The Development of Matriculation Chemistry Module: Needs Analysis

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Abstract

The needs analysis study was conducted to obtain information from matriculation chemistry students and lecturers about 1) the problems encountered by the students and lecturers during the teaching and learning of matriculation chemistry subject, 2) the most challenging topics in matriculation chemistry syllabus and 3) the needs for the development of the teaching and learning module. This needs analysis study is a survey study involving 127 first semester matriculation students and eight matriculation lecturers selected by random sampling technique. Questionnaire was used as instrument for this study. It was divided into four parts: demographics, matriculation chemistry problems, matriculation chemistry topics difficulty level and suggestions to facilitate the learning of difficult chemistry topics. The results showed that matriculation chemistry is difficult because the subject is abstract. Besides that, feedback on the difficulty of matriculation chemistry topics showed the most difficult topic is the chemical bonding. Therefore, there is a need to develop a module that can be used as supporting materials in the teaching and learning of chemistry for matriculation students. In conclusion, students and lecturers need teaching and learning aids in chemical bonding topic to improve student's understanding. The implication of the findings provided references to the development of effective teaching and learning module.

Keywords: Needs analysis, matriculation chemistry, module, chemical bonding, difficulty, Augmented Reality

INTRODUCTION

Science education is frequently viewed as a mechanism to help a country to achieve its goal of being a developed country based on science and technology. Chemistry is a part of the curriculum that might help students grow intellectually by encouraging them to inquire about nature and how it changes. Meanwhile, chemistry education can provide students with unique possibilities to see the world from a "chemical" perspective and to assist them in learning important natural concepts. The relevance of chemistry as a need for a country's technological growth cannot be overstated.

There are three levels of representation in chemistry: macroscopic, sub microscopic, and symbolic [1]. Macroscopic (observable phenomena such as colour and phase), sub-microscopic (conceptualization of molecules and atoms), and symbolic (equations and chemical formulas) are three levels of representation in chemistry [2-3]. A student can only apply appropriate chemical models and concepts to predict and explain a chemical reaction after comprehending these three stages and their interrelationships. As a result, chemistry is regarded as one of the most difficult subjects to master [4]. There have been

a lot of studies conducted, starting from the identification of students' difficulty [5] in chemistry to the ability of teachers to present material [6].

Chemistry teachers are currently confronted with the problem of providing material to students who have preconceptions about the topic being difficult or complex. There are many reasons contribute to student's perceptions of chemistry as a difficult subject to master. One of the main reasons is students find many chemistry concepts are abstract [7]. Next, another source of difficulty in the learning of chemistry is misconception to understand chemical concepts. Misconceptions exist when it comes to abstract concept such as chemical bonding because students have a great difficulty visualising and understanding the concepts involved [8].

One of the most challenging tasks for undergraduate chemistry students is to visualise molecular conformations, complex compound structures, and chemical reactions in three dimensions. Every area of our life, including education, has been transformed by modern computer technologies. As a result, many academics and educators are attempting to improve student learning and knowledge production by incorporating technologies that better illustrate theoretical concepts, such as implementing augmented reality and virtual reality when explaining molecular geometry visualisation in chemistry.

Chemistry is one of the most essential subjects in STEM education and has a significant impact on science student's academic achievement [9]. Chemistry is a compulsory subject for all students in the science stream module of the Four Semester System (SES) and the Two Semester System (SDS) in the Matriculation program. The objective of Matriculation Chemistry is for students to understand the fundamental concepts of chemistry. This curriculum is designed and implemented to ensure that students receive the most comprehensive chemistry quality education as part of the matriculation program. However, a comparison of the 2018 and 2019 *Sijil Pelajaran Malaysia* (SPM) examinations shows that the number of SPM candidates taking chemistry subject is decreasing [10]. The decrease in this number could have an impact on the MOE's efforts to generate sufficient workforces in the field of science and technology for the country through matriculation program. This low enrolment caused a downward trend in scientific stream students that began in secondary school and has influenced student engagement in STEM fields at public higher learning institutions.

