

# Augmented Reality-Based Learning Media Design: Its Compatibility to Blended Learning

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## ABSTRACT

This objectives of this study are to find out: (1) the functionality and the compatibility of the AR-based game for Blended Learning model (2) describe users' perspectives on its potential for blended learning activities. The design of the game called ArReadSpeed has gone through several stages that encompass pre-design input taking, design stage, and pre-trial evaluation stages. The inputs generated from the prospective users and two experts serve as feedback needed for the game prototype making, while the inputs from the pre-design stage have become the basis for the media design. This paper reports the results of the trial stage that was intended to gather information about the readiness of the game for real use that encompasses the content and construct validity aspects. The obtained feedback was then used to evaluate if the media is readily usable for the blended learning model. The results of the trial showed that the aspects of both content and construct validity were both very good. In addition, the trial results also show that the tried game is considered as a decent product, attractive, and easy to use for independent learning, making it readily usable for the real blended learning context. The upcoming step to do is to determine if the product is indeed an effective medium for learning that can enhance students' reading skill.

**Keywords:** *Augmented Reality, blended learning, ArReadSpeed game, independent learning*

## 1. INTRODUCTION

Much literature has confirmed that Augmented Reality (henceforth AR) allows the users to feel as if they are experiencing the direct physical objects that appear as if life in the real world, so that it will add to a more realistic and fantastic experience for learners. AR technology combines two virtual objects or three-dimensional objects into a real three-dimensional environment that projects virtual objects in real-time [1] AR supplies the real world with virtual objects, so the computer, then, generates content that adds to the real world interactively and in real-time. The game designed based on AR can be designed in a more innovative and attractive with the display of 3D models of game components [2] Despite being quite recent in its presence in the world of education, Augmented Reality (AR) brings with it a capability to revolutionize teaching and learning as it offers unprecedented opportunities for enhancing teaching and learning. It is believed by many that Augmented Reality may allow educational institutions to advance and enrich their curriculum with a new way of teaching and learning. AR offers substantial potentials for enriching students'

learning by allowing them to see an augmented world that they never experienced before as a result of the geographical and cultural differences [3].

Reading, in particular for comprehension, is relatively boring for learners in particular when the texts are presented in the traditional ways and where students have to go through them using the techniques of scanning and skimming for comprehension purposes. Rau, Zheng, Guo, and Li [4] once posits that the adoption of AR technology in education is believed to be able to enhance reading and the teaching of reading skills. On that belief attempt has to be made to innovate the way the reading activity for comprehension can be of interest for students and from which learning experience can be enhanced. Besides, the compatibility of the AR-based game for reading purposes is another aspect to be sought especially because according to Delianidi, et.al. (2017) as the augmented reality technology and the blended-learning mode are combined, there is a significant improvement of the learning procedure. The response to such a problem is designing a game for reading comprehension activities based on Augmented Reality.

The purpose of this paper is to report the trial of the ArSpeedRead game designed to help high school students learn to improve learners' English reading text comprehension. The research objectives are to determine: (1) the functionality of the game and its suitability for the context of blended learning and (2) describe the user's view of its potential for blended learning activities. The trials and evaluations are reported. The significance of this study will be the improved quality of English language learning particularly in improving students' reading comprehension and the opportunity to use the game into the model of blended-learning mode.

## 2. THEORETICAL REVIEW

Augmented Reality (AR) is a technology that incorporates two or three-dimensional objects into a real three-dimensional environment, from which these virtual objects are projected in real-time, making the new object looks like the real-life object. Unlike Virtual Reality (VR) which produces a fully virtual environment, Augmented Reality, in contrast, creates an object in an enhanced real world. Azuma [5] in his paper entitled 'A Survey of Augmented Reality' brings a new light into what augmented reality is and concludes that. "Some researchers define AR in a way that requires the use of Head-Mounted Displays (HMDs)", while it is not any more necessarily the case as now technological advancement has allowed for such a technology to be played on the mobile gadgets by taking the advantage of the provided mobile gadget cameras.

The above definition seems to have been inspired by Milgram and Kitshino's [6] term, mixed reality, which refers to the entanglement between the true physical and virtual environment in the stretch of the continuum. This mixed reality lies in between the fully virtual environment whereby all inputs are digitally simulated and the true real world whereby contents are fully unsimulated, making them mixed realities.

