learning: Report for BECTA.

Holmes, A., Vargas, J. D., Swan, K., Jennings, S., Meier, E., & Rubenfeld, L. (2002). Situated professional development and technology integration: The capital area technology and inquiry in education (CATIE) mentoring program. *Journal of Technology and Teacher Education*, *10*(2), 169-190.

Ikuta, K. S., Swetschinski, L. R., Aguilar, G. R., Sharara, F., Mestrovic, T., Gray, A. P., ... & Dhingra, S. (2022). Global mortality associated with 33 bacterial pathogens in 2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *400*(10369), 2221-2248.

Issroff, K., & Scanlon, E. (2002). Educational technology: The influence of theory. *Journal of Interactive Media in education*, *6*.

Istiningsih, I. (2022). Impact of ICT integration on the development of vocational high school teacher TPACK in the digital age 4.0. *World Journal on Educational Technology: Current Issues*, *14*(1), 103-116.

Kumar, N., Rose, R. C., & D'Silva, J. L. (2008). Teachers' readiness to use technology in the classroom: An empirical study. *European Journal of Scientific Research*, *21*(4), 603-616.

Kaur, M., Sandhu, M., Mohan, N., & Sandhu, P. S. (2011). RFID technology principles, advantages, limitations & its applications. *International Journal of Computer and Electrical Engineering*, *3*(1), 151-157.

Khan, M. S. (2020). *Teachers' use of technology in Punjab's schools: A comparative case study of a public, a private, and a partnership school* (Doctoral dissertation, University of Leicester).

Khan, S. R. (2019). Dr. Muhammad Jehangir Khan.

Major, T. E., & Mangope, B. (2012). The constructivist theory in Mathematics: The case of Botswana primary schools. *International Review of Social Sciences and Humanities*, *3*(2), 139-147.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers' college record*, *108*(6), 1017-1054.

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of educational research*, *77*(4), 575-614.

Law, N. (2009). Mathematics and science teachers' pedagogical orientations and their use of ICT in teaching. *Education and Information Technologies*, *14*, 309-323.

Lipsey, M. W., Puzio, K., Yun, C., Hebert, M. A., Steinka-Fry, K., Cole, M. W., ... & Busick, M. D. (2012). Translating the Statistical Representation of the Effects of Education Interventions into More Readily Interpretable Forms. *National Center for Special Education Research*.

Maré, M. G. J., & Mihai, M. A. (2018). Factors contributing to the level of acceptance of technology in affluent private schools. *Journal of Research on Technology in Education*, *50*(4), 333-349.

Minty, R. (2017). *The viability of teaching and learning mathematics using information and communication technologies (ICTs) in Gauteng paperless classrooms* (Doctoral dissertation, University of the Witwatersrand)

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers' college record*, *108*(6), 1017-1054.

Mullamaa, K. (2010). ICT in Language Learning--Benefits and Methodological Implications. *International education studies*, *3*(1), 38-44.

Morrison, J. R., Ross, S. M., & Cheung, A. C. (2019). From the market to the classroom: How ed-tech products are procured by school districts interacting with vendors. *Educational Technology Research and Development*, *67*, 389-421.

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of information technology for teacher education*, *9*(3), 319-342.

Murthy, S., Iyer, S., & Warriem, J. (2015). ET4ET: A large-scale faculty professional development program on effective integration of educational technology. *Journal of Educational Technology & Society*, *18*(3), 16-28.

Oyetade, K. E., Zuva, T., & Harmse, A. (2020). Technology adoption in education: A systematic literature review. *Adv. Sci. Technol. Eng. Syst. J*, *5*(6), 108-112.

Pratiwi, V. U. (2020). Improving Students' Writing Skills through Collaborative Learning: A Case Study of Senior High School Veteran 1 of Sukoharjo. *Theory and Practice in Language Studies*, *10*(5), 527-535.

Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: Identification of drivers, barriers, and business models of educational technology companies. *International Journal of Educational Technology in Higher Education*, *17*(1), 1-21.

Roblyer, M. D. Integrating educational technology into teaching. *(No Title)*.

Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *The future of children*, 76-101.

Sandoval, W. A. (2013) Educational design research in the 21st century. In *Handbook of design in educational technology* (pp. 388-396). Routledge.

Sardone, N. B. (2012). Teaching classic literature with comic books and virtual lit trips. *English Journal*, 67-70.

Scrimshaw, P. (2004). Enabling teachers to make successful use of ICT.