There are several factors contribute to the decreasing number of students in science participation and achievement in matriculation. At all stages of education, students found it was challenging to comprehend and acquire science subjects especially chemistry. Dani Asmadi, Azraii and Othman [11] investigated students' and teachers' perspectives on difficulty faced by the teachers and students in the teaching and learning of matriculation chemistry. They concluded that students do not understand the fundamental ideas of chemistry. Meanwhile, teachers commented that matriculation chemistry topics are difficult due to the abstract concepts and visualisation problems.

Mohd Nor and Nor Hidayah [12] identified the learning issues that secondary school students have when it comes to chemistry subject. According to the findings, students have poor knowledge of chemical equations and majority of the students struggled with chemical equations. Students experienced learning challenges in basic chemistry knowledge. All the problem statements mentioned were faced among students enrolled in the SES programme. This is because the proportion of students who participate in the SES programme obtain low grades of chemistry in the SPM examination. This indicates that most students do not master the concept of chemistry over their school years, resulting in poor performance in the SPM examination.

There are three levels of representation in chemistry: macroscopic (observable phenomena such as colour and phase), sub-microscopic (molecular and atom concepts), and symbolic (equations and chemical formulas) [2]. Only after mastering these three levels and their interrelationships can a student use appropriate chemical models and concepts to predict and explain a chemical reaction. This makes chemistry considered one of the most difficult subjects to learn [4]. Although SES students are often

misunderstood as having less academic competency, they can be given reinforcement to increase their understanding in chemistry.

In addition, the teacher's teaching strategy has an impact on the students' learning process and, as a result, on their understanding of science ideas. The challenge in realising the teaching process and making learning more relevant is due to the mindset of the teacher who uses the traditional method. This is due to the fact that traditional education is teacher-centred and encourages students to be passive in the classroom, where they are not directly participating in the learning process. As a result, this teaching technique fails to inspire students to continue their chemistry studies. Furthermore, because there are no two-way communications between teachers and students, this strategy will cause students to remain with their existing concepts.

Regarding this matter, this research intended to make an early analysis to determine the problems encountered by the students and lecturers during the teaching and learning of matriculation chemistry subject, the most challenging topics in matriculation chemistry syllabus and the needs for the development of teaching and learning module.

LITERATURE REVIEW

Difficulty in Chemistry Learning

There are several factors that have been identified as contribute to the decreasing number of students in science participation and achievement. One of them is the negative attitudes towards science subjects. Aziz and Lin [13] found that students developed a negative attitude toward science because the concepts were too difficult to understand. Aiken [14] defines attitude as a tendency to act positively or negatively toward situations, objects, concepts, institutions, or individuals. Student attitudes are the key to success in learning chemistry. Cheung [15] divided attitudes toward chemistry into four categories: satisfaction of learning chemistry, enjoyment of conducting chemistry lab activities, importance of chemistry in life and behavioural tendency to study chemistry. According to certain studies, students have a negative attitude toward science learning including chemistry subject [13]. Turner, Ireson and Twidle [16] in their study, went into greater information about why students disliked chemistry. More common reasons include writing too many sheets of paper; learning too many words; complex experiments; room odours; and tough schoolwork. Furthermore, it is difficult to gain a thorough understanding of chemistry phenomena.

According to Rott and Marohn [17] study, all student's understanding of chemical concepts develops in a comparable pattern. Furthermore, Nik Zarini and Salmiza [18] discovered that science education in Malaysia still emphasises passive memorization of knowledge transmission rather than inquiry and student-centred approaches. However, studies conducted by Adeline and Lay [19] found that students had a high knowledge of the relevance of chemistry in life, but they did not have a positive attitude toward chemistry due to other issues such as a lack of enthusiasm in studying chemistry.

