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RESEARCH ARTICLE

From student feedback to design: Revisiting mobile courseware interfaces

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Abstract: This exploratory case study investigated students' preferences for mobile courseware tailored to student tasks, presenting a new classification for the app elements utilized in education. Preferences for mobile app interface elements were assessed through an action tracking system, while an embedded evaluation form highlighted reasons behind the preferences. The results showed that students predominantly preferred the apps due to their ease of use and attractive designs, though some criticized the form elements for being difficult and time-consuming. Evaluations of the interface elements differed based on their features and the content of the activities.

Keywords: interface design, interface elements, mobile courseware, human-computer interaction

1 Introduction

With the integration of mobile devices in learning environments, educators have introduced various courseware. Mobile learning supports student-centered learning, allowing learners to engage with resources at their own pace. Mobile learning also supports informal and authentic learning. It promotes personalized learning, enabling students to choose tasks based on their preferences (Santoianni, 2021). Interfaces for mobile devices have developed through an extensive process influenced by the capabilities of operating systems. Interfaces play a key role in mobile learning by ensuring easy access to information and addressing individual needs (Fessakis, Gouli, & Mavroudi, 2013), which in turn makes learning more flexible and personalized. Thus, engaging interfaces in courseware can foster student-content interaction and help develop their creativity (Jahnke & Liebscher, 2020). In online learning, the elements like menus, links, and graphics which should be harmonious, easily recognizable, and cohesive. Also visual appeal is considered vital for enhancing student mobile learning performance (Adnan et al., 2015; Lauc et al., 2020).

Mobile learning interfaces should focus on features that are easy to use and match students' needs and preferences. However, it is important to ensure that these apps are actually effective for learning. Papadakis (2023) pointed out that app developers often label their products as "educational" for young children, but these labels don't guarantee that the apps are validated for educational use. By aligning the design with these factors, mobile learning environments can become more intuitive, efficient, and supportive of student-centered learning, ultimately enhancing the overall learning process. Therefore, studying students' preferences on mobile courseware interface designs can provide valuable insights for designers and educators, helping them create more effective and engaging learning experiences.

1.1 Mobile courseware interface designs and students' preferences

The main function of interfaces is to facilitate interaction between learners and the instructional content, effectively capturing learners' attention (Zamri & Al Subhi, 2015). Various educational software interfaces, such as computer simulations, are emphasized in numerous studies especially in the context of personalized learning (Papadakis et al., 2022). Software interface designs are assessed from both the designer's and user's viewpoints, prompting companies to publish guides for app developers. These design guides aim to enhance usability across platforms (Neil, 2014; Nilsson, 2009). Among the most well-known is Nielsen's Ten Usability Heuristics (Nielsen, 1995), and another approach involves refining interface designs using experimental data from usability tests (Warsi, 2011; Zaini et al., 2017).

The limited cognitive capacity of learners highlights the need for meaningful, clear, and appropriate interface designs, particularly in educational applications (Yung & Paas, 2015). User preferences are influenced by various factors, including individual characteristics such as motivation, enjoyment, satisfaction, personality, and experience level (Ketipov et al., 2024). Additionally, interface elements like input features, output indicators, dialog structures, color use, icons, commands, graphics, natural language, 3-D elements, and user support also play a significant role (Shneiderman et al., 2016). Furthermore, task complexity, ranging from easy to demanding, and productivity factors such as output enhancement, quality improvement, cost reduction, error minimization, and reduced labor and usage time, also influence user preferences (Gao et al., 2014). In this context, Chatzopoulos (2022) emphasized that app selection should be guided by factors such as suitability for the target age group, the ability to cover a broad range of learning objectives, and the availability of free downloads.

Shneiderman et al. (2016) suggest that designers often try to empathize with users by thinking from their perspective and drawing on their own experiences. However, despite principles advocating for consideration of both teachers and students, instructional app designers frequently struggle to adhere to these due to their personal biases, design habits, and limitations of the software tools they use (such as programming languages and authoring software). This creates a dilemma between the preferences of designers and users regarding interface designs that must be addressed.

Previous studies suggest that interface elements can significantly influence user preferences, and these preferences can, in turn, shape application usage. Research has often focused on aspects like data input forms and reporting processes. For instance, Adak and Durdu (2011) found that the most efficient data input methods involved buttons, combo boxes, radio buttons, and text boxes, in that order. Castelluci and MacKenzie (2011) evaluated text entry methods on Android devices and identified the virtual keyboard as the most effective. In addition, Azenkot and Lee (2013) found that users preferred voice recognition over the virtual keyboard for free text input tasks.

Examining data input methods and text entry techniques is crucial, as they directly impact students' ease of use and satisfaction with mobile learning platforms. Elements like voice recognition and varied input forms contribute to smoother, more intuitive interactions. In online learning, where quick, effective interaction is vital, the study ensures that interface designs meet the needs of digital learners. This highlights the importance of tailoring mobile learning applications (Almaiah, et al., 2022). It's important to note that many evaluations of instructional apps tend to focus mainly on basic design elements like color and size, often overlooking other key factors. In this context, some studies suggest that quantitative data and its descriptive analysis at the development stage can help gather students' preferences regarding the elements of learning apps (Verawati, et al., 2022). Another study revealed positive feedback in the surveys conducted on the application, implying that evaluations can be gathered directly through the apps (Retuerto & Andrade-Arenas, 2023). By collecting such data, user interaction can be better understood, allowing for improvements in the learning experience that more effectively cater to learners' needs, ultimately enhancing the app's overall effectiveness in online environments.The study explores a framework for gathering student feedback and incorporating it into the design process, offering valuable insights for mobile courseware designers.

1.2 Aim of the study

In mobile courseware, interface elements are typically shaped by style guides, design guidelines, the software tools used, and the designers' own creativity and habits. While these apps are intended for student use, student feedback often takes a backseat in the design process. This study aimed to identify student preferences for interface elements in mobile courseware, enabling designers to consider these preferences when planning the interface before developing the courseware.

