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Transforming Learning Spaces for Elementary School Children with Special Needs

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Abstract

The study aims to develop a prototype eLearning system and to gather feedback from teachers on the developed prototype to demonstrate its effectiveness. The study uses a four-phase iterative process to develop and analyze a prototype eLearning system: understanding the problem, designing the system, developing the system, and gathering user feedback. Seventeen teacher who teach physically disabled children in five schools in Banjarmasin South Kalimantan Indonesia were involved in setting up the operating procedures, working on the development of the school, and involved in the user feedback sessions varied among the schools. Results reveal that this prototype significantly helps teachers of children with special needs. It is recommended that the authorized body considers developing a policy for all schools for children with special needs, especially schools that support physically disabled learners, to implement this eLearning system.

Key words: *Learning space; user experience; interaction design; disability; aqueduct.*

Introduction

The advances made in computer technology have impacted every aspect of human life, and they have made it possible for people to communicate in networked computer systems. Since 1990 when computers were first networked, human networked communication has become very pervasive (Preece, Sharp, & Rogers, 2015). The evolution has been very swift, especially over the last decade when online videos have become ubiquitous.

These advances have gone beyond personal satisfaction, making users expect efficiency and effectiveness in their interactive products (Ahmed Sheikh, 2017). Hence, the way people communicate, learn new things, converse, and enjoy entertainment have all changed and mostly, this change has come from technology (Schneiderman, Plaisant, Cohen, Jacobs, Elmqvist, & Diakopoulos, 2016). Change happens everywhere, and while there have been some drawbacks, the

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impact of this change has been very beneficial. In particular, technology-based change has allowed more people to participate in society (Cooperet al., 2014).

In teaching and learning, the technology-based evolution has enabled pedagogy to become more dynamic (Mayer, 2011). The definition of the classroom has been revised because now, as long as they have a computer connected to the Internet, anyone can learn anything from anywhere. Terms such as blended learning, flipped classroom, virtual classroom, and collaborative learning are now frequently used. In such a context, learning content is designed in the form of media-rich presentations by using videos, animation, and simulations and not just graphics and text (Mayer, 2011). These are all components of electronic learning (eLearning), which goes beyond simply digitizing books (Soendari et al., 2010). However, to be effective, eLearning must be designed carefully, and it must be appropriate for learners (Mayer, Heiser, & Lonn, 2001; Preece, Sharp, & Rogers, 2015; Schneiderman, Plaisant, Cohen, Jacobs, Elmqvist, & Diakopoulos, 2016). Siahaan (2002) underlines that eLearning serves three functionalities: it is a supplement, complement, and substitution for conventional learning styles. While, previously, it was generally accepted as a supplement to normal learning processes, its role has progressed along with the advancement of technology into a more complementary and substitutive one, with many institutions of higher learning offering virtual learning at the degree level (Efendi & Zhuang, 2005). Gradually, this will allow the learning ecosystem to move towards more sustainable and environmental practices (Alharthi & Spichkova, 2017).

The actualization of these concepts can be used effectively for learners with special needs. For every learner (either living with or without a disability), their ecosystem for teaching and learning consists of infrastructure and content (Zulaiha, 2017). The infrastructure refers to the mechanisms that make it possible to learn, while content refers to the learning objects in the infrastructure. These two components must develop together for them to be effective. Many infrastructure technologies have been designed for learners with special needs, including hardware (such as wheelchairs) or software (such as screen readers). However, software-based infrastructure has not developed as quickly or as efficiently (Rajapakse, Brereton, & Sitbon, 2018).

Efforts to support learners with special needs have been extensively researched. Special schools have been established with specific curricula and teaching pedagogies (Zulaiha, 2017;

Nurulnadwan, 2015). In Indonesia, the government has been leading this change; for example, Law No. 20 Year 2003, 5(2) states that people with physical, mental, emotional, intellectual, and social disabilities have the right to receive an education that matches their needs. Meanwhile, Law No. 23 Year 2002, 51 states that children with physical and intellectual disabilities must be provided with similar access to both mainstream and special education.

Thus, various types of special schools have been designed and developed in Indonesia (Bandi, 2006). As an example, the Elementary School for Special Education (ESSE) provides education for children with special needs. It works with children with six categories of disabilities: visual impairments, hearing impairments, intellectual disabilities, aqueduct, dyslexia, and the autism spectrum disorder. In terms of teaching and learning methods, each category is approached individually based on the specific strengths and weaknesses of that disability.

For children with visual impairments, as they are not able to see things, they rely mainly on their hearing and touching abilities; hence, lectures are appropriate education tools. These are strengthened with conversations and the question-and-answer technique. They also have access to books in Braille, pictures that are produced to be touched, and new technologies such as 3D printing (Buehler, Comrie, Hofmann, McDonald, &Hurst, 2016). Meanwhile, children with hearing impairments normally have difficulties studying alone because they mostly learn through social interaction (Zatul, Nurulnadwan, Ariffin, & Mohd Saifullizam, 2011; Abdul Mutalib, Sobihatun Nur, Ahmad, Mahmuddin, & Syarifah Nadiya, 2015). Without close guidance in learning, they prefer to do other physical activities (Norida, Nur Tahrina, & Ariffin, 2012). Hence, the most appropriate technique for these students is teacher-centered learning (TCL). In TCL, teachers guide learners closely, ensuring that they focus during the learning process. Similar to children with visual impairments, children with an intellectual disability can be taught using the lecture approach, but the use of aids that stimulate and strengthen the learning process is also necessary. In most cases, children with an intellectual disability are not able to attend lectures independently (Siti Zulaiha & Ariffin, 2015). Children with autism spectrum disorder have various characteristics and their teachers have to know and understand their specific characteristics and approach these learners accordingly (Frauenberger, Makhaeva, & Spiel, 2017).