Chemistry is a discipline of science that consists of many concepts, facts and symbols. There are several factors that make chemistry difficult to learn such as abstract concepts [20] and misconception in chemistry [21]. Currently, there is significant and relevant study on students' misconceptions about chemical bonding in the literature [22]. Many studies have been conducted in order to identify students' misunderstandings in the field of chemistry [23-24]. Other research showed students cannot distinguish ionic and covalent bonding [25-27], students do not understand the electrostatic nature of the chemical bond [28] and students have misconceptions about the polarity of molecules and also on the geometrization of molecules [25,29]. Additionally, studies show that students confused intramolecular and intermolecular forces [25,27] and misconceptions on melting and boiling points or on solubility and electrical conductivity of substances [25,30].

There are many reasons contribute to most student's perceptions of chemistry as a difficult subject to master. One of the main reasons is students find many chemistry

concepts are abstract [20,31]. Next, another source of difficulty in the learning of chemistry is misconception to understand chemical concepts [22-24]. Misconceptions exist when it comes to abstract concept such as chemical bonding because students have a great difficulty visualising and understanding the concepts involved [32]. Learning difficulties and a lack of academic confidence in science subjects are identified as the major reasons why many students do not pursue science stream [33-34]. In addition, this finding was in line with a study by Nor Hidayah and Zanaton [21], which found that many students refused to choose science stream because they are concerned about low achievement in their exams. Additional, chemophobia or chemistry anxiety is one of the factors contributing to a decrease in student involvement in chemistry and related fields, including a lack of interest in science [19,33].

In addition, the teacher's teaching strategy who uses the traditional method has an impact on the students' learning process and thus on their understanding of science ideas [34]. For all these reasons, Nahum, Mamlok, Hofstein and Taber [35] analysed how the chemical bond is taught and emphasized features of traditional education that can contribute to learning difficulties. As a result, they proposed a new method of teaching chemical bonds which is based on current scientific knowledge, new pedagogical content knowledge and technological integration in chemistry teaching and learning.

METHODOLOGY

Research Design

The purpose of this study is to obtain information from the views of students and lecturers of the SES matriculation program related to the learning problems of chemistry course, DK014. This research implemented a survey design. A survey design is conducted to collect data about individuals or a group of individuals in terms of issues relating opinions, attitudes, skills, or others at one point in time by using questionnaire forms [36].

Research Sample

The research sample comprised of matriculation students and chemistry lecturers from one of the matriculation colleges in northern Malaysia. A total of 127 SES students who were enrolled in the semester one 2019/2020 session and eight chemistry lecturers involved in this needs analysis study. The total population of SES programme is 190 students. The sample selection technique from the population is achieved by random sampling. According to Krejcie and Morgan [37] and Cohen, Vigoda and Samorly [38], sample size of 127 is sufficient.

Table 1 shows the final semester one examination (*Peperiksaan Semester Program Matrikulasi, PSPM)* grade of the students.

Table 1

Background Information of PSPM Grade

Module	Gender	PSPM Grade				Total
		A	B	C	D	
M001	M	1	12	3	0	16
	F	3	11	20	3	37
M002	M	1	6	14	3	24
	F	2	8	10	3	23
M003	M	0	0	2	5	7
	F	1	4	9	6	20
Total		8	41	58	20	127

Table 1 shows the background information of students PSPM grade according to their module (M001, M002 and M003). According to Table 1, the students' PSPM grade is in the moderate range. The majority of students get B and C for their PSPM grades.

Research Instrument

Data in this research was collected by using Needs Analysis Questionnaire. Google Forms have been distributed to both students and lecturers of SES programme in order to evaluate the topic difficulty level in Matriculation Chemistry Syllabus. Vasantha and Harinarayana [39] discovered that web-based surveys such as Google Forms are more reliable than face-to-face surveys. Another study indicated that web-based survey methods have more advantages such as response speed, costs, response rate, and variable costs [40].

