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Research Article

Impact of Flipped Classroom Approach on Students' Learning in Post-Pandemic: A Survey Research on Public Sector Schools

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This research focuses on the increasing dependency on flipped classrooms with the merger of distance teaching and learning instead of face-to-face classrooms during the pandemic, which impacted student's performance and learning post-pandemic. The primary purpose of this research study was to identify support, motivation, participation, collaboration, assessment, and feedback gained through the use of flipped classrooms with the merger of distance teaching instead of a physical classroom in the pandemic situations and the challenges faced by teachers in using flipped classroom. The main intention is to analyze flipped classroom effectiveness as an emerging concept in a pandemic situation. In this research, a methodology is recommended step by step below in the methodology section—a quantitative research method used to collect accurate and reliable results. A survey research method was used in this study. The populations of 90–73 respondents among higher secondary grade students of the public school in Sukkur were selected for data collection. For managing the data, SPSS statistics software was used. In inferential statistics, an independent-samples *t*-test was used for the analysis of data. The results were analyzed based on gender mean score. The significant findings from this study suggested that the flipped classroom is a practical learning approach that enhances student engagement, performance, and learning in the class. It is summed up that a large number of students favoured the flipped classroom approach over traditional pedagogy. This study will help to further integrate this approach into higher levels of institutions by keeping in mind its effectiveness and hindrances in Pakistan.

1. Introduction

This research study emphasized a paradigm shift that undergoes a significant transformation by merging education and technology. Great progress can be observed in the educational field to transform learning. The revolutionary advancement in the educational field has led teachers, students, and parents to use technological-based approaches at home and school [1]. During pandemic situations, the flipped classroom as an instructional strategy is being used by most teachers with the merger of distance teaching and learning instead of face to face. A flipped classroom is one of the innovative instructional approaches and reordering of classroom teaching and learning. It consists of two segments: in the first one, students' role has more value in which teacher directs and instructs students through technology-based approaches, and students watch lessons and videos at home. In the second phase, the teacher organizes an interactive session inside the classroom. However, flipped classrooms involve students in technology-based approaches that include instructional audio and video resources to solve real-world problem-solving [2]. A flipped classroom is a widely implemented strategy at all higher education levels in many developing countries.

1.1. Background of the Study. In the pandemic situation of COVID-19 in Pakistan, a flipped classroom is a practical pedagogical approach that involved teachers, students, and parents more actively in teaching and learning as schools were closed. The results revealed flipped classrooms as a widely used strategy promoting active learning, collaborative learning, engagement, motivation, peer-assisted learning, and self-directed learning. In addition, this study will also help us to recognize cultivated intrapersonal, leadership, critical thinking, and other 21st-century skills through flipped classrooms. On the other hand, the flipped classroom also showed limitations. It claimed that most countries suffer stiffly and have not started online teaching due to a lack of resources. The importance of physical classrooms cannot be replaced by alternative learning modes [3].

This research study contributes to the use of flipped classrooms in Pakistani schools, as it was an alarming situation that not many research studies found in Pakistan. This research study intends to identify support, motivation, participation, collaboration, assessment, and feedback gained through the flipped classroom in public sectors used with the merger of distance teaching instead of physical classrooms in post-pandemic situations and challenges that teachers face while using flipped classrooms. Students and teachers want to eliminate traditional teaching methods and shift to digital pedagogies in the classrooms, most prominently in pandemic situations. This research study will establish the uniqueness in exploring the impact of usefulness of flipped classrooms on post-pandemic situations in Pakistan. As the flipped classroom is advanced technological approach in the educational field, it is proven to be more useful to deal with the post-pandemic situation. Unfortunately, teachers in Pakistan are not aware of flipped classroom approach and even no evidence of research on the effectiveness of flipped classrooms, but this research study is helpful for teachers and students in terms of the effectiveness of flipped classrooms in public schools in Pakistan. Due to the prolonged closure of the schools, the post-pandemic has a fragile impact on education. The post-pandemic results showed that those schools that continued their academics through an online learning management system had a great positive impact on student's learning, but on the other hand, those who were not able to start online classes due to the lack of resources do not perform well.

1.2. Problem Statement. The world is evolving and changing drastically, and it is affecting the educational field also. The physical classroom was considered a norm or tradition, but now it has challenged the teachers, students, and other staff, especially in pandemic situations. Nevertheless, a shift has been observed from gaining knowledge sitting in a four-sided surrounded wall to remote learning. Due to the disruptive pandemic, Pakistan's education system has to flip its teaching and learning system. Schools started to engage their administration, staff, faculty, and students in online teaching and learning without compromising their system's functioning and save their staff and learners. In this pandemic situation, a type of blended learning that we call "flipped classroom" is one of the strategies used by teachers [4]. That is why this study aimed to analyze the effect of flipped classrooms on students' attitudes during pandemic situations and the challenges faced by them during this pandemic while using flipped classroom approach. It is necessary to identify whether it is supporting students in their learning path or not. There are not much more quantitative research studies on flipped classroom from the perspective of students. Hence, it is necessary to research to identify its impact and challenges encountered by higher secondary students.

1.3. Theoretical Framework. The theoretical framework is defined as a blueprint that supports the study by relying on a formal theory [5]. The triple E model talks about engagement in terms of active learning and collaborative learning strategies, enhancement in terms of content knowledge by merging technological tools such as videos/lectures, and extension in terms of interpersonal, leadership, and problem-solving skills. In this way, the triple E model favours this study to achieve research objectives.

1.4. Triple E Model. Professor Liz Kolb developed a triple E model at the University of Michigan, School of Education, in 2011. This model guides K12 educators to bridge the connection between effective practices and technology tools for enhancing learning. A research study claims a point that the integration of effective technology tools leads to good instructional strategies. In this case, the triple E model provides an opportunity to evaluate which tool is more effective to meet learning goals and ultimately improve students' achievement. This practical framework measures the effectiveness of educational apps used in lesson plan development and students' learning [6]. This framework is comprised of three main components. It includes enhancement, engagement, and extension of learning goals. However, they are interchangeably different from each other and have unique characteristics. In this research study, some of the aspects of the triple E model are used, which were relevant to the research objectives. For this study, we have used engagement and enhancement for the development of the questionnaire. The primary purpose of conducting this research study was to identify support, motivation, participation, collaboration, assessment, and feedback gained through flipped classrooms. From the engagement element, we have discussed the active engagement of students in flipped classrooms in terms of the best strategies defined in the literature that are problem-based learning, think pair and share, simulation, and discussions that help construct knowledge. Moreover, the enhancement element helps to understand how flipped classrooms aid in developing students' content knowledge. Further, it also tells us whether the used flipped classroom approach scaffolds in easily comprehending the concept and whether the flipped classroom made any difference to traditional teaching in achieving learning goals or not.