Saunders, J. M. (2014). *The flipped classroom: Its effect on student academic achievement and critical thinking skills in high school mathematics*. Liberty University.

Syafryadin, H., & Salniwati, A. R. A. P. (2019). Digital storytelling implementation for enhancing students' speaking ability in various text genres. *International Journal of Recent Technology and Engineering (IJRTE)*, *8*(4), 3147-3151.

Thomas, S. (2016). Future Ready Learning: Reimagining the Role of Technology in Education. 2016 National Education Technology Plan. *Office of Educational Technology, US Department of Education*.

Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educational technology research and development*, *65*, 555-575.

Tzenios, N. (2020). Examining the Impact of EdTech Integration on Academic Performance Using Random Forest Regression. *ResearchBerg Review of Science and Technology*, *3*(1), 94-106.

Varghese, N. V. (2023). Quality Assurance and Academic Integrity in Higher Education in India. In *Handbook of Academic Integrity* (pp. 935-951). Cham: Springer International Publishing.

Walkington, C. A. (2013). Using adaptive learning technologies to personalize instruction to student interests: The impact of relevant contexts on performance and learning outcomes. *Journal of educational psychology*, *105*(4), 932.

Xie, K., Nelson, M. J., Cheng, S. L., & Jiang, Z. (2023). Examining changes in teachers' perceptions of external and internal barriers in their integration of educational digital resources in K-12 classrooms. *Journal of Research on Technology in Education*, *55*(2), 281-306.

Zubairi, A., Khalayleh, A., Baloch, I., Mazari, H., Kaye, T., & Groeneveld, C. (2022). *Pakistan Digital Learning Landscape Analysis*. EdTech Hub.

Zulfqar, A., & Hussain, S. N. (2022). Adaptation of Technology in Open Distance Learning: A Case Study of AIOU. *Pakistan Journal of Distance and Online Learning*, *5*(1).

Appendices

Appendix A (Mode1 & Model 2 for Mathematics Test Scores)

Table 4.7 Regression of Education Method on Mathematics Score

```
. reg MathScores EducationMethod

      Source |       SS           df       MS      Number of obs   =        91
-------------+----------------------------------   F(1, 89)        =      7.95
       Model |  328.813852         1  328.813852   Prob > F        =    0.0059
    Residual |  3682.94439        89  41.3813976   R-squared       =    0.0820
-------------+----------------------------------   Adj R-squared   =    0.0716
       Total |  4011.75824        90  44.5750916   Root MSE        =    6.4328

------------------------------------------------------------------------------
  MathScores | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
EducationM~d |   3.820488   1.355334     2.82   0.006     1.127468    6.513508
       _cons |       19.96   .9097406    21.94   0.000     18.15236    21.76764
------------------------------------------------------------------------------
```

Table 4.8 Regression of Seleted variables (Education Method ,Class Size, Family Size and Income Level) on Mathematics Test Scores

```
. reg MathScores EducationMethod  ClassSize FamilySize IncomeLevel

      Source |       SS           df       MS      Number of obs   =        91
-------------+----------------------------------   F(4, 86)        =      7.99
       Model |  1087.29206         4  271.823014   Prob > F        =    0.0000
    Residual |  2924.46618        86  34.0054208   R-squared       =    0.2710
-------------+----------------------------------   Adj R-squared   =    0.2371
       Total |  4011.75824        90  44.5750916   Root MSE        =    5.8314

------------------------------------------------------------------------------
  MathScores | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
EducationM~d |   .8438081   1.417434     0.60   0.553    -1.973958    3.661574
   ClassSize |  -.5600947   .1276659    -4.39   0.000    -.8138862   -.3063032
  FamilySize |  -.2152606   .6177418    -0.35   0.728    -1.443291    1.012769
 IncomeLevel |  -5.15e-06   7.49e-06    -0.69   0.494      -.00002    9.74e-06
       _cons |   36.81357   4.331353     8.50   0.000     28.20313    45.42401
------------------------------------------------------------------------------
```

(Model 1 & 2 for English Test Scores)

Table 4.9 Regression of Education Method on English Test Scores

```
. reg EnglishScores EducationMethod

      Source |       SS           df       MS      Number of obs   =        91
-------------+----------------------------------   F(1, 89)        =      4.06
       Model |  56.7247869         1  56.7247869   Prob > F        =    0.0470
    Residual |  1244.00049        89  13.9775336   R-squared       =    0.0436
-------------+----------------------------------   Adj R-squared   =    0.0329
       Total |  1300.72527        90  14.4525031   Root MSE        =    3.7387

------------------------------------------------------------------------------
EnglishScores | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
EducationMethod |   1.586829   .7876967     2.01   0.047     .0216927    3.151966
          _cons |      18.34   .5287255    34.69   0.000     17.28943    19.39057
------------------------------------------------------------------------------
```