SES students were chosen as they had completed all semester one matriculation chemistry syllabus. Both student and lecturer versions of questionnaire contains four parts. Part A gathers their background information. Meanwhile, Part B asks about the difficulties confront by students in learning matriculation chemistry. Respondents were asked to state their level of agreement using 4-point Likert scale of Strongly Disagree (SD), Disagree (D), Agree (A) and Strongly Agree (SA) in Part B. Next, Part C comprises a list of difficult topics based on the SES Matriculation Chemistry Syllabus. They were asked to state their agreement using 4-point Likert scale of Very Difficult (VD), Difficult (D), Easy (E) and Very Easy (VE). Finally, in Part D respondents were asked to give suggestions to facilitate student's chemistry learning.

This questionnaire was adapted from questionnaire used by previous study conducted by Dani Asmadi, Azraai and Othman [11]. Both questionnaires were proofread by subject-matter experts for its accuracy in items and content. Pilot study showed that the Cronbach's alpha for the questionnaire is .75 for student version and lecturer version is .89. Table 2 shows the item distribution in Needs Analysis Questionnaire.

Table 2

Item Distribution in Needs Analysis Questionnaire

Part	Title	Item Distribution
Part A	Demography	
Part B	Difficulties Confront by Students in Learning Matriculation Chemistry	1-5
Part C	Difficult Topics on the SES Matriculation Chemistry Syllabus	1-9
Part D	Suggestions to Facilitate Student's Learning	Open-ended questions

Procedure

At the beginning of the second semester, student's data were collected after exam results were announced. Two different sets of questionnaires were distributed to the respondents (students and lecturers) via Google Forms. Respondents were reassured that the questionnaires were anonymous, that it was not a test but rather a research attempt to explore their perception about matriculation chemistry learning. No time limit was given for the filling out of the questionnaires. After form submission, the responses from the Google Forms were analysed. Responses from respondents were stored and organized in a Google Sheets. Finally, the frequency and percentage were calculated.

RESULT AND DISCUSSION

Part B includes items to evaluate the problems encountered by the students and lecturers during the teaching and learning of matriculation chemistry subject. The items with high frequency and percentage values are considered as having more problems encountered by the lecturers and students during the teaching and learning of matriculation chemistry subject. Next, the topics with high frequency and percentage values are considered as having high difficulty.

Table 3 summarises the responses from the perspective of both students and lecturers on the difficulties faced in the learning of matriculation chemistry.

Table 3
Difficulty Faced in The Matriculation Chemistry Learning

No	Item	Agreement			
		Student		Lecturer	
		f	%	f	%
1	The matriculation chemistry course is difficult to understand because the concepts are abstract.	90	70.87	7	87.50
2	Teaching aids are not sufficient for visualization of abstract chemistry concept.	71	55.91	8	100.00
3	Only two-dimensional (2D) static images are used as teaching aids.	89	70.08	7	87.50
4	The learning in the classroom is emphasis on answering tutorial questions.	85	66.93	6	75.00
5	The interactive animation educational module allows a better understanding of the abstract chemistry concept.	118	92.91	8	100.00

The findings in Table 3 shows the students' and lecturers' perception towards the chemistry teaching and learning process in the matriculation college. About 70.87% students and 87.50% lecturers agreed that chemistry course is difficult to understand because of the abstract concepts. This finding is in line with the opinion of Lay and Kamisah [9] that science subjects are abstract in nature and require depth of understanding and visualization skills. Meanwhile, 55.91% students and 100.00% lecturers agreed that insufficient teaching aids makes abstract chemical concepts difficult to visualise.

Chemistry contains many abstract concepts that are difficult to understand and visualise. Christyowidiasmoro and Sumpeno [41] asserted that the difficulty can be better understood if the concepts can be made into real and easily captured by the student. A higher number of students (N = 89) and lecturers (N = 7) agreed that only two-dimensional (2D) static images were used as teaching aids during teaching and learning

of chemistry in their matriculation college. This is because chemistry reference book is used as reference for students at matriculation colleges. However, not all chemistry problems such as atomic structure and chemical bonding can be solved by reading chemistry texts [41].

