Chapter 14
Students' Perception of ICT Use in Higher Secondary School Students: An Exploratory Factor Analysis Approach

Gouranga Patra, Sumona Datta, and Rikta Mukherjee

Abstract Information and communication technology (ICT) made a lot of changes in the process of education. It helped students in their holistic development of learning. The application of ICT-based education in India is not significantly higher but we observed a lot of initiatives taken by private and public organizations to make it an alternative mode of teaching and learning. But it is quite difficult for school-level applications because of infrastructure, use of technology devices, and Internet connectivity. Therefore, the present study attempted to examine the student's perception of ICT used and how ICT helps students in their teaching and learning development. A total of 401 participants were administered a set of items that included statements about their attitude toward ICT use. The data were analyzed using descriptive statistics, inferential statistics, and principal component analysis. We found that there are four important determinants of the ICT-enable teaching and learning process, the *effectiveness of learning, innovation in learning, engagement in learning*, and *learning efficacy*. The other notable outcome is that the perception of ICT-based learning between gender is the same but there is an attitudinal difference concerning their geographical location and academic background. Therefore, the study gave us an indication that if schools develop proper infrastructure which is needed for ICT-based teaching, and design the course curriculum in line with technology-based teaching, then it should be the effective method of teaching and learning in school education for the holistic development of students.

Keywords Perception · ICT · Exploratory factor analysis · Higher secondary school · Digitalization

G. Patra (✉)
Department of Management, Adamas University, Kolkata, West Bengal, India

S. Datta
Government General Degree College, Singur, Hoogly, West Bengal, India

R. Mukherjee
School of Education, Adamas University, Kolkata, West Bengal, India

A. Omrane et al. (eds.), *Digital Technologies for Smart Business, Economics and Education*, Arts, Research, Innovation and Society,
https://doi.org/10.1007/978-3-031-24101-7_14

1 Introduction

Information and communication technology is an important tool in our daily life. It is the basic thought of the digitalization era. Information and communication technology (ICT) was widely used in various industries, but during the pandemic it acted as a basic parameter of the education system (Tezci, 2012; Kubiatko & Halakova, 2009). It played a more important role in changing the educational curriculum starting from the pedagogical process to deliberation of thought. The traditional methods of teaching-learning have become challenging after the introduction of ICT in education.

However, research suggests that the use of ICT is not very effective for the students in their learning outcomes (Woreta et al., 2013; Sarfo & Ansong-Gyimah, 2011; Tezci, 2012; Drent & Meelissen, 2008). Venkatesh and Abrami (2006) conducted a study to access the perception of students based on ICT-based teaching using expectancy-value theory. The theory is based on persons' perceived value and expectancy of success which determine their intention to perform a job. The study proposed that students are likely to use ICT-based teaching if they develop perceived value, which is related to the high success of innovation and value perceived to offer more than perceived cost. It claimed that perceived value leads to decision-making which may enhance their adaptation (Wigfield & Cambria, 2010; Pintrich & Schunk, 2002). Nevertheless, educational institutions are trying to adopt the online platform in their teaching-learning process. The basic reasons for acceptability are ease of use, learning flexibility, and a controlled environment from a remote location system. To enhance the engagement level of students, there is a need for the instructor's presence and learner interaction and to make them confident about the ease of use of technology and its benefits (Gray & DiLoreto, 2016). In India, education through ICT is in a nascent stage, due to the problem of infrastructure a major chunk of government institutes is unable to adopt it, but in due course the government is trying to implement ICT in their education system. Teachers play an important role in the implementation of ICT because they integrate pedagogy with technologies to enhance student learning. Therefore, all the intricacy related to the operational process must be understood by the trainer to make a learning environment for students by proving a space for information exchange and generating deeper thinking (Zhu, 2018).

Research indicated that the effectiveness of ICT implementation depends on the computer usage of the students. Teo (2008) claimed that students' positive attitudes toward computer technology have a direct positive influence on their innovative use of ICT. Woodrow (1991) points out that "awareness of student attitudes towards computers is a critical criterion in the evaluation of computer courses and the development of computer-based curricula." Therefore, it is obvious that schools must have the proper infrastructure of computer labs and trainers which could increase students' attention and develop a positive perception of ICT use (McLachlan et al., 2010). Students' perception of the use of ICT depends on three major criteria: how it adds value to their learning system, the expectancy of success, and the cost

associated with that. A positive relation among these indicates a higher tendency for ICT use. Charles and Issifu (2015) explained that the use of ICT perception differs among the students from private and public schools. Most private school students acknowledge the value of ICT in learning, but many do not integrate it into their studies. Different scenarios are noted for public schools because there is a lack of proper infrastructure, trainers, and awareness levels. The study also noted that the use of ICT may help administrators, students, and employers. It develops a good educational delivery process for students for enhancing their learning procedure, knowledge, and skills in the real world of work mainly in the school education system.