Currently, the available means and infrastructure are sufficient for the needs of children with special needs. These include teaching and learning aids and relevant electronic media. However, these tools have not been optimized to ensure that parents are part of the teaching and learning process and, together with the teachers, monitor the children's progress and performance (Tosho, Mutalib, & Abdul-Salam, 2016).

As a consequence, to ensure that teaching and learning are optimized for the children with special needs, this study develops a dedicated online system that bridges the gaps among children with special needs, their teachers, and their parents by using ICT. The bridging concept allows parents to view their children's progress and performance at any time. More importantly, teachers can carry out learning activities more conveniently, while at the same time they can engage with the children and communicate with their parents online. Consequently, this system will improve the children's' productivity in their learning process.

While there are various types of disabilities, children with physical disabilities (aqueduct) are the focus in this initial stage. This is because this study asserts that children with hearing impairments (Mutalib et al., 2015), visual impairments (Aziz, Roseli, & Mutalib, 2011), dyslexia (Kalka& Lockiewicz, 2017), intellectual disabilities (Murphy & McFerran, 2017), and autism spectrum disorder (Ip et al., 2018) require a dedicated specific interface approach. Systems for these learners must be designed for their respective needs as each group, and each individual in these groups is unique (Preece, Sharp, & Rogers, 2015). In contrast, physical disabilities are more general, so learning systems for children with physical abilities can share common features.

Accordingly, the aim of this research is twofold: first, this study aims to develop a prototype eLearning system and to gather feedback from teachers on the developed prototype to demonstrate its effectiveness. While this section establishes the background of the study, including a description of the problem and aim of this research, the following section describes the process involved in the development of the prototype and collation of feedback. Then, a discussion on the impact of the system follows, and finally, the paper is concluded with a discussion on the way forward.

Method

Research Design

Achieving the goals of this study requires a systematic and scientific approach. This is because the aim is to make sure that the new system is effective, efficient, and enjoyed by the users. More importantly, this study realizes that the users are unique. Hence, a specific process was chosen, which is illustrated in Figure 1.

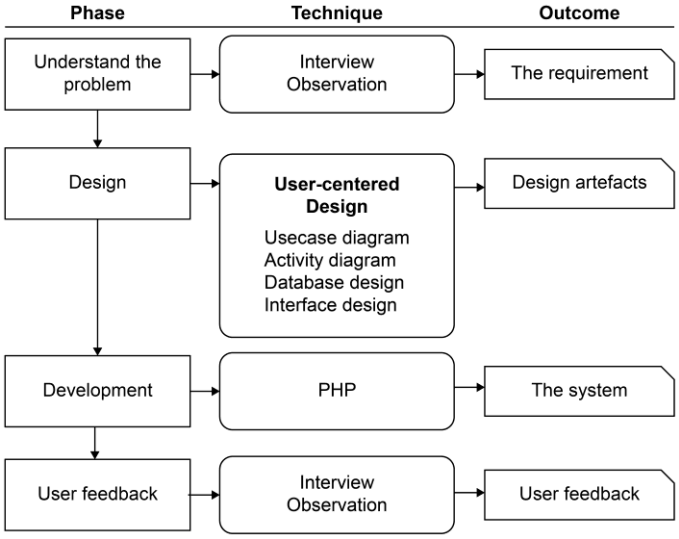

Figure 1. Methods for achieving the goal

Figure 1 illustrates the four phases of this study: understanding the problem and gathering the requirements, designing the system, developing system, and collecting user feedback. Various techniques are used through the four phases, as described briefly in the following paragraphs.

Understanding the Problem

In order to understand the current limitations, and to identify the users' needs, this study engaged with policymakers, teachers, and physically disabled children. Different techniques were used for collecting the information; the policymaker was interviewed, while the teachers and children were interviewed and observed when they were performing tasks. All interviews in this phase were unstructured so that the participants were free to express their thoughts on the current learning practices and the particular needs of the special education. It was done using the quick-and-dirty paradigm to understand the limitations of the current practice and what is necessary to assist the

