LEXISGURU: Mobile Application for Learning Basic Lexis in English for Kids

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Abstract. Lexis is an essential part of English vocabulary that puts a good foundation on a child's English knowledge. In this rapidly globalizing world, it is fundamentally essential to learn English from a young age. In recent years eLearning, mobile applications have been developed for teaching Lexis to children. The market of educational mobile apps, especially for English language learning, has been rapidly growing. Especially in a country like Sri Lanka, English is not the mother tongue, it is the second language. So, when that second language is not taught right the child will lose interest in learning that language. The problem is that the existing lexical learning mobile applications does not aim at keeping the child interested and interactive in the learning process and in Sri Lanka, children find it difficult to understand these lexical parts. As a result, teachers and parents had to spend a lot of time to teach them those lexical parts. We designed and developed a mobile application called "LexisGuru" that uses interactive and effective ways to teach three lexical parts that are homophones, synonyms, and antonyms to children aged between 8–10 in Sri Lanka. This mobile application uses Machine Learning (ML), Image Processing (IP), gamification that includes collaborative environments, and speech recognition techniques. The developed mobile application was introduced to primary level learners, and they were all very attracted and interested while using this application. The attractive user interfaces, the pretests, and posttests, notifying the child when he loses focus while learning, using interesting stories and activities to teach lexis, playing a game with multiple players, and asking questions from the lesson and taking the voice inputs gave a new experience and showed that making the mobile application interactive as possible is an effective way to teach lexis to children.

Keywords: Mobile application · Lexical learning · Machine Learning (ML) · Image Processing (IP) · Voice recognition

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1 Introduction

Many Sri Lankan students find it difficult to cope with the English Language and it is evident by the statistics and school performance indices of the department of Examinations, Sri Lanka. In 2019, fail rates of English language are 37% and 46% at G.C.E. Ordinary Level examination and G.C.E. Advanced level examination, respectively [1]. Furthermore, in a research which involved a group of university students at Southeastern University of Sri Lanka shows that 40% of university students have passed the ordinary level English examination, while only 20% have passed the Advance level General English examination [2]. Lexis is one essential component of language and language development. Limited lexical knowledge can lead learners to frustration and demotivation. This has a negative impact on the student's future career [3].

According to the survey carried out with primary and secondary level English teachers in Government schools and Private schools, the most difficult and doubtful part of the English vocabulary is Lexis. Out of Lexical parts Homophones, Synonyms and Antonyms were identified as the most difficult parts. Lexical development has become an integral part of language acquisition. According to the "TKT, KAL Module of Cambridge university" Lexis refers to single words or sets of words that have a specific meaning [4]. Learners can build fluency in English by learning vocabulary systematically. Without grammar, people can talk little but without vocabulary, people can talk nothing. Hence lexis, help learners to develop their ability to use English in real contexts.

1.1 Mobile Based Learning

Mobile-based E-learning is the latest version of E-learning. Mobile learn encapsulates the ability to progress through course content on one's own personal devices such as smartphones and tablets. Mobile Learning offers ultimate accessibility & flexibility to learners especially for children as they can access learning courses anytime, anywhere via their parents' mobile devices.

Technology has a huge demand in the community and has a great relationship between education and technology. In the 21st century, the usage of technology is considered as the best solution for several common problems. Among those technologies that can be used, machine learning, speech recognition, collaborative learning, and face recognition have taken major positions.

1.2 Speech Recognition

Natural language communication with a computer adds to applications a new dimension. Speech recognition is a process that enables computers, mobile phones, and various devices to recognize and translate spoken language into text format. It improves the interaction between humans and machines by converting to speech to text. Applications which use speech dialogues are more user friendly than other applications. As per the research done by Heni and Hamam (2016), small children enjoy the applications embedded speech recognition [5].

1.3 Collaborative Learning

Collaborative learning technologies allow peer-to-peer virtual connection via virtual devices including real-time data synchronization for communication in a virtual environment. Machine learning is another technology that allows machines to learn from data. It brings together statistics and computer science to enable computers to learn how to do a given task without being programmed to do so.

1.4 Attention Detection

Attention is an important variable to be measured since it plays a fundamental role in the accumulation of information with the stimulus of the learner's memory during the integration of knowledge [6]. As per researchers, in e-learning, students often far away and out of teachers' control which may cause students do not have strong learning motivation and might feel fatigued and inattentive for learning. Hence, A real-time attention measuring approach can support better control the learning attention of students in unsupervised learning environments such as mobile applications [7].