Fu (2013) explained various benefits associated with the ICT-enabled learning process. It helps learners to learn anytime and anywhere. They can access their study material 24 h from any location. It helps the learner to interact with the instructors and peers through virtual classes with ease and convenience. It allows learners to solve their academic-related issues without any boundaries. It is also a cost-effective method, like learning and teaching no longer depend exclusively on printed materials. Students can explore them to gain knowledge through various sources and there is ample scope to enhance their value. They can learn through MOOC courses, video clips, audio sounds, and visual presentations.

Research suggests that an ICT-based teaching module is a path to making the teaching-learning process more learner-centric and the course and curriculum have been designed for different levels of learner adaptation (Castro Sánchez & Alemán, 2011). In ICT mode, learner involvement is higher in the learning process of the virtual classroom. In each step learner responses can be counted, they could be assigned by the instructor to solve their problem, design their plans, and so forth (Lu et al., 2010). ICT, therefore, is a platform for both teachers and students to make learning mechanisms more convenient, effective, and objective oriented.

ICT is a process that gradually transforms the education system from classroom-based to automation which is more on digital space. It is not only limited to developing a customized learning management system designed for content development, but also study material preparation, assessment, evaluation, and discussion among students on academic matters. Additionally, it helps educational administrative activities like admission, registration, grievance handling, payment system, and single-window solution to student problems. There are a lot of studies indicating that ICT has a significant impact on the academic performance of students (Lowther et al., 2008; Weert & Tatnall, 2005). As Weert and Tatnall (2005) claimed, effective use of ICT enhances the quality of education and the learning process. It helps the learner to change their expectation of learning through the various sources of knowledge that depart from traditional approaches. As time goes by, the expectation of seeking a new dimension of knowledge level will enhance the willingness of students. Skills in using ICT will be an indispensable prerequisite for these learners. Researchers have explained the benefits of ICT-enabled teaching-learning.

Brush et al. (2008) have stated that ICT helps students to search various topics, solve the problem which they are unable to solve, and make an effective solution to the problem in their learning process. ICT makes knowledge acquisition more accessible, and concepts in learning areas are understood while engaging students

in the application of ICT. Therefore, it assists students to access digital information effectively and efficiently. Castro Sánchez and Alemán (2011) describe that ICT helps to search for new knowledge through accessing, selecting, organizing, and interpreting information and data. Based on learning through ICT, students are more capable of using information and data from various sources, and critically assessing the quality of the learning materials. It enhances support for student-centered and self-directed learning.

ICT helps to produce a creative learning environment. Chai et al. (2010) mentioned that ICT provides various learning methods for looking into the problem. For example, in a reading class, students can read e-books but using ICT tools they can transform them into various formats which make them easy to access. Therefore, it designs various applications that provide an innovative way to meet learning and learner needs.

ICT develops a collaborative learning environment and connects others in a remote location. Koc (2005) mentioned that the use of ICT makes learning transparent like students can discuss, share, and work together from any location if they have Internet access. This makes it a timeless system. For example, virtual or teleconference classes invite students from various locations for debate and discussion, for solving problems, exploring new ideas, as well as the development and design new thoughts and processes. There may be different methods of the learning solution. Students not only get exposure to rich knowledge but also get opportunities to share their learning outcomes to express themselves and reflect on their learning. Therefore, undoubtedly, ICT is a very useful tool in the teaching-learning system. It helps students with their holistic development of learning which makes them update their learning for a better career option. There are numerous studies indicating that in higher education systems implementation of ICT-based learning is progressing very fast because students understand and adapt to technology. It is therefore quite obvious that irrespective of their use of technology in general, they accept ICT-based learning.

Indeed, government schools are not able to support ICT-based teaching because of infrastructural issue which is not in proper shape but significant initiatives have been observed by the government to improve the infrastructure. But there is a significant development in private schools that have set up their computer lab, digital library, Wi-Fi system, smart classroom, and online value-added courses. Therefore, in the present study, we will examine the students' perception of the ICT-enabled teaching-learning system and how this system helps them for creating a better learning environment and develop their career progress.

2 Review of Literature

In the introduction, we have discussed the pros and cons of the use of ICT in the education system. But it is a fact that in higher education, the implementation level of ICT is high because of their understanding and willingness to adopt it. In this section, we will critically review researchers' contributions in this area.