physically disabled children. In such a paradigm, interviewing one policymaker, such as a senior national civil servant, is sufficient. Such a person has supervised special education in the country for many years, and his or her expertise is highly appreciated. In addition to supervising policy-making for special education, the expert also takes part in motivational programs for students in special needs education. Subsequently, for the purpose of understanding the problem space, given his or her expertise, this person was very useful and provided sufficient policy-making information. Meanwhile, the teachers were selected among those teaching children living with a disability in Banjarmasin, Kalimantan. This study selected the city of Banjarmasin as the research site because it is the city with the most inclusive education in Kalimantan (Zainuddin, 2018). A well-established inclusive school, SLBA Fajar Harapan, was selected in the city. Generally, students at the school have performed well both academically and in their co-curriculum. As interviews provide rich data, interviewing three teachers was sufficient. Those three teachers were considered as pioneers in the school, as they have mentored various programs for the students, and established the operational procedures for inclusive learning and for setting up the school. From the students at the school who were living with a disability, eight learners were chosen to participate in the research. In this phase, involving one school in the research was considered sufficient for understanding the common practices and problems because generally primary schools in Indonesia are homogeneous. To verify this, before deciding to interview students at SLBA Fajar Harapan, the syllabus and learning materials of five other inclusive schools in the city were analyzed. This determined that they used a similar system, syllabus, and learning materials.

In the interviews, the policymaker noted that user communication is currently distorted. This is because the communication among teachers, students, and parents is limited to students' attendance. On days that they are absent, they are not able to receive information. When they miss any important information, this affects their learning process. The policymaker believes that part of the reason for such a scenario is because an online system is not used in primary schools. Both the policymakers and teachers said that they would be happy to accept an online system that could bridge this gap. They viewed an eLearning system as an investment that could help them face certain challenges in the Fourth Industrial Revolution (IR 4.0).

Meanwhile, observing the teachers and children completing tasks in the classrooms, this study found that the difficulties that the physically disabled children had with moving limited their

learning process. The teachers sometimes had to help the learners move, and in some cases, turning the face was difficult for some children. In such conditions, the teachers had to consider repeating the learning content many times. They also have to attend to each child separately and follow the individual pace of the child, making the teaching process slow.

When interviewed, the teachers said that they had not completed their syllabus. However, this was not their main concern, because they do not aim to make the children excel academically. Instead, allowing the children to enjoy learning was their main concern. At the same time, having to repeat the learning content many times, was tiring for the teachers. These were some of their concerns, which could affect their professionalism, and further reduce the children's motivation.

As a response to this scenario, they said that they would prefer a system that provides content for their students. At the same time, the system should provide information about each child for them so that they can profile each learner. For the purpose of security, only authorized users would have access to the input function of the system while viewing the information was open. Based on these requirements, a system was designed, which is discussed in the following sections

Design

As a web-based system was required by the users, Unified Modeling Language (UML) was used to design the system. Three design artifacts were used to visualize the system: a usecase diagram, an activity diagram, and a database design. In addition, the system interface was also designed. In this user-centered design (UCD) approach, the teachers, as the users, were consulted on all of the design artifacts. Meanwhile, the user interface design was also presented to the users for their feedback. The involvement of users in the designing phase is part of the strategy to develop an effective interface for the users (Schneiderman et al., 2016).

Usecase Diagram

There are three user groups in the eLearning ecosystem developed for the physically disabled children: the school administrators, parents and students, and teachers. The usecase diagram for each group is illustrated in Figures 2 to 4, respectively.

Figure 2 illustrates how the administrators manage the registration of teachers, children, and parents.

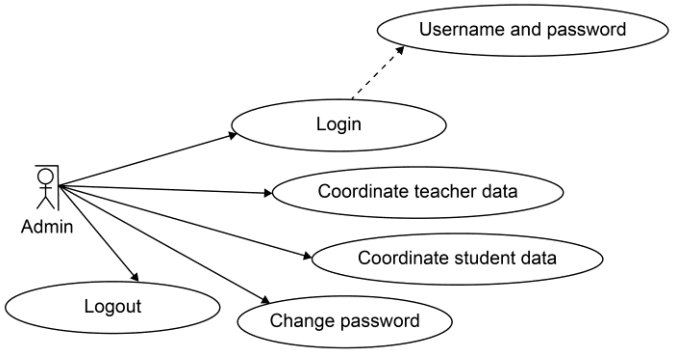

Figure 2. Usecase diagram for administrators

The tasks teachers can perform in the system include managing content, questions, and students' grades, as can be seen in Figure 3. Meanwhile, parents can interact with the teachers and view their children's grades and test questions, as seen in Figure 4.