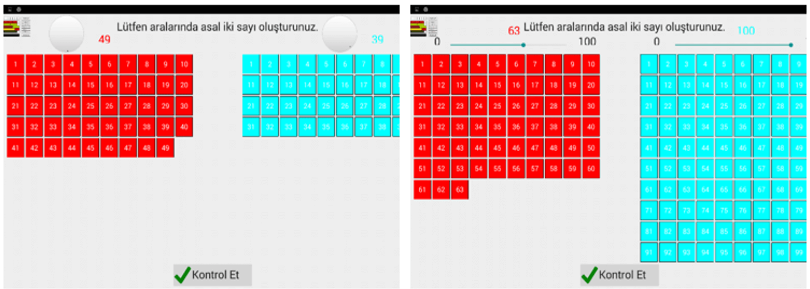
In accordance with the study's objectives, the research questions are: 1) What interface elements do students prefer in mobile courseware? 2)What factors influence students' preferences for these interface elements in mobile courseware?

2 Materials and methods

This research focused on evaluating secondary school students' opinions on interface elements in mobile courseware. Descriptive data gathered from student feedback were analyzed to explore the relationship between their views and the design element features. As a descriptive research, the study emphasized the investigation of various form elements in mobile software interfaces. Additionally, it is categorized as an explanatory case study, specifically addressing "why" and "how" questions. The research process was conducted in three stages:

Stage 1: The researchers, along with three mathematics experts, first identified the topics that 8th-grade students struggled with in mathematics, especially those connected to other subjects. They developed activity scenarios to address these topics, outlining tasks for each scenario, such as data entry, selection, calculation, interpretation, evaluation, and problem-solving. The activity scenarios and tasks were reviewed and finalized by the experts, ensuring alignment with both vertical and horizontal learning objectives.

Stage 2: Draft designs for five scenarios were created, incorporating insights from expert interviews and student participation in the learning process. The researchers determined the interface elements for each draft design based on their classification. Subsequently, alternative designs were developed, maintaining fixed factors like location, size, and color to keep all variables except the interface elements constant, following the researchers' taxonomy. The interface elements or mobile device features for student interaction were the only aspects modified, allowing students to engage with various elements. The study focused on five main activities: Prime Numbers, Equation Factory, Geometric Objects, Coordinate System, and Probability, as illustrated in Figure 1.



Arcdial Trackbar

Figure 1 Alternatives of Prime Numbers activity using arcdial and trackbar

Alternatives of each activity were designed using different interface elements. Two different alternatives of the Prime Numbers activity are given in Figure 1. All screen features, except for the interface elements, were kept constant as alternatives, allowing for interchangeable interface elements that performed the same task. In the activity illustrated in Figure 1, both arcdial and trackbar were utilized to generate prime numbers.

Stage 3: Once the software development was completed, the mobile application was introduced to the students. During this implementation phase, students were not taught the relevant subjects through traditional methods; instead, they interacted solely with the mobile courseware. As they used the software, data regarding their interactions with the interface elements were collected through a follow-up registration system and evaluation forms, as shown in Figure 1.

2.1 Participants

The study comprised 92 eighth-grade students (51 girls and 41 boys) from three secondary schools, each drawn from distinct socioeconomic backgrounds, during the fall semester of the academic year. The sample size was intentionally selected to encompass a broad range of student viewpoints and to capture diverse experiences with mobile learning technologies. By including participants from schools with varying socioeconomic contexts, the study sought to explore how these factors may shape students' preferences for courseware interfaces. This strategy was designed to offer a balanced perspective, enhancing the relevance of the findings to a wider student demographic. The distribution of students across schools is detailed in Table 1.

Table 1 Participants

Schools	Gender		Total
	Female	Male	
Secondary School A	10	8	18
Secondary School B	28	29	57
Secondary School C	13	4	17
Total	51	41	92

2.2 Data Collection

The data were collected through the follow-up system and the evaluation form.

2.2.1 The follow-up system

The tracking system collects and stores data on several aspects of student interactions with the mobile learning application. This includes the interaction number (how many times a student interacted with an interface element), interaction time (the duration spent on each element), evaluation score (the rating given by the student after completing the task), and evaluation opinion (the student's comments regarding their score). Data is organized within a dedicated structure, allowing for effective analysis of their experiences while using the mobile courseware.

2.2.2 Evaluation form

In the mobile courseware, after completing the designated tasks, students are presented with an evaluation form displaying an image of the interface element for reference. They are asked, "How convenient is it to perform this operation with this object?" with a 5-point Likert scale. Two categories of feedback were established: positive (3 points or above) and negative (below 3). Students could select from positive options such as "Easy to Use," "Used to It," "In a Short Time," "Nice Shape," or "Other," and from negative options like "Difficult to Use," "Not Used It Before," "Time-consuming," "Not Like Its Shape," or "Other," to explain their ratings.

2.2.3 Data analysis

While using the mobile courseware, data on the number of interactions, time spent, evaluation scores, and student feedback were collected through software developed by the researchers. The time spent refers to the duration between the first and last interactions with an interface element while completing a task. The number of interactions indicates how many times students engaged with the interface element to finish the task. The evaluation score is a rating (1-5 points) assigned by students to the interface element. Aligned with the classification of interface elements created by the researchers. Table 2 shows that input elements can be grouped in directly and indirectly elements.

Table 2 Classification of mobile courseware interface elements

Input Elements						
Directly				Indirectly		
Standard		Interactive		Via Keyboard	Via Screen	Via Features of the Device
Single Item	Multiple Items	Single Item	Multiple Items			
Switch Spinbox Keypad Rating Stepper Label Button Checkbox Speedbutton	Listbox Radiobutton Charlistbox	Slider Arcdial Spinner Trackbar	Sizepicker Combobox Grid Touchbase	Textbox Comboedit Grid Editbase Numberbox	Gestures Drag and Drop Touching Element	Sound element Motion element Rotation element

3 Results

In the study, interface elements were divided into two categories, direct and indirect, according to the data source in the interaction process.