Shrestha et al. (2019), Salloum et al. (2019), and Pérez-Pérez (2020) explained the mode of online teaching for developing students' confidence levels. It is applicable not only for higher studies but also for higher secondary and secondary students. It is noted that a lot of educational institutions offer online coaching for the preparation of students for examination. They also identified that satisfaction level depends on certain factors like age, gender, prior knowledge of computer literacy, and learning style. It is stated by Rogers et al. (2019) and Dearing and Cox (2018) that day-by-day technology literacy has increased for students because of a high level of use of smartphones and digital devices. They explained that diffusion of innovation is an appropriate model for technological adaptation in the education system. There is a need for proper spread out of information so that the interest level of the students will automatically increase. As Mlekus et al. (2020) stated, the technology adaptation model depends on two important factors, perceived usefulness and perceived ease of use. These two depend on course structure, learner instructional ability, level of students' engagement, the perceived learning capacity of the students in an online learning environment, and finally instructor presence with students' satisfaction. Gray and DiLoreto (2016) also claimed that students' engagement depends on learner interaction on perceived students' learning and instructor presence. It is a fact that online education is a new concept and this is evolving with rapid technology. Therefore, the design of course structure, pedagogy with technologies, and the instructors should be provided a space for information exchange and to generate deeper thinking, so that the interest level of the students will enhance (Zhu, 2018). Martin and Bolliger (2018) explained that student engagement leads to increased student satisfaction, enhances their level of motivation, reduces the sense of isolation within the study period, improves their academic performance, and finally creates a comfortable online learning environment. Therefore, it is the role of the instructors, designers, and administrators to design the course in a lucrative manner so that it enhances learner engagement. Abbasi et al. (2020) highlighted the popularity and acceptance level of e-learning in India and stated that due to rapid digitalization and effective use of communication technology, it gains greater attention among the students to have experience with e-learning using ICT. They have become more inclined toward online learning tools to interact with each other and the instructor. Khan et al. (2021) explained the preferences of students for e-learning as it provides them much freedom to connect with their teachers and fellow students and engage with their study materials in the comfort and flexibility of space and time. The easy access to study resources is found to be one of the major reasons for students to opt for e-learning. The study indicates that e-learning technology enables easy information access leading to positive attitude formation of students toward it.

There is a lot of research conducted on the issue to understand the use of ICT and its' link to academic performance (Hatlevik et al., 2015). Irrespective of a space like a school or home, ICT has an impact on learning (Wang, 2019; Fernández-Gutiérrez et al., 2020). Skryabin et al. (2015) suggested that ICT use in the classroom makes a significant impact on students' learning performance. Petko et al. (2016) investigate the relationship between ICT use and learning. They found a positive relationship between skill enhancement in mathematics, science, and reading skills while

used at home. Selwyn (1999) and Woodrow (1991) explained that the success of educational technology in school programs depends on the attitude of students and teachers. Teo (2008) discussed that perception toward ICT-based teaching-learning enhances if the readiness to accept computer technology increases in school. Hence, there is a need for proper infrastructure and awareness to enhance the readiness level. Dorup (2004) found that students have a positive attitude toward technology and that leads to a preference for ICT use in teaching. Kennewell (2001) gave a similar statement in that the positive attitude of the students can be increased with factors like classroom organization, classmate willingness, teachers, and the environment of schools.

There are some drawbacks of the ICT-based teaching process which have been heavily noted during pandemics when schools were closed for a long period. It is observed that the dropout level is high, as the students were unable to adapt to the courses because the courses are unsupervised and self-spaced and learning is isolated (Rice, 2006; Kopnina, 2020; Borup & Stevens, 2016). In this situation, it is important to enhance the motivation level of the students which may help them to develop self-efficacy that will increase their persistence and reduce the abandonment of learning (Jung & Lee, 2018).

Students' self-efficacy increases their degree of confidence to achieve a certain goal (Breslow et al., 2013; Jordan, 2014). It is also noted that students with higher self-efficacy are more likely to participate, persist, work harder, and have fewer adverse emotional reactions (Trautner & Schwinger, 2020). Students with high self-efficacy are more persistent to adopt ICT/online learning of education which leads to learning efficacy (Danesh & Shahnazari, 2020).

In school education, the major role of a teacher is to enhance the students' engagement level. In classroom teaching, it is quite high because the teacher has a physical interaction with the students (Hall et al., 2011). Researchers have defined the students' engagement level into three criteria: cognitive, behavioral, and emotional (McLennan & Keating, 2005, Hall et al., 2011). These are associated with willingness of learning, level of participation in the class, and interest in various activities (Fredricks et al., 2004; Kong et al., 2003). Some researches prove that technology helps to increase students' engagement level as well as control their learning (AAS, 2006; Abel, 2005).

Studies relating to ICT-based teaching and students' engagement, however, generate a mixed response. Some studies explained its impact on solving the critical problem as well as retention, critical listening, evaluating, and explaining (Paechter, Maier & Macher, 2010; Bransford et al., 2004); others, however, put forward contradictory findings. For instance, limited access to ICT and less confidence in technology usage may lead to less engagement. Cadwalladr (2012) proposed a blended learning environment that helps develop a "learner" feeling to the students rather than being only "listeners." Coats (2005) suggested that a learning management system is an effective tool for a better learning environment and retention level. Hattie (2003) explained that teacher–student interaction is the greater predictor of learning engagement. It is explained by the researcher that the design of pedagogy, infrastructure, Internet access, and study material supply through a learning

management system make a potential contribution to the enhancement of students' engagement (NCTM, 2012; Shuva, 2010).

There are a few studies that have been conducted by Gray and DiLoreto (2016), Zhu (2018), and Bolliger (2018) to judge the effectiveness of ICT in enhancing students' engagement. The researcher suggests that learner-to-instructor engagement strategies seemed to be most valued among the three categories of student engagement. Icebreaker/introduction discussions and working collaboratively by using online communication tools were rated as the most beneficial engagement strategy in the learner-to-learner category, whereas sending regular announcements or email reminders and providing grading rubrics for all assignments were rated most beneficial in the learner-to-instructor category. Thus, we can conclude that student engagement increases student satisfaction, enhances student motivation to learn, reduces the sense of isolation, and improves student performance in the online learning environment.

