

## **Students' Perspectives on the use of the Atomic Game-Based Learning for Secondary School Chemistry**

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### **Abstract**

Technology has become part of our daily life, where it helps to ease our work, to communicate, get entertainment and even to learn. In education, technology has become essential as it creates a new approach of delivery in teaching and learning. Various approaches were invented or developed by educators to assist learning process. Nowadays, integrating game elements in the educational content is crucial and beneficial not only to the educators but also to the students. Game is one of the alternative methods that offers an interactive teaching and learning. It can increase student's motivation and excitement to learn on the subject and at the same time encouraging active learning among them. They can access the learning materials at the tip of their finger using smartphones, tablets, mobile computers, and other digital devices. They can create their own study plans, where and when to study at their convenience and it is more effective as compared to the traditional approach. The aim of this study is to examine students' perspective towards the use of Atomic Game-Based Learning (AGBL) app for secondary school chemistry in assisting their learning activities to the topic of structure on atom. AGBL is an Android based app that was designed and developed by integrating game element in the subject contents to support teaching and learning process. A total of 32 Form 4 students were involved in this study. The findings showed that the app does assists the student to score the in-game quiz as compared to the group of students who learned through hardcopy notes and flash cards. Besides, it also shows that 53% of the students strongly agreed that this app could be used as a tool of delivering the topic to the students. Therefore, this app can be counted as one of the effective approaches in teaching and learning of the chemistry subject.

**Keywords:** Chemistry, Atomic Game-Based Learning, Atom Structure, Interactive Learning, Game Element.

## **Introduction**

### *Mobile Learning*

Chemistry is the science of matter, its properties, structure, changes or reactions and the energy that accompanies these changes. Chemistry is specifically divided into several fields: analytical chemistry, organic chemistry, inorganic chemistry, physical chemistry, and biochemistry (Department of Chemistry, 2018). Chemicals greatly affect our lives; therefore, chemistry is one of the most important fields until now. The use of chemicals will continue to increase and humans will always be looking for new materials. Therefore, chemistry became crucial for the development of the human's quality of life because it helps improve healthcare, protect the environment, and aid conservation of natural resources.

Due to its importance, chemistry has become a compulsory subject for every science stream student. Yet, many of the students had problems learning the subject, where it is hard to understand theoretically, no visualization and eventually lead to less interest and motivation to learn and explore the subject (Yunus & Ali, 2018). In order to increase students' motivation in learning chemistry, researchers have continuously developed or invented various new approaches or applications to make teaching and learning of chemistry become more interesting and entertaining. With increasingly advanced technological developments, there are many alternative media that can be used by educators to help improve students' learning process. In this case, the use of smartphones seems to be the best device to support mobile learning.

Mobile learning indicates the use of mobile devices in which offering learning process to be easier and reachable everywhere (Bukharaev & Wisam, 2018). Mobile learning can also be defined as a facility or service that provides information and educational contents electronically to learners that help attainment of knowledge without worrying about location and time (Darmawan, 2013). To increase the excitement in learning, various approaches were created. One of them is by integrating games in learning activities, which is known as educational games. Integrating games in learning process is not something new, many educational mobile applications have been developed combining game elements to assist educators to deliver the knowledge to the students efficiently and attractively.

### *Educational Games*

Educational games are games that were designed with a special purpose to teach users on some topics, develop concepts, understanding and to guide or train user skills. In addition, the game should be able to motivate the users to continue to play it (Hurd & Jenuings, 2009). Educational games are very practical and suitable to attract most of the age groups. In addition, educational games were not only used as a medium of entertainment, but also suitable for education. It enables students to learn and gain knowledge in an interesting and entertaining environment. According to Mohamed & Khalid (2017) in their research, elements of motivation and active student engagement become among the causes of the educational games' existence. Through games, it can stimulate and encourage collaborations (Weng et al., 2018), competencies, increase skills and develop creative thinking among students (Galustyan, Petelina & Ryzhenkov, 2019).

Sari et al (2017) developed an android-based educational game for learning colloid material where this app helps to develop the process of thinking and attitude. Wardani et al. (2017) also developed a chemistry board game called alchemist board, which aimed at enhancing students' learning outcomes and critical thinking ability. Winarti et al. (2017) developed computer game-based medium named "Chemtective" which was designed by

collaborating the chemistry subject and detective stories to motivate and increase interest among students to learn chemistry.

