Smart Learning Companion (SLAC)

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Abstract—Augmented Reality (AR) tends to merge the computing world with the real world, giving way to an incredible user experience. This field is not only limited to entertainment but has been utilized in various domains including healthcare, education and training. Realizing the potential of Augmented Reality in improving the learning experience, researchers have explored many ways of incorporating AR in the field education. Consequently, this research is focused on providing interactive and customized learning experience to book readers. We present a mobile application, Smart Learning Companion (SLAC), for physical books that provide a virtual content for a book. The virtual content includes, 3D animations, Quizzes, explanation of content in native language and many other features. The virtual content is activated as soon as pages are scanned with a mobile phone or tablet. Smart Learning Companion explains animated educational content and provides an interactive user experience. The aim of SLAC is to encourage students to learn on their own by making books more interactive. Smart Learning Companion provides explanation in Urdu, solutions of exercises with animations, quizzes for each section, and overall result that shows the student progress. This will help to reduce the dependency of students on others for learning making them capable of self-learning. Smart Learning Companion applications are developed for four books to conduct the experiments. Experimental study is conducted to show the effectiveness of Smart Learning Companion application. The results show that our application helped students to understand the concepts more easily as explanation was provided in national language of Pakistan, that is, Urdu.

Keywords—SLAC (Smart Learning Companion), AR (Augmented Reality), Self – Learning, Smart Way of Learning, Traditional Way of Learning, Mobile Applications.

1 Introduction

Augmented Reality (AR) and education has been one of the most promising fields of Human-Computer Interaction. Augmented Reality has proved to be very helpful in learning as it is the best way for students' engagement towards education. Application based on AR can help teachers in explaining complex topics to students with ease using 3D view. AR based learning systems improves the student interaction.

The aim of this research is to provide interactive and customized learning experience to book readers. We present Smart Learning Companion (SLAC) - a mobile application for physical book that provides an interactive virtual content for a book. The virtual content includes, 3D animations, Quizzes, explanation of book content in native language, that is, Urdu and many other features. The virtual content is activated as soon as pages are scanned with a mobile phone or tablet. SLAC provides animated educational content and provides an interactive user experience. SLAC is designed in a way that it encourages student to learn on their own. Therefore, it reduces the dependency of students on others for learning making them capable of self-learning. The key feature of SLAC is that it provides explanation in native language which makes student more comfortable in learning. Further, the SLAC includes solutions of exercises with animations, quizzes for each section, and overall result that shows the student progress.

SLAC applications are developed for four books to conduct the experiments. The four books which are selected are recommended text books for schools in Pakistan for Urdu Language, Computer Science, Mathematics and Arabic. We also conducted an experimental study to show the effectiveness of Smart Learning Companion application. The results show that our application helped students to understand the concepts more easily as explanation was provided in native language, that is, Urdu. Also, students had an option to repeat the explanations which allows them to learn on their own pace. The overall experience of Smart Learning Companion was every effective and students were willing to learn as they enjoyed the animated content.

2 Smart Learning Companion (SLAC)

SLAC is an android application developed to remove dependency of students on tutors, parents or any other person to teach them. The main users of SLAC are the students of primary and secondary. The objective of SLAC is to enhance self-learning in students by adaptive learning. It delivers four applications related to different books which is available on play store. We have developed applications using augmented reality where students can easily place their mobile camera on book pages. It provides objects, animated video and description in audio for various topics. Unity 3D software is for creating animations.

3 Experiment

3.1 Participants

Five participants of age five to twelve were recruited for the experiments. The participants' native language is Urdu however they have good understanding of English. They are familiar with android smartphone and tabs.

3.2   Methodology

We tested SLAC applications on four different books with the users to evaluate the usability. We compared the results of experiments on the basis of observations obtained through two different cases. In case-I which is experiment using traditional method of learning we asked users to learn on their own from book without using SLAC. In case-II users are given SLAC for each book. We evaluated SLAC using three measures effectiveness, learnability and satisfaction. Co-operative evaluation techniques are used, hence users were allowed to criticize the applications.

Urdu Language Book Experiment Using Case-I: In case I, five users were asked to read a chapter from Urdu Language book. Each user was required to understand the whole chapter story on their own. They were given around 8-10 minutes. When the time was completed the students were given the quiz related to same chapter to evaluate their understanding. The scores of quizzes were recorded.

Urdu Language Book- Experiment Using Case-II: In case II users were given SLAC to understand the same chapter as discussed in case I within same time limit. Figure-1 shows the main screen of application. The users were asked to attempt a quiz to evaluate their understanding of chapter. The scores were recorded.