Moreover, the triple framework works well with the educational theories including constructivism, humanism, and cognitivism. This triple E framework provides an

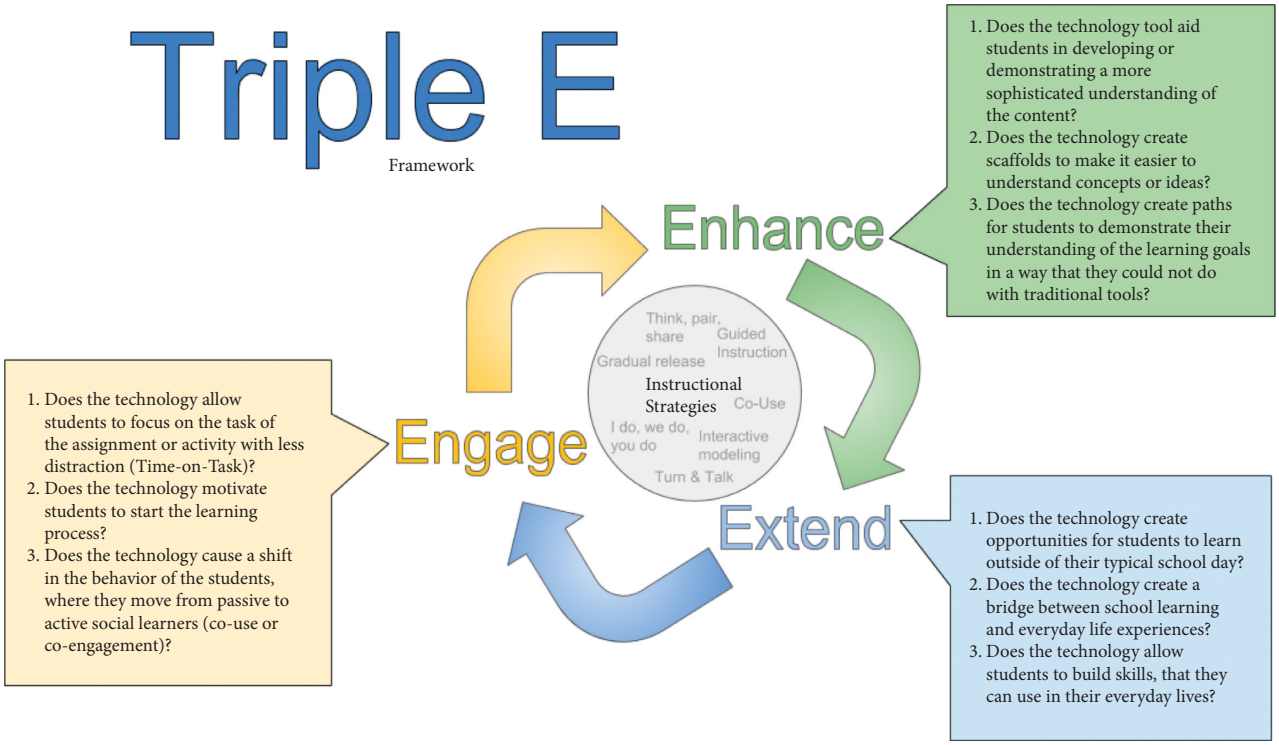

Figure 1: Triple E framework (from the study of Professor Liz Kolb).

opportunity for teachers to be critical in making solicitous choices of technology tools in teaching. It helps educators design lessons that add authenticity, active learning, social skills, and creativity to learning goals [7]. There are multiple frameworks and models that educators use in the teaching process by integrating technology. All have their benefits, but none of the other models directly focused on integrating technology to achieve learning goals.

Nevertheless, the triple E framework is a practical tool that brings instructional strategies, learning goals, and effective tool selection. The educators who use the triple E framework put learning first and technology second [7]. The three factors are at the heart of the triple E framework, as shown in Figure 1.

1.4.1. Engagement. This component of the triple E framework helps to know that technology focused on task/activity/assignment without any distraction. In a like manner, it also explains that technology tool motivates students in beginning the learning process. It also causes a change in students' behaviours from passive to active learners [8]. The flipped classroom has significant value in engaging students in active learning. Teachers use combinations of different learning experiences, online tutorials, and technological tools to achieve learning goals. The best strategies defined in the literature are problem-based learning, think pair and share, simulation, and discussions that help construct knowledge. While explaining the importance of presentations and individual/paired quizzes, it was stated that these active strategies empower students in attaining higher levels of Bloom's taxonomy [9].

1.4.2. Enhancement. This component of the triple E framework helps to understand how technology tools aid in developing students' content knowledge. Further, it also tells us whether the used technological tool scaffolds in easily comprehending the concept and whether the technological tool made any difference to traditional teaching in achieving learning goals (Kirkwood, A. and Price, L., 2014). This study also aimed to explore the enhancement of students' content knowledge through flipped classrooms. Stone [10] emphasized that teachers make extra efforts in achieving desired learning outcomes. The content materials taught using traditional instructions became easy and understood by students themselves through video watching, discussions, and projects. These methods allowed teachers to cultivate critical and analytical abilities in students. Outside class time is more spent on self-learning. Some scholars argued that technology is not essential for learning, but it is easiest for teachers to efficiently manage online material and teaching and learning resources. It also improves the interaction between teachers and students before and after the class [11].

1.4.3. Extension. In the last phase, it explains the opportunities created for students outside the classroom. It also bridged the gap between school learning and daily life experiences. It also develops skills in students that will help them in their future life. This study also investigates the role of flipped classrooms in cultivating life skills. Flipped classroom helps in learning content and develops skills such as leadership, problem-solving, and critical skills. This approach promotes application-based activities for students. This model not only assumes grasping content knowledge

but also uses the learned concepts in real life. In this way, students become responsible for their learning [12]. Learners apply their knowledge through discussions, projects, or presentations to extend students' knowledge beyond the classroom and relate to everyday lives. Flipped learning helps to develop 21st-century skills such as communication, thinking, interpersonal, and self-directional skills to get ready to deal with the challenges of the 21st century [13].

1.5. Significance of the Study. This study offers a great understanding of the impact of pandemic situations on the education system of Pakistan. A transformational shift from face-to-face teaching to flipped classrooms tied up with online teaching has left teachers, parents, and students learning many things. It will be significant for the educators as it defines the effectiveness and gaps of flipped classrooms with clear and explicitly explained instructions before the online session. Additionally, it will suggest that teachers make student-centred learning and spend their online teaching in discussions, debates, and other interactive learning opportunities during pandemic situations. Moreover, it provides a pathway for future researchers to further explore the perceptions of parents and students about the use of flipped classrooms throughout pandemic situations. It is beneficial for the parents to recognize the effectiveness of flipped classrooms as it helps them be aware of the information presented to their children. Having access to the information will help them to involve in students' learning. This research study will establish the uniqueness of exploring the impact of pandemic situations on the usefulness of flipped classrooms.

2. Literature Review

2.1. Teacher's Digital Skills in the Pakistani Education System. Pakistan is one of the largest countries in the world concerning its population density. It is ranked as the 6th most populated country globally [14]. In a thickly populated country such as Pakistan, providing basic facilities such as health and education becomes a daunting task for the government. However, Pakistan has declared constitutional responsibility to provide free quality education to children aged 5–16 years. However, Pakistan's schooling system is very diverse, with its schools ranging from state-run government schools to private schools, which are further divided into low-cost and elite private schools. In the past few decades, a mushroom growth has been observed in Pakistan's number of private schools. This increase results from parents' lack of faith in state-owned schools with inadequate facilities and numerous other discouraging factors such as teacher absenteeism and inadequate student-teacher ratio [15].