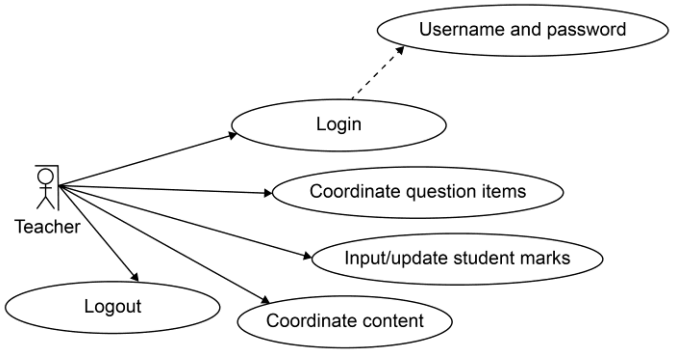

Figure 3. Usecase diagram for teachers

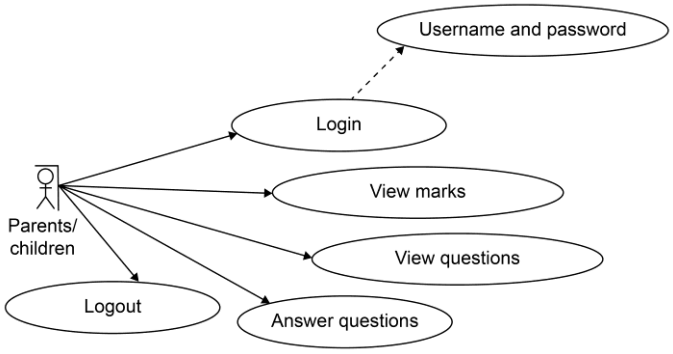

Figure 4. Usecase diagram for parents and children

Activity diagram

Seven activity diagrams were developed for the system: login, administrators, parents, teachers, changing passwords, managing material, and managing test questions. As logging in and changing password are common activities, they are not discussed in this paper. The other five are illustrated in Figures 5 to 9 and discussed in the following paragraphs.

The administrators' activity diagram is depicted in Figure 5, and they can manage the accounts for all users; other administrators, teachers, parents, and children.

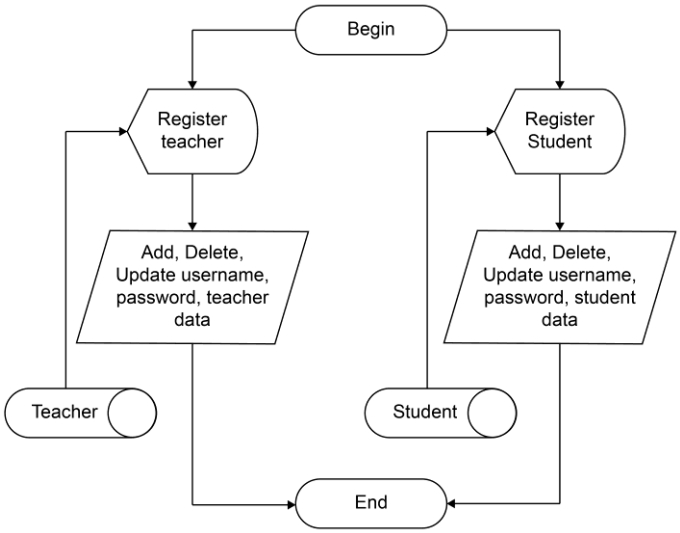

Figure 5. Activity diagram for administrators

Figure 6 depicts the activity diagram for parents, and they are able to upload material, answer questions, and view and download grades.

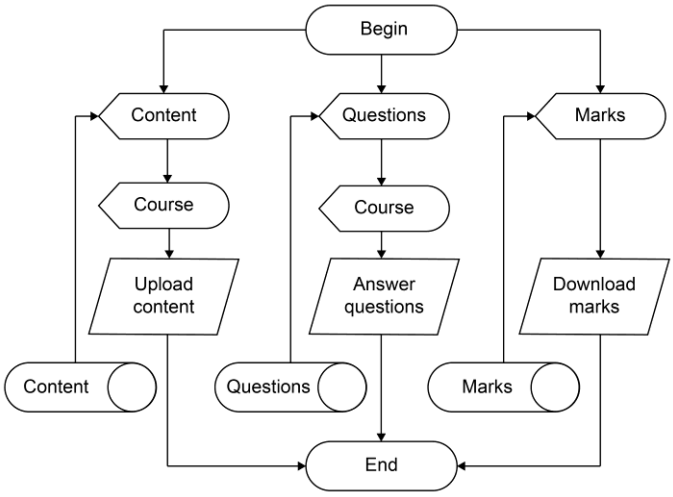

Figure 6. Activity diagram for parents

Almost similar to the tasks parents can do, teachers are allowed to upload material, manage questions, and manage grades, as seen in Figure 7.

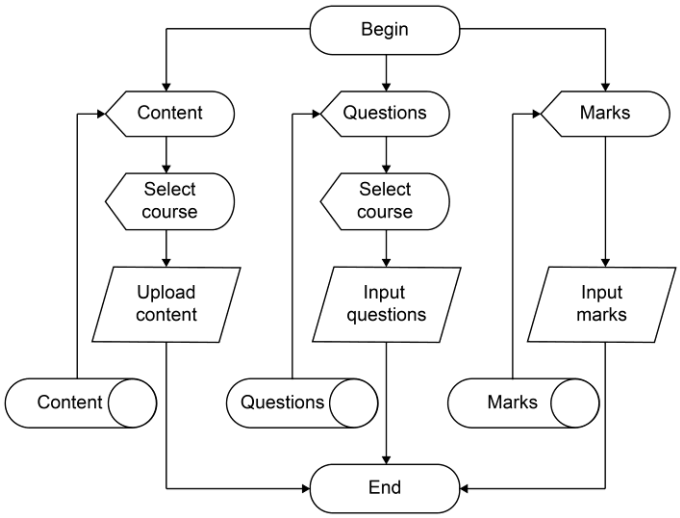

Figure 7. Activity diagram for teachers

Managing materials involves uploading and downloading. Both teachers and parents are involved in this activity, as seen in Figure 8. Meanwhile, Figure 9 illustrates the activity diagram for managing questions.