Mathematics Book-Experiment Using Case-I: In case I, users were given a word problem on the topic of division. Each student had to solve the question on their own without by reading the book. Users had to read and understand the questions to solve it correctly. The users were observed and the time was recorded. The quiz was also conducted to evaluate the understanding

Mathematics Book Experiment Using Case-II: In case II, users were given similar word problems to solve using SLAC. . Figure-2 shows the main screen of application. The participants used SLAC by hovering their mobile camera on target question. A video was played that explained the whole question in native language along with 3D objects. After the completion of video students were asked to extract data from question and to identify which operation should be applied. After this activity a quiz was conducted related to same topic to analyze their way of learnings and the scores were observed

Similarly, experiments were conducted with two other SLAC applications, that is, Arabic and Computer Science, using case I and case II. In case I, users were asked to read the book and their understanding was evaluated. In case II, users were asked to use SLAC. The quiz was conducted to evaluate the understanding.
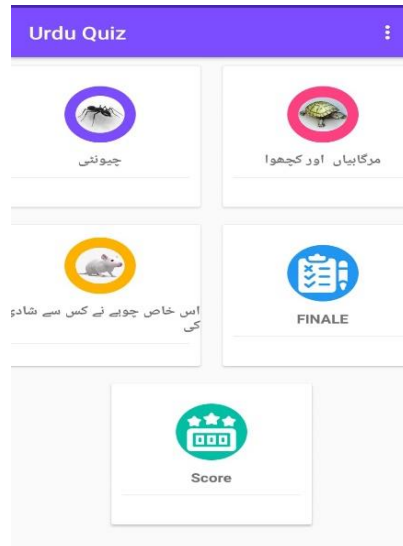
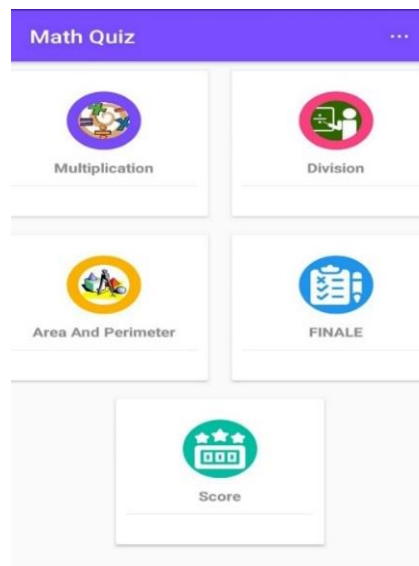**Fig. 1.** Main Screen of Urdu Application

Fig. 2. Main Screen of Math Application

4 Measurement and Result

We use metrics given in Table 1 to measure effectiveness, learnability and satisfaction.

Effectiveness refers to the accuracy and completeness of users in achieving the specified goals. Satisfaction refers to the user's perceptions, feelings, and opinions about the product. It is acquired through interviews or questionnaire. For evaluating user satisfaction, a post-test questionnaire was given for task set. Table I shows the attributes that has been measure in this evaluation in terms of usability and satisfaction.

Table 1. Metrics and Description

Attributes	Metrics	Description
Effectiveness	Percentage of completion	The percentage of user who correctly complete and accomplish the goal of each task.
	Time to learn	Time to read the task set and remember that task.
	Number of errors	Number of errors made while reading scenarios and during the task execution
Learnability	Time taken to understand	Total overall time taken to complete one task and achieving the goal of each task.
Satisfaction	Questionnaire	Measure satisfaction from the application through QUIS-CSQU questionnaire.