While another 66.93% students and 75.00% lecturers agreed with the statement that learning in the classroom is emphasis on answering tutorial questions. Conventional methods such as fact memorization or only answering questions with no further exploration do not encourage students to think critically and limit their understanding. Learning science should not be limited to memorizing facts and passing exams [42]. Indeed, it should be interesting and focused on empowering learners to develop their competencies [43]. The highest percentage of agreement was item 5. A total of 92.91% students and 100.00% of lecturers agreed that interactive animation educational module allows a better understanding of the abstract chemistry concepts. This indicates that they need an interactive module as a teaching and learning aid in class. Meanwhile, Table 4 shows the summary on the student's responses on difficulty level of SES matriculation chemistry topics. Table 5 shows lecturer's responses on difficulty level of SES matriculation chemistry topics.

Table 4

Student's Responses on Difficulty Level of SES Chemistry Topic

	Topic	Easy		Difficult	
		f	%	f	%
1	Matter	126	99.21	1	0.79
2	Atoms, Molecules and Ions	124	97.64	3	2.36
3	Mole Concept	125	98.43	2	1.57
4	Chemical Equilibrium and Stoichiometry	110	86.61	17	13.39
5	Electronic Configuration	116	91.34	11	8.66
6	Periodic Table	118	92.91	9	7.09
7	Chemical Bonding	57	44.88	70	55.12
8	Chemical Equilibrium	117	92.13	10	7.87
9	Reaction Kinetics	123	96.85	4	3.15

The findings from Table 4 and 5 show that the chemical bonding topic has the highest percentage of difficulty level in the matriculation chemistry syllabus. A total of 55.12% of students and 62.50% of lecturers shared similar perception on difficulty level of this topic.

Table 5
Lecturers' Responses on Difficulty Level of SES Chemistry Topics

No	Topic	Easy		Difficult	
		F	%	f	%
1	Matter	8	100.00	0	0.00
2	Atoms, Molecules and Ions	7	87.50	1	12.50
3	Mole Concept	7	87.50	1	12.50
4	Chemical Equilibrium and Stoichiometry	8	100.0	0	0.00
5	Electronic Configuration	7	87.50	1	12.50
6	Periodic Table	8	100.00	0	0.00
7	Chemical Bonding	3	37.50	5	62.50
8	Chemical Equilibrium	8	100.00	0	0.00
9	Reaction Kinetics	8	100.00	0	0.00

Students considered chemistry an unimportant and irrelevant subject to learn [44]. For many students, chemistry is considered as a difficult, complex and abstract subject [9, 45-46] that involves particular intellectual abilities and an excessive amount of effort to learn. There are a number of reasons for students finding chemistry is difficult to learn. One of the difficulties faced by chemistry students is making a connection between the macroscopic and sub-microscopic worlds [47]. Several reports support the view that the interaction between macroscopic and microscopic is a source of difficulties for many chemistry students and the examples include chemical bonds [28].

Therefore, most students have difficulty in understanding the chemical bonding topic and thus have many misconceptions about it. Chemical bonding contains abstract ideas that cannot be directly applied in daily life. The concept of chemical bonding requires visualisation skills in order to understand the geometrical shape of a molecule, there is a large probability of student misconceptions. The study conducted by Ballester, Calatayud, García, Sabater and Trilles [48] found that the percentage of students incorrectly answered a question regarding molecular geometry and polarity was extremely high. Even more surprising, this misunderstanding came from university first-year chemistry and pharmacy students who had succeeded in chemistry at secondary school. It could be due to fact that most of students just memorise chemical concepts in the textbook without depth understanding. Hence, it is important to know which teaching and learning method would be favoured by the students in the chemistry learning. The suggestion of students and lecturers to assist them in the teaching and learning of difficult chemistry topics is presented in Table 6.

