Education and Information Technologies (2024) 29:6163–6187
https://doi.org/10.1007/s10639-023-12063-2

Design considerations of interactive multimedia learning materials for students with special needs. Study of cases

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Received: 24 January 2023 / Accepted: 18 July 2023 / Published online: 29 July 2023

Abstract

Creating digital educational materials, individualized and customized, for students with special needs is necessary; these individuals need materials that are developed especially for them. When materials are created for students with disability, it is vital to consider their disability situation, age, interest, and level of skills. There are some studies that implemented these types of materials, but these are not development studies. They focused on the effects of the material but not how it should be. There is a lack of study in the literature focusing on design considerations when developing interactive multimedia materials for students with special needs. Thus, there is a need for creating digital educational materials for students with special needs and an investigation of analyzing, developing, and integrating materials into special education. The present study aims to reveal what should be considered when developing interactive multimedia materials for students with special needs. This designed-based research was conducted with four students, three males and one female, two of whom have an intellectual disability, one has Down syndrome, and one is autistic. In addition, data were collected from two special education teachers and five experts during the material development phase. The study had four phases, and the fourth phase lasted six weeks. Results show that materials for students with special needs should be interactive, flexible, individualized, and simple; the design should not be tiered; sounds and effects should be dynamic, and if possible, concepts can be arranged by the teacher.

Keywords Assistive technology · Material development · Students with special needs

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1 Introduction

There is massive technological development globally; however, most technologies are developed for normal people. Technologies for people with disabilities are not being developed at the same rate as those for normal people (Constantin et al., 2017; Davies et al., 2004; Isaila & Nicolau, 2010). Also, technology integration research often ignores special education (Starks & Reich, 2023). Technologies enable people with disabilities to overcome the difficulties in their environment and increase their chances of acting independently (Rose et al., 2007). Technologies can also be used for problems related to various situations, such as planning, execution, attention, memory, literacy, and social and behavioral (Lopresti et al., 2008). These technologies, which make life easier for people with disability, are called assistive technologies (ATs).

ATs have a significant impact on teaching-learning activities. ATs can help close the gap between students with special needs and their peers (Atanga et al., 2019). The use of technology contributes to the learning of students in need of special education at all levels, increases their success, improves their self-confidence(Sivin et al., 2000), and provides essential opportunities (Deveci Topal et al., 2021). Computers and related technologies can significantly enhance the capabilities of children with learning disabilities(Zhang, 2000) and improve learning achievements, motivation, and engagement (Cheng & Lai, 2020). ATs also provide a significant advantage in overcoming the learning problems of individuals with intellectual disabilities (ID) and autism (Yıldız, 2010). Researchers have mentioned the benefits of employing AT and software applications to improve students' learning achievements in special education (Abidoğlu et al., 2017; Chiang & Jacobs, 2010; McNicholl et al., 2019). But, even today, students who need special education have difficulties accessing devices, the internet, and software (Starks & Reich, 2023).

Interactive multimedia materials have excellent learning potential, allowing for establishing a relationship between the user and the material. Therefore, students must interact actively with the material (Ampa, 2015). Also, these materials have an important impact on motivation, and students with special needs must be motivated (Lämsä et al., 2018). Thus, these materials can help students with special needs (Li et al., 2003) and improve their learning achievements (Abidoğlu et al., 2017). Nowadays, devices have rich features for developing interactive multimedia materials. Content can be prepared in different concepts and has different multimedia features. Touch-screen devices can offer learning methods (Cheng & Lai, 2020) and enrich interactive multimedia materials. Interaction with a touch screen can be attractive and improve their learning motivation.

On the other side, there has been a shift in special education over the past few years from desktop programs to mobile applications (Cheng & Lai, 2020). Interactive multimedia materials can be used easily in mobile environments, too. However, most of the materials in the mobile application stores are not suitable for special education. Special needs students do not react similarly to their peers when using devices like computers, tablets, and smartphones. As Cheng and Lai (2020) stated that when materials are developed, it is vital to consider their age, interest, and level of skills. These individuals need materials that are developed especially for them,

which should be individualized (Coşkun & Alper, 2019). Therefore, there is a need for creating digital educational materials for students with special needs (Abidoğlu et al., 2017), and it is crucial to proper planning and decision-making (Tsikinas & Xinogalos, 2020).

In a similar study, Khan (2010) developed a multimedia learning material for autistic and down syndrome students in light of Mayer and Moreno's principles and tested this with these students. He stated that the groups found their material enjoyable, but students with down syndrome cannot transfer enjoyment to their learning. He found that these groups cannot benefit at the same rate. Ong and Yahaya (2022) studied audiovisual context with autistic and down syndrome students. They found that the two groups should not utilize the same material because the learning performance varies. Lin et al. (2012) developed a material and looked at its effect. They stated that interactive multimedia materials are very effective for learning and innovative and interesting for these students and reduce learning barriers and difficulty.