4.1 Urdu language book

In case I, one out of five students were only able to understand the whole chapter within time. The result of quiz was below average as students did not comprehend the chapter. Using SLAC, three out of five students completed their task within time limit and two students faced difficulty to understand the whole chapter story. Among three students one student had some usability issues while using the SLAC application as it was difficult to switch to a new learning method. The average score of quiz was better than in case I. Figure 3 shows the effectiveness and Figure 4 shows the learnability using case-I and case-II for Urdu Language.
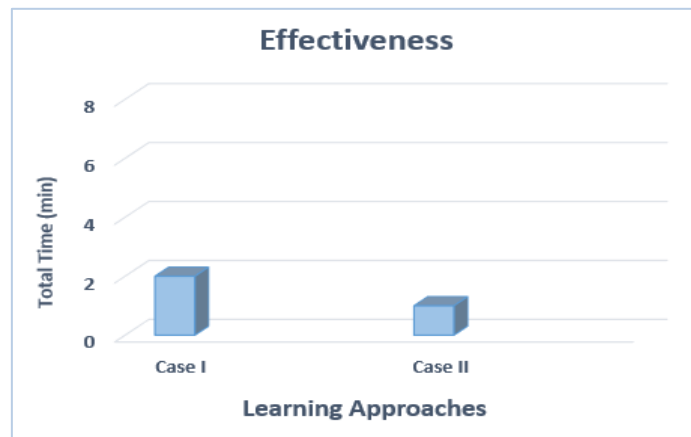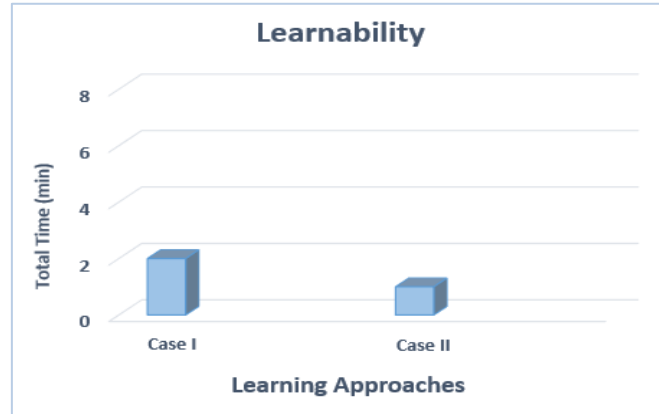

Fig. 3. Effectiveness of Urdu Language Book

Fig. 4. Learnability of Urdu Language Book

4.2 Mathematics book

In case I, five out of two students were only able to understand the questions within the time. In case II, with SLAC, four out of five students completed their task within time limit and only one student faced difficulty to understand the operation applied. Figure-5 shows the effectiveness and Figure 6 shows the learnability using case-I and case-II for Mathematics Book.

The results of effectives and learnability for other two books, that is, Computer and Arabic are depicted in Figures 7 to Figure 10.

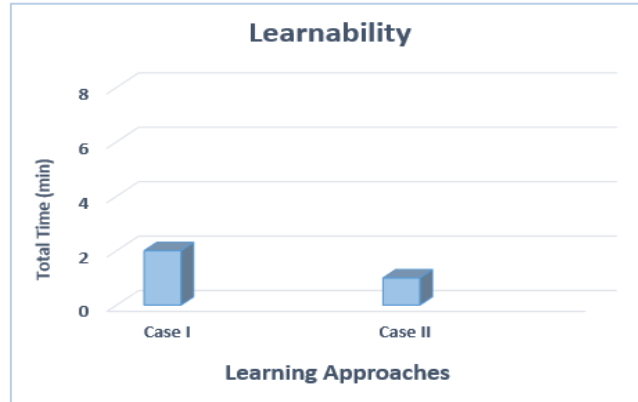**Fig. 5.** Effectiveness of Mathematics
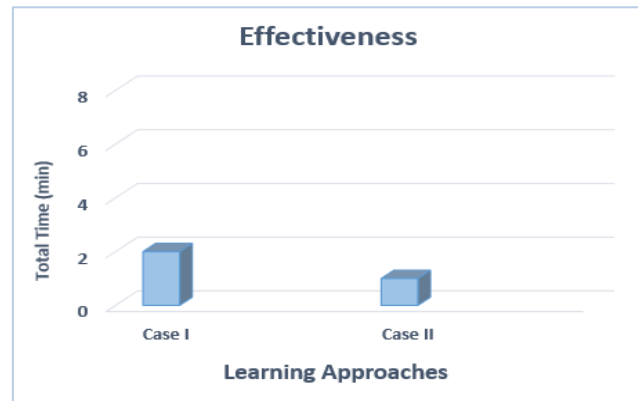
Fig. 6. Leanability By Users in Mathematics Book