Unlike VR (Virtual Reality which purely concerns with virtuality, AR is categorized as a mixed-reality, whereby real physical and digital simulations come to existence in the human's experience [5]; [6]. Such a stretch of a continuum from the real to virtual environments is ingeniously illustrated by Milgram & Kitshino as follows:

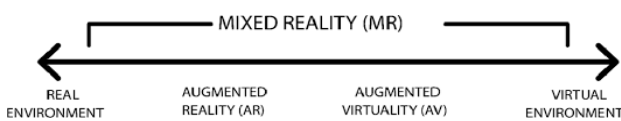


Figure 1. Reality to Virtuality continuum graph adapted from Milgram & Kitshino [6]

To avoid confusion and limiting AR to specific technologies, this paper defines AR as a system that has the following three characteristics:

- 1) Combines real and virtual,
- 2) Interactive in real-time,
- 3) Registered in 3-D.

Base on the above, there appear to be three characteristics that characterize AR. The first characteristic is combining the real and virtual worlds. The second characteristic is interactive in real-time. The third characteristic is that it allows it to be displayed in 3D mode

From all the above definition, however, there have been some reviews by some succeeding theorists and researchers since the one proposed by Azuma [5], there has been a renewal of understanding about what AR is all about. The definition has been further expanded and more clarification has been added to it. Among the experts who have been attempting to revise and clarify it is Craig [7] who posits that "Augmented reality: A medium in which digital information is overlaid on the physical world that is in both spatial and temporal registration with the physical world and that is interactive in real-time". This newly revised definition adds to the 3 major characteristics of AR that has been [5] set out early on by Azuma, which further clarify that AR should not be considered as a typical technology per se, but should be more as a new kind of medium.

The table below presents the aspects that Craig [7] adds to the previous concept of AR.

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The four key aspects or ingredients for AR technology, according to Craig [7]:

1. the real world is augmented by digital information that is highlighted from the point of view of the physical world.
2. the registered information is displayed with the physical world.
3. the displayed information is dependent upon the real location and the physical world perspective of the person.
4. the AR experiences are interactive, in that they can perceive information and if desired they can make changes to the information. The interactivity level ranges from simply changing the physical perspective to the new information manipulation and creation.

By considering the novel understanding that AR is a medium that facilitates interaction between physical and virtual environment, attempts to improve the quality of learning is currently wider opened and as such the prospective users or learners may likely to undergo a

new experience in the learning endeavor as a result of the AR use. In the same vein, the above new key aspects should make them more relevant to anyone, in particular educators, wishing to design AR-based games or activities in their instructional plans.

### ***Criteria for good learning media***

Learning media can be interpreted as a functioning and useful tool to channel learning messages [8]. Media in general means an intermediary, while learning media are anything such as tools, objects, environment, etc. that can be used to convey information, especially learning materials. Using learning media in the process of instruction can facilitate educators in delivering learning material to students because the purpose of using learning media in teaching and learning is not just to complete the teaching and learning process but also to improve the students' attention for improving a quality learning. Thus, good learning media are expected to facilitate the teaching and learning process so that it can improve the quality of teaching and learning to be able to improve the learning outcomes.

According to Sanaky [8], among the function the media plays is a stimulus for learning because it can:

1. present objects and steps.
2. make a duplication of the object.
3. make abstract concepts a concrete concept.
4. gives the same perception.
5. overcome time barriers.
6. present information consistently.
7. give a learning atmosphere fun, relaxed, and attractive.

Walker & Hess [9] stated that the criteria in reviewing the quality of the instructional media, among other things, are based on:

- 1) quality of contents and objectives, including accuracy, importance, completeness, balance, interest or attention, fairness, and suitability of the situation of the student.
- 2) The quality of learning, including providing learning opportunities, providing assistance for the learning, motivating quality, flexibility learning, relationships with other learning programs, quality social learning interactions, test quality, and assessment, providing an impact on students, and having an impact on teachers and their learning.
- 3) Technical quality, including readability, ease of use, or display quality impressions, the quality of response handling, the quality of program management, and quality of documentation.