There are not many studies that focus on developing interactive multimedia materials for students with special needs. However, there are studies that put forward principles, for multimedia development, such as Mayer (2001) principles and universal design for learning (UDL). Mayer developed these principles for typically developing children. Students with special needs did not account (Ong and Yahaya, 2023). Besides that, universal design for learning is commonly used in studies for developing materials. That provides developing flexible and versatile materials in order to meet individuals with a wide range of abilities and characteristics (Kadevarek, 2009). UDL especially considers individual differences and is effective but not an approach centered on students with special needs for students with special needs (Lin et al., 2012). Therefore, there is a need for design principles for developing multimedia materials, especially for students with special needs (Cheng & Lai, 2020; Techaraungrong et al., 2017).

1.1 Aim of the study

The aim of the present study is to develop interactive multimedia material with the design-based research approach and to reveal design considerations while developing interactive multimedia materials for students with special needs. To do this, the following research question was sought to answer: *What design issues should be considered while developing interactive multimedia materials for students with special needs?*

2 Method

Design-based research, used in this study, aims to produce knowledge with an improvement in the instructional design, development, and evaluation process. Designed-based research was defined as a "systematic and flexible approach aimed to improve educational applications by doing iterative analyses, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings" (Wang & Hannafin, 2005). Design-based research, used in this

study, aims to produce knowledge with an improvement in the instructional design, development, and evaluation process (Richey et al., 2004). Interactive multimedia, used by teachers and students and evaluated by experts, was developed for students with special needs in the present study. The material was improved iteratively by one of the researchers, according to observations of students and interviews with teachers and experts.

2.1 Participants

The study was conducted with four students, three males, one female, and two teachers. One student was a male with Down syndrome, two with moderate intellectual disability (one male and one female), and the other was a male with autism. Intellectual disabilities are divided into 4 groups: mild, moderate, severe, and profound. In this study, students with intellectual disabilities were classified as moderate. Students with autism and Down syndrome are not included in classifications such as intellectual disabilities in terms of learning difficulties. Although the fact that the students are from 3 different disability groups is seen as a limitation, they present the same set of special needs for learning. Considering their disabilities, they can learn using appropriate teaching strategies (Diken, 2012; Mittler, 1995; Wishart, 2001).

Students were selected from a special education school through the purposive sampling method. and that did not pose a problem for the study. Moreover, the different reactions of the students with different diagnoses provided a richness of results. The various reactions of students with different disabilities allowed us to view the material from different perspectives and improve it. Before the study, they were not familiar with computers and touchable technologies.

Student	Disability	Sex	Age
Student 1	Intellectual Disability	Male	12
Student 2	Intellectual Disability	Female	13
Student 3	Autism	Male	9
Student 4	Down syndrome	Male	11

Two special education teachers with about five and three years of experience were in all classes simultaneously and had daily computer skills. Besides students and teachers, during the study, data was gathered from experts in instructional technology (IT) and special education (SE). The five experts in IT were Ph.D. candidates; of the five experts in SE, two had Ph.Ds, and three were Ph.D. candidates.

2.2 Data collection

Data was collected via 13 interviews and 20 h of observation (Table 1). Researchers prepared interviews and observation forms, and expert opinions were gathered about forms and revised for validity. Interviews were conducted with teachers before, during, and after the implementation of the study and with experts during the development of the material before implementation. In interviews, the opinions of teachers and experts about materials were asked. One of the researchers observed 20 class

Table 1 Data collection process in terms of phase and participant

	Student(4) (Obs.)	SE Teachers(2)	Experts in SE (5)	Experts in IT(5)
Preparation Phase	X	X		X
Phase 2		X	X	X
Phase 3		X	X	X
Phase 4	X	X		

hours in 6 weeks during courses. In observations, students' actions were observed, noted to observation form, and then interpreted by researchers.

Content analyses conducted by creating a framework from the data obtained via observations and interviews in light of the research question.

2.3 Data collection tools

In this study, data were collected through semi-structured interviews and observations. Researchers developed interviews and observation forms, and expert opinions were gathered about forms and revised for validity. The interview questions were developed by the researcher based on issues investigated in the aim. The questions were about material properties. They were reviewed by experts, and necessary changes were made by the researcher.

The observation form was used to note whether the students knew correctly or not, as well as what different behaviors they exhibited. The form was used for each learning objective and consisted of 2 parts. In the first part, it was marked which questions the students answered correctly or not in the activity, and in the second part, the students' reactions to that activity were noted. These observation forms were created in line with the objectives and by using the opinions of special education teachers and the measurement tools they used in other lessons.

2.4 Validity and reliability

The study was conducted over six weeks, and one of the researchers was present to ensure adequate validity and reliability. Interviews were conducted at each stage of the study with more than one expert, and were recorded. The first researcher conducted interviews. One or both of the other researchers participated in some of the interviews. Also, observations were recorded on camera. Observations and interviews were carried out in a way that supported each other. The records and collected data were validated by peer review. A selected video was given to a person with a PhD. in the same field who was asked to fill in the observation form. This form was compared with the researcher's form, and it was seen that the same true/false answers and the same behaviors were noted. There was no significant difference between the two forms.

2.5 Context of the study

In the first three phases of the study, teachers and field experts were interviewed before implementation. The last phase of the study was conducted with students in a special education school and took 6 weeks. This school serves students with intellectual disabilities, down syndrome, and autism disorder. There were two teachers, and there was a maximum of 4 or 5 students in each class. There were 4 students in the class where the study was conducted and all of them were included in the study. Generally, instructions were conducted one by one. Also, before the study, there was no Interactive White Board (IWB) in the school. The IWB was bought by a project supported by the university for this study and donated to the school. To eliminate the innovative effect, IWB was installed in the classroom 2 months in advance and used by teachers in the classroom. Teachers were included in the study by taking their opinions at each stage of the process.