On the other hand, private schooling offers accountability as parents are the only source of finance for these schools, so teacher absenteeism and other similar issues are not present here. However, the state of low-cost private schools is again questionable as Andrabi et al. [16] highlighted the school fees issue of low-cost private schools. We live in a fast-changing world, and this change is apparent in the technological field. Recent technological advancements have reshaped the employment market as machines have replaced many jobs, and many are predicted to go to the extent of the advancement in AI and robotics [17]. This is a worrisome situation, and it asks for a shift in our traditional schooling to cope with changing world requirements. Pakistan has taken some serious steps in the right direction with the change in the curriculum by integrating technology and remapping the teacher education program in 2009 [18].

Nevertheless, again, for a richly populated country like Pakistan that spends only a tiny fraction of the budget on education [19], these policy changes might only remain present on paper but be absent in practice. As for the low-cost private school provision of technological devices, Internet and other facilities are unfeasible, and high-cost private schools might provide all these facilities, but only a fragment of a pupil can afford elite schools and the government to reshape all state schools a scant budget is quite hard. Researchers have already found that the expenditure of technological resources, malfunctioning of the Internet, and unavailability of trained teachers are a great hindrance to equipping the government schools with technology [20].

2.2. Flipped Classroom Approach as Emergency Remote Teaching. Unlike online teaching, emergency remote teaching is a temporary transformation of instruction delivery to substitute mode, specifically in crisis. The main aim was to organize these educational setups to provide feasible remote teaching solutions in an emergency. This article provided many examples of schools and universities implementing technology-based approaches such as mobile learning, blended learning, and flipped classrooms. [4]. An emerging concept in education is gaining popularity day by day in promoting a student-centred approach. The flipped classroom concept was brought up by Jonathan Bergmann and Aaron Sams, who helped the students who missed their in-class activities due to any reason. They made a series of online video lectures to watch while sitting at their homes. In this way, videos were used remotely by other people also. By looking at this process, Sam decided to use it in their teaching and learning process to upload the topic-related video before class and asked them to watch it, using in-class timings for discussions and collaborative group activities. In this way, this teaching and learning approach flipped the concept of traditional classrooms [21].

According to Bergmann and Sams [2], an essential tool for flipped classrooms is technology. For access to online pre-recorded videos, students need technology in their homes. Similarly, teachers also require technological tools to record, edit, and publish video lectures, although it needs planning, time, commitment, and effort for successful online content delivery. Furthermore, the length and information shared in the video must be appropriate to students' capacity, age level, and attention span to engage students actively.

However, the excellent quality of video leads to a successful flipped classroom [2]. Today in a pandemic situation,

many teachers have chosen video lectures instead of in-person lectures due to the shutdown of traditional physical classes. A study showed the difficulty teachers struggled with and explained the importance of online resources in pandemic situations. Lipomi [22] favoured video as an active remote learning approach in this pandemic situation. This approach is convenient for students to forward, pause, and rewind the uploaded lectures. The combination of digital learning and flipped classroom approach provides a platform for enhancing students' and teachers' pedagogical skills. Integration of technology provides opportunities for students to access material even outside the boundary of schools. Transformational teaching and learning showed a positive impact in the educational world. The use of video is an essential and effective multimedia tool created by merging images, text, and sound. This research also pointed out that students find it more effective and comfortable to understand and use their critical thinking skills to discuss content instead of the traditional way to read textbooks [22].

Alghamdi et al. [23] discovered five main reasons through which flipped classroom works. It increases student engagement, strengthens team-based skills, offers students guidance, promotes classroom discussion, and offers opportunities for teachers. Furthermore, a study reported that 99% of teachers use flipped classrooms in junior and secondary schools. The empirical result showed that science was the most flipped subject with 46%, maths was at 32%, and the English language stands at 12% only. In addition, 67% showed improvement in student learning and an 80% boost in student engagement. The online resources utilized by maths teachers include Khan Academy, through which students watch videos, practice sums, and take quizzes.

Similarly, science teachers use both online and offline mediums. They engage students in watching videos on YouTube or emailing the material to them. They enriched students' understanding by employing open-ended questions, graphic organizers, and sentence framing [24].

A review of the studies favoured practical support and brought a revolutionary reform instead of traditional classroom settings. It is revealed that Chinese students, habitual of traditional classroom activities, were not competent at cooperative learning as a substitute for individual learning. Cooperative learning is one method in which learners work for one goal and widen one's own and group competencies. It promotes interaction and emphasizes the individual and group accountability. It requires small group intrapersonal skills that function to improve group effectiveness. By assigning a different task to each group, a member will make students responsible for their learning. This model proves to be good for Chinese students' motivation (Yang, 2014).

2.3. Integration of Flipped Classroom Approach in Pakistan. Reviews of studies about the flipped classroom approach in Pakistan unveiled that teachers play a crucial role in learners' learning activities. Similarly, it also highlighted the importance of parents' and peer's role in creating a meaningful learning environment. As flipped classrooms advocate group learning activities, teachers must guide and facilitate group leaders to manage and organize activities by enhancing 21st-century skills. A research study highlighted the significance of flipped classrooms in the Pakistani context that classrooms must be favourable to learning and students engaged in collaborative learning, discussions, concept mapping, and communicative applications through intelligent devices. Further, they described two types of material aids in the learning and teaching process. E-reading material has excellent value in student's comprehension and retention power [25].

Another research article explored the viewpoints of Asia universities related to flipped classrooms. Culture is the dynamic element that shapes an individual's beliefs. So, this study highlighted the contrast between Western and Asian teachers' beliefs, which directly hit their teaching philosophies. Asians consider students as passive learners, and Westerners have the opposite view. Asian students view their teachers as sources of information and highly rely on them for high test scores.

On the contrary, Western students preferred to learn independently. Unlike this, the inverted classroom approach favours the teacher's role as a facilitator by the side of students. This shift is causing students in anxiety, and teachers cannot handle it due to adhered traditional beliefs. The result analyzed from the nine Asian countries that suggested continuing this unconventional model is developing a caring environment, enhancing students' learning, and emphasizing active learning. Furthermore, many students uphold globalization in this modern technological world where information is far from their fingertips and considers teachers' secondary sources. While supporting flipped classrooms, students additionally focused on soft skills to be successful in the future [26]. Another study proposed flipped classrooms as a solution to traditional hierarchical beliefs of teachers and students. The conclusion reported that flipped classrooms positively affect students' motivation and engagement in English writing tasks.

Moreover, the interactive teaching environment and satisfaction from the students' side proved that flipped classroom is an innovative approach and allows teachers to spend more time-solving students' learning problems [27]. Literature suggests that a lack of reasoning and critical skills is found in students' becoming proficient and competent.

One reason, which is causing deficiency in these skills, can be attending boring lectures in face-to-face classes. A flipped classroom is the solution to this issue because it focuses on constructivism, which says, "Individuals use their prior knowledge to experience new concepts." In a like manner, the author also valued the importance of flipped classroom as it plays a vital role in enhancing higher-order cognitive skills [28]. Hence, Pakistan's education system leads towards team-based, problem-based learning, and other innovative teaching methodologies to cope with pandemic situations in crisis. It is recommended in a study conducted in Pakistan that policy-makers and curriculum developers take steps towards promoting the emerging concept of flipped classrooms in the institutions and curriculum of Pakistan [29]. A study explained the significance of flipped classrooms as compared to traditional classrooms.