3.1 Direct interface elements

The form elements in the Direct category generate data autonomously during the interaction process. These interface elements are further divided into two subcategories: standard interface elements and interactive interface elements, based on their types of interaction.

3.1.1 Direct-Standard (DS) interface elements

The standard interface elements under the direct category are fulfilled instantly in the interaction process. Standard interface elements are grouped as single and multiple, according to the amount of data they provide to the user.

3.1.2 Single DS elements

Interface elements classified as single, e.g. Switch, Spinbox, Keypad, Rating, Stepper, Label, Button, Checkbox and Speedbutton, can store only one datum on them. The time spent by the students in activities with single interface elements, the number of interactions they made with the interface elements during this time, and the averages of the evaluation points they gave to the interface elements are given in Figure 2.

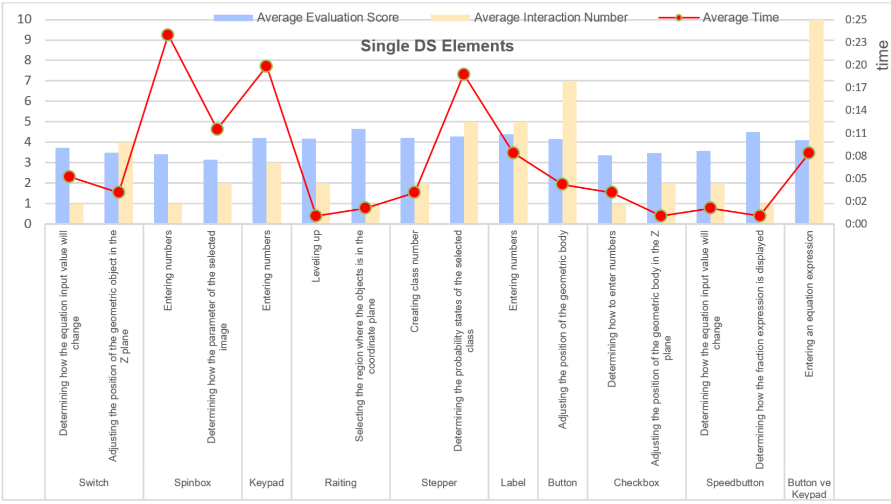


Figure 2 Time spent on individual interface elements, interaction counts, and average scores

The data obtained from the individual interface elements in Figure 2 revealed that the evaluation scores ranged from 3.15 to 4.65 and the evaluation points given by the students changed according to the purpose of the interface element use. For example, when the Speedbutton was used for the purpose of "determining how the equation input value will change", it got 3.58 points, and when it was used for "determining how to display the fraction expression", it got 4.50 points. Spinbox required the longest time (00:24) and the use of Button and Keypad together required the highest number of interactions (10) for the students to complete the given tasks. The reasons for the scores given to single interface elements by the students obtained from the evaluation form are given in Table 3.

Table 3 shows that, despite the students' positive views on single interface elements in general, the "difficult to use" evaluation of Keypad, Checkbox, Spinbox and Speedbutton elements was frequently expressed as a negative opinion by many students.

3.1.3 Multiple DS elements

Interface elements classified as multiple, e.g. Listbox, Radiobuttons and Chartlistbox, can store more than one datum on them. The time spent by the students in activities with multiple interface elements, the number of interactions they made with the interface elements during this time, and the average of the evaluation points they gave to the interface elements are given in Figure 3.

The evaluation scores for the various interface elements in Figure 3 ranged from 3.73 to 4.48. It was found that students completed the tasks quickly, typically with no more than two interactions. Reasons for the scores given by the students to the multiple interface elements are given in Table 4.

As the intended use of radiobuttons, an interface element in Table 4, changed, students' perceived difficulty varied. Eight students reported difficulty when radiobuttons were used to "determine the activity level," while only two experienced challenges when they were used to "choose the object's location on the coordinate plane." Remarkably, most elements in this group were rated as "Easy to Use."

3.2 Direct-Interactive (DI) interface elements

If the interactive interface elements under the direct category are verified by the system after the interaction process is over, the task is fulfilled. Interactive interface elements are also grouped as single and multiple according to the amount of data they provide to the user.

Table 3 Treasons behind student scores for individual interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Switch	Determining how the equation input value will change	43	12	8	5	-	15	2	6	1	-
	Adjusting the position of the geometric object in the Z plane	40	10	19	5	-	6	4	6	1	1
Spinbox	Entering Numbers	44	8	14	7	1	5	1	11	-	1
	Determining the parameter of the selected image	46	6	10	4	-	14	3		2	-
Keypad	Entering Numbers	45	6	11	6	-	10	5	8	1	-
Rating	Leveling up	47	9	13	9	-	6	4	4	-	-
	Selecting the region where the object is located in the coordinate plane	48	8	16	13	-	3	1	3	-	-
Stepper	Creating class number	54	9	13	6	-	4	-	4	1	1
	Determining the probability states of the selected class	46	6	13	19	-	-	2	5	1	-
Label	Entering Numbers	47	14	13	7	-	5	2	4	-	-
Button	Adjusting the position of the geometric body	52	8	14	7	-	6	1	3	-	1
Checkbox	Determining how to enter numbers	36	12	5	10	-	15	4	6	1	-
	Adjusting the position of the geometric body in the Z plane	42	11	12	5	-	11	5	1	3	2
Speedbutton	Determining how the equation input value will change	41	9	15	6	-	14	1	6	-	-
	Determining how the fraction expression is displayed	45	15	16	9	-	2	-	2	3	-
Button and Keypad	Entering an equation expression	4	9	13	8	-	10	2	6	-	-

Table 4 Reasons for the scores given by the students for the multiple interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Listbox	Choosing a geometric object	57	11	11	6	-	2	2	2	-	1
Radiobuttons	Determining the level of activity	50	9	2	7	-	8	3	2	3	-
	Determining how to display the fraction expression	51	10	16	6		5	-	2	1	1
	Choosing the place of the object on the coordinate plane	53	7	18	9	1	2	-	2	-	-
Chartlistbox	Choosing the desired class from the class list	57	7	11	6	-	6	-	4	1	-