### ***Augmented reality for language learning***

AR may potentially make a difference in education, where it may offer a change from the conventional style

of learning to a more interactive one which allows students to interact with the learning content [10]. The offered novelty is compatible with the recent mobile technological advancement with the widespread use of mobile gadgets. Both tablets and smartphones altogether have over time been increasingly powerful and ubiquitously more and more affordable to almost all people from different walks of life. Their use has given advantage for users both in terms of practicality and accessibility since the iPad and other similar mobile gadgets presence [11]. Both tablets and mobiles phones provide computer users with many benefits for being able to use them without being tied to desktop computers stationarily installed in the computer lab [11]; [12].

Besides being interactive, AR is also immersive in the sense that students experience authentic physical and mental situations similar in the real world, through their interaction with the virtual environment [13]. With such an immersive environment, AR, with its novelty and design, may provide students with its facilitation in visualizing visual imageries presented in a fictionary fashion [14].

One learning model that can best be integrated into technology-based media is the blended learning model. According to Driscoll [15], blended learning is learning that combines or combines various web-based technologies to achieve educational goals. Thorne [16] defines blended learning as a mixture of e-learning and multimedia technologies, such as video streaming, virtual classes, online text animation combined with face-to-face learning activities in the classroom. Blended learning is a learning environment designed to integrate face-to-face learning, face to face with online learning that it aims to improve student learning outcomes.

From the previous research, students can rapidly improve their reading comprehension using Augmented Reality as with it they (easily) encounter unfamiliar words and can use the interactive interface to figure out the meaning of the unfamiliar word [17]. Besides, a previous study by Bacca [18] found that as students used AR applications in an English reading class they tend to spend less effort in the process of using AR in the classroom, besides their positive attitudes to using it which results in a higher level of achievement in the English reading skills. Thus AR-based games should be a perfect match with the blended learning model.

## **3. METHOD AND RESEARCH PROCEDURE**

The method used in designing this augmented reality-based boardgame for reading comprehension learning media is an iterative method with rapid prototyping. The iterative method with rapid prototyping allows the game designers to go back to the previous

given given improvement once weaknesses and erroneous functions were identified. So, if there is an error on processes or imperfection of elements of the games like the rules on the game can be immediately repaired or revised.

This game making makes use of vuforia as the platform of the design. Vuforia is a software that was developed by Qualcomm for support in making Augmented Reality. Vuforia uses its source a consistent target of the computer vision that focuses on image recognition. The working principle of vuforia is to use targets. Fernando [19] proposes several types of targets in vuforia, which are as follows:

- a. Image Targets, for example, photos, game boards, magazine pages, covers books, product packaging, posters, and greeting cards.
- b. Frame Markers, 2D picture frame types with special patterns that can be used as a game.
- c. Multi-target, for example, product packaging or boxed-shaped products or square. This type can display simple Augmented images in 3D reality.
- d. Virtual Button, which can make a button as an area of the box as the target image.

**Research Subjects**

Most of the respondents were 12 years old. Demographically, the participating students in the trial were mixed of male and females students, where 52 % of which were male with a total of 22 students, while 48% comprising as many as 20 students. In this research, however, no analysis is made based on the age group and sexes.

**Research Procedures**

The design stages and the trial which encompass trial and evaluation are reported. The inputs obtained from the pre-design stage are the basis for the design of the media; at the same time, the inputs from trial stage that involves the users candidates provide valid feedback both in content and construct aspects. Both types of feedback were used to evaluate the readiness of the game as a learning medium for the blended learning activities.

Playtesting is done after the game-making process was completed and the game was ready to be played. Playtesting aims to test the level of pleasure, the purpose of game creation delivered, and problems in the game mechanism. Testing is done by involving 10 respondents which is in accordance with Fullerton’s [20] suggestion. As part of the trial, this game testing made use of a questionnaire to find the hands-on opinion of the users. The questionnaire adopts the Likert scale that ranges the value of responses from 1 to 5 whose meanings signify the following:

1. Value 1 strongly disagrees with the statement

2. Value 2 does not agree with the existing statement
3. Value 3 with hesitation existing statement
4. Value 4 agrees with the statement which exists
5. Value 5 strongly agrees with the existing statement

There were two types of statements in the questionnaire, the first is based on the element of fun or pleasure in the game playing and the second is the element of convenience in the game use and game control. The statements follow Quinn’s [21] survey, model. In the element of pleasure, there were 5 statements contained in the questionnaire which were answered by the respondents after the respondents have completed playing the game. These statements are sampled as follows:

- a. This game is fun
- b. The game's appearance is visually appealing
- c. The characters in the game card are interesting
- d. Boring game
- e. Use of Augmented Reality technology interesting

Both the hands-on responses and the data gathered from the questionnaire were used to measure the content and construct validity.