This method improves students' conceptual understanding and is more beneficial, engaging, and enjoyable than the traditional. Students responded that they feel motivated and engaged throughout the process of flipped classroom approach. They also suggested that this strategy can work in the Pakistani context if shared in native languages. Video sharing is productive in enhancing student's engagement and learning [30].

2.4. Importance of Flipped Classroom in Enhancing Student's Engagement/Learning. A flipped classroom is getting popularity and importance in the educational process. Day [31] conducted an experimental study in Boston and compared two groups of students, one was traditional and the other was experimental, which used flipped classroom. Significant results showed that the group used flipped classrooms to perform better in their final grades than traditional ones [31]. A review of studies unfolded many benefits of flipped classroom approach. According to Awidi and Paynter [32], flipped classroom as a pedagogical approach proves to be a transformational model in enhancing students' engagement, increasing students' learning experience, and eventually improving students' outcomes. The use of flipped classroom approach supports the meaningful construction of active knowledge and experiential learning. However, some of the researchers identified social learning as an improved element in the practical use of flipped classroom. Further researchers suggested that flipped classroom also proves to be a better option for enhancing student motivation, managing cognitive load, and improving learning outcomes [32]. For instance, a study reported that more than half of the studies consider flipped classroom as one of the key components of imparting quality education, and it plays a significant role in improving students' learning outcomes gathered by standardized test scores, GPAs, and other assessments. According to one of the reviewed studies, flipped classrooms enhanced students' motivation by 18% and active engagement until 14%. In addition, it also highlighted some other areas that are improving through the use of flipped classroom, including satisfaction, confidence, active and meaningful knowledge, creativity, problem-solving skills, more retention, application skills, and ICT skills. At the same time, the same study focused on another aspect: pedagogical contributions as flipped classrooms provide opportunities to collect data from different online resources, and students can access it while sitting anywhere. In this way, it provides flexibility to the teachers and students for access and enjoyment and satisfaction. The same study reported that students taught through flipped classrooms have a 1% improvement in attendance and a 1% reduction in course withdrawal. In the same manner, university students showed a more positive attitude towards the use of flipped classrooms as opposed to the conventional method, and the result revealed a 14% increment in perceptions of students. Also, interaction between student-teacher and student-student rose by 20% because this model provides more time and effort to them. At last, another advantage, which is reported in this study, is that it also contributes to using class timing more efficiently as it provides time to read/watch lectures at home and spend in-class time in more student-centred activities such as discussion, debate, feedback, and hands-on activities [33]. Other studies evaluated the efficacy of flipped classrooms by conducting online quizzes, wrap session, and discussion forums, resulting in that this approach proved to help improve student's performance and attendance [34]. Reference [35] discovered another benefit of using flipped classrooms in marketing courses by engaging students in online project-based learning. The result showed that the model developed learning interest, effectiveness, and teamwork [35]. A flipped network (2012) researched teachers who used flipped classrooms in junior, high, and secondary school. The study indicated that 99% of teachers showed a willingness to continue this approach, student performance improved by 67%, and students' engagement increased by 80% [24]. Another study suggested that flipped classrooms make learners responsible for their learning. Students feel free to use other online resources to comprehend and enjoy online lectures because they have sufficient time. It engages parents in contributing to their child's learning. The study showed that parents' involvement in students' homework improves students' academic achievement [26]. Cognitive load theory states that it is difficult for working memory to retain information, so in this regard, another benefit of flipped classroom is that it allows students to review the video again whenever they need it and take notes of important information. This report also mentions that this model increases students' collaboration, presentation skills, problem-solving skills, and other skill development. It also shared a unique advantage: it educates parents and can watch video lectures with their children [9]. Further, this study claimed that flipped model engages students in class timings and outside the class means at their home to be connected with learning tasks. Both quick supplies of formative feedback and concentration on their learning are positive characteristics of flipped classrooms [27].

2.5. Pitfalls of Using a Flipped Classroom. Undoubtedly, the flipped classroom model has changed the traditional educational setting, teaching methodologies, and students' learning styles. On one side, it has a range of flexible benefits that positively affect different teaching and learning aspects. In contrast, this model has also imposed some challenges reported in one of the research articles. It claimed that massively dependent on technological tools and Internet access is difficult for teachers who do not have Internet access to upload video lectures and problematic for students who do not possess electronic devices in their home [9]. Following this limitation, another study supported that due to the absence of technological tools, students will not be able to prepare before class and actively engage in activities during class. Technology competency is also considered troublesome for teachers; video lectures with poor quality and limited pedagogical skills and technical issues affect students' learning negatively. In addition, it is also reported that there is an inverse relationship between the length of the

video and videos viewed by students. Insufficient technological competency causes poor and low student learning outcome and ultimately affect the efficacy of flipped classroom [26, 33]. It is also problematic for novice teachers to engage students during video watching actively. They need extra effort and time to demonstrate how to take notes of important information during watching videos [9]. While exploring students' perspectives about flipped classrooms, it is revealed that students feel an extra burden as this model is structured to watch or read lectures at home and that is why students do not feel feasible and do not prefer this model as they are habitual of traditional classrooms. Therefore, students feel anxiety, resistance to change, and adoption problems with this model [33].

Another study shared some limitations of flipped classrooms including teachers feeling burdened, which utilizes much material in this approach. Sometimes, teachers feel boring while using it. It is also mentioned that sometimes students do not complete their homework, which is responsible for low outcomes in their academic results. Moreover, research conducted in China also highlighted some existing problems in carrying out flipped classrooms. It claimed that flipped classroom learning leads to poor performance due to poor video and audio graphics.

Similarly, teachers who are not competent enough to use graphics edit and compose them to cause decreased student interest and low learning efficiency. Similarly, a poor classroom structure and design are responsible for creating problems for teachers. As in traditional classrooms, they easily engage students through their lectures and other strategies, but it is difficult for teachers to engage students in other activities except answering their queries from watched videos already at home.

The growing number of studies also discussed another point about the active participation of parents in monitoring their child's activities, which leads to students' higher grades. So, the obstacle is with those parents who are not well-educated and are not aware of this new interactive model. As there is minimal paperwork, then it would be difficult for parents to assess student's performance [33]. Equally crucial to mention, a study indicates students' negative perceptions about flipped classroom approach, and they used the term "Teaching our self" without being guided or instructed by teachers more explicitly and making them responsible for their learning that has caused fear among students due to being unsure about their success.

Further, they expressed fear of workload and claimed that it might be feasible and suitable for teachers but not positively influence all students. Even though students of other disciplines such as business, medical, and nursing showed a willingness to continue this model for their learning, another exciting issue pointed out by a growing number of research studies is evaluating and assessing problem-solving and critical skills while incorporating this model. As the literature indicates, this paradigm shift needs a change in teachers' and students' traditional solid beliefs [36]. The reviewed studies identified three main themes, student's perceptions, faculty's perceptions, and other operational challenges. Data related to students' perception argued that students need more explicit guidance to work in groups. If students feel any difficulty during video watching and could not ask any question during it, teachers using limited resources leads not understand the value of flipped classroom approach. Operational challenges include no Internet access, challenging to ensure that students have watched a video or not, no ICT skills for teachers, and less institutional [37-40].