It is also noted from the abovementioned review that most of the studies have been done with higher education institutions. At the school level, the studies are limited. Despite that, it is reflected in the review that ICT helps in enhancing students' engagement, increases learning efficacy, and enhances the effectiveness of learning. Nevertheless, the review also revealed a few difficulties in the use of ICT in teaching and learning. In this context, we are trying to investigate the above components in the school education system because we found a significant transformation of the education system from offline to online during the pandemic.

3 Objectives of the Study

- To explore the components of the students' perception of ICT use.
- To examine if there is a mean difference in the perception of ICT use among the male and female students.
- To examine if there is a mean difference in the perception of ICT use among the students from urban and rural districts of West Bengal.
- To examine if there is a mean difference in the perception of ICT use among the students from science, arts, and commerce backgrounds.

4 Method

Participants Participants were 401 young adults (Male = 198, Female = 211; Mean age = 21.75 years, SD = 2.85) studying in different universities in three different districts of West Bengal. Students belonged to different academic backgrounds, that is, science, arts, and commerce. Inclusion criteria included the use of ICT in the academic curriculum of the students.

Tool Participants were asked a set of 13 statements, about the effectiveness of ICT use among the students. The statements included three response categories, "Never," "Rarely," and "Always."

Procedure Permissions were obtained from the colleges and universities across the three districts for data collection. After permissions were obtained, rapport was established with the students. The set of statements was administered in small groups of students. After data collection, the data were cleaned and analyzed using different statistical analysis techniques.

Statistical Analysis Principal component analysis was done to explore the component structure of the students' perception of ICT use. Cronbach's alpha was done to examine the internal consistency of their response. Further, the mean differences in their perception were checked concerning their gender, location, and academic background using a t-test and one-way analysis of variance.

5 Results

5.1 Descriptive Statistics

Table 14.1 shows the mean and standard deviation of the 13 items. The mean values of all 13 statements ranged between 2.03 to 2.28, while the standard deviation value ranged between 0.55 to 0.68.

Table 14.1 Descriptive statistics of the 13 statements ($n = 401$)

Items	Mean	Std. Deviation
Q1	2.07	0.550
Q2	2.04	0.590
Q3	2.13	0.685
Q4	2.18	0.639
Q5	2.23	0.655
Q6	2.03	0.597
Q7	2.21	0.597
Q8	2.28	0.653
Q9	2.24	0.613
Q10	2.19	0.626
Q11	2.21	0.598
Q12	2.20	0.609
Q13	2.21	0.600

5.2 Exploring the Component Structure of Students' Perception of ICT

The multivariate component structure of the students' perception of ICT was explored using the principal component analysis (PCA). The correlation among the statements was found to be adequate, and hence PCA was fitted.

PCA with Varimax rotation (orthogonal rotation) extracted four components, explaining a total variance of 51.06%. Based on the items that loaded on each of the components, the components were named. The first component correlates with four items and is named *Effectiveness in Learning*. The second component also correlates with four items and is named *Innovation in Learning*. The third component correlates with two items and is named *Engagement Through ICT*. Finally, the fourth component correlates with three items and is named *Learning Efficacy*. Hence, the perception of students toward the ICT method can be understood in terms of four components, that is, its *Effectiveness in Learning* (effectiveness of ICT in facilitating the learning process), *Innovation in Learning* (innovation brought in teaching pedagogy through ICT), *Engagement Through ICT* (student engagement generated through ICT), and *Learning Efficacy* (belief that one can learn better through the use of ICT) (Table 14.2).

Table 14.2 Principal component analysis exploring the component structure of students' perception of ICT ($n = 401$)

	Components			
Statements	1	2	3	4
Q-9 ICT in the teaching-learning method could better construct knowledge for the students	0.730			
Q-11 ICT helps to improve the quality of teaching	0.603			
Q-7 Makes the teaching meaningful and this makes learning more effective	0.558			
Q-3 Enhances knowledge sharing capacity	0.439			
Q8 Updated pedagogy tools to solve complex problem		0.743		
Q10 Dynamic and innovative learning environment		0.716		
Q12 Helps in teaching-learning process especially to relate with real-life practices		0.660		
Q6 Teachers can evaluate the students' progress quickly and properly by the use of ICT tools		0.470		
Q5 Helps the students to be more engaged in the lesson			0.823	
Q4 Makes learning more comfortable with easy resource available			0.736	
Q2 Helps express my depth of knowledge after teaching by using ICT				0.780
Q1 Makes understanding of lesson more interesting				0.730
Q13 ICT makes the teaching resources and materials more creative				0.436

5.3 Reliability of the Domains of Students' Perception of ICT Use

Finally, after the components were extracted, Cronbach's alpha for each of the four domains were checked to examine the level of consistency in the components extracted. It was found that all the components are moderately consistent and therefore reliable (Table 14.3).

5.4 Mean Differences in Students' Perception of ICT

Following the PCA extraction, the item raw scores were converted to factor scores for standardizing the values. Finally, mean differences with respect to gender, district, and stream of the study were compared for the four components of students' perception of ICT.