3 Results

In this section, the findings are explained together with the changes made during the process, and the process is divided into four phases (Fig. 1):

After analysis of the data in four phases, findings were interpreted under four headings: content, design, interaction, and usability.

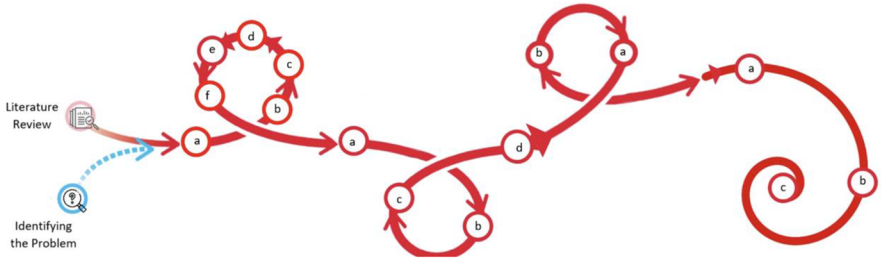
3.1 Preparation phase

According to teachers' interviews, "teaching animals" was first selected as the subject in this phase. Then, the teachers were asked what they wanted in the materials. They stated that objects in the stage should be related to the animal because they thought it increased persistence.

> *For example, you can have a club next to your dog, a carrot in the hands of the rabbit, and the backplane can play a song about the rabbit. (Teacher 1)*

Additionally, they wanted to hear the animal's sound when touching it and, after the teaching session, initiate activities like "which is the dog?" The first draft was developed according to interviews with teachers and aimed to show the potential (interaction, multimedia) of the material that would be designed. That draft attempted to create a natural environment with trees, flowers, and kinds of plants and animals placed in various parts of the scene. Also, opportunities for interaction were added to the animals. When a student touched any animal (Fig. 2), it grew to the center of the scene (Fig. 3), and the animal sound was heard. At the same time, other animals disappeared from the scene. And menus were placed bottom of the screen as the main page, voice, pictures, and videos.

Students used the first draft in the classroom and were observed by the researcher (Fig. 4). Besides that, the draft was shown to IT experts, who were interviewed. During the observation, problems were noted, and the problems merged with the



Preparation Phase		Phase 2		Phase 3		Phase 4	
a	Interview with teachers	a	Taking the goals of the subject	a	Getting teachers' and experts' opinions	a	Implementing
b	Choose a subject	b	Developing the storyboards	b	Revising the material	b	Getting teachers' and experts' opinions
c	Developing the draft	c	Getting teachers' and experts' opinions about storyboard			c	Observing students and getting teacher opinions, revising the material, and continuing this iterative process for 6 weeks.
d	Implementing the drxaft	d	Development of pilot material				
e	Observing the students						
f	Interview with teachers						

Fig. 1 Design-based research process stages

interviews. In light of these, the material was developed, and attempts were made to fix problems.

In the first draft, the menu was placed bottom of the scene, but during observations, it was observed that the students touched the menus unconsciously. Therefore, the menu was placed on top of the scene. After that, only teachers could reach the menu. When tapping on *Menu*, other links come up. The menu was hidden because it could also be used on tablets. IT experts and teachers stated that the scene's other objects (flowers, trees, etc.) could confuse students since they could pay attention to these objects. For this reason, other objects were removed from the material, and only animals were placed in the scene.

> *The material is very complex; it should be simpler. (IT Expert 2)*

Another issue teachers and experts mentioned was that all animals should not be placed in the scene because students can be distracted by the different animals. This was observed in the implementation of the draft, too. Students randomly selected an animal and started playing with the material as a game:

> *As you see, students select different animals in such a crowded context (*Fig. 1*). During teaching, it confuses their mind. For this reason, we can use this material in the generalization session but not in the teaching session. (Teacher 1)*

A significant result observed was that the content should be full screen. The taskbar of the operating system was accessible. Students accidentally or intentionally opened the operating system's menu or switched to open programs in the taskbar. It has also been observed that the IWB installed in the classroom is higher in terms of location, making it difficult for students to access the objects placed on top of the material. For this reason, it was decided to put the objects in places accessible to the students. If the material is used in tablets, this result would be inapplicable.