Yet, the mobile game content and genre are different according to the age and the subject matter. Each of the game has its own property and style as it may differently affect the players according to their age. A research shows that, different age group has a different interest in game genre (Eichenbaum & Kattner, 2015). Therefore, choosing the suitable game genre for the project may impact on how the students will react towards the project, as well as how the students learn chemistry through the game. Previously, we have developed the Atomic Game-Based Learning for Secondary School Chemistry (Abdul Rahman et al., 2020) by adding game elements to enhance students' interest in learning chemistry. A game was developed with the contents in accordance with the Form 4 secondary school chemistry subject on "structure on atom" topic. It is proposed to evaluate the level of understanding of the students towards the topic.

#### *Atomic Game-Based Learning App*

Traditional teaching and learning is no longer seen as efficient in helping students understand difficult topics because it takes time as compared to the use of online application (Abdul Rahman & Ab Ghani, 2019). The use of online applications in learning is gaining attention in the field of education. An online application is an approach that can attract students to study in complex and difficult subjects. Educators also highlighted the use of these applications to assist conventional teaching in helping students learning activities inside and outside the classroom. As technology is known to be limitless and keep on improving, the government has given its support and encourage teachers and educators to adapt technologies into teaching and learning process (Amiruddin et al., 2014).

Therefore, the Atomic Game-Based Learning (AGBL) was developed for the secondary school chemistry subject, which focuses on structure on atom topic. The content of the app is in accordance with the secondary school chemistry syllabus of Form 4. This app was developed to help students to understand the topic, with some game elements added to it. The app can also be used by teachers as a teaching aid to attract or engage students' attention in the classroom. AGBL is an android based application that was developed by combining the element of game and learning where the students will learn the subject while playing the game. The player engagement and graceful failure element were applied.

Through AGBL app, the player (student) needs to read simple and short hints or notes throughout the game. This is to ensure they can capture the contents of the topic better. AGBL has several levels that the students will have to go through to complete certain objectives. They will need to understand the key-points scattered throughout the levels to keep progressing in the game. Figure 1 shows the AGBL's start screen menu and Figure 2 shows the game interface.

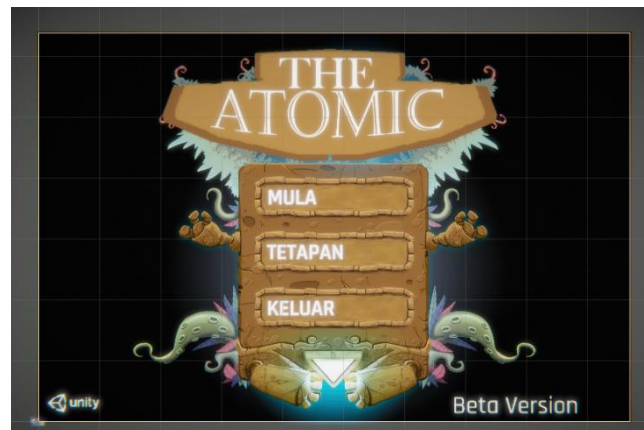


Figure 1. Main menu of AGBL's start screen menu.



Figure 2. AGBL game interface

In order to proceed to the next level, the player needs to pass the quiz section. The player needs three keys, which obtained throughout a level, to unlock the quiz section. The keys were collected during playing the game and they hold different information related to the topic (for example, one key may have information on gas, solid etc.) and can be used to answer the quiz questions. The quiz consists of a few questions, and each question has its own mark and time limit. So, the player has limited time to answer each question. Figure 3 shows the example of question in the quiz section.

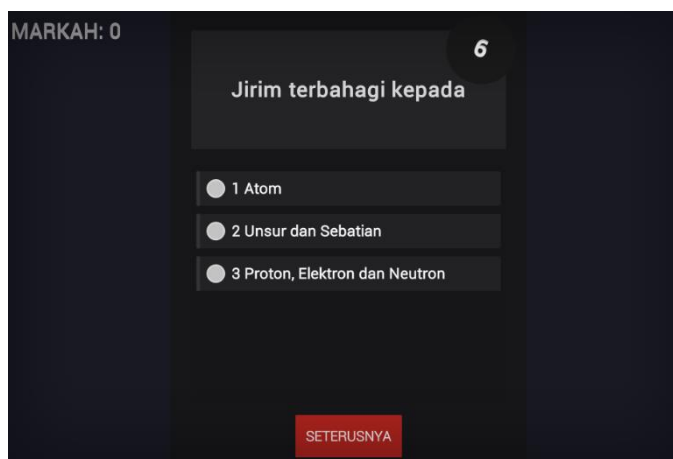


Figure 3. Quiz section in the game

### Methodology

In this pilot study, we have used two study instruments; Part 1 is conducting quiz and Part 2 is conducting a survey on the use of the app. There are 32 Form 4 students from the secondary school involved in this study. For Part 1, students are divided into two groups:

- i) Group 1: learning the topic through hardcopy notes and flash card (conventional study)
- ii) Group 2: learning the topic through AGBL app.