3. Methodology

This study aimed to analyze the support and motivation gained by students, participation, and collaboration during in-class and out-of-class activities, assessment, and feedback provided to students through the flipped classroom with the merger of distance teaching instead of a physical classroom in the pandemic situation.

3.1. Research Design. In this regard, the quantitative research design is suitable for the targeted subject of this research study. Despite relying on a survey based on a close-ended questionnaire, the primary purpose of this study would only be quantitative. This research study demands accurate and reliable analysis to understand the experiences of secondary grade students regarding flipped classrooms practiced in pandemic situations. For the data collection, three public sector schools were chosen in Sukkur, Sindh, and Pakistan.

3.2. Population and Sampling. According to Morgan's sampling table, from the population of 90, almost all 73 students were selected as respondents to participate in this study. The sample of this study was the students of higher secondary grades of public school in Sukkur, Sindh, and Pakistan.

3.3. Data Collection Tool. Keeping in mind the quantitative method, choosing an instrument with close-ended questions was necessary to keep participants' focus in one direction and attain reliable and accurate results. The survey research method was implemented face to face to understand people's beliefs, attitudes, motivations, and behaviours. This instrument was adapted from Awidi and Paynter [32], who conducted a study to investigate the impact of flipped classroom approach on the student learning experience. The questionnaire was modified according to the requirement of this study in the shape of adding an item, deleting an item, or changing the item's content. The questionnaire was divided into three main sections followed by demographic information of students. The demographic data covered the respondent's name, gender, grade, and name of the school. The first section was about support and motivation in using flipped classrooms, the second section was participation and collaboration in using flipped classrooms, and the last one was related to assessment and feedback in flipped classrooms.

Table 1: Significant difference emerged after applying independent-samples *t*-test.

		Independent-samples t-test								
		Levene's test for equality of variances		*t*-Test for equality of means						
		F	Sig.	*t*	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
SMFC	Equal variances assumed	4.033	0.048	−2.165	73	0.034	−0.38500	0.17786	−0.73963	−0.03037
	Equal variances not assumed			−2.111	59.110	0.039	−0.38500	0.18242	−0.75001	−0.01999
PCFC	Equal variances assumed	0.198	0.658	−2.354	73	0.021	−0.45424	0.19301	−0.83909	−0.06940
	Equal variances not assumed			−2.360	69.094	0.021	−0.45424	0.19246	−0.83817	−0.07031
AFFC	Equal variances assumed	0.044	0.835	−0.647	73	0.520	−0.10485	0.16203	−0.42793	0.21823
	Equal variances not assumed			−0.650	69.431	0.518	−0.10485	0.16132	−0.42664	0.21695

3.4. Data Analysis Approach. The data are analyzed based on these sections. Thirty items in the questionnaire were designed to express the level of agreement and disagreement with specific items on a five-point Likert scale (i.e., strongly disagree, disagree, neutral, agree, and strongly agree). It was conducted after the pandemic situation as students experienced the flipped classroom approach during pandemic. After taking the consent from students, questionnaires were distributed among the male and female students of secondary grades, i.e., higher secondary grade students of public schools in Sukkur, Sindh, Pakistan. After gathering the data, it was inserted into SPSS 24.0 for the data analysis. The data were statistically analyzed from the collected questionnaires. Independent-samples *t*-test and inferential statistics were used to determine the significant difference between two unrelated groups. Independent-samples *t*-test was used to test a comparison of mean between males' and females' higher secondary grades to analyze students' attitudes towards flipped learning.

4. Results and Findings

This section presents the findings of collected data and the analysis in terms of means and standard deviations of each construct. In addition, the below findings are supported by tables and figures for a comprehensive understanding—this research study purposed to investigate the student's attitude towards flipped classrooms during pandemic situations. The inferential statistics analysis was used to obtain the mean and standard deviation values of the dependent variable; that is, gender includes male and female. Initially, an independent-samples *t*-test was applied to test the hypothesis of the study. After analyzing the results, the decision was made based on the mean score and standard deviation whether the hypothesis will be rejected or accepted. For the first hypothesis, this study found a significant difference in the mean score of support and motivation in using flipped classrooms among male and female students (Table 1) because $t(73) = -2.165$ and $p = 0.034$.

Similarly, the means of both groups ($M = 2\text{-}1650$, $F = 3.0000$) specified that there is a change in observation. Furthermore, after testing the second hypothesis, the results indicated a significant difference in the mean score of participation and collaboration during flipped classrooms among male and female students (Table 1) because $t(73) = -2.354$ and $p = 0.021$. Similarly, the means of both groups ($M = 2.6700$, $F = 3.1242$) specified that there is a change in observation. Following the process, the third hypothesis was tested, and it was found that there is no significant difference in the mean score of assessment and feedback during flipped classrooms among male and female students (Table 1) because $t(73) = 0.647$ and $p = 0.520$. Similarly, the means of both groups ($M = 2.8800$, $F = 2.9848$) specified that there is no change in observation. Overall findings resulted from the first testing hypothesis, the alternative hypothesis is accepted, and the null hypothesis is rejected. Similarly, the second hypothesis indicated the same results. In contrast, a vital distinction is found in the third testing hypothesis in which the null hypothesis is accepted; however, the alternative is rejected.

Cohen's *d* statistics for independent-samples *t*-test were used to report each construct's effect size, indicating its significance (see Table 1). The effect size is interpreted according to the benchmark proposed by Cohen [41] as small effect size ($d = 0.2$), medium effect size ($d = 0.5$), and large effect size ($d = 0.8$). The variations based on gender emerged from the calculations that relied on standardized mean differences. According to Cohen's *d* statistics, the effect size was $d = 0.7$, a large effect size for the first construct about support and motivation gained through flipped classroom approach, which shows a highly significant difference in the mean of males and females on a gender-based.

In contrast, $d = 0.8$ was found for the effect size of another construct about participation and collaboration in flipped classrooms, and it is also considered a large effect size. A negative result has been observed while calculating effect size for assessment and feedback in flipped classrooms; $d = 0.21$ is reported as a small effect size. This shows no

Table 2: Description for all items.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. deviation
Item 1	73	1.00	5.00	2.9726	1.57209
Item 2	73	1.00	5.00	2.8493	1.32990
Item 3	73	1.00	5.00	2.6027	1.33062
Item 4	73	1.00	5.00	2.5753	1.32201
Item 5	73	1.00	5.00	2.6575	1.41636
Item 6	73	1.00	5.00	2.8493	1.36087
Item 7	73	1.00	5.00	2.5753	1.48995
Item 8	73	1.00	5.00	2.6438	1.36799
Item 9	73	1.00	5.00	3.3014	1.47841
Item 10	73	1.00	5.00	2.8630	1.57511
Item 11	73	1.00	5.00	2.4521	1.32331
Item 12	73	1.00	5.00	3.1233	1.51790
Item 13	73	1.00	5.00	2.7534	1.39225
Item 14	73	1.00	5.00	2.6438	1.50342
Item 15	73	1.00	5.00	2.9315	1.45611
Item 16	73	1.00	5.00	2.7673	1.48624
Item 17	73	1.00	5.00	3.0411	1.51326
Item 18	73	1.00	5.00	3.0822	1.47905
Item 19	73	1.00	5.00	3.0274	1.45270
Item 20	73	1.00	5.00	2.9315	1.36757
Item 21	73	1.00	5.00	3.5205	1.53758
Item 22	73	1.00	5.00	2.8356	1.43385
Item 23	73	1.00	5.00	3.7323	1.28538
Item 24	73	1.00	5.00	2.8356	1.36436
Item 25	73	1.00	5.00	2.7323	1.27453
Item 26	73	1.00	5.00	3.1781	1.39784
Item 27	73	1.00	5.00	2.6301	1.41918
Item 28	73	1.00	5.00	2.7260	1.53894
Item 29	73	1.00	5.00	2.3973	1.52516
Item 30	73	1.00	5.00	2.7260	1.48380

significant difference in the means of the two groups, i.e., males and females.