2 Related Work

With the development of technology, many people tend to do research and develop applications based on mobile-based learning for the basics of English. Even though, most of the existing applications are focusing on gamification-based learning, a very smaller number of applications and research are focusing on collaborative learning and speech recognition systems to improve the user's interactivity and interest while learning. Also, it is important to check the knowledge, and to teach according to the level of knowledge is very important. Most of the research and applications are not focusing on knowledge level of users. Although the teaching methods are in a good standard, it is useless without a good concentration. Hence, student concentration on the lesson is another most important factor.

Karn et al. in (2019) has done a research to show the growth of knowledge level between the pre-test and the post-test among school students [8]. They identified a significant improvement in knowledge level in pre-test and post-test to school students regarding eye diseases. Overall knowledge before the test was 44% which was low and was increased to 71% after the test. Another research on automatic speech recognition (ASR) for second language learning examines how automatic speech recognition (ASR) can be used to improve pronunciation in a second language [9].

In a research on face detection and face recognition in mobile applications focuses to developing a mobile application for a smartphone to detect the human face [10]. As per the researcher, in the mid-1960, computers were used to detect the human face and lately robust facial recognition systems were developed. To have proper recognition, it is very important to understand the factors such as distance between eyes, the width of the nose, and the depth of eye sockets. There are myriad mobile applications related to Lexis available on the Google play store. Most of the existing applications mainly focused on teaching and learning one part of lexis, as only Homophones. Most of the

applications provide some activities related to lexical words and there is no proper way of teaching theoretical parts of lexis. Most of the existing mobile applications focused on single-player game-based learning rather than using gamification-based collaborative learning. And, they have implemented level-based learning according to the knowledge level of most students. Further, checking the child's attention when using the application and child interaction with the application using speech recognition is very rarely used in existing applications.

"LexisGuru" application has more features over the other existing lexis learning applications. In this application, kids can learn all three lexical parts (Homophones, synonyms, and antonyms) as individual learning or collaborative learning. Individual learning contains gamification with speech recognition and teaching lexis using storytelling. Collaborative learning has two player-based collaborative gamification including interesting teaching methods for lexical learning. Before the learning and Gamification modules, this application would identify the child's knowledge level of lexis using pretest and post-test. Further, this application tracks the child's attention on the content while learning.

3 Methodology

As the first step, a questionnaire-based survey was conducted among primary English teachers to gather important facts to come up with a best solution for teaching English Lexis to children. According to the survey findings, building a mobile application was the best solution and as a result the "LexisGuru" mobile application was developed using Android Studio platform. The following Fig. 1 shows the system overview of the application.

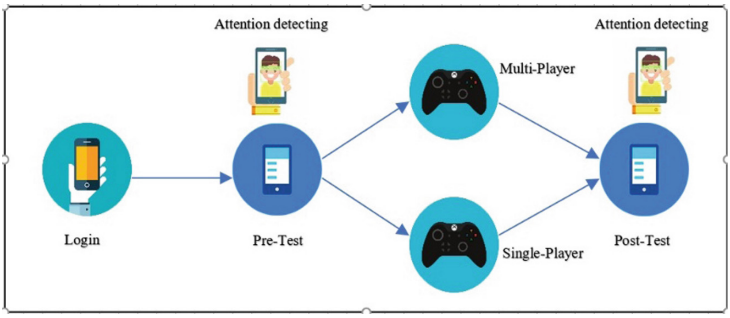

Fig. 1. System overview diagram

The application was designed to teach lexis in an interesting manner using gamification and speech recognition. Also, the application can detect user's attention while using the application. Hence, the "LexisGuru" application consists with four main functions; Identify and compare knowledge level of the user via pre and posttests,

Teaching lexis using storytelling embedded with speech recognition, Two-player collaborative Game-based lexis learning and Student attention monitoring.