3.1.1 Preparation phase – summary

Decisions taken at this stage are as follows:

1. The menu should be placed at the top of the stage, so students cannot reach the menu. Also, the menu should be hidden for tablets.	Design/ Usability
2. The material should be more straightforward, and the trees, flowers, etc., moved from the scene.	Content
3. During teaching, there should be only one animal in the scene.	Content
4. The material should be open in full-screen mode.	Usability
5. The objects in the material should be placed at a level that students can access.	Usability

3.2 Phase 2: Taking objectives and developing storyboards

After the implementation of the first draft, teachers set objectives and prepared a table of objectives for the main implementation. In this table, there were 11 animals and 33

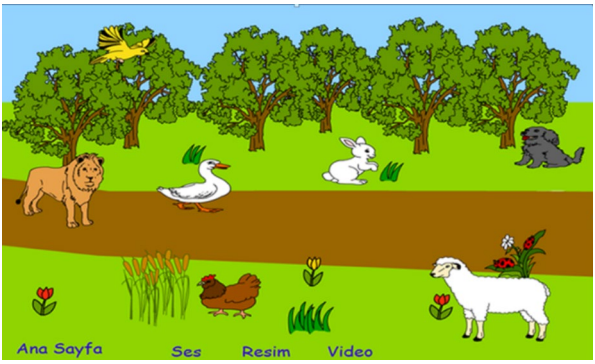


Fig. 2 Main scene

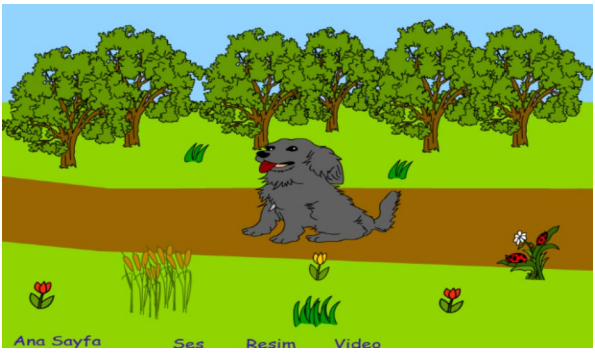


Fig. 3 Animal scene

Fig. 4 First implementation

Fig. 5 Storyboard main scene

Fig. 6 Storyboard animal scene

objectives about where they live (on the land, in the air, in the water) and how people benefit from those animals (meat, milk, wool, riding). In addition, an interview was held with teachers about the implementation process. The joint decision of the researchers and the teachers was that only 11 animals would be taught, with the targets reduced since the whole of the targets could not be reached within six weeks. So, eleven animals (dog, lion, cow, bee, sheep, horse, rabbit, camel, frog, fish, elephant) were selected to be taught. A total of 22 targets were chosen. 11 were "showing the animal and asking what it is," and 11 were "look at the animal and say which is …".

After setting the objectives, storyboards were developed for all scenes, considering the problems in the first phase. Then, it was shown to teachers, 4 IT experts, and a special education expert. In line with their opinions, storyboards were developed, and problems were fixed.

In these storyboards, in the first scene, there are animals, and when the animal is touched, the animal page opens (Fig. 5). Every animal page contains five steps. In the first step (Fig. 6), only an animal picture appears, and the teacher teaches the animal on this page. In the second step, another animal is in the scene, and the teacher wants the student to choose the right animal. In the third, fourth, and fifth stages, there are 2, 3, and 4 (Fig. 7) animals in the scene, and students are expected to choose the right animal.

The interviewees expressed their views about the background color, buttons, sound, and orientation. A color was selected which would not distract the students.

No sound was used for the background. An expert (IT 1) suggested that students would hear the animal's sound when touching an animal, which was added to the material in the preparation phase.

3.2.1 Development of pilot material

The storyboard was given to designers to develop. They were told in detail what the material was to be developed for and what kind of user was addressed. They developed the material in a way to attract children's attention, and the researchers and experts decided on the menu, links, and background. The menu and links were large and attractive, so they decided to make them smaller and less attractive.

Another issue was that, in the first phase, teachers wanted to add a doghouse near the dog and a carrot in the rabbit's paws. However, in this phase, the teachers stated that these added items would confuse the students. For this reason, the doghouse and bone next to the dog were removed.

> *At first, we want to have a carrot in the rabbit's hand and a doghouse near the dog. However, it could make more challenging the learning in the first show of animals (Teacher 1).*

3.2.2 Phase 2 – summary

Decisions taken at this stage are as follows:

1. Change the background color to a discreet color.	Design
2. Change and simplify the menu link.	Design
3. Change and simplify the shapes of the other links.	Design
4. Remove objects (such as the doghouse, carrot, and bones) making it difficult for the student to focus on the animals.	Content