**4. RESULTS AND DISCUSSION**

The procedure of research and development of the Augmented Reality-based learning media for English Reading for Junior High School students adopting a board game model. The design of this model took 4 stages, namely the analysis, the design, the making of program code or implementation, and the testing phases. The game is workable on both Android and IOS mobile gadgets platforms. The basic learning material contained in this learning media includes reading comprehension, learning materials that are adjusted to the syllabus applicable to the level of Junior High School students as a part of the blended learning model. From the trial, the data indicated the following results.

The post-trial validity test

Table 1: Validity test results

	Component				
	1	2	3	4	5
	<b>.885</b>	-.196	-.182	-.059	.201
	<b>.868</b>	-.214	-.053	-.131	.225
	<b>.643</b>	-.023	.280	.176	.146
	<b>.823</b>	.186	.093	-.041	-.178
	-.137	-.122	.011	<b>.762</b>	-.008
	-.008	.143	-.244	<b>.739</b>	.109
	.135	.008	.354	<b>.712</b>	.273
Extraction Method: Principal Component Analysis.					
Rotation Method: Equamax with Kaiser Normalization					
a. Rotation converged in 6 iterations.					

As indicative from the table both the adaptability and the playability of the ArReadSpeed are valid. Thus, it can be said that the game meets the construct and content validity. Such a claim is further elaborated hereunder.

**The adaptability of the game**

**1.1 It is easy to learn how to play ArReadSpeed**

42 responses

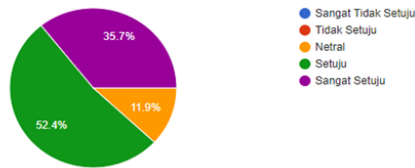


Figure 2. playability

Figure 2 shows that 11.9% of respondents are neutral, 35.7% strongly agree, and 52.4% agree with the statement that learning how to play “ArReadSpeed” is easy for them.

**1.2 My interaction with ArSpeedRead is clear and understandable**

42 responses

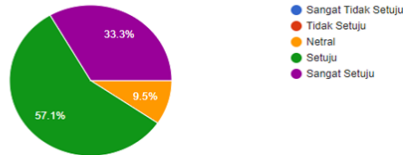


Figure 3. clarity and understandability

Figure 3 shows that 9.5% of respondents are neutral, 33.3% strongly agree, and 57.1% agree with the statement that their interaction with “ArReadSpeed” is clear and understandable.

**1.3 I find ArReadSpeed is easy to use**

42 responses

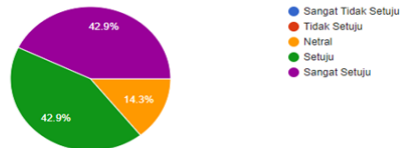


Figure 4. easiness to use

Figure 4 shows that 14.3% of respondents are neutral, 42.9% strongly agree, and 42.9% agree with the statement I feel "ArReadSpeed" is easy to use.

**1.4 It does not take long to master ArRead Speed**

42 responses

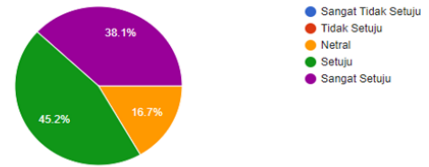


Figure 5. learnability

Figure 5 shows 16.7% of respondents are neutral, 38.1% strongly agree, and 45.2% agree with the easy statement for me to be good at playing "ArReadSpeed".

**2. Playability of the game**

**2.1 Playing ArSpeedREad is fun**

42 responses



Figure 6: funnes

Figure 6 shows 4.8% of respondents are neutral, 40.5% strongly agree, and 54.8% agree with the statement that playing "ArReadSpeed" is fun.