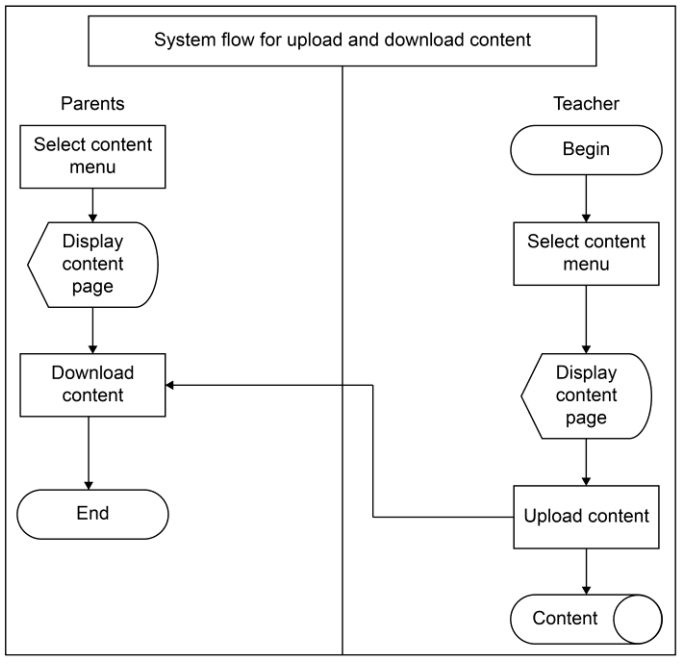

Figure 8. Activity diagram for managing materials

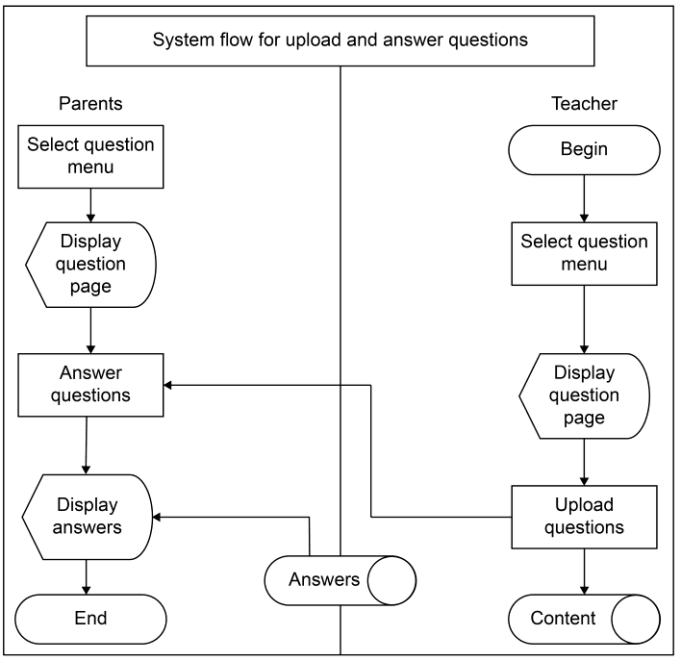

Figure 9. Activity diagram for managing questions

Database Design

The database for the system is represented using a conceptual data model. This is visualized in Figure 10, and 9 tables are used for the system.

