Work in Progress: STEM Students' Experiences with Educational Technology Tools

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Abstract

There has been an increased use of educational technology tools in STEM classrooms in the past few decades. Previous studies have discussed the impact of design, development, and use of educational technology tools on creating an interactive learning environment for students. However, in the realm of user experience, limited studies explored the context of technology and students' experiences while interacting with educational technology tools, such as students' perceived ease of use. Accordingly, this *work in progress* study explores reflections of students' experience while interacting with the most commonly used education technology tools in postsecondary classrooms. For this study, we recruited thirty undergraduate STEM students from two midwestern educational institutes. Our primary research question was: What are students' perceptions of using educational technology tools in postsecondary STEM classrooms? We collected data using an open-ended questionnaire, where students reported their experiences with educational technology tools in their classes. The students' data were analyzed using descriptive statistics and thematic analysis. The descriptive analysis indicated that students broadly used three types of education technology tools. The first type was primarily used to manage the course content, such as reading materials, grades, quizzes, assignments, and discussion (e.g., Piazza and Blackboard). The second type was used to keep students engaged during the lectures (e.g., Kahoot and clickers). The third type was the social media application (e.g., YouTube) to learn the course content. Thematic analysis revealed the presence of five themes, i.e., students perceived academic relevancy, academic usefulness, ease of use, design issues, and utility issues with the education technology tools. This study highlights the students' perceptions of their interactions with the education technology tools in STEM courses. The study of these perceptions may help us to design better educational technology tools for student-centered learning environments. Furthermore, this preliminary study is a guiding step towards understanding students' expectations with educational technology tools.

Introduction

In the past few decades, there has been a vast interest in integrating educational technology into STEM classrooms. Although there is still a debate on the effective integration of technology in a classroom environment, most researchers agree on the potential benefits of using educational technology as an effective cognitive or instructional tool (e.g., [1], [2]). For instance, Bruce and Levin [3] have suggested that educational technology can be used as an effective tool to assist and curate student-centered learning environments such as encouraging inquiry, enhancing communication, and assisting in students' self-expression. Further, several studies have highlighted the undeniable importance of technology tools for the STEM courses, especially for courses that promote problem-based or hands-on learning [4]. The rationale of this effectiveness is due to the potential of educational technology tools to simulate real-life experiences, provide scaffolding in complex cognitive tasks (e.g., solving math equations), personalized feedback, and build collaboration among peers [5].

Seeing the potential of educational technology, many studies have explored the educational technology tools' development and their impact on the students' experiences [6], [7]. For instance, Carlisle et al. [8] discussed the development and design of an educational technology tool named Raptor (Rapid Algorithmic Prototyping Tool for Ordered Reasoning) which scaffolds students in programming learning. They found that the students learn better using Raptor as it allows them to express the algorithm visually. In another study, Goldman [9] discussed the integration of the educational technology tool (i.e., Julie) to redesign the programming curriculum for better students' learning. However, limited studies have explored the students' experiences while using educational technology in the context of their usability experience (e.g., [10], [11]).

This work's overarching goal in progress study is to understand the students' perceptions of using the education technology tools. This study is vital because limited studies have explored the students' experiences with educational technology tools in the STEM domain. Furthermore, this study may help future educational technology researchers to understand students' expectations about the educational technology tools. This study's primary question is: What are students' perceptions of using educational technology tools in postsecondary STEM classrooms?

Literature Review

With the rapid development of educational technologies, a large body of literature discussing the development and integration of technology to enhance STEM classrooms has emerged. However, there is a lack of consensus on the definition of educational technology. Some researchers argue that educational technology can be defined as "the effective use of technologies, tools, techniques, resources, and processes to support learning, performance, and instruction" [12, p.10]. Another conceptualization of educational technology is any new hardware, computer, or software used to improve the classroom learning environment [13]. This study has used a similar conceptualization and refers educational technology as using any new hardware or software to supplement students' learning experiences.

Prior studies have discussed the students' experiences in two broad categories. First, studies have used the education technology tool as an intervention and explore the impact of students' interaction with this tool on their learning experience. (e.g., [14]–[16]). Second, limited studies have discussed the students' experiences (e.g., usability and perceptions) while using the educational technology tools. For instance, Asiimwe & Gronlund [17] used a Technology Acceptance Model (TAM) survey to study students' usability experience of mobile learning management systems (LMS). Their analysis revealed that even though students were frustrated with the user experience of mobile LMS (MUELE), they really liked the cost-effectiveness and accessibility of the mobile LMS for completing their tasks. Similarly, Dart et al. [18] discussed the factors responsible for improving the students' perceptions about the usefulness and ease of using an educational technology tool (i.e., worked example videos). They found that the students' perceptions can be improved if the application provides better accessibility to the course content, user-friendly design, and alignment with the course content.