3.1 User Knowledge Level Detection and Comparison via Pre and Post Tests

The knowledge level identification feature (Fig. 2) of the "LexisGuru" mobile application has been used to identify the appropriate knowledge level of the user and teach the lessons accordingly. Identifying the appropriate level for the child ensure the child start in the correct level of lexis according to his/her existing knowledge. Otherwise, child may feel boarded to learn already known concepts. Hence, machine learning techniques were used to identify the knowledge level. Due to the Covid-19 pandemic, data was gathered using online techniques such as Sharing google sheets. There are 10 questions for the pre-test covering all three lexical modules of Synonyms, Antonyms, and Homophones. Each user has 20 min for completion. The correct and incorrect answers were taken as 1s and 0s. Both accuracy of the answer and the time taken to complete the pre-test were included in the dataset. According to the pre-test child's knowledge will be categorize into three levels. Similarly, post-test was used to check the child's knowledge improvement after every lesson. Hence, three data sets were maintained for the three different sections of lexis.

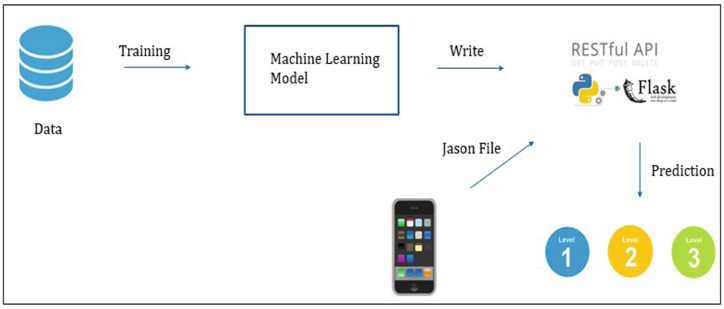

Fig. 2. Level identification high-level diagram

Analytically 70% of the data was used to train the Machine Learning (ML) model and 30% of the data used for testing the training data set. Initially, the model was created using both the Decision Tree (DT) algorithm and the Random Forest (RF) algorithm to select the best solution. When considering both models RF model was more successful for level prediction due to high accuracy level. Finally, successfully trained data set with approximately 2300 data was used for the pre-test and data set of approximately100 data was used for post-test.

When developing the "LexisGuru" application, both pre-test and post-tests were created using android studio IDE. PyCharm IDE was used to train the dataset. Data was passed through a JavaScript Object Notation (JSON) file with the time taken to complete both tests. Flask API was used to retrieve the data from the front-end and to

receive the correct output from the server. If the child's response regarding the pre-test is like Level 1, the screen displays Level 1 as the suitable knowledge level for the child. This process demonstrates in Fig. 3 (Left). similarly, if it is Level 2 screen displays as Level 2 and if it is Level 3 screen displays as Level 3.

Upon the completion of the post-test, the "LexisGuru" will indicate whether the child has been passed or failed the corresponding level. The Fig. 3 (right) shows the interface of the post-test, and the result of post-test.

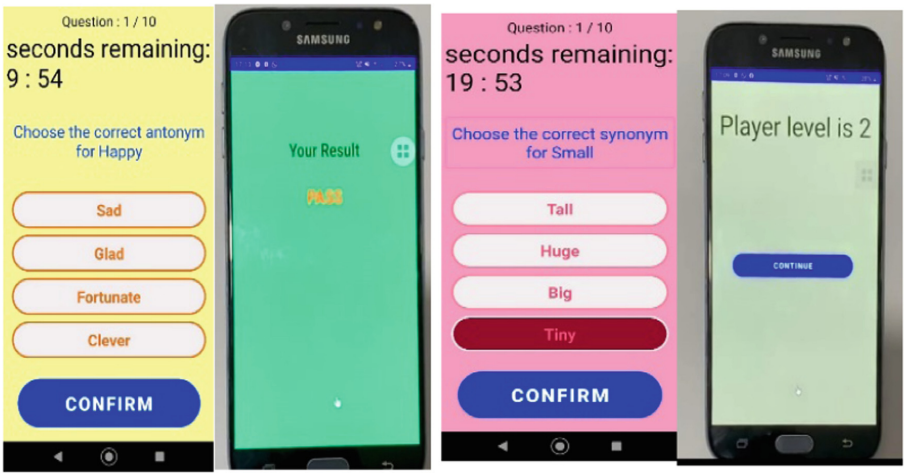

Fig. 3. Pre-test interface with output of pretest and post-test interface with post-test results

3.2 Teaching Lexis Using Storytelling Embedded with Speech Recognition

Maintaining curiosity and attention in teaching learning process is challenging. This component focuses on preserving user's interest and interactivity during the learning process using storytelling embedded with speech recognition. Android studio was used to develop this component.