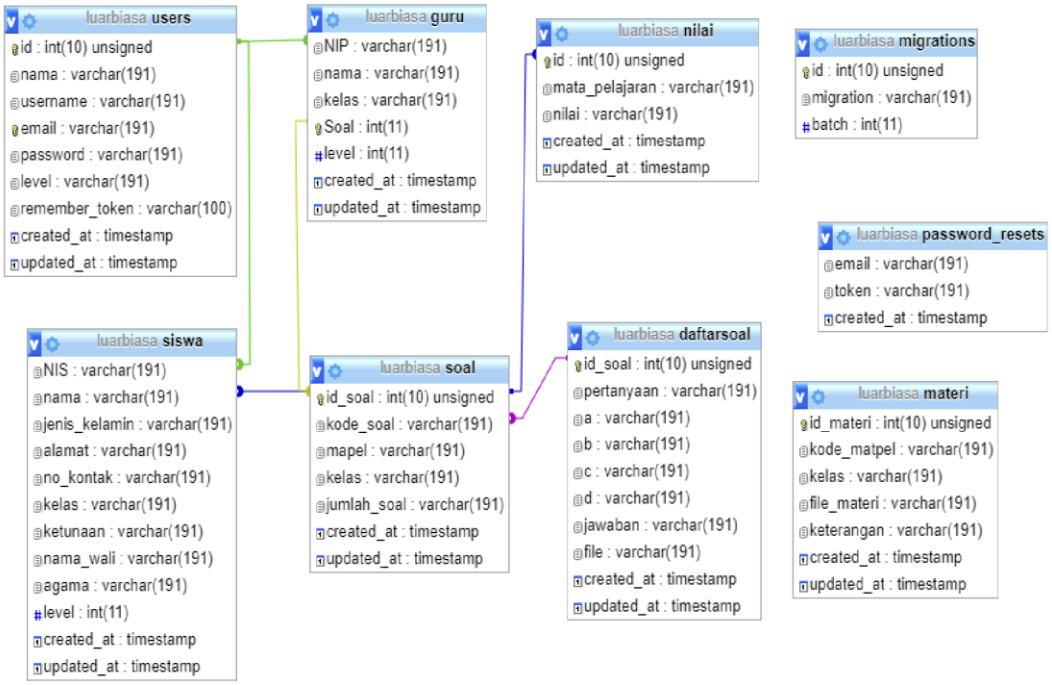

Figure 10. The database designs

All the design artifacts (usecase diagram, activity diagram, and database design) were verified by the teachers. For the purpose of verification, this study presented the teachers with the artifacts and described how the system works. When the teachers were clear about the system, their feedback was collected. The process was repeated iteratively until the final design was agreed upon.

Interface design

Based on the agreed design artifacts, the interface for the system was designed, in the form of a storyboard. The physically disabled children were involved in designing the interface. Similar to the earlier design artifacts, the interface was designed through an iterative process. A sample of the storyboard is illustrated in Figure 11.

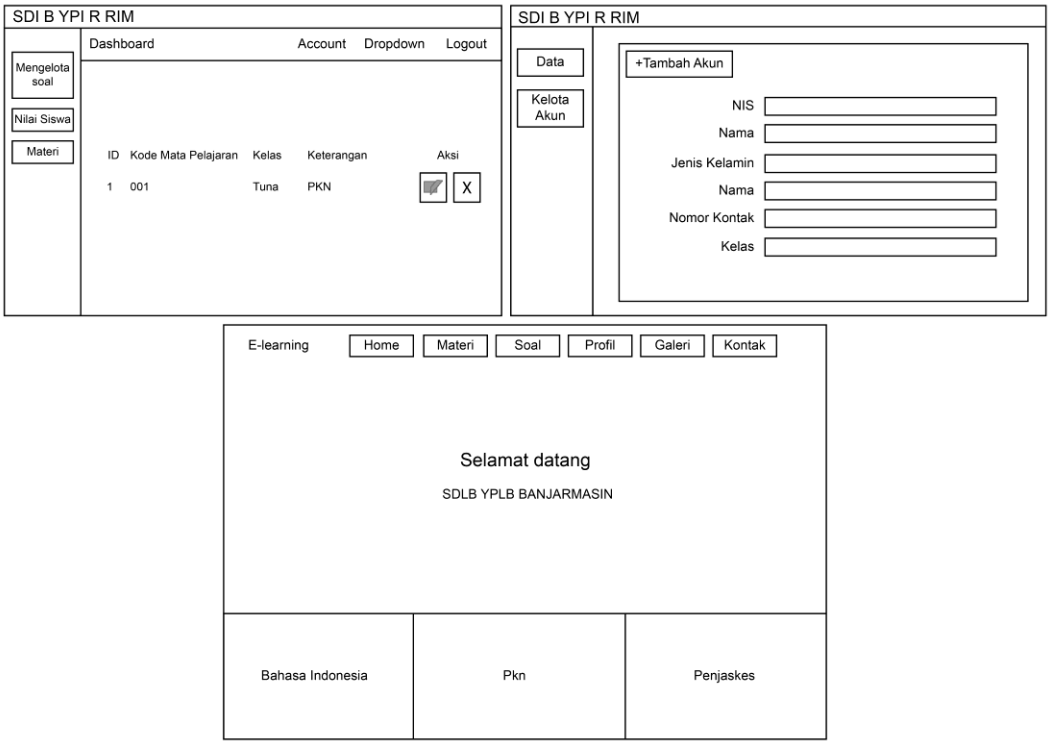

Figure 11. The Storyboard

Development

Based on the storyboard, the system was then developed. The development was carried out primarily using PHP with CSS, and the database runs on MySQL. Similar to the design of the system, the artifacts in the development phase were also iteratively evaluated by the users.

User Feedback

When the prototype was ready, user feedback on the eLearning system was collected. As the main users for the system are teachers, this study first collected their feedback, and they were observed and interviewed in their natural setting. Both techniques are recommended because they allow the participating teachers to express their views naturally (Gill et al., 2008).

Altogether, five schools with special education for physically disabled children in Banjarmasin were involved (SLBA Fajar Harapan, SDLBN Sungai Paring, SMPLB Katon, SMALB Keraton, and SLBN Martapura). The number of teachers involved in the user feedback sessions varied among the schools and in total, 17 teachers volunteered to participate. All the teachers that teach physically disabled children, were involved in setting up the operating procedures and working on the development of the school. This was a sufficient sample size because data were collected after they experienced the system, so it was not perceptive. This has been proven to be sufficient by many studies, such as that of Nurulnadwan (2015), Zulaiha (2017), and Sheikh (2017). During the sessions, their interactions with the system and the interview were video recorded. This approach assisted the study because data from these techniques is richer (Cohen, Manion, & Morrison, 2000). Later, the video content was analyzed, focusing on their body language and conversation. Their answers in the interviews were content-analyzed and coded into themes.