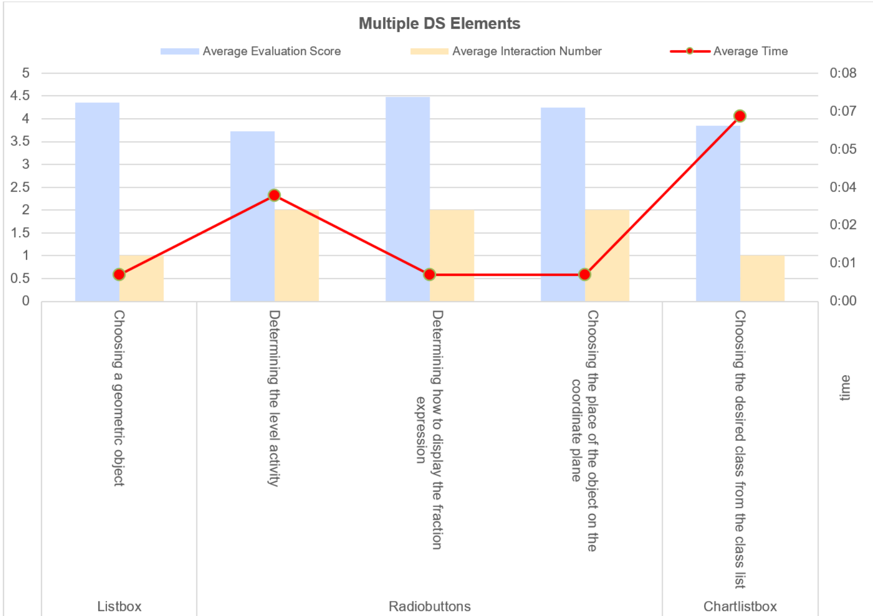


Figure 3 Time spent for interactions, and average scores for interface elements

3.2.1 Single DI elements

Interface elements classified as single, e.g. Slider, Arcdial, Spinner ve Trackbar, can store only one data on them. The time spent by the students in activities with single interface elements, the interactions they made with the interface elements during this time, and the averages of the evaluation points they gave to the interface elements are given in Figure 4.

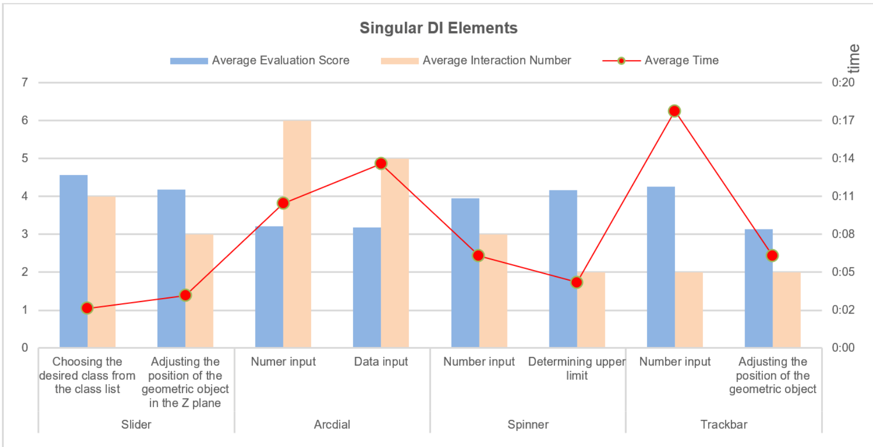


Figure 4 Time spent in individual interactive elements, interaction counts, and average scores

Although the purpose of using Arcdial, one of the individual interactive interface elements, changed, there was no significant difference in the evaluation score it received. Overall, Arcdial had the lowest evaluation score and required the most interactions to complete the task. In contrast, the Slider achieved the highest evaluation score. The reasons for the scores given to the individual interactive interface elements are summarized in Table 5.

Table 5 shows that, positive opinions of the students towards the single interactive interface elements were mostly "Easy to Use". The students stated that the interface element that they liked the most, was easy to use, and were used to was the Spinner, and the interface element that enabled them to perform the tasks in a short time was the Trackbar.

3.2.2 Multiple DI elements

Interface elements classified as multiple, such as Sizepicker, Combobox, Grid Touchbase, and Combotrackbar, can store multiple data points. Figure 5 presents the time students spent on activities with these multiple interface elements, the number of interactions they made, and the average evaluation scores they assigned to the elements.

Table 5 Reasons for scores assigned by students to individual interactive elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Slider	Choosing the desired class from the class list	47	11	17	12	-	1	-	1	3	-
	Adjusting the position of the geometric object in the Z plane	40	9	14	9	-	10	3	5	1	1
Arcdial	Number input	41	10	12	7	-	11	3	5	2	1
	Data input	40	8	14	6	-	9	3	9	3	-
Spinner	Number input	50	12	9	8	1	5	-	6	-	1
	Determining upper limit	44	13	10	13	-	4	2	5	1	-
Trackbar	Number input	44	9	18	12	-	3	2	2	1	1
	Adjusting the position of the geometric object	46	8	13	8	-	9	-	7	-	1

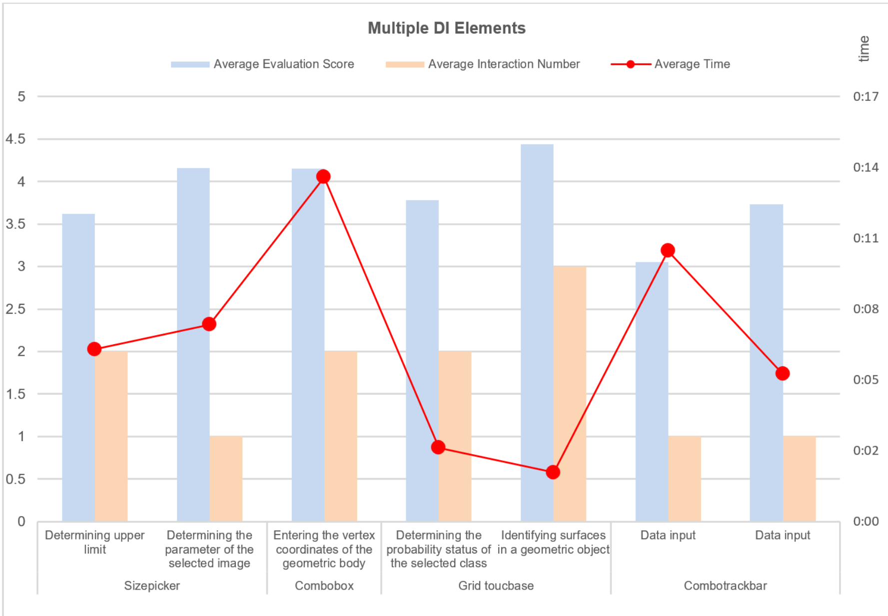


Figure 5 Time spent on direct multiple interactive elements, interaction counts, and average scores