Gender differences were examined using an independent sample t-test and the difference was found to be non-significant, that is, both male and female students perceive the use of ICT to be equally effective ($p = 0.57$), innovative ($p = 0.37$), and to be promoting engagement ($p = 0.61$) and learning efficacy among students ($p = 0.76$) (Table 14.4).

On comparing the perspective of students from different districts, it was found that the students significantly differed among themselves with respect to their perception of ICT use in promoting student engagement [$F\ (2, 406) = 11.94, p < 0.0001$]

Table 14.3 Cronbach's alpha of the domains of students' perception of ICT use, extracted through PCA ($n = 401$)

Name of the component	Items included	Cronbach's Alpha
Effectiveness in learning	9, 11, 7,3	0.51
Innovation in learning	8, 10, 12, 6	0.62
Engagement through ICT	5,4	0.55
Learning efficacy	2, 1, 13	0.51

Table 14.4 Descriptive statistics and Independent sample t-test showing gender differences in the domains of students' perception of ICT use ($n = 401$)

Domains		Mean	SD	t test	df	p value
Effectiveness in learning	Male ($n = 198$)	5.14	0.99	0.571	407	0.568
	Female ($n = 211$)	5.09	0.93			
Innovation in learning	Male ($n = 198$)	5.72	1.09	0.902	407	0.368
	Female ($n = 211$)	5.61	1.21			
Engagement through ICT	Male ($n = 198$)	3.45	0.90	0.517	407	0.606
	Female ($n = 211$)	3.41	0.81			
Learning efficacy	Male ($n = 198$)	4.07	0.92	0.310	407	0.757
	Female ($n = 211$)	4.04	0.76			

Table 14.5 Descriptive statistics and one-way analysis of variance (ANOVA) showing mean differences in the domains of students' perception of ICT use concerning the different districts of West Bengal ($n = 401$)

Domains		Mean	SD	F Value	df	p value
Effectiveness in learning	Howrah ($n = 137$)	5.01	0.90	2.23	2, 406	0.11
	Hooghly ($n = 57$)	5.01	0.99			
	Birbhum ($n = 217$)	5.21	0.99			
Innovation in learning	Howrah ($n = 137$)	5.58	1.09	1.06	2, 406	0.35
	Hooghly ($n = 57$)	5.56	1.13			
	Birbhum ($n = 217$)	5.74	1.19			
Engagement through ICT	Howrah ($n = 137$)	3.29	0.85	11.94**	2, 406	0.0001
	Hooghly ($n = 57$)	3.08	0.86			
	Birbhum ($n = 217$)	3.61	0.82			
Learning efficacy	Howrah ($n = 137$)	3.89	0.75	9.28**	2, 406	0.0001
	Hooghly ($n = 57$)	3.82	0.78			
	Birbhum ($n = 217$)	4.22	0.88			

$^{**}p < 0.01$; $^{*}p < 0.05$

Table 14.6 Descriptive statistics and one-way analysis of variance (ANOVA) showing differences in the domains of students' perception of ICT use with respect to their academic background ($n = 401$)

Domains		Mean	SD	F Value	df	p value
Effectiveness in learning	Science ($n = 286$)	5.14	0.97	0.75	2, 406	0.47
	Commerce ($n = 53$)	5.13	0.78			
	Arts ($n = 70$)	4.99	1.04			
Innovation in learning	Science	5.58	1.16	5.70**	2, 406	0.004
	Commerce	6.15	0.87			
	Arts	5.64	1.23			
Engagement through ICT	Science	3.47	0.83	3.90*	2, 406	0.02
	Commerce	3.55	0.78			
	Arts	3.18	0.97			
Learning efficacy	Science	4.11	0.84	2.63	2, 406	0.07
	Commerce	3.94	0.71			
	Arts	3.89	0.91			

$^{**}p < 0.01$; $^{*}p < 0.05$

and learning efficacy [$F\ (2, 406) = 9.28,\ p < 0.0001$]. Students from the Birbhum district perceived the use of ICT to be more engaging and to be promoting efficacy in learning, in comparison to their counterparts from other districts (Table 14.5).

Finally, the students also differed significantly in their perception of ICT use with respect to the role of ICT use for bringing innovation in the learning process [F (2, 406) = 5.70, $p < 0.001$] and generating engagement among students [F (2, 406) = 3.90, $p < 0.02$] (Table 14.6).

6 Discussion

The present study had two objectives: first, to explore the components of students' perception of ICT use, and second to examine if any difference exists in their perception, concerning their gender, location, and academic backgrounds.