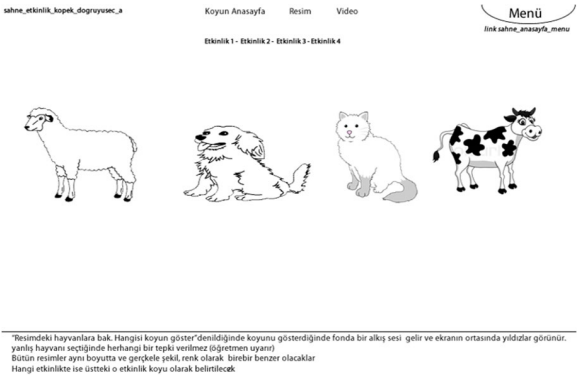


Fig. 7 Storyboard activity scene

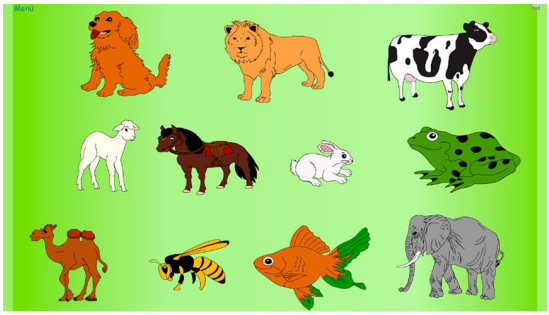


Fig. 8 Main scene

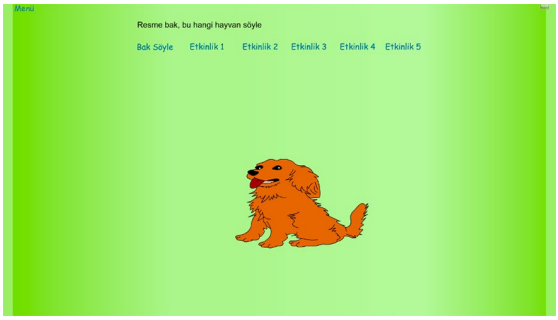


Fig. 9 Animal scene

3.3 Phase 3: Revision of the material

In this phase, the researcher revised the material as decided in Phase 2. As seen in the picture, the welcome page is designed very simply. The menu and links have been simplified and positioned to be unobtrusive. The narration pages are simplified (e.g., removing the doghouse next to the dog and removing the carrot near the rabbit), and the background color is set so that it does not distract. Students can start the activity by selecting an animal (Fig. 8).

As seen in Fig. 9, first, there is the "Look and tell" activity. In this activity, the teacher teaches the animals by showing them the animal. When the animal is touched, the animal grows to the center of the scene, the stars blink, and the authentic sound of the animal is heard. The teacher touches the animal after introducing it, and the effects emerge (Fig. 10). Then the student becomes actively involved in the process.

When the activity links are touched, there are animals to be taught and other animals for comparison. In these activities, the teacher wants students to show the animal.

As stated in the teacher's target chart in each activity, three different animals are placed next to the animal to be taught (Fig. 11). The aim is that the student knowingly touches the animal being taught among these four animals. When the student touches the right animal, the animal enlarges to the center of the scene, and the effects of star and clapping emerge. The other animals fade from the screen.

Fig. 10 When student knows

Fig. 11 Activity page with 3 distractors

3.3.1 Review of material by experts

After the material was developed, a meeting was held with four SE experts, and the material was explained using an IWB. Then, opinions were taken on the material through a focus group interview. In addition, the material had been e-mailed to another specialist with a doctoral degree in special education. This expert reviewed and discussed the material through questions and answers for several days via mail.

In the first draft of the material, there are four activities for each animal. However, following the advice of the experts, it was decided to increase the number of activities to five. The number of activities increased to five since 80% of four events cannot be obtained numerically. Students must achieve 80% to succeed.

> *Knowing 3 out of 4 activities achieves 75% success. However, 80% success must be achieved for the student to attain independence. For this reason, achieving 80% success in four events is necessary. For this reason, it would be better to have 5 activities. (SE 1)*

3.3.2 Drawings and colors

Experts emphasized that the drawings should be made to look like real animals that the students will encounter in everyday life.

> *As regards picture selection, the first step you need to take into account is the selection of drawings, which children may encounter more in their daily lives.*

Could you choose a more common dog that can be seen in the day rather than the golden retriever genus in the picture of the dog? (SE 4)

Besides, they stated that different colors should be used for different animals on the screen. Otherwise, students might confuse the animals because of their colors.

The colors of some animals are very close to each other (SE 1).
If the animals' colors are close to each other, the students may confuse them. Therefore, different colors should be preferred. (Teacher 3)

3.3.3 Size of animals

The animals in the content are different sizes (like lions and bees). For example, when the lion is placed as a distracter for the bear or bee, it is planned that both animals will be minimized at the same rate and put into the content. It was said that this would not be correct and that each animal should be the same size. In practice, since the size is thought to be a distractor, the drawings of all animals are brought to the same size. The expert who was contacted by mail also mentioned the same issue.

The size of each animal must be the same, the student can choose the right animal from the size. (SE 2)

3.3.4 Distractor numbers

Experts also expressed different views on the number of distractors in the activities. Some experts stated that the number of distractors in each exercise should be reduced from 3 to 1 and adapted to the student's level. For this reason, four options to choose the right one would be more difficult than two options to choose the right one and said that it would make teaching difficult.

3 distractors may not be suitable for the student's level. It might be better if there was a single distracter at first. (SE 1)

SE 2 stated that it would be better to have 1 distractor in activity 1, 2 distractors in activity 2, and 3 in activity 3.

It will be better if the number of distractors increases as the activity changes. (SE 2)

However, the same expert stated that students with special needs might exhibit differences among themselves, so the number of distractors in the activities may vary according to the student's situation.

There will be tremendous differences in students with intellectual disabilities. The five animals you show can be found in the student who will be able to identify him/her, also not. (SE 2)

It was decided to put one distractor in each activity, considering all these interviews and the opinions of the teachers who developed the practice. However, there was another disadvantage in the material. When the number of distractors was 1, the right animal was positioned 3 times on the right, 2 on the left, or 2 on the right, and 3 on the left. The last decision was to make it dynamic. Teachers can now change distractors according to the student's characteristics.