Figure 5 indicates that the combotrackbar received the lowest evaluation score. Additionally, its score declined as the time per interaction increased, despite being used for a similar purpose. Among the interactive multiple interface elements, the grid touchbase achieved the highest evaluation score. The reasons for the students' evaluations of the interactive multiple interface elements are presented in Table 6.

Table 6 present that many positive evaluations of the interactive multiple interface elements included "Easy to Use," "Used to Use," and "Sort Time." Students indicated that the grid touchbase was the easiest to use and allowed them to complete tasks quickly. They reported being most familiar with the combobox, while the sizepicker was their favorite interface element. In contrast, the combotrackbar received the most negative evaluations.

3.3 Indirect interface elements

In the process of interaction in indirect interface elements, data are generated via screen, virtual keyboard or device features which play an intermediary role in the data creation process.

3.3.1 Interface elements via keyboard

Figure 6 illustrates the time students spent on activities in Textbox, Comboedit, Grid Editbase, and Numberbox are the interface elements in this category, where data is entered using the virtual keyboard.

Table 6 Reasons for students' evaluations of interactive multiple interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Sizepicker	Determining upper limit	40	11	13	9	-	7	4	7	-	1
	Determining the parameter of the selected image	39	15	13	12	-	5	1	6	-	1
Combobox	Entering the vertex coordinates of the geometric body	47	16	13	6	-	1	2	4	1	2
Grid toucbase	Determining the probability status of the selected class	56	7	8	6	-	8	-	4	2	1
	Identifying surfaces in a geometric object	43	11	17	6	-	7	2	6	-	-
Combotrackbar	Data input	36	8	13	7	-	17	1	9	1	-
	Data input	36	12	5	10	-	15	5	7	1	1

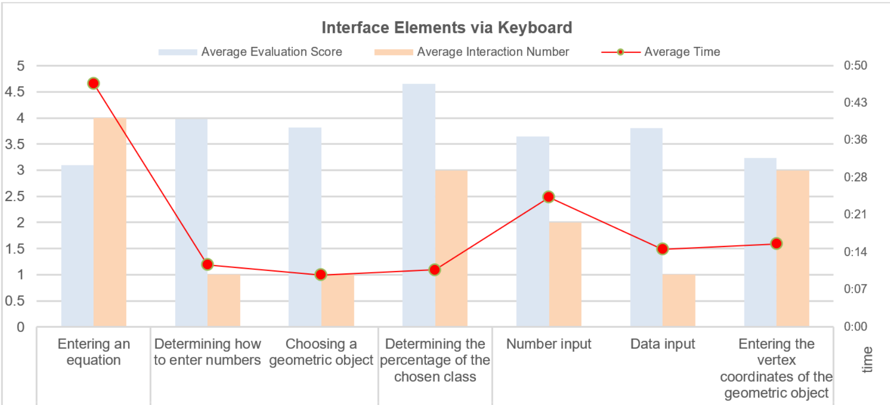


Figure 6 Time spent on keyboard-based elements, interaction counts, and average scores

The evaluation score of the interface elements used through the keyboard discussed in the study, except for the grid editbase, was lower than 4. The Textbox in this category with the lowest evaluation score had a higher number of interaction and time required to complete the given task compared to the others. The reasons for the evaluations of the students about the interface elements through keyboard are presented in Table 7.

Table 7 shows that the textbox received the most negative feedback from students. Specifically, 19.6% of participants reported difficulties using the textbox, while 6.5% indicated that they had never used it before.

3.3.2 Interface elements used via screen

Gestures, drag-and-drop, and touch-and-move are the interface elements in this category, where data is entered via the screen. Figure 7 presents the time students spent on activities with these screen-based interface elements, the number of interactions made, and the average evaluation scores assigned to each element.

Gestures and drag-and-drop interface elements were provided to students for various purposes. As the intended use changed, students' evaluation scores for these elements also varied. The reasons for students' evaluations of the screen-based interface elements are detailed in Table 8.

In the activities carried out with Gestures and drag-and-drop, students' ability to use this interface element changed as their tasks changed.

3.3.3 Interface elements via device features

Voice recognition, motion sensors, and rotation sensors are the interface elements in this category that utilize device features for data input. Figure 8 presents the time students spent on activities with these elements, the number of interactions made, and the average evaluation scores assigned to each interface element.