**2.2 Playing ArSpeedRead is amusing and encouraging**

42 responses

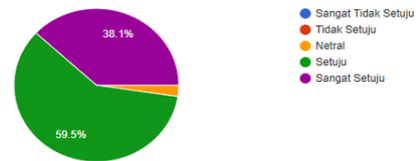


Figure 7. amusingness

Figure 7 shows that 2.4% are neutral, 38.1% strongly agree, and 59.5% agree with the statement that playing “ArReadSpeed” is amusing and encouraging.

**2.3 Playing ArSpeedRead is entertaining**

42 responses

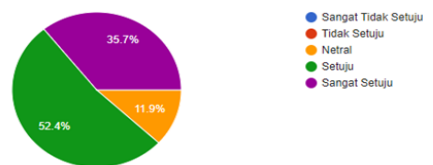


Figure 8. entertainingness

Figure 8 shows that 11.9% are neutral, 35.7% strongly agree, and 52.4% agree with the statement that playing "ArReadSpeed" is very entertaining.

Concerning the last 3 figures above, the average respondent agrees and considers "ArReadSpeed" very pleasing, fun, and entertaining to play. In the data above 54.8% of respondents said they agree with the statement playing "ArReadSpeed" is fun, then 59.5% of them agreeing that playing "ArReadSpeed" is encouraging, and 52.4% agreeing with the statement that playing "ArReadSpeed" was very entertaining.

In response to the 4 statements above, on average the respondents agree and consider that "ArReadSpeed" is easy to use. With image data from 4.56 which shows 52.4% of respondents said they agreed to the statement that learning how to play "ArReadSpeed" was easy for me, then Figure 4.57 with 57.1% of respondents agreed that my interaction with "ArReadSpeed" was clear and understandable, next picture 4.58 with 42.9% agree with the statement I feel "ArReadSpeed" is easy to use and figure 4.59 with 45.2% agree with the easy statement for me to be good at playing "ArReadSpeed".

The results showed that learning media which were developed meet the quality aspects of adaptability and playability criteria. The results of which were drawn from the testing of the product of the game to a group of game players trying the workability of the game and find it satisfactorily usable and does function well.

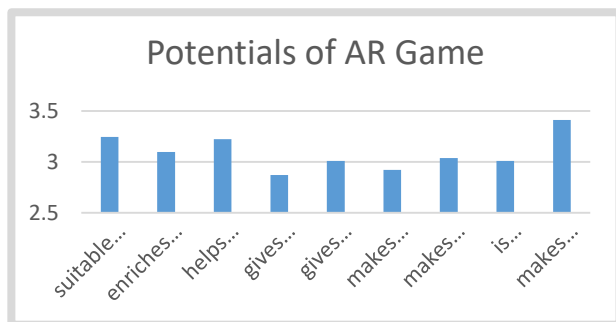


Figure 9. Responses to the compatibility to blended learning

Table 9 above shows the overall responses of the respondents to the questionnaire concerning what they think about the potential of the ArSpeedRead for the blended-learning model. Most of the respondents are in agreement and even show strong agreement that the game under trial is prospective for the blended-learning use. It is evident from the chart that the game is suitable for classroom learning support material and helps to understand the classroom material better. Even among the prominent responses show that the game makes them more involved in the face-to-face learning activities. Apart from the fact that they are not quite determined if

the game gives them more freedom to learn and if the game makes the learning more effective, overall responses lead to the common agreement that indeed the game is suitable for the blended-learning context.

In testing the blended learning model using board games and mobile phones as a means of reading English reading and answering questions, the combination of board games and mobile phones is used to make the game more interesting, also for the reason that the trends of the current and future electronic gadgets lie on the mobile types of gadget, no longer on the stationary ones like desktops, laptops, or notebook. The advantage of using mobile gadgets is their handiness and the flexibility of use. The advantages of board games are games that require friends or co-players to play with so that the gamers can interact with one another even though the weakness of boardgame is that it cannot be added to reading, video, and sound.

Boardgame design is a strategy game whereby for the player to win it, he must place the card to take the chest or hinder the enemy movement and reach the finish. This game was also intended to defeat each other, this is because of seeing human tendencies, there is a certain satisfaction when one is beating other players. Meanwhile, to achieve victory in the game, in addition to reaching the finish, the player must collect as many points as possible.