As discussed above, the independent-samples t-test compares the mean of two unrelated groups. Similarly, this study compared the gender-based mean of males and females presented in Table 2. It shows genders and constructs on a vertical axis and participants, mean, and standard deviation on the horizontal axis. The findings indicated that the overall mean score is 2.6150 and the standard deviation is 0.65 for male respondents ($n = 40$) as opposed to female respondents ($n = 33$), whose mean score is 3.0000, and the standard deviation is 0.86 for the first construct about support and motivation gained through flipped classroom (see Figure 1). With a bit of difference, for the second construct about participation and collaboration throughout flipped classroom approach, the overall mean score is 2.67, and the standard deviation is 0.83 for male respondents ($n = 40$) as opposed to female respondents ($n = 33$), whose mean score is 3.12 and the standard deviation is 0.807 (see Figure 1). Likewise, the findings for the third construct about the assessment and feedback process in flipped learning revealed that 2.88 is the overall mean and 0.70 is the standard deviation for male respondents ($n = 40$), which is different from female respondents ($n = 33$); i.e., 2.92 is overall means and 0.67 is the standard deviation. According to the Hassam (2015) mean range table, the overall mean of each construct

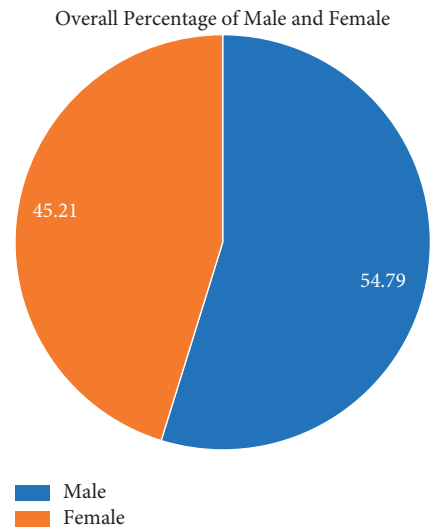

Figure 2: Overall percentage of male and female.

is in the moderate range. No more significant difference was found in males and females of higher grades.

Figure 2 presents the overall percentage according to gender, i.e., male and female. The percentage showed that 45% of females attempted the questionnaire, while on the other hand, 55% of males participated in this research study. Furthermore, the below results are discussed explicitly in terms of description for all the 30 items that are elaborated under the heading of each construct's mean and standard deviation.

4.1. Support and Motivation in Using Flipped Classroom (SMFC). The results related to this construct showed that many students expressed their satisfaction with the support and motivation gained by students through flipped classrooms. The overall mean score for item 1 is observed as (2.97), which indicated that more than 40% of respondents preferred flipped classroom approach over the traditional classroom, while only 28% disagreed with this statement ($M = 2.84$, $S = 1.32$). In a like manner, the mean score of Item 2 reported as 2.84 highlighted that majority of participants, i.e., 15%, strongly agreed and 27% agreed that flipped classroom motivated them to take online quizzes and lectures ($M = 2.60$, $S = 1.33$). 50% of respondents strongly agree on the Likert scale with the statement that the prerecorded lectures motivated them to learn more about the topic/subject ($M = 2.57$, $S = 1.32$). Along with the same, 2.60 overall mean score of Item 3 showed that 44% of responses are in favour that out-of-class and in-class tasks increase the cognitive load ($M = 2.65$, $S = 1.41$). In the same way, the overall mean score for item 4 is 2.57, which revealed that most respondents agreed that flipped lectures supported learning difficult concepts in the subject. The overall mean score is 2.65, which says that flipped classroom is a key to increasing intrinsic motivation, and this statement was supported by 45% of respondents, while only 30% were not agreed and the remaining was neutral. 2.84 mean score was observed for item 6 ($M = 2.84$, $S = 1.36$). A high frequency of

responses, i.e., 26%, was strongly agreed and 31% were agreed that flipped classrooms helped to complete tasks on time ($M = 2.57$, $S = 1.48$). As a learner, 54% of students see themselves as competent when using digital sites during flipped classrooms ($M = 2.64$, $S = 1.36$). Findings showed that a high percentage of students disagreed with the statement that they faced difficulty using digital sites while using flipped classrooms, which means it was easy for most students to use technology ($M = 3.30$, $S = 1.47$). Likewise, significantly more students strongly agreed (28%), agreed (14%) than disagreed (11%), and strongly disagreed (23%), but (16%) expressed a neutral view regarding the use of flipped classroom in the face-to-face classes other than pandemic situations ($M = 2.86$, $S = 1.57$).

4.2. Participation and Collaboration in Using Flipped Classroom (PCFC). The majority of students strongly agreed that flipped classrooms gave more opportunities to communicate with other students ($M = 2.45$, $S = 1.32$). However, 11% strongly disagreed, and 10% disagreed regarding participating actively during a discussion in the flipped classroom ($M = 3.12$, $S = 1.51$). 35% of students favoured that the instructors' strategies improved students' team-based skills and peer-to-peer interaction, while 14% were neutral and 31% were disagreed ($M = 2.75$, $S = 1.39$). More than 50% of responses showed that flipped classroom activities were primarily based on 21st-century skills ($M = 2.64$, $S = 1.50$). It was easy for 42% of students to collaborate with other fellows during online quizzes ($M = 2.93$, $S = 1.45$). Again, the proportions of students with strongly agree were relatively high when asked to create excitement for class, content, and learning in flipped learning ($M = 2.76$, $S = 1.48$). However, 50% of respondents expressed disagreement with the statement that flipped classroom increases deep thinking (problem-solving, analysis, and reasoning) ($M = 3.04$, $S = 1.51$). A high percentage of respondents (38%) disagreed that flipped classroom is an enjoyable learning method ($M = 3.08$, $S = 1.47$). 35% of respondents agreed; however, 38% of respondents and 14 exceptions with neutral regarding multiple strategies were used in out-of-class group activities ($M = 3.02$, $S = 1.45$). The majority agreed that adequate time was spent on pre-reading materials in flipped classroom ($M = 2.93$, $S = 1.36$). The findings revealed that 2.76 is the overall mean for male respondents, which differs from female respondents, i.e., 3.12 overall mean as shown in Table 1 ($M = 2.87$, $S = .846$).