Table 7 Reasons for students' evaluations of keyboard-based interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Textbox	Entering an equation	39	5	12	9	-	18	6	3	-	-
Comboedit	Determining how to enter numbers	50	10	5	10	1	8	3	2	2	1
	Choosing a geometric object	52	7	18	9	-	4	-	2	-	-
Grid editbase	Determining the percentage of the chosen class	52	7	17	7	-	7	1	-	1	-
Numberbox	Number input	48	13	10	7	2	-	1	6	4	1
	Data input	42	10	12	8	-	9	3	7	1	-
	Entering the vertex coordinates of the geometric object	42	13	13	3	-	9	2	9	-	1

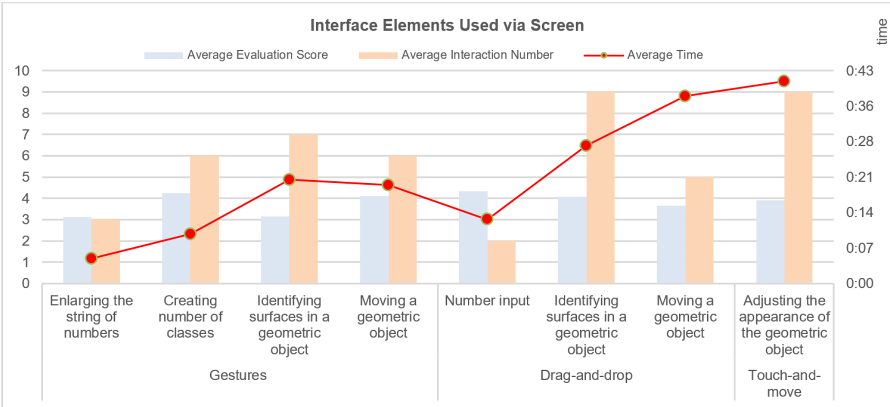


Figure 7 Time spent on screen-based elements, interaction counts, and average scores

Table 8 Reasons for students' evaluations of screen-based interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Gestures	Enlarging the string of numbers	42	12	8	7	-	11	3	6	3	-
	Creating number of classes	46	12	15	6	-	10	-	3	-	-
	Identifying surfaces in a geometric object	40	9	12	9	1	12	2	4	2	1
	Moving a geometric object	47	10	12	6	-	11	1	2	1	2
Drag-and-drop	Number input	54	14	9	7	-	3	2	2	1	-
	Identifying surfaces in a geometric object	42	16	15	6	-	7	1	4	1	-
	Moving a geometric object	42	14	9	7	1	12	2	3	1	1
Touch-and-move	Adjusting the appearance of the geometric object	48	14	8	10	-	6	-	4	1	1

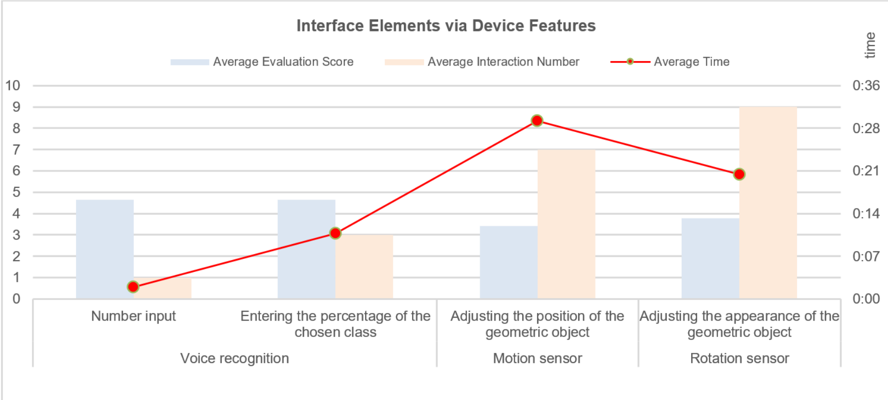


Figure 8 Time spent on device-based elements, interaction counts, and average scores

Although the intended use of the voice recognition interface element varied, students assigned it a significantly higher evaluation score compared to other elements. In contrast, the rotation sensor required more interactions to complete tasks, while the motion sensor took more time than the voice recognition element. The reasons for students' evaluations of the device-based interface elements are presented in Table 9.

Table 9 Reasons for students' evaluations of device-based interface elements

Interface Element	Purpose of use	Positive Opinions					Negative Opinions				
		Easy to use	Used to it	Short time	Nice shape	Other	Difficult to use	Not used before	Time consuming	Not like shape	Other
Voice recognition	Number input	61	4	16	5	-	1	2	3	-	-
	Entering the percentage of the chosen class,	50	7	13	11	-	4	-	6	-	1
Motion sensor	Adjusting the position of the geometric object	37	10	12	7	2	18	2	3	-	1
Rotation sensor	Adjusting the appearance of the geometric object	35	15	10	10	-	13	4	4	1	-

Table 9 shows that, positive feedback for the interface elements used through the device outweighed negative opinions. Students noted that the voice recognition interface was easy to use (f=61) and facilitated quick task completion (f = 16). It received the fewest negative comments, while students reported difficulties with the motion (f=18) and rotation (f=13) sensors. Figure 9 presents the durations, and average interaction numbers about each classification category.

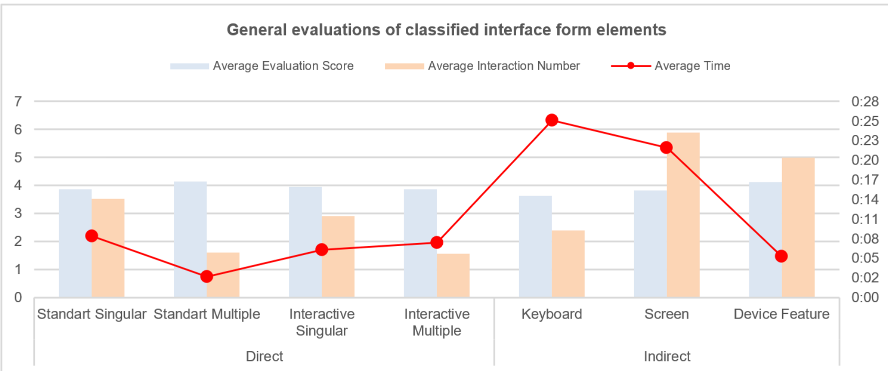


Figure 9 Overall evaluations of classified interface form elements

Figure 9 shows that students provided varied responses to the interface form elements across different categories. They rated the interactive single elements higher than the standard single elements. However, when comparing multiple interface groups, the standard elements scored higher than the interactive ones. Additionally, within the indirect class, data entry through device features was more favorably received.

3.4 Interface elements used for the same purpose

The interface elements were used in activities for different purposes in this study. The evaluation score of the interface elements used for the same purpose, the time spent with the interface elements and the average of the number of interactions the students made with the interface element during this time are presented in Table 10.