This function is two folded, lexical teaching and single player game. An animated story with various characters used to teach lexis with many examples. The story is narrated as an audio output. The single player game uses speech recognition, audio outputs as well as attractive animations to keep the user interactive and fascinated while playing the game. Each level of the game has a pool of questions and random questions presented to the user when the user plays the game. The number of questions increased in each level to improve the complexity of the game. The questions presented as audio outputs using Android Text to Speech engine. Game instructions present as audio outputs prior to the game and the answer of the user has been taken as a speech input. The correctness of the given answer shown as the output with feedback for incorrect attempts (Fig. 4).

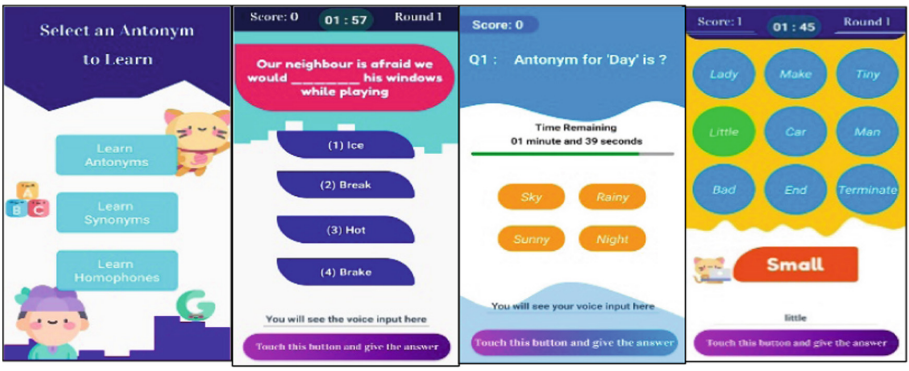

Fig. 4. Speech recognition game UI

Figure 5 shows the speech recognition process of Android and the speech recognition service in the android studio has been used. The speech recognition service grants the access to the speech recognizer and the API in the speech recognizer processes the speech input and convert to a text.

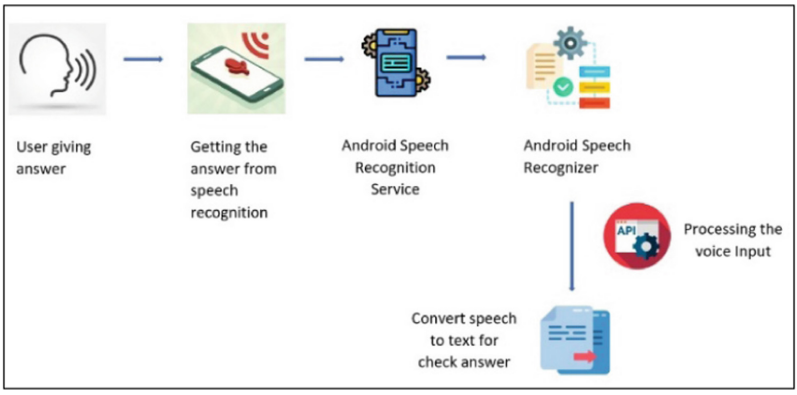

Fig. 5. Speech recognition process of android studio

3.3 Teaching Lexis via Two-Player Collaborative Game-Based Learning

This function used to increase the interactivity with the learners in the teaching learning process. This phase has used android studio IDE to reduce the complexity of the game while giving a smooth experience for those who use the application. The application has used real-time database functionality in Firebase to give real-time data synchronization between two devices. The application has 3 lexical modules as Homophones, antonyms, and synonyms. All these modules have a teaching part and a gaming part, and each module consists of different learning styles and different puzzle-based games. Matchmaking mechanism was used to select 2 players for the game with same

knowledge level. Figure 6 (Left side) shows the mechanism of data synchronization in the firebase real-time database.