Table 4.10 Regression of Selected Variables (Education Method,Class Size, Family Size and Income Level) on English Test Scores

```
. reg EnglishScores EducationMethod ClassSize FamilySize IncomeLevel

      Source |       SS           df       MS      Number of obs   =        91
-------------+----------------------------------   F(4, 86)        =      3.61
       Model |  187.126134         4  46.7815334   Prob > F        =    0.0090
    Residual |  1113.59914        86  12.9488272   R-squared       =    0.1439
-------------+----------------------------------   Adj R-squared   =    0.1040
       Total |  1300.72527        90  14.4525031   Root MSE        =    3.5984

------------------------------------------------------------------------------
EnglishScores | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
EducationMethod |   2.671986   .8746696     3.05   0.003     .9332001    4.410771
      ClassSize |   .2282719     .07878     2.90   0.005     .0716623    .3848814
     FamilySize |    .319466   .3811958     0.84   0.404    -.4383262    1.077258
    IncomeLevel |  -6.04e-06   4.62e-06    -1.31   0.195    -.0000152    3.15e-06
          _cons |   12.03862   2.672789     4.50   0.000     6.725287    17.35195
------------------------------------------------------------------------------
```

4.11 Regression Summary for Mathematics and English Scores

```
      Total |         91      100.00

. summarize MathScores EnglishScores ClassSize FamilySize

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
  MathScores |         91    21.68132    6.676458         0         30
EnglishSco~s |         91    19.05495    3.801645         8         29
   ClassSize |         91    24.03297    5.604464        17         31
  FamilySize |         91     4.78022    1.008874         3          8
```

4.12 Correlation Matrix Table

Variables	**Class Size**	**Family Size**	**Income Level**
Class Size	1.0000		
Family Size	0.0170	1.0000	
Income Level	0.1944	0.0479	1.0000

Appendix B **INTERVIEWS**

Open-ended Interviews with Private High School Teachers

(Mathematics and English)

Introduction of the Interviewer:

I am Farzana Parveen Jafferi , doing research on topic 'Augmentation of EdTech for better student learning outcomes' at PIDE. I want to learn about problems faced by O Levels teachers of English and Mathematics in using technology in their classes for their students' better learning and performance.

I assure you that this information will not be shared with anyone except to draw my own analysis and conclusions to find out the ways that could help these teachers to incorporate education technology in their teaching methodology for better students' learning and their own innovative teaching skills.

Background Information

1. **Experience with EdTech Tools:**

How familiar are you with educational technology tools? (e.g., very familiar, somewhat familiar, not familiar)

What types of EdTech tools have you used in your teaching?

Main Interview Questions

2. **Attitudes Towards EdTech:**

How do you personally feel about using EdTech tools in your teaching?

Have you noticed any resistance among your colleagues towards adopting new technologies? If so, what are the main reasons for this resistance?

---

3. **Support Needs:**

What kind of support do you think would help you better integrate EdTech tools into your teaching? (e.g., technical support, additional training, peer support)

Are there specific resources or support systems you wish were available?

---

4. **Initial Training and Support:**

Can you describe the initial training you received for using EdTech tools?

Do you feel that the training was sufficient? Why or why not?

What kind of ongoing support or professional development is available to you for using EdTech tools?

---

5. **Time and Workload:**

How does the use of EdTech tools impact your workload?

Do you find it challenging to balance your existing responsibilities with the time required to learn and integrate new EdTech tools? Can you provide specific examples?

---

6. **Technical Issues and Infrastructure:**

What technical challenges have you faced when using EdTech tools? (e.g., internet connectivity, device issues)

How do these technical issues affect your ability to effectively use EdTech tools in the classroom?

---

7. **Impact on Teaching and Learning:**

How do you think EdTech tools have impacted your teaching practices?

Have you observed any changes in student engagement or learning outcomes since you started using EdTech tools?

---

8. **Suggestions for Improvement:**

What suggestions do you have for improving the adoption and integration of EdTech tools in your school?

Are there any specific EdTech tools or features you believe would be particularly beneficial?