Table 10 shows that using different interface elements for the same purpose can lead to variations in students' evaluation scores, particularly in number input. For instance, when the Combobox was used to "enter the vertex coordinates of the geometric object," the evaluation score was 4.15, but it dropped to 3.23 when the Numberbox was utilized.

4 Discussion and conclusion

This study aimed to identify student preferences for form elements in mobile instructional app interfaces. The findings were discussed from the perspectives of both students and designers, as well as the characteristics of the form elements. Frequently used interface elements were integrated into mathematics lesson activities, allowing students to evaluate them while working in their natural learning environments. In this study, various interface form elements of arcdial, spinbox, numberbox, spinner, trackbar, drag and drop, and voice recognition were used for the same purpose. Overall, students gave positive evaluation scores to these elements. While arcdial, numberbox, spinner, spinbox, and trackbar each utilized distinct interaction methods, voice recognition allowed for sound-based interaction. Voice recognition received the most positive feedback, whereas arcdial garnered the most negative opinions, likely due to its cumbersome use (Park et al., 2011; Park et al., 2013). The differences in interaction styles among the elements may explain the variations, and voice recognition was identified as the fastest data entry method.

In this study, students' evaluations of various interface form elements serving the same purpose differed. The textbox, which relied on a virtual keyboard for data entry, required more time than a customized input element created by the researcher. Nilsson (2009) recommended using customized elements over virtual keyboards, while Page (2013) found the QWERTY keyboard to be faster than keypad options. Despite receiving a lower rating from students, this finding contradicts recommendations for frequent textbox use in non-mobile applications (Stephens et al., 2002), suggesting that mobile instructional app elements are viewed differently in mobile settings.

Button elements received the highest number of interactions and evaluations. Healey (2007) overlooks this and advises designers to use compact interface elements. Analyzing interaction numbers and durations revealed that the textbox and keypad required more time and interactions to complete tasks, likely leading students to perceive them as "time-consuming" and negatively impacting their evaluations.

Radiobuttons and spinbox elements had similar evaluation scores, interaction numbers, and time spent. Difficulties in using these elements didn't impact their scores. While the chartlistbox required one interaction for the task, the slider needed four, yet this increase did not lower the slider's score; instead, it improved, likely due to differing interaction styles. Additionally, a single interaction with the slider was completed much faster than with the chartlistbox, negatively affecting the latter's evaluation score.

In this study, however, the chartlistbox was assessed against a different interface element, revealing its drawbacks. When compared to the grid editbase for voice recognition tasks, the grid editbase took longer to complete, negatively impacting its evaluation score. This may be due to the differing interaction styles of the elements. This finding aligns with Azenkot and Lee (2013), who argued that voice recognition is more effective than a virtual keyboard.

Button, grid touchbase, trackbar, and slider elements received slightly higher evaluation scores than their alternatives for the same purpose. Students noted that buttons and grid touchbase were quick and easy to use, trackbar was efficient, and slider had an appealing design. The grid touchbase also demonstrated favorable completion times. Notably, touch-and-move had the highest interaction values, aligning with Nilsson (2009) and Tang et al. (2016), who found that touch-operated interfaces perform better than gesture-based ones. Additionally, drag-and-drop operations took longer than both grid touchbase and gesture interfaces for similar tasks.

A significant difference was observed between the evaluation scores of comboedit and listbox, likely because tasks with comboedit took more time. The listbox's ability to display all options

Table 10 Interface elements used for the same purpose

Usage Purposes of Interface Elements	Interface Elements	Avg.Evaluation Score	Avg.Interaction Number	Average Time
Determining how the equation input value will change	Switch Speedbutton	3.73 3.58	1 2	0:06 0:02
Choosing the desired class from the class list	Chartlistbox Slider	3.85 4.56	1 4	0:07 0:03
Adjusting the position of the geometric object in the Z plane	Switch Checkbox Slider	3.50 3.46 4.19	4 2 3	0:04 0:01 0:04
Number input	Spinbox Keypad Label Arcdial Spinner Trackbar Numberbox Drag and Drop Voice Recognition	3.42 4.20 4.39 3.22 3.95 4.28 3.65 4.32 4.64	1 3 5 6 3 2 2 2 1	0:24 0:20 0:09 0:11 0:07 0:18 0:25 0:13 0:02
Determining how to display the fraction expression	Speedbutton Radiobuttons	4.50 4.48	1 2	0:01 0:01
Determining the parameter of the selected image	Spinbox Sizepicker	3.15 4.16	2 1	0:12 0:08
Determining the level	Rating	4.19	2	0:01
Creating number of classes	Stepper Gestures	4.20 3.15	2 7	0:04 0:21
Determining the probability status of the selected class	Stepper Grid Toucbase	4.28 3.78	5 2	0:19 0:03
Choosing the place of the object on the coordinate plane	Rating Radiobuttons	4.65 4.25	1 2	0:02 0:01
Adjusting the position of the geometric object	Button Trackbar Motion Sensor	4.17 3.13 3.43	7 2 7	0:05 0:07 0:30
Determining how to enter numbers	Checkbox Comboedit	3.37 3.98	1 1	0:04 0:12
Entering an equation	Button and Keypad Textbox	4.11 3.10	10 4	0:09 0:47
Choosing a geometric object	Listbox Comboedit	4.36 3.82	1 1	0:01 0:10
Determining the level of activity	Radiobuttons	3.73	2	0:04
Data input	Arcdial Combotrackbar Numberbox	3.18 3.05 3.81	5 1 1	0:14 0:11 0:15
Determining upper limit	Spinner Sizepicker	4.16 3.62	2 2	0:05 0:07
Entering the vertex coordinates of the geometric object	Combobox Numberbox	4.15 3.23	2 3	0:14 0:16
Identifying surfaces in a geometric object	Grid Toucbase Gestures Drag and Drop	4.44 3.15 4.07	3 7 9	0:02 0:21 0:28
Determining the percentage of the chosen class	Voice Recognition Grid Editbase	4.65 4.65	3 3	0:11 0:11
Enlarging the string of numbers	Gestures	3.13	3	0:05
Moving a geometric object	Gestures Drag and Drop	4.09 3.65	6 5	0:20 0:38
Adjusting the appearance of the geometric object	Touch and Move Rotation Sensor	3.92 3.77	9 9	0:41 0:21

simultaneously enhances usability, contributing to its higher score. Although numberbox and combobox had similar interaction counts and durations, their evaluation scores differed due to students finding the numberbox more challenging and time-consuming. Structurally, numberbox requires indirect data entry via a virtual keyboard, while combobox allows direct selection from a dropdown, impacting students' evaluations. Nilsson (2009) similarly emphasized the importance of using interface elements that enable direct interaction.