4.3. Assessment and Feedback in a Flipped Classroom (AFFC). Contradicting the results of the first two constructs, negative results emerged in the third construct about assessment and feedback in flipped classrooms. More than 50% of respondents disagreed that online assignments were more accessible to handle in flipped classrooms than assignments given in face-to-face classrooms ($M = 3.52$, $S = 1.53$). 39% of respondents showed agreement, and 24% were neutral; however, the remaining disagreed that the teacher always shared the assessment criteria before flipped class ($M = 2.83$, $S = 1.43$). A high proportion of respondents disagreed that their performance was excellent in online quizzes compared with face-to-face class tests ($M = 3.73$, $S = 1.28$). A high dimension of respondents agreed that feedback given by the instructor gave them direction to improve ($M = 2.83$, $S = 1.36$). More than 50% agreed that feedback also helped them improve digital technology skills ($M = 2.73$, $S = 1.27$). A high percentage of respondents showed agreement, while talking about the feedback given by the instructor in the flipped classroom was challenging to understand and incorporate ($M = 3.17$, $S = 1.39$). Likewise, significant respondents (45%) agreed that instructors used different assessment methods to assess flipped classrooms ($M = 2.72$, $S = 1.53$). However, 46% agreed that pen-paper assessment is easy than online quizzes ($M = 2.39$, $S = 1.52$). 49% agreed, 28% disagreed, and 14% were neutral that creative skills are discouraged in flipped classrooms ($M = 2.72$, $S = 1.48$).

5. Discussion

This section discusses the findings in light of previous studies conducted on flipped classrooms in different contexts. The results showed that students are more likely to prepare beforehand in flipped classrooms than in traditional classes. It also showed that flipped classrooms helped students to manage the cognitive workload in pandemic situations. Moreover, pre-recorded lectures also allowed students to shape their learning according to their personal needs and learning styles. It also concluded from the results that it improves students' motivation to learn more about the topic.

Similarly, previous studies also supported this concept as findings showed that flipped classrooms enhanced the quality of learning. The literature also reported that learning complex content via watching videos and other learning strategies helped students perform better [42]. In addition, Akçayır and Akçayır [33] advocated the idea that flipped classroom enhances student's motivation and level of engagement, which are essential elements of the conducive learning environment. However, contradictory results were also found while discussing the difficulties or issues faced using technological digital tools. Many students from poor backgrounds lack the technological skills and competencies in public sector schools in Pakistan. For this reason, the research study highlighted the importance of technology competency as troublesome, and video lectures with poor quality and limited skills and technical issues affect students' learning negatively [26, 33].

It is also revealed from the results of this study that flipped learning helped develop 21st-century skills such as communication, thinking, interpersonal, and self-direction among students of public schools to deal with the challenges of the 21st century. Hussain, Minaz, Ahmad, and Idris [25] also highlighted the same idea in their study that flipped classroom advocates group learning activities, teachers must guide and facilitate group leaders to manage and organize activities by enhancing 21st-century skills. Findings also showed the significance of flipped classroom approach as a high number of students agreed that for the other part of a flipped learning approach, their teachers engage them in group activities, discussions, mind mapping, or

brainstorming activities to make the learning environment conducive. In the same way, a research study highlighted the significance of flipped classrooms in the Pakistani context that classrooms must be favourable to learning and students engaged in collaborative learning, discussions, concept mapping, and communicative applications through intelligent devices. No doubt, flipped classroom has significant value in engaging students in active learning.

Furthermore, when it is asked the students about the assessment taken in the flipped learning approach, they believed that teachers used different learning experiences, online tutorials, and technological tools to achieve learning goals. On the other hand, the best strategies defined in literature are problem-based learning, think pair and share, simulation, and discussions that help construct knowledge. While explaining the importance of presentations and individual/paired quizzes, it was stated by students in this study that these active strategies use critical thinking skills to empower their engagement. A research study also supports this point that in attaining higher levels of Bloom's taxonomy, a flipped classroom is a purposeful approach [9].

On the contrary, findings showed that no proper assessment methods were used to assess flipped classroom learning in public schools in Pakistan. Many teachers in these schools did not use any criteria for the assessment before the class, which is negatively affecting the student's performance and achievements. However, it is seen in a study that supported the use of formative assessment in flipped classroom approach along with real-life applications, inquiry-based learning, and collaborative and cooperative group discussions for more authenticity [1].

6. Conclusion

It can be concluded from this research study that flipped classrooms in some areas are proved as a practical approach, but in others still, it needs some improvement. The significant findings from this study suggested that the post-pandemic results showed that flipped classroom as a practical learning approach enhanced student engagement, performance, and learning in the class. It is also summed up that after the pandemic situation, a large number of students favoured the flipped classroom approach over traditional pedagogy. As noted above, flipped classroom model enhanced student's engagement, increased student's learning experiences, and improved students outcomes, supported meaningful construction of active knowledge and experiential learning, satisfaction, confidence, creativity, problem-solving skills, more retention, application skills, and ICT skills, and improvement in attendance and reduction in course withdrawal after the pandemic situation. On the other hand, findings also showed that the flipped classroom assessment methods failed to improve students' learning and performance that mean assessment methods that were used in flipped classroom were not effective. This area, which is assessed in flipped classrooms, still needs to be researched for further amelioration. In addition, some other hindrances in effectively using flipped classroom approach including students with less competency in IT skills, teacher's limited pedagogical skills, and technical issues in gadgets affected student's learning negatively in flipped classroom approach; students felt an extra burden and anxiety. Students were also unsure about their success and workload. Students find difficulties in choosing an appropriate strategy for in-class timings. Students also faced difficulties in evaluating and assessing problem-solving and critical skills.

This study will help to further integrate this approach in higher levels of institutions by keeping in mind its effectiveness and hindrances in Pakistan. This research study will be the remarkable help for the teachers as well students to implement in their teaching and learning process. It is more useful for the school stakeholders to choose alternative approaches such as flipped classrooms to continue their learning process. This study is much more useful for the parents to prepare their child and have an eye on their child's learning during online classes.

Data Availability

The data are not applicable to this study.

Conflicts of Interest

The authors of this research study declare that there are no conflicts of interest.

References

[1] S. J. DeLozier and M. G. Rhodes, "Flipped classrooms: a review of key ideas and recommendations for practice," *Educational Psychology Review*, vol. 29, no. 1, pp. 141–151, 2017.

[2] J. Bergmann and A. Sams, "Before you flip, consider this," *Phi Delta Kappan*, vol. 94, no. 2, p. 25, 2012.

[3] Education Week, "Map: coronavirus and school closures," 2020, https://www.edweek.org/ew/section/multimedia/map-coronavirus-and-school-closures.html.

[4] C. Hodges, S. Moore, B. Lockee, T. Trust, and A. Bond, "The difference between emergency remote teaching and online learning," *Educause Review*, vol. 27, 2020.

[5] M. Vaismoradi and S. Snelgrove, "Theme in qualitative content analysis and thematic analysis," *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, vol. 20, 2019.

[6] L. Kolb, *Learning First, Technology Second. The Educator's Guide to Designing Authentic Lessons*, ISTE, Eugene, OR, USA, 2017.

[7] L. Kolb, "Keynote: the triple E framework: using research-based strategies for technology integration," in *Proceedings of the SITE-Society for Information Technology & Teacher Education International Conference 2020*, 2020.

[8] H. N. Mok, "Teaching tip: the flipped classroom," *Journal of Information Systems Education*, vol. 25, no. 1, p. 7, 2014.

[9] M. B. Gilboy, S. Heinerichs, and G. Pazzaglia, "Enhancing student engagement using the flipped classroom," *Journal of Nutrition Education and Behavior*, vol. 47, no. 1, pp. 109–114, 2015.