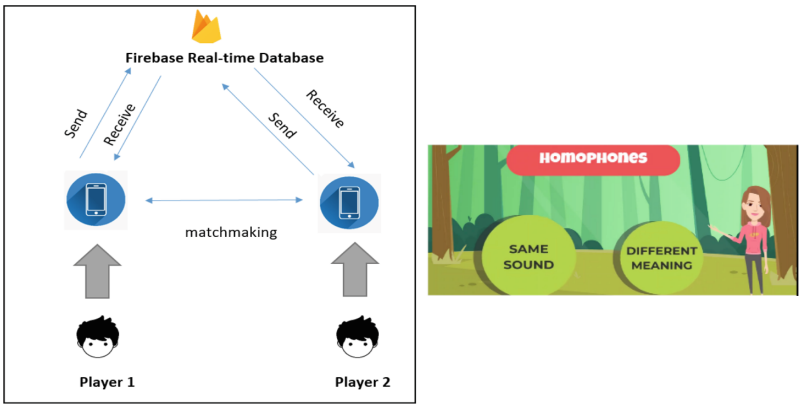

Fig. 6. Data synchronization in firebase (Left) and teaching session (Right)

Accordingly, event listeners catch the value change in one device and synchronize that value change in another device. In-room connection feature one device is creating a room and that is shown in the other devices as a room join invitation. When the second player accepts the invitation both players are connecting to start the game. Also, users could go through the teaching section before starting the game. The teaching section is consisting with a 3D animated video as shown in the of the Fig. 6 (Right side).

Gaming session begins with the voice-activated instructions, and it consists with puzzle-based mind games developed using Java language. Each game has real-time data synchronization modules developed using firebase event listeners and handlers. While playing the game, a tasked permed by one player has been caught by the data synchronization module and notify the other player and change the game state real time as shown in Fig. 7.

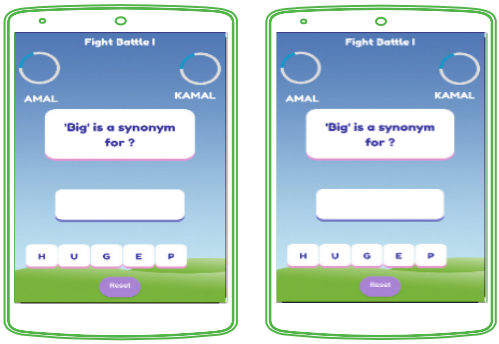

Fig. 7. Multiplayer game UI

Every level has 3 puzzle activities and at the end of each activity application prompts the marks and the winner. At the end of each level, the application prompts detailed progress of the activities and move to the next level in both devices real time.

3.4 Student Attention Detecting Using Google Mobile Vision API

Maintaining attention while teaching is challenging in teaching learning process. Hence, this component mainly focuses on detecting and rebuilding the user's attention using Google Mobile Vision API (Fig. 8). The technology used in this component tracks the orientation of facial landmarks and provide information related to facial features.

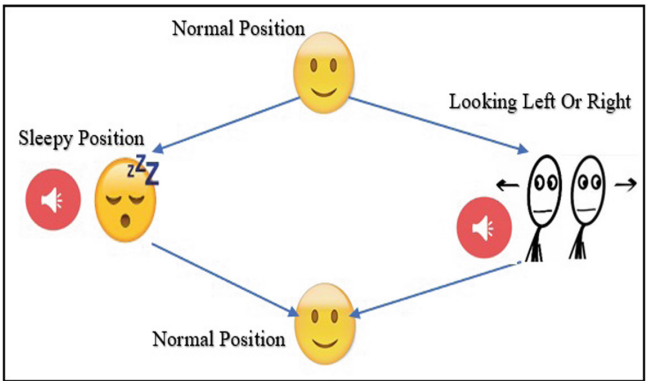

Fig. 8. Attention detecting overview diagram

In user attention detection process, focal point was used to identify whether the user is sleepy during the lesson. In here, eye opening probability was used as a measurement. Then left and right eye-opening probabilities were calculated separately. When human eyes are open, probability is closer to 1.0 and otherwise it is less than 0.2 (Fig. 9).