At the end of the game and conventional study, students were given the same set of questions related to the topic they have learned. Group 1 students, answered the question through Google Form and Group 2 students answered the question through the app. The purpose is to discover score obtained by each group. The results are discussed in the next section.

For the Part 2 of the study, the 32 students will use the app and answer the survey questionnaire to obtain their opinions towards the use of the app in learning activities. This is to identify if there are any flaws in the app and suggestions for the app improvements. The questionnaire is divided into three sections:

- i) Section A: Student's background
- ii) Section B: Student's perspectives towards the app
- iii) Section C: Student's suggestions or opinions to improve the app

The students were asked to rate the statements in the questionnaire according to the following scales: strongly disagree, disagree, natural, agree and strongly disagree. Table 1 shows questions asked in the questionnaire for section A and B.

Table 1

*Questions in the Survey Questionnaire*

<b>Section A: Student's background</b>	
<b>No.</b>	<b>Questions</b>
1.	Demographic Information.
2.	Do you like Chemistry?
3.	Do you think Chemistry is difficult to learn?
4.	Time spent on mobile phone a day.
5.	Do you use your mobile phone for academic purpose?
<b>Section B: Student's perspectives towards the app</b>	
1.	The app is easy to use.
2.	The app can be use anytime and anywhere.
3.	The app is interactive.
4.	The app improved my knowledge in different way.
5.	The app improved my understanding towards the topic.
6.	Learning through the app is fun and interesting compared to traditional way (hardcopy notes or flash card).
7.	The app able to attract me to study the topic.
8.	The app is recommended to be use in teaching and learning activities.

**Results and Discussions**

Figure 4 shows the score analysis from Part 1 of the study, where a quiz was conducted to find out the score results for each group. As mentioned previously, Group 1 students answered the quiz through a Google Form (they read the hardcopy notes and flash card) and Group 2 students answered it through the app (right after playing the game).

From the figure, average score is between 0 to 40 marks for students from Group 1 and average of 41 to 80 marks for students from Group 2, which is higher than the Group 1. The interactive notes displayed throughout the game were probably the main contributor to the higher score, as the students need to memorize them to keep progressing in the game. In short, the students are motivated to complete the game.

Table 2 and Table 3 show the result analysis for the Part 2 of the study, that is survey questionnaire for section A and section B respectively. Table 2 shows demographic information where there are 13 male students, and 19 female students were involved in this study. 53% of the students like the chemistry subject, whereas another 47% dislikes the subject. Based on the survey, 72% of them agreed that this subject is difficult to learn. This is because there are massive number of formulas that are needed to be memorized. We also found that most of them spent more than 7 hours a day on their mobile phones, that is 63%. This shows that students are well-experienced in using their mobile phone. However, the percentage of the students that use mobile phone for academic purposes are less than non-academic.

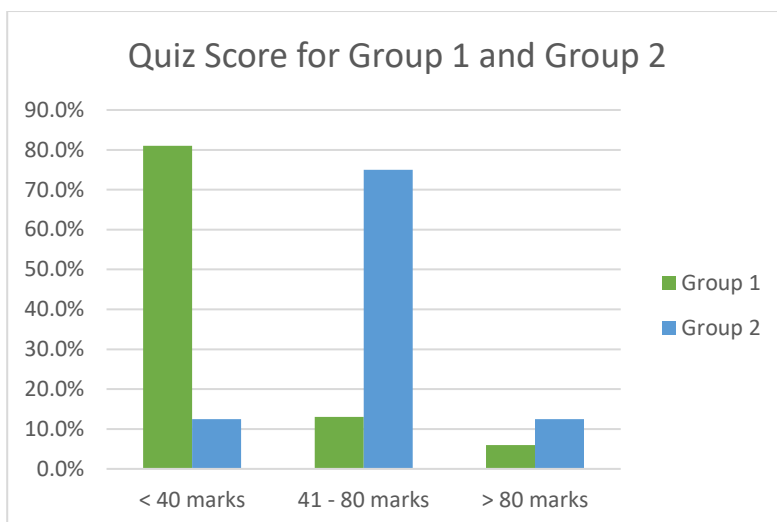


Figure 4. Quiz score for Group 1 and Group 2

Table 2

Student's Background (Section A)