Closing

Additional Comments:

Is there anything else you would like to add about your experience with EdTech tools that we haven't covered?

Thank You

Appendix C

BAHRIA COLLEGE ISLAMABAD
ENGLISH PAPER
1ST ASSESSMENT
9(A & B)
TOTAL MARKS: 30

TIME ALLOWED: 1 HOUR

Name: **Class/Section:**

Q1.

(a). Summary (20 marks)

Read the passage and write a summary of the changes created by the car and the disadvantages the car has brought, as outlined in the passage.
Use your own words as far as possible. You will be awarded upto **10** marks for the content and **10** marks for the quality of your writing.
Your summary must be in continuous writing (not note form) and no longer than **150 words**.

No. of words:

(b). Short Response (5 marks)

The passage provides three solutions at the end to reduce the negative effects of car usage: staggering working hours, encouraging shared transportation, or implementing congestion charges.

Select **one** of the three solutions and discuss its potential effectiveness, taking into account any difficulties that may arise during its implementation.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

(c). Vocabulary (5 marks)

Give synonyms for each of the following words:

1. Unprecedented (line 2)_____
2. Sprawling (line 9)_____
3. Detrimental (line 23)_____
4. Phenomenon (line 41)_____
5. Exasperation (line 41)_____

Cars

1 No invention has ever created a greater revolution than the car has, giving freedom of mobility on an unprecedented scale for those able to afford them; people used to be restricted to the villages where they were born, but nowadays car owners have been liberated from the narrow confines of their homes. A journey of a few miles on foot could easily take more than an hour, unlike the speed of such journeys by car. Linked to this revolution came the possibility of greater social interaction, resulting in wider circles of friends and increased communication with families. Greater flexibility in work also came about: it was possible to live in the country and work in town, and those already living in towns and cities could also go further afield to work. Sprawling urban areas resulted; for example, modern London is spread over hundreds of square miles. The modern city with its surrounding industrial and residential suburbs is largely a product of the car industry.

2 Road building schemes launched in the mid-twentieth century in many countries, such as the USA, Germany and Italy, meant that the car changed the appearance of whole countries as existing roads were extended and new highways built. Although other forms of city transport have developed, such as trams, buses and underground trains, the advantage the car has over these is that the car alone makes door-to-door trips possible.

3 Although initially perfected in France and Germany, the car was first mass-produced on factory assembly lines in the USA by Henry Ford; at the peak of production in the early twentieth century his factories were responsible for an output of 10000 cars every day, thus creating many jobs. Many countries today are involved in car manufacturing: over 19 million people are employed in the car industry in India alone.

4 None of these changes has come without a cost. In the short term, cars have a detrimental effect on public health because the fuel they burn gives off pollutants which can weaken the body's defences against diseases such as respiratory infections. Removing lead from petrol has gone some way to addressing this problem and, additionally, most modern cars are equipped with devices called catalytic converters which reduce toxic pollutants. Longer term damage to the environment is caused by cars as they emit greenhouse gases which contribute to global warming by damaging the ozone layer that protects life on earth from the sun's ultraviolet rays.

Appendix D

Bahria College Islamabad

9(A & B)

Maximum marks = 30

Mathematics Assessment Paper

April 2024

Name: **Class/Section:**

Question 1

(a) Find the equation of straight line passing through the points A(-2,1), B(3,-4) [3]

(b) Consider the equation 3x+2y=4.
Complete the table

x	-2	0	2
y			

and on a sheet of graph paper, draw the graph of the equation 3x+2y=4

(c) On the same axis draw the graph of x=1.5 and y= -2

[3+1+1]

(a) Find slope and y-intercept of the equation $\frac{x}{5} - \frac{y}{6} = \frac{1}{2}$

(b) Hence find the coordinates of the points at which the line cuts the x-axis.

Question 2

[3]

[3]

(c) Calculate the area and perimeter of the triangle formed by the points A(-1, 3), B(4, 3), and C(2, -3).

[3+2]

(d) A point D has coordinates (t, -3) find value of t if the area of the triangle DBC is 36 units^2.

[2]

(a) If the gradient of the line joining the points (m,4) and (3,-4) is 9, find the value of m.

Question 03

[2]

(b) Given that the coordinates of the points P and Q are (3, -2) and (-1, 6) respectively. Find the coordinates of the point R that lies on the x-axis such that PR=QR.

[04]

[3]

(c) Find the equation of the straight line which passes through the point (2,-1) and having the same gradient as the line $3y = 6x + 5$