Results

The results discussed in this paper are twofold; the prototype and the feedback gathered from the users (teachers).

The prototype

Having secured the design during the design phase, the system was developed. Samples of screenshots for the system are illustrated in Figures 12 to 17.

Figure 12 illustrates the main page. This is how the system welcomes users, and each time they sign in there is a new metaphor on the main page. The menu buttons are provided on the upper right-hand side, close to each other. This requires a minimal amount of cursor movement from the users, which helps the physically disabled children. Meanwhile, Figure 13 illustrates the page for teachers. The buttons are provided consistently in the left pane, and the main window is for the content. When the teachers manage their learning materials, the menu buttons in the left pane

remain consistent and only the content changes, as seen in Figure 14. This is similar for managing questions, as seen in Figure 15.

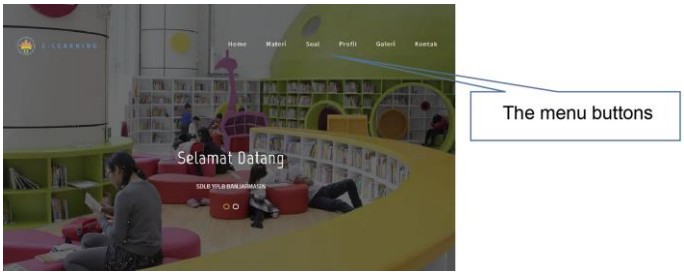

Figure 12. The main page

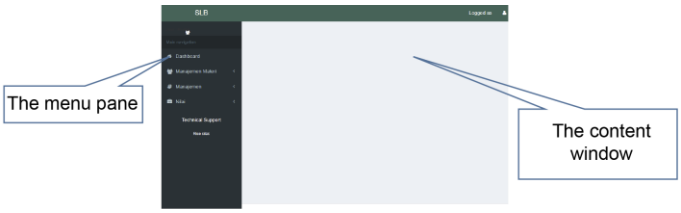

Figure 13. Menu for teachers

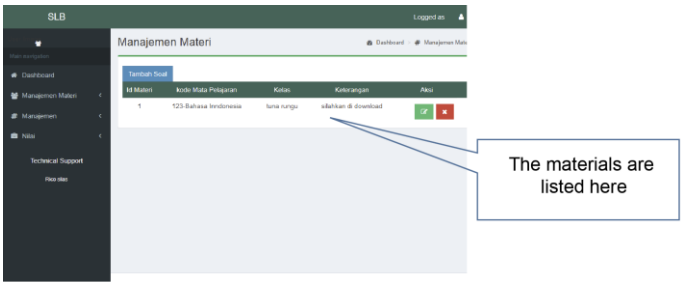

Figure 14. Managing learning materials

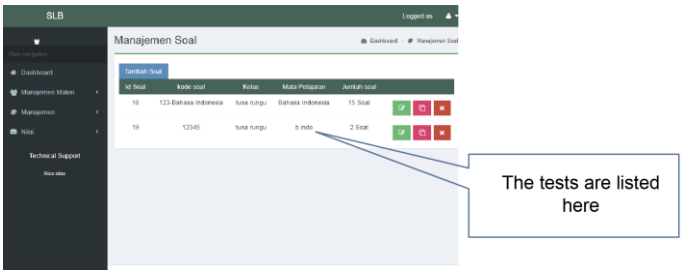

Figure 15. Managing tests

The interaction style for teachers in managing their materials and questions is very straight forward. The interface is simple and the teachers can focus on the main task only, without anything

else appearing on the screen to distract their attention. Preparing the answer option is also very straight forward, as seen in Figure 16.

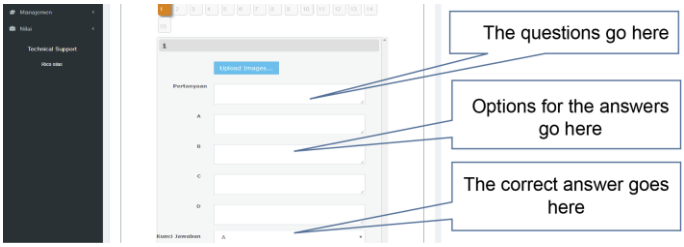

Figure 16. Preparing questions with answer options

Meanwhile, when the test was made available for students to answer, the teachers could monitor the students as they took the test. Through the system, teachers could see who was completing the test and who was not, as illustrated in Figure 17.

Figure 17. Monitoring students answering the test

During the design and development of the system, the main concern was providing signals for the users. The approaches used to provide signals for the users include the use of color, text, tabs, and audio (Mayer, Heiser, & Lonn, 2001).

User Feedback

When the teachers, who are the users of the developed prototype, were allowed to experience the prototype, they cooperated completely. There was no difficulty in ensuring that they behave naturally because they participated actively in the designing and development phases. Hence, this study guarantees that the gathered data are free of bias or external influence.

Through observations, the teachers were seen using the prototype smoothly. Their tasks were to upload and manage materials and to upload and manage tests. All of the teachers were able to accomplish these tasks. However, the time they took for the tasks varied but the variation in the

time taken was not very long. This partly depends on the performance of the machines that they used as well as the speed of their Internet. While performing the tasks, the teachers used the cursor less often, unless they had specific objectives.