No	Question	Male		Female	
1.	Demographic Information.	13 students		19 students	
		<b>Yes</b>		<b>No</b>	
2.	Do you like Chemistry?	53%		47%	
		<b>Yes</b>		<b>No</b>	
3.	Do you think Chemistry is difficult to learn?	72%		28%	
		< 1 hour	1 to 3 hours	3 to 7 hours	>7 hours
4.	Time spent on mobile phone a day.	0%	3%	34%	63%
		<b>Yes</b>		<b>No</b>	
5.	Do you use your mobile phone for academic purpose?	53%		47%	

Table 3

*Student's perspectives towards the app (Section B)*

No	Questions	Percentage (%)				
		SA	A	N	D	SD
1.	The app is easy to use.	66	28	6	0	0
2.	The app can be use anytime and anywhere.	84	9	6	0	0
3.	The app is interactive.	63	28	9	0	0
4.	The app improved my knowledge in different way.	56	22	9	13	0
5.	The app improved my understanding towards the topic.	59	28	13	0	0
6.	Learning through the app is fun and interesting compared to traditional way (hardcopy notes or flash card).	78	16	3	3	0
7.	The app able to attract me to study the topic.	69	16	9	6	0
8.	The app is recommended to be use in the teaching and learning activities.	53	41	6	0	0

\*SA – strongly agree, A – agree, N – natural, D – disagree, SD – strongly disagree

Table 3 shows the percentage of students' perspectives towards the use of the AGBL app in learning the topic. 66% of the students strongly agreed that the app is easy to use. This may be due to their skills and frequency of using online applications. 84% of them strongly agreed that this app can be used anytime and anywhere as it can be installed on their mobile phones, as compared to having to bring their hardcopy notes. We also discovered that 63% of them find this app is interactive as it offered gaming elements and colorful background display. The app is believed has improved their knowledge in a different way (as compared to the conventional way), where 56% students strongly agreed to this question. From the table, we also discovered 59% of the students strongly agreed that the app has improved their understanding towards the topic, and they discovered that learning through the app is more fun and interesting. Besides, 69% of them strongly agreed that this app attract them to study and 53% of them recommended this app to be used in the teaching and learning activities.

In section C, the study opens to any suggestions or opinions from the students towards the AGBL app. This is important to help the developer to improve the app's features especially the contents of the app. Table 4 have listed some of the suggestions and opinions obtained from the survey. The result shows that the app is well accepted as an alternative approach, where it helps them to get motivated to learn and understand the featured topic.



Table 4

Student's suggestion or opinions towards the app (Section C)

No	Suggestions or Opinions
1.	More engaging background music.
2.	Adding more game characters.
3.	Adding more game's levels with different questions.
4.	Adding more Chemistry topics with a different level of difficulty.
5.	Change the color of the layout.
6.	Make it available in multi-platform (eg: iOS or other platforms).
7.	The game itself should reflect the topic.
8.	This approach should be applied to other subjects.
9.	Give some rewards at each level.
10.	This is good app and it can reduce the use of printed paper (hardcopy notes).
11.	Recommended to be used – interactive.
12.	Not so easy for students who did not interested on game.
13.	Change the game's genre.
14.	Easy for student to understand the topic.
15.	This app helps me easily memorized the topic and I enjoyed play and learn at the same time.

### Conclusion

Integrating the technology and education is essential nowadays to provide an engaging environment for students to learn, as newer generations of students are deemed to be technology oriented. The mobile game app is intended to provide an interactive approach of learning and mastering the topic. It has a great potential for students to learn chemistry fundamental concepts, and it can promote motivation to learn the subject. By providing an interactive note throughout the game, quizzes at every level and rewarding them for their motivation to finish the game, perhaps the app can provide a lot of benefits especially to the targeted user. The result from the study shows that the app has been successfully attracts their interests towards the topic that were once they think hard to master. With a little motivation given in the app, the students were able to score the quizzes, as well as mastering the topic.

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