The surveyed literature also showed that the studies have explored students' experiences with educational technologies to profile their learning approaches and conceptions. For instance, Lin et al. [19] used three different survey instruments. They captured students' conception (i.e., students' mental representation of self-learning), approaches (i.e., ways that learners used mobile applications to facilitate their learning process), and learners' profile (students' understanding of the application usage). Their study categorized students' experiences and found a correlation between the students' approaches to adapt mobile learning and their learning approaches. Another study [20] used different students' experience constructs (e.g., perceptions, self-efficacy, and behavioral intention) as a measure to understand the students' mobile learning adoption. Their analysis revealed that students' experiences such as perceived usefulness, ease of use, and attitude are the primary indicators to decide the students' adoption of the mobile technology tools.

Even though the literature on educational technology tools has discussed a few constructs of students' experiences like learning experiences, expectations, or usability experiences, there is further need to explore other constructs of students' experiences. The human-computer interaction (HCI), a field specifically focused on studying design and user interaction of technology, categorized the user experience broadly into three categories [21]. These categories are user expectations or perceptions (e.g., motivation, perception, or emotions, etc.), technology design characteristics (e.g., practical design, simplicity, functionality, and usability, etc.), and the interaction context (e.g., the utility of experience, social settings, and autonomous use, etc.). Therefore, there is a need to explore and understand the different constructs of students' experiences, ultimately helping future researchers design better and engaging education technology tools. Hence, this study will contribute to the existing literature on students' perceptions of their interactions with the educational technology tools in the postsecondary STEM courses. This study may help future researchers to improve educational technology tools. Further, this study is a work in progress and a guiding step to understand students' experiences with educational technology tools.

Research Methods

Site

For this study, we recruited students from two Midwestern educational institutes. The purpose of selecting two institutes was to get a broad range of STEM students' experiences. Therefore, one institute was a world-renowned public university, and the other was a community college. However, the analysis was not impacted by the student association with any of the institutes.

Participants

There were thirty STEM students. The students' reflections on their experience with the education technology were collected through an open-ended survey. Table 1 shows a detailed description of the students' university, gender, and ethnicity.

Table 1. Demographic profile distribution of 30 STEM students

Demographic Values	No. of Participants

University	
Ivy Tech Community College	1
Purdue University	29
Gender	
Male	10
Female	20
Ethnicity	
Asian American	5
Black or African American	6
White or European American	12
Hispanic or Latin American	1
Others	6

Data collection

To inform the study, the students were asked to reflect on their experiences using the following question:

How often have you been in courses where some **educational technology tools**, especially mobile applications, have been used? Tell us something about your experience.

a. Please state the name of the application(s) or other technology tools (e.g., Clicker, CATME, Socrative, Any quiz software, etc.).
b. What you liked about that application(s) and why?
c. What you didn't like and why?
d. Were those applications academically relevant? If yes, why, if no, why not?

Data Analysis

The study focuses on exploring the students' perceptions of using educational technology tools in postsecondary STEM classrooms. To inform our study, we employed descriptive statistics on the first open-ended question to see the range of the educational technology tools participants have used. For the three open-ended survey questions, the study used thematic analysis to understand, organize, and capture valuable information from the students' responses [22]. For the thematic analysis, the guidelines provided by Braun and Clarke [22] have been followed. These guidelines proposed the following phases to analyze the qualitative data 1) getting acquainted with the data; 2) produce initial codes/ labels; 3) looking for themes; 4) assessing themes; 5) defining and naming themes or main ideas; 6) generating the report.

Results

Descriptive statistics of the used educational technology tools by students

In this section, we present the summarization of the educational tool used by our participants. Table 2 shows the range of educational technology used in the postsecondary STEM classrooms as discussed by students in response to question 1. Also, it shows the primary purpose of these tools.

Table 2. Descriptive statistics of the educational technology tools.

Educational Technology tools	Number of participants	Purpose of the tool
Kahoot	5	Engagement during the lecture
iClicker	24	
Hotseat	20	
Quizlet	3	
Lon Capa	3	Managing the course content/activities
Canvas	1	
Top hat	1	
Piazza	5	
Blackboard	4	
WileyPLUS	1	
Grade scope	1	
GroupMe	1	
Slack	1	
CATME	11	
YouTube	1	Provide learning tutorial

From Table 2, it can be seen that the students broadly used three types of technology tools. The first type was primarily used to manage the course content and associated activities, such as reading materials, grades, quizzes, assignments, collaboration, and discussion (e.g., Piazza and Blackboard). The second type was used to keep students engaged during the lectures (e.g., Kahoot and iClickers). The third type was a video tutorial application (e.g., YouTube).