3.3.5 Phase 3 - summary

Decisions taken at this stage are as follows:

1. Increase activity count to five.	Content
2. Some animal drawings and colors have been changed.	Design
3. Teachers can change the count of distractors dynamically.	Content
4. The distractor count should be changed dynamically.	Content

3.4 Phase 4. Implementation

3.4.1 Effects

In the observations, it was seen that the students were pleased by the effects. They reacted positively to the stars and applause sounds, and even one of them was applauded. The student with Down syndrome started to touch the screen because he liked the effects very much. Because of the focus on effects rather than learning, the sound effects for this student brought about a negative situation. The same problem was not observed for other students. Other students were happy with these effects too, but they didn't focus on the effects rather than learning as the student with Down Syndrome.

The teachers' rationale on this issue was that the student could memorize the selection that effects came from and make a selection based on that. In other words, he did not learn the dog; he learned the shape that causes stars and sounds to come out of that shape. Therefore, teachers stated that removing these effects during the implementation would be more appropriate.

We thought these would be effective in the first stage. In the first stage, he tried to find the star, he tried to find the voice. I don't think that sound and growth have any effect, and I think it even has a negative effect. The child focuses on effects rather than animals. They were going out of the target. (Teacher 2)
We have shut down the sound because the sounds are hints in the evaluation. (Teacher 2)

In addition to this view, teachers stated that students with intellectual disability exhibit very different characteristics from each other. Sounds and effects have a negative effect on some of the students in this group, but they can be effective in other groups of students.

> *The performances of children are different. So sound will be used for some, effects will be used for some, and there will be no effect for some. (Teacher 1)*
> *Why didn't we cut the sound of the stars and not the growth? Because in this group, they gave negative results, but they can be effective in a different group. (Teacher 1)*

In addition to this, it was observed that another student with autism displayed stressful and grumpy behavior when he came to the IWB, but he subsequently liked the effects, and he was observed to calm down. Likewise, it was observed that a shy student liked the sound of applause and stars when he clicked on the animal, and he relaxed. We recall here that the teachers wanted to remove the effects altogether because only one student reacted differently to the effects. However, the impact did not affect other students negatively, so it was understood that the effects differed from student to student.

Apart from these effects, the animals' sounds have also been added to the content (e.g., barking for the dog, the moo sound for the cow). These sounds are heard when the animal is touched in Look and Tell activities. However, the teachers insisted that these sounds should also be absent. As a justification for this, they argued that when a concept is first taught, multimedia elements will give negative results because it will be easier for intellectually disabled students to learn only one feature of a concept at the same time.

> *The main problem is that target behaviors have nothing to do with multimedia. The target behavior was to learn about the animal. The interactive board would be more effective if the animal had a voice. But for this, the 1st target behavior had to be acquired. (Teacher 1)*

However, when the lecture videos were watched again, it was observed that this student did this from time to time, and from time to time he responded without paying attention to the effects. Teachers also stated this in their opinions.

> *These behaviors in student 1 decreased. If we continued to practice a little more, it would be entirely over. (Teacher 2)*

An option to turn effects and sounds on and off has been added to the content upon request from the teachers when such a situation occurs with the effects. Teachers could turn the sounds and effects off and on at any time by selecting this option.

Teachers said the sounds could also be used in the post-instruction generalization phase. They stated that the animals' voices could be given in the generalization phase, which would be more effective.

We said we could use sounds and their natural environment, but it would be better if we gave it at the generalization stage. (Teacher 1)

3.4.2 Distractors

Another problem experienced during the implementation process is that the correct animal is placed on the right in three out of five activities. In comparison, it is placed on the left in the other two activities. This is a must. The student's first choice of the right animal and the applause and star effects sometimes caused him to learn the location of those effects instead of the concept. In the 2nd activity, even if the animal's location changed, he waited for the effects to come by touching the left side again. However, it is seen in camera records that this happens infrequently. Teachers believe that all these negativities can be eliminated in time. For this reason, it was decided to change the distractor count dynamically.

While the activity changed in the process, the number of animals increased, and different situations were tried. While explaining the rabbit, 1 distractor was put in Activity 1, 2 distractors in Activity 2 (Figure x), and 3 distractors in Activity 3 and 4. While the high number of distractors did not affect two students, it was observed that one student was confused and had difficulty; the autistic student could not show the right animal. However, considering the overall success, it has been observed that this is directly proportional to the student level.

3.4.3 The same color of distractor and animal

An important finding emerging from the observations and teachers' opinions is that the distractor's colors should be different. For example, while teaching the white dog, the white cat used as a distractor made it difficult for the student to learn. In teaching several animals, it was observed that the distractors were the same color as the animal being taught, confusing the student. Another point expressed by the teachers is that the animal being taught must have the same color in every activity. However, it may be possible to present an animal in different colors in generalization sessions. Showing the same animal in different colors while teaching makes it difficult for the student to learn. It was seen that teachers should be enabled to change distractors dynamically.

3.4.4 Asking the negative

Another situation is the questioning of the negative. When students are asked, "which is not a dog?" the effects will occur if they choose the dog; even though the student is wrong, applause and stars will cause the student to learn the wrong answer. Therefore, a negative option has been added to the material, and when this option is selected, the appropriate feedback is provided by teachers when the wrong answer is selected. Another problem experienced here is that when the student answers the question "which one is not?" correctly, the effects can cause the student to learn the

wrong thing. However, since this may give different results in some students, the effects were dynamic and left to the teacher's preference.