Fig. 7. Effectiveness of Computer Book
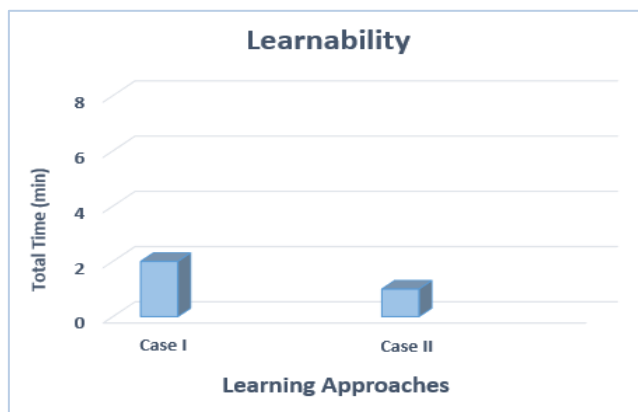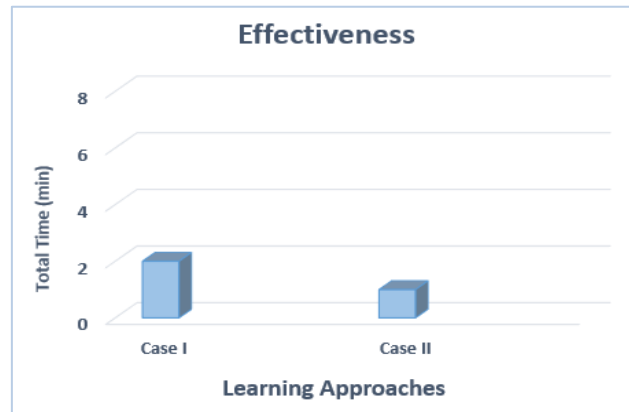
Fig. 8. Learnability Computer Book
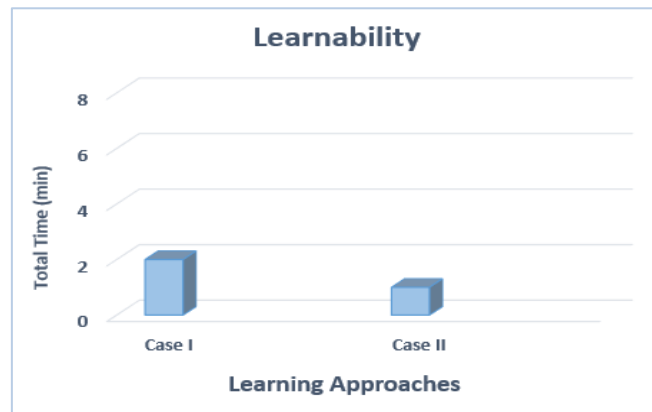
Fig. 9. Effectiveness of Arabic Book

**Fig. 10.** Learnability Arabic Book

4.3 Satisfaction

The General Information Questionnaire has been given to users in order to describe their knowledge of using traditional method and smart way of learning using smart learning companion application. Table-3 shows questionnaire.

The General Information Questionnaire has been given to users in order to describe their user experience of using SLAC application. Table-II shows questionnaire and Figure 11 summarizes the results which shows that users were very satisfied with the SLAC.

Table 2. Satisfaction Questionnaire

General Information Questionnaire	
Name:	Age:
Gender: Boy/Girl	Class:
1	I am satisfied that overall system is easy to use.
2	It was simple to use this system.
3	I can effectively learn knowledge using this system.
4	I am able to efficiently learn how to use the system.
5	I feel comfortable using this system.
6	I believe I have gained more knowledge using this system.
7	This information provided with this system is clear.
8	The information provided for the system is easy to understand.
9	The organization of information on the system screen is clear.
10	The interface of this system is pleasant.
11	I like using the interface of this system.
12	This system has all the features I expect it to have.
13	Overall, I am satisfied with this system.
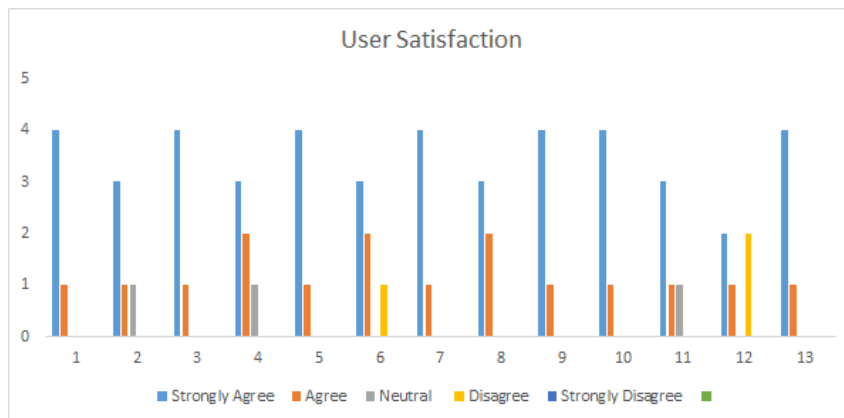
Fig. 11. Overall User Satisfaction

5 Conclusion

This paper presents SLAC, a smart learning companion application for improving the learning experience. The application has been developed using augmented reality. The purpose of the development of smart learning companion application is to encourage self-learning among students. The SLAC was developed for four books and experiments were conducted to test the effectiveness, learnability and satisfaction. The results show that SLAC was more effective and users enjoyed the learning experience. The use of native language reduced the learning time and users were more comfortable using the SLAC. We intend to extend SLAC platform such that teachers and parents can also interact and provide feedback.

6 Acknowledgement

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