This point is obtained from each correct answer every time the player gets a special chest or card. Winning is determined by getting bigger points. The correct answer is determined by the player's ability to answer questions based on English reading. It is this ability that is needed to answer questions that spur players to practice reading English. That way, learning English through this game is fulfilled. To make it more interesting, the added time limitation is in reading and answering questions, thus encouraging players to improve their ability to master English reading. One way to do so is through learning via this game.

This game is designed to be played by 2 to 4 players. but it does not rule out the fact that it can be played alone or individually to hone a strategy to achieve victory. one of these strategies with the ability to answer from the English reading. the higher the ability to answer questions in the game, the more chance of victory is granted when the game points are obtained by the players in the group. If it is done alone, the player will just use the AR on the card then answer the question himself or herself.

So, overall, from the questionnaire, the respondents' opinions show that both content and construct validity aspects are very good. The results of the trial also indicate that games are viable, interesting, and easy-to-use when are in the real use of independent learning. In

other words, the final evaluation has proven that the game is readily usable for the actual blended learning context. The upcoming stage to do is measuring the effectiveness of the product in improving students' reading skills.

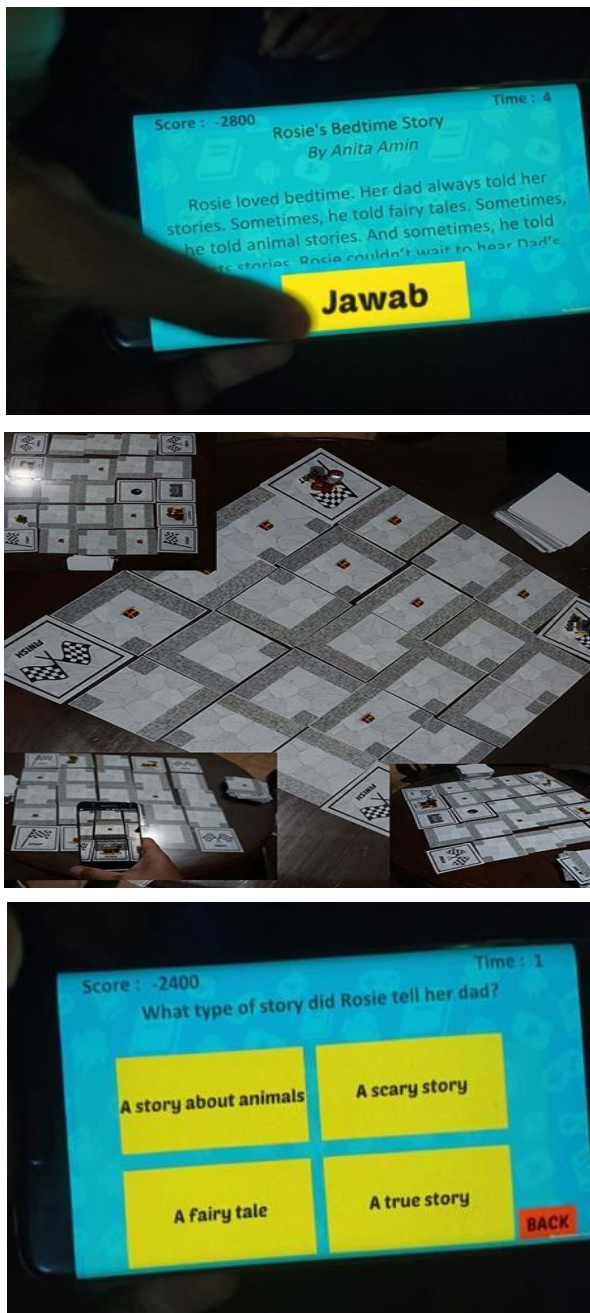


Fig 10. Boardgame with AR

## 5. CONCLUSION

The result of the playtesting suggests that the game has been found interesting and easy to play, giving valuable credit to this game design suggesting that the game is decently designed game readily useable for a functional learning medium. Also, from the comment as well as from the questionnaire responses, they indicated that the game meets both content and construct validity aspects. The respondents admit that from the overall experience trying to play the game, they admitted that the game quality is a decent game. The results of the game trial also prove that it is indeed a decent product, in a sense that it is attractive and easy to use either for group or independent learning mode. After all, the final evaluation prove that the game could be readily used for the real blended learning activities. The upcoming stage to do is to test if it is indeed an effective product that manages to enhance the students' reading skills.

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