[10] V. I. Stone and J. P. Lane, "Modeling technology innovation: how science, engineering, and industry methods can combine to generate beneficial socioeconomic impacts," *Implementation Science*, vol. 7, no. 1, pp. 44–19, 2012.

[11] G. J. Hwang, C. L. Lai, and S. Y. Wang, "Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies," *Journal of Computers in Education*, vol. 2, no. 4, pp. 449–473, 2015.

[12] E. V. Karmanova, E. V. Chernova, and A. S. Dokolin, "Modeling knowledge assessment with gamification technology on E-learning platform," in *Proceedings of the 2019 International Multi-Conference on Industrial Engineering and Modern Technologies (FarEastCon)*, pp. 1–6, IEEE, Vladivostok, Russia, 2019.

[13] K. Sakulprasertsri, "Flipped learning approach: engaging 21st century learners in english classrooms," *LEARN Journal: Language Education and Acquisition Research Network*, vol. 10, no. 2, pp. 132–143, 2017.

[14] F. Khan, W. Ahmed, A. Najmi, and M. Younus, "Managing plastic waste disposal by assessing consumers' recycling behavior: the case of a densely populated developing country," *Environmental Science and Pollution Research*, vol. 26, no. 32, pp. 33054–33066, 2019.

[15] B. Alcott and P. Rose, "Schools and learning in rural India and Pakistan: who goes where, and how much are they learning?" *Prospects*, vol. 45, no. 3, pp. 345–363, 2015.

[16] T. Andrabi, J. Das, and A. I. Khwaja, "A dime a day: the possibilities and limits of private schooling in Pakistan," *Comparative Education Review*, vol. 52, no. 3, pp. 329–355, 2008.

[17] C. Lee, M. Kim, Y. J. Kim et al., "Soft robot review," *International Journal of Control, Automation and Systems*, vol. 15, no. 1, pp. 3–15, 2017.

[18] A. J. Khokhar and S. Javaid, "Students and teachers perceptions of ICT use in classroom: Pakistani classrooms," in *Proceedings of the Asian Conference on Technology in the Classroom*, Kobe, Japan, 2016.

[19] R. Malik and A. Naveed, "Financing education in Pakistan: the impact of public expenditure and aid on educational outcomes. Research consortium on educational outcomes and poverty (RECOUP)," *Dhaulagiri Journal of Sociology and Anthropology*, vol. 11, 2012.

[20] S. Salam, Z. Jianqiu, Z. H. Pathan, and W. Lei, "Strategic barriers in the effective integration of ICT in the public schools of Pakistan," in *Proceedings of the 2017 International Conference on Computer Science and Artificial Intelligence*, pp. 169–172, Jakarta, Indonesia, 2017.

[21] L. Drake, M. Kayser, and R. Jacobowitz, "The flipped classroom. An approach to teaching and learning," 2016, https://www.newpaltz.edu/media/the-benjamin-center/P.Brief_2020Vision-Flipped%20classroom.pdf.

[22] D. J. Lipomi, "Video for active and remote learning," *Trends in Chemistry*, vol. 2, no. 6, pp. 483–485, 2020.

[23] T. Alghamdi, W. Hall, and D. Millard, "A classification of how MOOCs are used for blended learning," in *Proceedings of the 2019 4th International Conference on Information and Education Innovations*, pp. 1–7, New York, NY, USA, 2019.

[24] S. M. P. Schmidt and D. L. Ralph, "The flipped classroom: a twist on teaching," *Contemporary Issues in Education Research*, vol. 9, no. 1, pp. 1–6, 2016.

[25] S. Hussain, M. Minaz, N. Ahmad, and M. Idris, "The effect of E-reading and printed document reading on student's comprehension and retention power," *International Conference on Computational and Social Sciences*, vol. 25, 2015.

[26] J. S. M. Chua and F. A. Lateef, "The flipped classroom: viewpoints in Asian universities," *Education in Medicine Journal*, vol. 6, no. 4, 2014.

[27] H. Z. Shafi, F. Rahman, M. Asif et al., "Concentrate management technologies for desalination processes leading to zero liquid discharge: technologies, recent trends and future outlook," *Desalination and Water Treatment*, vol. 105, pp. 92–118, 2018.

[28] A. S. Sultan, "The flipped classroom: an active teaching and learning strategy for making the sessions more interactive and challenging," *JPMA. The Journal of the Pakistan Medical Association*, vol. 68, no. 4, pp. 630–632, 2018.

[29] M. Minaz and A. Ahmad, "Gender wise comparison of flipped classroom strategy on the performance of prospective teachers," *Advances in Social Sciences Research Journal*, vol. 5, no. 3, 2018.

[30] K. Sattar, A. Sethi, A. Akram, T. Ahmad, J. John, and M. S. B. Yusoff, "Flipped classroom teaching modality: key concepts and practice endorsements," *Education in Medicine Journal*, vol. 11, no. 1, p. 10, 2019.

[31] L. J. Day, "A gross anatomy flipped classroom effects performance, retention, and higher-level thinking in lower performing students," *Anatomical Sciences Education*, vol. 11, no. 6, pp. 565–574, 2018.

[32] I. T. Awidi and M. Paynter, "The impact of a flipped-classroom approach on student learning experience," *Computers and Education*, vol. 128, pp. 269–283, 2019.

[33] G. Akçayır and M. Akçayır, "The flipped classroom: a review of its advantages and challenges," *Computers and Education*, vol. 126, pp. 334–345, 2018.

[34] C. Stöhr, C. Demazière, and T. Adawi, "The polarizing effect of the online flipped classroom," *Computers in Education*, vol. 147, Article ID 103789, 2020.

[35] W. L. Shih and C. Y. Tsai, "Students' perception of a flipped-classroom approach to facilitating online project-based learning in marketing research courses," *Australasian Journal of Educational Technology*, vol. 33, no. 5, 2017.

[36] C. Rotellar and J. Cain, "Research, perspectives, and recommendations on implementing the flipped classroom," *American Journal of Pharmaceutical Education*, vol. 80, no. 2, p. 34, 2016.

[37] C. K. Lo and K. F. Hew, "A critical review of flipped classroom challenges in K-12 education: possible solutions and recommendations for future research," *Research and Practice in Technology Enhanced Learning*, vol. 12, no. 1, pp. 4–22, 2017.

[38] H. Perraton, "A theory for distance education," in *Distance Education: International Perspectives*, pp. 34–45, Routledge, New York, NY, USA, 2020.

[39] R. Slama, J. Reich, C. J. Buttimer et al., "Remote learning guidance from state education agencies during the COVID-19," 2020, https://edarxiv.org/437e2.

[40] X. H. Wang, J. P. Wang, F. J. Wen, J. Wang, and J. Q. Tao, "Exploration and practice of blended teaching model based flipped classroom and SPOC in higher university," *Journal of Education and Practice*, vol. 7, no. 10, pp. 99–104, 2016.

[41] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, Erbaum Press, Hillsdale, NJ, USA, 2nd edition, 1988.

[42] S. H. B. Halili, N. Hijja, N. Rabihah, H. Sulaiman, and R. A. Razak, "Exploring the flipped classroom approach in the teaching and education international," 2019, https://www.ei-ie.org/en/detail/16723/covid-19-educators-call-for-global-solidarity-and-a-human-centred-approach-to-the-crisis.