Exploration of the students' perception extracted four components, namely, *Effectiveness in Learning*, *Innovation in Learning*, *Engagement Through ICT*, and *Learning Efficacy*. It implies that the perception of students is understood in terms of the importance placed on the effectiveness of ICT in facilitating the learning process, innovation brought in teaching pedagogy through ICT, student engagement through ICT, and the belief that one can learn better through the use of ICT. This finding is a novel addition to the existing literature in this area of research since all previous literature focused on perceived usefulness and ease of use (Mlekus et al., 2020). However, the present finding is in line with the research findings of the Mlekus study. The components extracted are similar to the ones reported to be contributing to the student's perception of the use of ICT. For instance, the researchers discussed the role of ICT in generating student engagement as one of the key factors in shaping the students' perception. Similar findings had been reported by Gray and DiLoreto (2016) and Zhu (2018) as well. Their research also focused on the importance of teaching pedagogy in ICT use and the innovation involved in the same. The effectiveness of ICT use as one of the contributing factors was also reported previously by studies like that of Abbasi et al. (2020), who reported the importance placed on digitalization and effective use of communication technology for generating popularity and the acceptance level of e-learning. Further, studies on ICT usage in classrooms also emphasized the engagement level among students. For instance, findings from Paechter et al. (2010) and Bransford et al. (2004) reported a strong association between the use of ICT and student engagement.

It is, however, important to note that the fourth component extracted, that is, *Learning Efficacy*, has not been explored previously. Students' perception of ICT use is hugely affected by their belief about their capability to learn through ICT. This finding provides empirical evidence for studies like that of Danesh and Shahnazari (2020), which state that students with high self-efficacy are more persistent in the adoption of ICT or e-learning. Therefore, the present finding has a significant contribution to exploring and understanding the students' perception of ICT use.

In a further attempt to understand the prevalence of students' perception of ICT among different groups of students, it was found that both male and female students equally perceive the use of ICT. Rahim and Rahman (2002) and Mizrachi and Shoham (2004) found that no significant difference exists in the perception of ICT use among male and female students. However, a few other studies like Kubiatko and Halakova (2009) and Khan et al. (2021) examined the perception of ICT adaptation and found a significant difference in attitude among males and females.

Therefore, we may conclude that there is no uniformity in the inference drawn and that it may vary due to differential access to ICT tools, subject, and geographic location.

Further, the students differed among themselves concerning their perception of ICT use in promoting student engagement and learning efficacy. Additionally, we found that the students from commerce backgrounds found the use of ICT to be affected by the level of engagement and innovation, in comparison to other students from science and arts backgrounds. As reported by Danesh and Shahnazari (2020), Paechter et al. (2010), and Bransford et al. (2004), these components play a significant role in shaping the perception of ICT use among students. It is, therefore, important to note that students from different locations do differ in their perception of engagement and capability to learn. Probably this may be explained by the infrastructure and overall acceptance among students from different locations and different backgrounds.

The study findings have important implications for designing courses and developing e-learning pedagogies. Academicians should consider the students' perception of innovation in the teaching-learning process and the perception of their capability to learn through the use of ICT while designing e-learning pedagogies. Well-designed and enriching pedagogies are not only more effective but also motivate students to a greater extent, hence creating a learning niche. Present findings, therefore, have serious implications for enriching the teaching-learning process in the new normal phase of blended learning through ICT.

7 Conclusion

The present study explored the different dimensions of students' perception of ICT use in their learning process. A detailed exploration of the process revealed four components, namely, *Effectiveness in Learning*, *Innovation in Learning*, *Engagement Through ICT*, and *Learning Efficacy*. It may be concluded that the exploration of this perception has led to a better understanding of students' overall attitudes toward ICT use. The study delineates that perceptions of online teaching-learning methods differ in various geographic locations. The study gave us an indication that if schools develop infrastructure in line with ICT requirements then it can be an alternative route of learning and students can enhance their knowledge and skill which is interdisciplinary. If we look into our new education policy, more focus is given to the holistic development of the students, and the learning process should be a more skill-based and blended mode of learning. Therefore, the present study is a learning construct for the schools that are yet to start the ICT-based method of teaching-learning.

References

AAS. (2006). *Report on mathematics and statistics*: *Critical skills for Australia's future*. The National Strategic Review of Mathematical Sciences Research in Australia. Australian Academy of Science. Retrieved March 25, 2022, from http://www.review.ms.unimelb.edu.au/FullReport2006.pdf

Abbasi, S., Ayoob, T., & Malik, A. (2020). Memon, S.I. Perceptions of students regarding E-learning during Covid-19 at a private medical college. *Pakistan Journal of Medical Sciences, 36*, S57–S61.

Abel, R. J. (2005). *What's next in learning technology in higher education*. The Alliance for Higher Education Competitiveness. Retrieved February 10, 2022, from http://www.a-hec.org/index.html

Bolliger, D.U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online learning 22*, 205–222.

Borup, J., & Stevens, M. A. (2016). Parents' perceptions of teacher support at a cyber charter high school. *Journal of Online Learning Research, 2*, 227–246.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2004). *How people learn: Brain, mind, experience, and school: Expanded edition*. National Academy Press. Retrieved March 16, 2022, from http://www.csun.edu/~SB4310/How%20People%20Learn.pdf

Breslow, L. Pritchard, D. E., DeBoer, J. Stump, G. S., Ho, A. D., Seaton, D. T. (2013). Studying learning in the worldwide classroom research into edX's first MOOC. *Research and Practical Assessment, 8*, 13–25.