3.4.5 Phase 4 - summary

1. Sound and effects have been made dynamic.	Interaction
2. Animal voices have been made dynamic.	Interaction
3. Different colors were chosen for the distractors.	Design
4. The teacher can decide on color, shape, and distractor.	Content
5. The status of asking for negatives has been added.	Interaction
6. No effect occurred if asked negatively.	Interaction

4 Discussion

This study aimed to reveal what should be considered while developing interactive multimedia materials for students with special needs. After analysis of the data in four phases, findings were interpreted under three headings: content and design, usability, and interaction, and discussed under these headings.

4.1 In terms of content and design

4.1.1 Simplicity of content

The first draft created a natural environment where the teaching would occur, and many animals were placed on the screen. However, because all animals were in the same scene, the concepts other than the concept to be taught attracted the students' attention. Vuran and Sezgin (2010) also stated that the concepts should be taught individually, even if they are close. In addition, even when teaching students without disabilities, it is necessary not to overwhelm students with too much information (Murphy & Golden, 2008). Also, it is known that according to universal design principles, materials should be simple and intuitive (Hitchcock & Stahl, 2003).

Having objects related to the concepts next to them at first would make it easier to learn them (For example, a hut next to the dog and a carrot near the rabbit). However, after the first draft was shown to the teachers, they said that having other objects next to the concepts would confuse the students and negatively affect the teaching. For this reason, they stated that objects that would attract students' attention should not be used. Fleming(1993) stated that decorative objects should be used sparingly; otherwise, students would force themselves to see the main object. Mayer (2001) touched upon this issue in the principle of redundancy in multimedia principles and stated that if more than one item is used simultaneously, there will be a cognitive load. It is also stated in the literature that students who need special education have problems obtaining and using the information in places where there is more than one stimulus (Tekinarslan, 2012). In generalization sessions, more than one concept can be used. For this reason, it is thought that the materials to be developed for students

with special needs should be simple, and only the concept aimed should be taught during primary education.

4.1.2 Object drawings

Teachers and experts stated that when the material was first shown, the animals drawn should be similar to real ones and in a style the students would encounter in their daily lives. It is thought that doing this will make it easier for the student to learn.Murphy and Golden (2008), Bishop (1999) andFleming (1993) also stated that in parallel with this finding, the materials should contain situations that students encounter daily. This subject is also emphasized in the principle of proximity to life, a teaching principle that declares real-life elements in teaching helps students learn (Sümbül, 2011).

4.1.3 Avoid distractors

Another point to be considered while developing material for these students is distractors. In this study, it was stated by the teachers that the distractors should be different from the concept to be taught in terms of color. During the application, it was observed that the color of the distracting animal was close to the color of the animal to be taught, making it difficult for the student to choose the right one. However, a study(Granzin & Carnine, 1977) observed that the more the distractor resembles the concept to be taught, the more quickly the students learn the concept (Tuncer & Altunay, 2012). This is also inconsistent with the finding of this study and is thought to be because the learning capacities of students with intellectual disabilities are very different. Prater (1993) also stated that the concept to be taught and the distractor to be used should have matching features, but their descriptive features should be different. Fleming(1993) stated that many distractor features should be the same, and a few features should be different. Distractors can get more challenging step by step based on student progress.

In the literature, it has been stated that due to the diversity of the needs and learning levels of students with special needs, appropriate planning should be done in education for the instruction to be effective (Boyle & Scanlon, 2009; Morrison et al., 2004; Özen, 2012). In concept teaching, the number of distractors should be adjusted according to the student. For this reason, the material should allow for a dynamic structure. Mainly since there is a difference in level among students with special needs, using more than one distractor may make learning difficult for one student. Still, at the same time, it may seem simple for another student. Student characteristics should be considered when choosing materials (Avcı, 2009; Çelik, 2007). This is parallel with the finding that the contents to be prepared for students should have a dynamic structure and offer different options according to the characteristics of the student.

4.1.4 Sound and effects

Another critical issue in developing the content is giving sound effects to the taught animal concepts. In the first sessions, the voice of the animal was supplied. When the animal was touched, its sound was heard in the Look and Tell event. However, teachers wanted it to be removed. The teachers stated that it would be difficult for these students to learn both the concept and the sound simultaneously. Just as the dog has a kennel next to it, giving the animal's voice while being shown makes learning difficult. This finding coincides with individuals with ID having problems obtaining and using the information in places with more than one stimulus (Tekinarslan, 2012).

4.2 In terms of usability

The usability in which the material will be used is also significant. Since the IWB in this study has a fixed platform, it must be installed at a certain height. This limits students' access to the top of the board. For this reason, the objects that students will use in the materials should be placed where students can reach them. Otherwise, the student will have difficulty touching the places that need to be touched. Jeffs et al. (2005) and Avcı (2009) drew attention to this issue. They stated that the material should be prepared in a way that the student can use comfortably and practically while preparing the material. It is also mentioned that in universal design, students should be able to use the material with little physical effort (Hitchcock & Stahl, 2003).