Further, it should be noted that the students, when asked about the application, mostly discussed their experiences about a mobile application, website, or hardware device used to poll the response system. Even though educational technology encompassed large categories of the tool, technology, and process, the perception of students' working with educational technology tools was limited to certain software or tools.

Thematic analysis

For the qualitative analysis of the three open-ended questions, thematic analysis encompassing the phases outlined by Braun and Clarke [22] was employed.

In the three questions, students were asked to inform about the aspects they liked, disliked, the academic relevance of their previously used educational technology tool, and the reason for their preference.

Table 3. Description of Thematic Analysis

Question: What you liked about that application(s) and why?		
Students' response	Codes	Themes
It was a way to check if I really understood what was going in class.	Self-evaluation of learning	Academic usefulness
It is a good platform to ask a question to the class & has discussion	Engagement and Participation	Academic usefulness
It helps to quickly… highlight the important points.	Ease of learning	Ease of use
Easy in working to complete a job done in a large class.	Easy to communicate	Ease of use
Question: What you didn't like and why?		
Students' response	Codes	Themes
Too complicated and not aesthetically pleasing. Overly complex, too many options	Cluttered Design	Design issue
CATME was never good at pairing	Poor quality of output	Utility issue
Old, obsolete, and fade in popularity both in & out of class	Poor Design	Design issue
Question: Were those applications academically relevant? If yes, why, if no, why not?		
Students' response	Codes	Themes
Connected me to class quizzes & participation	Access to the course activates.	Academic relevance
They can be used in lectures, seminars, and talks, etc.	Useful in different academic settings	Academic relevance

Thematic analysis of these questions revealed the following themes, i.e., students perceived academic relevancy, academic usefulness, ease of use, design issues (e.g., poor design), and utility issues (e.g., functional quality) with the education technology tools. Table 3. shows the students' prompts, codes, and their respective themes to briefly introduce the phase of thematic analysis.

Discussion & conclusion

The current study tries to capture students' general perceptions about their experiences with the educational technology tools. To inform our study, students were asked to reflect on the experiences with the previously used educational technology tools. To this end, our exploratory analysis showed that the purpose of the tools used by the students was to organize, access, collaborate, or engage with the coursework. Some students have also used social media tools (e.g., YouTube) to learn the class content. This is understandable because one of the primary purposes of integrating educational technology tools in the STEM course is to improve the students' accessibility, collaboration, and engagement with the classroom [4], [23], [24].

The second part of the study revealed that students valued the utility of their experience with educational technology. Therefore, students' perceived academic relevance, usefulness, and ease of use were the dominant themes that appeared while outlining their good experience with the educational technology tools. The results are consistent with the previous studies that have explored students' experiences using validated surveys (e.g., [17], [18], [20], [25]). Furthermore, popular surveys used previously, such as the Technology Acceptance Model (TAM; e.g., [17]) and Unified Theory of Acceptance and Use of Technology (UTAUT; e.g., [25]), have majorly captured the same themes (perceived usefulness and ease of use) that appeared in our study, i.e., perceived usefulness and ease of use. Therefore, these experiences should be considered while evaluating or designing the educational technology tools.

The thematic analysis of students describing their dislikes about their experience with the educational technology was interesting. The students mostly outlined the experiences associated with the tools' design aspects (e.g., poor design, complexity, functionality, usability experience, etc.). Hence, while explaining their dislikes about the experience, the predominant theme was the design issues with the educational technology. Therefore, there is a need for studies in the STEM domain exploring the educational technology tools' design aspects. This is important because several studies and experts have pointed out that if the educational technology tool's design is not carefully crafted, it could be challenging to keep the students engaged and reap the potential benefit [26]. Additionally, due to the current generation's limited attention span [27], students can easily get annoyed and disoriented by the applications that fail to provide the experience that they are looking for. Therefore, educational technology developers must tread carefully while developing the educational tools so as not to deter students from using them [28]–[30].

Limitations

Similar to any exploratory study, this experiment has few limitations. First, the thematic analysis has limited interpretive power as it was not grounded in the theoretical framework. Second, the analysis majorly relied on the participants' interpretation of the questions. Third, the analysis could have been enriched if the study had an equal representation of both selected institutes, race, and ethnicity. Finally, a mixed research study could have informed us better about the students' perception of using the educational technology tools.

Future directions

Being a work in progress study, a few directions could be suggested. First, the research can design a mixed research method to better understand the students' experience of using educational technology tools. Second, there is a need of validated instruments in the STEM literature that could capture all constructs of the students' experiences while using the educational technology tools. Finally, the future researcher can explore the mature HCI, a more informed field, to study mobile educational technology tool's experiences.

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