Brush, T., Glazewski, K. D., & Hew, K. F. (2008). Development of an instrument to measure preservice teachers' technology skills, technology beliefs, and technology barriers. Computers in the Schools, vol. 25, pp.112–125.

Cadwalladr, C. (2012). *Do online courses spell the end for the traditional university?* Retrieved February 10, 2022, from http://www.guardian.co.uk/education/2012/nov/11/online-free-learning-end-of-university.

Castro Sánchez, J. J., & Alemán, E. C. (2011). Teachers' opinion survey on the use of ICT tools to support attendance-based teaching. *Journal Computers and Education*, vol. 56, pp.911–915.

Charles, B. A., & Issifu, Y. (2015). *Innovation in Education: Students perception of implementing ICT in Learning in Second Cycle institute in Ghana, Procedia-Social and Behavioural Sciences, 197*, 1512–1519.

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

Coats, H. (2005). *Leverage LMSs to enhance campus-based students engagement*. Retrieved March 16, 2022, from http://net.educause.edu/ir/library/pdf/eqm05110.pdf

Danesh, J., & Shahnazari, M. (2020). A structural relationship model for resilience, L2 learning motivation, and L2 proficiency at different proficiency levels. *Learning and Motivation, 72*, 101636.

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs, 37*, 183–190.

Dorup, J. (2004). Experience and attitudes towards information technology among first year medical students in Denmark: Longitudinal questionnaire survey. *Journal of Medical Internet Research, 6*(1), e10.

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education, 51*, 187–199.

Fernández-Gutiérrez, M., Gimenez, G., & Calero, J. (2020). Is the use of ICT in education leading to higher student outcomes? Analysis from the Spanish autonomous communities. *Computers in Education, 157*, 103969.

Fu, J. S. (2013). ICT in education: a critical literature review and its implications, *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* vol. 9, no. 1, p. 112.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. (2004). School engagement: Potential of the concept: State of the evidence. *Review of Educational Research, 74*, 59–119.

Gray, J. A., & DiLoreto, M. (2016). The effects of student engagement, student satisfaction, and perceived learning in online learning environments. *International Journal of Educational Leadership Preparation, 11*, n1.

Hall, T., Strangaman, M. J & Meyer, P. (2011). Students' perceptions of teaching technologies, application of technologies, and academic performance. *Computers & Education, 53*, 1241–1255.

Hatlevik, O. E., Guðmundsdóttir, G. B., & Loi, M. (2015). Digital diversity among upper secondary students: A multilevel analysis of the relationship between cultural capital, self-efficacy, strategic use of information and digital competence. *Computers in Education, 81*, 345–353.

Hattie, J. (2003). *Teachers make a difference: What is the research evidence?* Australian Council for Educational Research Annual Conference on: University of Auckland.

Jordan, K. (2014). Initial trends in enrolment and completion of massive open online courses. *International Review of Research in Open and Distributed Learning, 15*, 1.

Jung, Y., & Lee, J. (2018). Learning engagement and persistence in massive open online courses (MOOCS). *Computers in Education, 122*, 9–22.

Kennewell, S. (2001). Using affordances and constraints to evaluate the use of information and communications technology in teaching and learning. *Journal of Information Technology for Teacher Education, 10*(1–2), 101–116.

Khan, M. A., Nabi, M. K., Khojah, M., & Tahir, M. (2021). Tahir, M. students' perception towards E-learning during COVID-19 pandemic in India: An empirical study. *Sustainability, 13*, 57. https://doi.org/10.3390/su13010057

Koc, M. (2005). Implications of learning theories for effective technology integration and preservice teacher training: A critical literature review, *Journal of Turkish Science Education,* vol. *2*, pp.2–18.

Kong, Q., Wong, N., & Lam, C. (2003). Student engagement in mathematics: Development of instrument and validation of construct. *Mathematics Education Research Journal, 15*(1), 4–21.

Kopnina, H. (2020). Education for the future? Critical evaluation of education for sustainable development goals. *The Journal of Environmental Education, 51*, 1–12.

Kubiatko, M., & Halakova, Z. (2009). Slovak high school students' attitudes to ICT using in biology lesson. *Computers in Human Behavior, 25*, 743–748.

Lowther, D. L., Inan, F. A., Strahl, J. D. & Ross, S. M. (2008). Does technology integration work when key barriers are removed?. *Educational Media International, vol. 45*, pp.195–213.

Lu, Z., Hou, L & Huang, X., (2010). A research on a student-centered teaching model in an ICTbased English audio-video speaking class. *International Journal of Education and Development using Information and Communication Technology, vol. 6*, pp.101–123.

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning, 22*, 205–222.

McLennan, B., & Keating, S. (2005). *Making the links to student learning*. Retrieved February 10, 2022, from https://ltr.edu.au/resources/DS6-600%20Managing%20educational%20change%20in%20the%20ICT%20discipline%20March%202009.pdf

McLachlan, C., Craig, A., & Coldwell, J. (2010). Student perceptions of ICT: A gendered analysis. *In ACE 2010: Proceedings of the Twelfth Australasian Computing Education Conference*. Australian Computer Society.