When they were interviewed (after experiencing the prototype), they shared their experiences sincerely. Their sincerity was evident in their facial expressions and body language (Preece, Sharp, & Rogers, 2015). In summary, they had no difficulty in using the prototype, and their detailed responses were classified into themes that are detailed in the following paragraphs.

The availability of the system helped the teachers to reach their students, as found earlier by Sweller, Ayres, and Kalyuga (2011). They appreciated the system very much because, with the system, the children could repeat the learning content themselves. In teaching and learning, repetition is important to enhance knowledge and understanding (Moore, 2012). The teachers could also focus on the learning content, and related activities, rather than repeating similar content for different users. This enabled students with different learning abilities to learn at their respective pace.

For the students with disabilities, being unable to attend school is common. However, with the system, they were able to follow the activity and learning content from home or anywhere where they had a computer and internet connection. This is an important innovation in the teaching and learning approach, which could reduce students' frustration. It is important because, for highly motivated students, they always want to follow the learning process.

As the learning materials and tests were available online, and accessible from anywhere, the teachers did not have to worry about whether their students missed the test if they missed the class (because of their disabilities). In addition, the feedback on the tests could be sent to the students and their parents very quickly, so the students could take appropriate action. This type of innovation reduces the amount of work for the teachers in many ways, especially because the system interface was very straightforward and easy to use.

Subsequently, the teachers' classroom approach could be innovated by using the system. The teachers could upload the materials beforehand (for example, a day before class), and the students could digest the material before coming to class. Hence, during the class hour, they could discuss

the uploaded materials. With this approach, the students could be more active, making the class more interesting.

Regarding the interaction style, they responded that the prototype was easy to use. The use of short instructions and familiar terminologies meant that they did not have to make guesses on how to use the system. As a result, they used the prototype with confidence. When they made an incorrect mouse-click, recovering from the error was very easy, and the left-pane menu helped to make their tasks easier to complete.

Using the system requires very little effort, and cognitively, they did not have to guess how to use the system because the buttons to click are expressive. While this was a small part of the designed system, it was significant that this was addressed (Sweller, Ayres, & Kalyuga, 2011). The captions on the buttons and the instructions are also very visible, and most clickable items are grouped close to each other. The frequently clicked buttons are mostly in one place, and this is a standard throughout the prototype. Moving from one task to another can be completed with just a single click. This eliminates waste in terms of mouse-clicks, cursor movements, and mental effort, as demonstrated by Ahmad and Mutalib (2017).

The system does not have any pop-up windows, and all content appears in the static content window. Hence, their attention is not disrupted by any unwanted information or actions. If the content appeared in a different window, they would have to exert an effort to view it, which is a burden (Nielsen, 1999; Paterno, Schiavone, & Pitardi, 2016).

Discussion, Conclusion and Implications

Based on the gathered feedback, through the observations and interviews, this study found that this system would be useful for schools offering programs for children with special needs. When learners have limited physical ability, their infrastructure needs to be more advanced. This has to be balanced. Students' physical and intellectual needs should be considered when creating a learning environment to effectively support their learning purposes. Their facial expression and body language reflected that the system was very useful. Previously, neither had Internet technology supported this type of communication approach nor was it sufficient. Now that Internet technology is advanced, systems like this eLearning system will become a common form of

infrastructure for learning. In fact, a similar system has been used to develop distance learning (Tosho, Mutalib, & Abdul-Salam, 2016; Dalle et al., 2017). This is in line with the expectation that in the IR 4.0, the use of technology will be absorbed into every aspect of human life.

If society does not make use of the Internet in learning spaces, because it is now part of everyday life for children, the children will use it for other purposes. Schools must create an advanced online learning environment, similar to the online experiences that children have at home. Children can use interactive TVs to shop, and this is expected to grow dramatically (Mahfuzah et al., 2013). While this has increased and enhances user experience (Azizah et al., 2013; Dalle et al., 2017), children with disabilities should also be able to benefit. Consequently, learning spaces must also develop advanced online experience while paying special attention to usability issues (Al-Aidaroos & Mutalib, 2015; Baharuddin & Dalle, 2017; Dalle et al., 2015).

The qualitative data analyzed in this study is sufficient to portray the eLearning system. We are gathering quantitative empirical data for further analysis. For quantitative analysis, data will be gathered from more schools, with a larger sample to ensure representativeness. When these data are ready for analysis, the discussion will include feedback from teachers, students, and parents on the impact of the system on their learning process. This will include a more thorough analysis of the differences between a control group and a treatment group.

The prototype system developed in this research is in the process of going mobile. In the meantime, we would like to recommend that the authorized body considers developing a policy for all schools for children with special needs, especially schools that support physically disabled learners, to implement this eLearning system. As reflected by the users, using the system is very straight-forward and requires no technical skills, which means that anyone could use the system without prior experience. Although it involves an investment, the outcome in terms of user experience is significant. It eliminates printing and logistics operation costs because feedback to parents and the two-way communication between the school and parents are made possible through the system.

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