One of the crucial points regarding the usability of the material prepared in the research is the necessity of placing the menus out of reach of students. In this case, students can go to different screens by touching the menus. For the same reason, it was observed that the material should be opened in full screen. Otherwise, the student can open other programs in the taskbar in the operating system and switch. This distracts the student's attention. The literature shows that the convenience of a material is also related to the fact that the user can navigate the material comfortably and make menu choices easily (Kaya, 2006). Hannafin and Peck (1988) stated that the student should use the material without needing an assistant. Alessi and Trollip (2001) also emphasized that most instructional designers advocate that control of the materials should be given to the users as much as possible. However, in the present study, it has been seen that the user's access to all the material, in the case of students with intellectual disabilities, poses problems contrary to convenience.

4.3 In terms of interaction

Effects and sounds corresponding to the student's input in the material can be considered within the scope of interaction. A strong potential of multimedia materials is that they enable students to engage in meaningful activities by allowing interaction in various forms (Alessi & Trollip, 2001). In working with students with special needs, immediate feedback should be given to the student's answer (Eripek, 1998), and the feedback should be aimed at increasing the student's ability to be correct in the future (Alessi & Trollip, 2001). Students generally expect teacher feedback when they do

an activity (Reis et al., 2010). Various effects were used in the prepared material for this purpose.

The impact of the effects used differs from student to student.Fleming (1993)Fleming (1993)Fleming (1993)Fleming (1993) stated that feedback would increase student satisfaction and motivation.Alessi and Trollip (2001)Alessi and Trollip (2001) Alessi and Trollip (2001)Alessi and Trollip (2001) also stated that using sound effects as feedback would increase students' attention, and giving immediate feedback by using technology makes learning more effective (Smith & Okolo, 2010). However, in the present study, when the correct answer is given, the sounds of applause and star effects may be pleasing to some students, while for others, it may create an obsessive situation. It is known that each child with a learning disability has unique behavioral patterns. Instead of focusing on the effects and finding the right animal, a student tries to focus only on the effects; a student also exhibited a unique behavior, and the effects had a negative effect. At this point, whatAlessi and& Trollip (2001) say is inconsistent with the principle.Mayer (2001) also mentioned this issue under consistency, one of the multimedia design principles. He mentioned that sounds unrelated to learning could attract the student's attention and distract them from the information to be learned, which is in line with the research finding.

Since some students react differently to effects, it is thought that the effects used in the materials should be prepared and presented based on the student's characteristics. In the literature, it is stated that when educational activities are carried out, taking into account the characteristics of these individuals, fewer problems are experienced, and it is possible to increase the student's success (Özen, 2008). It was observed that the students who were stressed while using the IWB became calmer when interacting with the material. Moreover, a student also applauded when the applause and star effect came on. In a study, it was stated that the activities performed on the computer caused more interest, insistence, and less anxiety in the students, and also a great liking of the students for the application (Reis et al., 2010). These results are in parallel with the findings of this study. The same study stated that the students wanted to spend more time with multimedia applications, supporting this finding.

While teaching a concept to the student, the feedback on the material is also crucial if the negative of the concept is asked and the student knows the correct answer. In such a case, it has been stated by the teachers that effects such as applause and stars may cause the student to learn the distracting concept instead of the concept to be taught. Teachers emphasized that if the students like the feedback on the wrong concept, they will focus on it. However, the student should also know whether the answer given is correct or incorrect. For this reason, instead of providing an effect that the student will like in negative questions, it has been seen that it is more appropriate to give feedback from the teacher that he/she knows correctly.

In summary, student profiles in special education practice schools vary, and the levels of the students in the classes created in these schools are not always the same. In this study, the levels of the students working together were different, and it was seen that the students reacted differently to the material. For this reason, it has been seen that the features such as animal sounds, the presence of other objects besides animals, effects, and the number of distractors mentioned above within the scope of content, design, usability, and interaction should be completely dynamic, making the

teacher's job easier and shaping the material for the individual. That is why learner-centered materials need to be developed. This gives teachers the flexibility to change the features of the material for each student. Learner-centered design is crucial when developing materials for these students because each student has unique and varied needs and other factors, such as individual characteristics and knowledge levels, come into play (Başer & Arslan-Ari, 2022). In this respect, it is vital to adapt materials to the characteristics of the students.

4.4 Implications

In this article, a material for direct instruction, one of the instructional methods employed in special education, has been developed. Future research can create materials for other teaching methods and test and refine design elements. In addition, further research can be conducted to determine what design factors should be taken into account for materials created using technologies with various forms of interaction (such as augmented reality, mobile technologies etc.).

4.5 Limitations

1. The study is limited to one school.
2. The students had different mental illnesses (Intellectual disability, autism, and Down syndrome).
3. Teachers had not used IWB before, though IWB had been installed two months before the study.

Funding This study is derived from the first author's PhD dissertation and was supported by Atatürk University Scientific Research Projects Coordination Unit (Project No: 2,012,286).

Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests Authors are required to disclose financial or non-financial interests that are directly or indirectly related to the work submitted for publication. Please refer to "Competing Interests and Funding" below for more information on how to complete this section.

Ethical considerations The study permission was obtained from the Ministry of National Education. The proposal, data collection tools, and data analysis details of the study were sent while obtaining the study permission. The personal data of the students were kept confidential. It was not shared with anyone other than the researchers.

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