Mizrachi, D., & Shoham, S. (2004). Computer attitudes and library anxiety among undergraduates: A study of Israeli B.Ed students. *International Information and Library Review, 36*(1), 29–38.

Mlekus, L., Bentler, D., Paruzel, A., Kato-Beiderwieden, A. L., & Maier, G. W. (2020). How to raise technology acceptance: User experience characteristics as technology-inherent determinants.

Gruppe. Interaktion. Organisation. Zeitschrift für Angewandte Organisationspsychologie (GIO), 51, 273–283.

NCTM. (2012). *The role of technology in the teaching and learning of mathematics.* National Council of Teachers of Mathematics. Retrieved April 10, 2022, from http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology%20final.pdf

Paechter, M., Maier, B., & Macher, D. (2010). Online or face-to-face? Students' experiences and preferences in E-learning. *Computers & Education, 13*, 292–297.

Pérez-Pérez, M., Serrano-Bedia, A. M., & García-Piqueres, G. (2020). An analysis of factors affecting students' perceptions of learning outcomes with Moodle. *Journal of Further and Higher Education, 44*, 1114–1129.

Petko, D., Cantieni, A., & Prasse, D. (2016). Perceived quality of educational technology matters: A secondary analysis of students' ICT use, ICT-related attitudes, and PISA 2012 test scores. *Journal of Educational Computing Research, 54*, 1070–1091.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications*. Prentice Hall.

Rahim, M., & Rahman, M. N. A. (2002). A study of computer attitudes of non computing students of technical colleges in Brunei Darussalam. *Journal of End User Computing, 14*(2), 40–47.

Rice, K. A. (2006). Comprehensive look at distance education in the K-12 context. *Journal of Research on Technology in Education, 38*, 425–448.

Rogers, E. M., Singhal, A., & Quinlan, M. M. (2019). Diffusion of innovations 1. In *An integrated approach to communication theory and research* (pp. 415–434). Routledge.

Salloum, S. A., Al-Emran, M., Shaalan, K., & Tarhini, A. (2019). Factors affecting the E-learning acceptance: A case study from UAE. *Education and Information Technologies, 24*, 509–530.

Sarfo, F. K., & Ansong-Gyimah, K. (2011). Ghanaian Senior High School students' access to and experiences in the use of information and communication technology. In *Education In technological world: Communicating current and emerging research and technological efforts* (pp. 216–222).

Selwyn, N. (1999). Students' attitudes towards computers in sixteen to nineteen educations. *Education and Information Technologies, 4*(2), 129–141.

Shrestha, E., Mehta, R. S., Mandal, G., Chaudhary, K., & Pradhan, N. (2019). Perception of the learning environment among the students in a nursing college in eastern Nepal. *BMC Medical Education, 19*, 382.

Shuva, N.Z. (2010). *Integrating ICT into University Curriculum.* University of Dhaka, Bangladesh. Retrieved March 10, 2022, from http://www.academia.edu/305888/ Integrating_ICT_into_University_Curriculum_A_Proposal_forthe_Faculty_of_Arts_University_of_Dhaka_Bangladesh.

Skryabin, M., Zhang, J., Liu, L., & Zhang, D. (2015). How the ICT development level and usage influence student achievement in reading, mathematics, and science. *Computers in Education, 85*, 49–58.

Teo, T. (2008). Pre-service students' attitudes toward computer use: A Singapore survey. *Australasian Journal of Educational Technology, 24*(4), 413–424.

Tezci, E. (2012). Factors that influence pre-service teachers' ICT usage in education. *European Journal of Teacher Education, 34*(4), 483–499.

Trautner, M., & Schwinger, M. (2020). Integrating the concepts self-efficacy and motivation regulation: How do self-efficacy beliefs for motivation regulation influence self-regulatory success? *Learning and Individual Differences, 80*, 101890.

Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Students' perceptions and practices. *Journal of Technology and Teacher Education, 14*(1), 173–207.

Wang, F. H. (2019). On the relationships between behaviors and achievement in technology-mediated flipped classrooms: A two-phase online behavioral PLS-SEM model. *Computers & Education, 142*, 103653.

Weert, T. V., & Tatnall, A. (2005). Information and communication technologies and real-life learning: New education for the new knowledge society, Springer, New York.

Wigfield, A., & Cambria, J. (2010). Expectancy-value theory: Retrospective and prospective. In T. C. Urdan & S. A. Karabenick (Eds.), *The decade ahead: Theoretical perspectives on motivation and achievement (advances in motivation and achievement)* (Vol. 16, pp. 35–70). Emerald Group Publishing Limited.

Woodrow, J. E. (1991). A comparison of four computer attitude scales. *Journal of Educational Computing Research, 7*(2), 165–187.

Woreta, S. A., Kebede, Y., & Zegeye, D. T. (2013). Knowledge and utilization of information communication technology (ICT) among health science students at the University of Gondar, North Western Ethiopia. *BMC Medical Informatics and Decision Making, 13*(31), 2–7.

Zhu, X. (2018). *Facilitating effective online discourse: Investigating factors influencing students' cognitive presence in online learning*. Master's Thesis. University of Connecticut Graduate School, Storrs, CT, USA.