Despite some interface form elements requiring extensive interaction, their evaluation scores remained high initially. However, as interaction time and the number of interactions increased, scores tended to drop. This decline may be offset in elements like gestures and spinner, which are perceived as innovative and better suited for modern interaction styles (Rautaray & Agrawal, 2015).

In general, factors like interaction time and frequency of interface elements are key in influencing how students assess them. Researchers emphasize the importance of these elements facilitating fast and easy data entry (Al-Otaibi & Kiaee, 2024). The study revealed that students valued criteria like "in a short time," "time-consuming," and "easy to use" more than "I am used to using it" or "I like the shape." This suggests a preference for ease of completing tasks and the significance of aesthetics. Among the elements assessed, combobox, speedbutton, sizepicker, label, spinner, and numberbox were the most familiar to students. Furthermore, other research indicates that designers tend to prefer elements that students are already familiar with (Taba et al., 2017).

Evaluation scores for standard interface form elements like switches, keypads, checkboxes, and buttons varied only slightly across different purposes. In contrast, scores for interactive elements (trackbar, rating, combotrackbar, grid touchbase, sizepicker) and indirect elements (numberbox, gestures, drag and drop) changed based on their usage. Overall, students rated all form elements positively, with scores ranging from 3.05 to 4.65, indicating favorable evaluations despite various influencing factors. Notably, "indirect" elements unique to mobile software differ significantly from desktop counterparts. High scores for features like rotation sensors, motion sensors, and voice recognition reflect their innovative qualities (Zuckerman & Gal-Oz, 2013).

When the purposes of interface elements shift, student evaluations often emphasize time-related aspects. Table 11 provides a summary of students' preferences for mobile interface form elements.

Table 11 Factors affecting students' views on interface elements

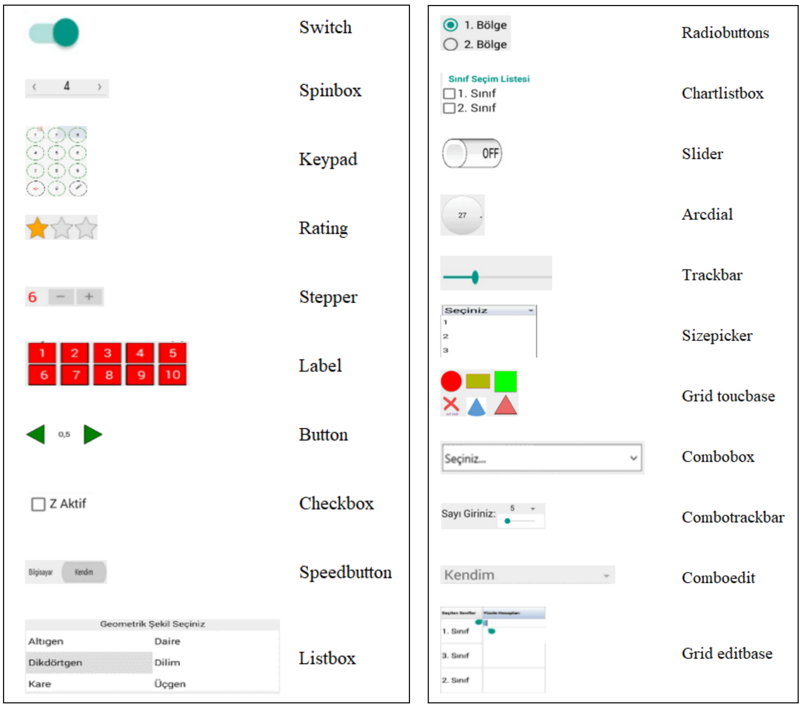
Interface Form Element Preferences		
Purpose of Use	Content Features	Nature of Content Portability To Mobile
	Interface Form Element Properties	Physical properties Interaction features Sense of intuition
	Student Characteristics	User Experience User Habits and Trends

Table 11 indicates that preferences for form elements are influenced by factors such as content, the characteristics of the interface elements, and student traits, along with their interactions. Content features relate to how well the material can be adapted to mobile environments; student characteristics pertain to users' experiences and habits with interfaces; and the properties of the interface elements involve their physical design, interaction styles, and how intuitively users can engage with them.

The study emphasized that students' preferences for mobile interface elements are influenced by a variety of factors, extending beyond the habitual practices of designers. It is essential for designers of mobile learning applications to prioritize student input alongside their own design principles and practices, as understanding student needs can significantly enhance the learning experience. By considering factors such as interaction times, potential input errors, and overall usability, designers can develop more effective and user-friendly learning environments. The use of indirect input methods and interactive features for multiple inputs is encouraged, with a reduced reliance on keyboard entry unless absolutely necessary. These findings contribute to ongoing discussions in mobile interface design, highlighting the importance of a student-centered approach.

To further enhance the application of these insights, future designs should involve continuous feedback from students throughout the development cycle. Integrating student input from the early stages would lead to more effective, user-friendly interfaces. By focusing on creating intuitive, student-centered designs, and gathering feedback early on, the design process can be made more straightforward. These interfaces can be improved through user testing and prototyping to make sure they are user-friendly, accessible, and meet the needs of students. This method would streamline the process for designers, facilitating the creation of software that not only satisfies student needs but also enhances their educational experiences.

Icons of interface elements



Conflicts of interest

The authors declare that they have no conflict of interest.

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