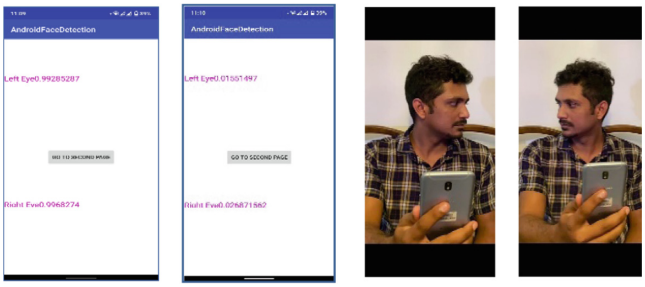

Fig.9. Eyes open and close position detection (Left) and looking left-side and right-side positions (Right)

Once the application identified a sleepy user, the system generates a real time voice output to draw the attention back to the lesson. Also, the application can identify distracting user as they are looking out of the screen (Fig. 9). This is done by recognizing the face orientation and head rotation of the user. The horizontal position of the face is measured by the command get position().x in the Google face API. When the value of the position X is between 90 and 140, the app identifies the user as concentrated to the lesson and otherwise as not. Here also the application gives a real time response using voice commands draw the attention back to the lesson.

4 Results and Discussion

Due to Covid19, the research team tested the application using few set of English teachers remotely. The APK file was sent to the teachers and feedback was taken using a google form. Accordingly, sixteen English teachers were involved in the testing phase.

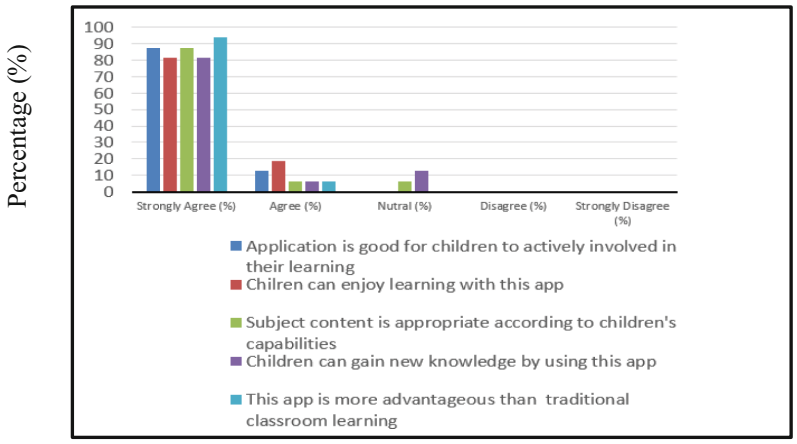

Fig. 10. English teachers feedback summary

The above Fig. 10 demonstrates the summary of statistics collected from the English teachers' feedback survey. Overall results indicate that most of the teachers are satisfied with the"LexisGuru" mobile application. Also, all the teachers agreed that application is good for active learning, children could enjoy the application and the application is better than traditional classroom-based learning. Only 3 teachers having unbiased impression on subject content appropriateness and ability of gaining new knowledge. None of the teachers involved in application testing phase were disagree or strongly disagree with any of the aspects mentioned above. The reason may be the low sample size due to Covid19 pandemic.

In addition to the above facts, the teachers were asked to comment on the application in an open-ended question in the questionnaire. One teacher mentioned that "This application seems very interesting". Another teacher's idea was that "This looks nice. I think student will like this". Another comment was that "This application is designed in a very interesting and attractive way. Also monitoring students' attention will be very useful too." A Few teachers have given some suggestions too, to improve the application such as adding more words to each lexical type and to include some other lexical sections too.

While considering all the facts it is evident that "LexisGuru" would be an application that can help children in gaining interest in English and obtaining higher grades for English in future.

5 Conclusion

Synchronization of latest mobile technologies and education contexts provide a fruitful learning experience for children since they be inclined to use mobile devices frequently. On the contrary to traditional classroom learning which gives board feeling mostly, mobile based learning implanted with latest technologies such as speech recognition, gamification and attention monitoring enables collaborative peer learning and fruitful and meaningful learning experiences. This research work studied the effectiveness and usage of mobile based learning over traditional classroom learning when teaching English lexis. Hence the mobile technologies and gamification with speech recognition techniques can moderate to give the best learning experience to children. This will lead to student centric active learning environments and children will get the chance to learn English lexis in a fascinating mode.

The testing results of qualitative data acquired through the survey shows higher teacher satisfaction in "Lexis Guru" application. As indicated in comments, "Learning lexis in this way will be very interesting to children", "This application will be very popular among children……" and "Attention monitoring is really good" teachers appreciated the proposed application. The overall system after development seemed promising at fulfilling its task but could be improved leaving room for future areas of research.

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