Table 6

Summary on The Students' and Lecturers' Suggestion to Overcome Teaching and Learning Problems of Matriculation Chemistry

Student's Suggestions	Lecturer's Suggestions
• I require highly imaginative media animation to help in the reinforcement of my memory for visuals presented during learning. As well as questions that commonly occur in the exam to enable me to understand the topic of the question and how it will be answered. • More online quizzes to enhance understanding. • Develop chemistry applications. • Create a chemistry video • Use of innovative learning methods. • Use the Augmented Reality application from the Play Store. • Create textbooks that include Augmented Reality technology. • Chemistry workshops should be held. Produce modules of learning in the form of easy-to-understand comics. • Multiply visual animated material.	• Develop interactive applications that make concepts easier for students to understand. • Create interactive modules. • Create interactive practice questions modules. • Use applications in teaching and learning. • Use digital technology. • Develop AR modules to help students learn difficult concepts.

Table 6 is the summary of the student's and lecturer's suggestions to overcome teaching and learning problems in matriculation chemistry. The information that had been collected was then analysed and the results were taken into consideration in developing teaching material to change conventional textbook-based learning. Traditional textbook-based teaching approach is no longer appropriate for today's students. When students perceive chemistry to be difficult to understand, their performance in this subject decreases. One of the matriculation chemistry learning objectives is students are able to explain chemical concepts and principles clearly and make connections to real life situations [49]. Students find it hard to understand the contents of lessons when involve visualisation concepts in matriculation chemistry syllabus. They need visualisation tools in order to improve their understanding and visualisation skills. Given that chemistry has highly abstract concepts, displaying animated three-dimensional (3D) objects is expected to provide a solution to the lack of interest in chemistry among students.

Hence, we would like to stress that there are many strategies to improve student's understanding about chemical bonding. To do that, teachers have to be aware of the more usual misconceptions in order to handle and implement new approaches to their teaching. Literature reveal that integrating technology into science classrooms has given teachers a lot of opportunities in developing interactive teaching methods [50]. As a consequence of the use of new approach of learning, students are able to reduce visualisation difficulties by using simulations, models or Augmented Reality (AR) technology. Furthermore, students and lecturers propose the development of a module

which integrates AR. AR is defined as the ability to interact with new information in a direct or indirect manner, thereby influencing the physical real-world environment by adding virtual computer-generated information to it [51].

Learning chemical bonding is usually boring because students only comprehend the book's theory and the teacher's explanations. By making applications that utilize AR, students are expected to be more interested and enthusiastic in learning chemical bonding [52]. Students can view and interact with 3D images in learning processes due to AR's detailed visualisation and object animation capabilities. According to Shelton and Hedley [53], AR has a lot of benefits, and it has a lot of potential for enhancing instructions and improving student understanding of complicated concepts and contents. Hence, AR is a very efficient technology for teaching and learning chemistry.

Future Directions: Augmented Reality (AR) as New Teaching Approach

The rapid advancement of science and technology has a significant impact on the learning process, as well as the delivery of material during the teaching and learning process. In the present digital era, learning media is a creative medium that is used to make the learning process more effective, efficient, and fun. As a result, multimedia technology is quite beneficial. This is supported by a study in the field of education, which shows that the use of multimedia technology for learning is growing rapidly [54].

In today's mobile technology, Augmented Reality (AR) is a popular multimedia technology that may be used as an engaging and interactive learning [55]. AR is a term that describes technologies that dynamically merge real-world surroundings with context-based digital information [56]. AR systems are now accessible to the public because of recent improvements in mobile computing. Mobile AR applications today use head-mounted displays, cameras, Global Positioning System (GPS), sensors, and internet access on smartphones and tablets to overlay dynamic, context-based, and interactive digital information over real-world settings. This new technology has a lot of potential for teaching, learning, and creative inquiry, thus it's likely to be widely adopted in education soon [57].

According to prior studies, AR applications can potentially enhance learning since they support user involvement, provide recent feedback, and are fun to use [58]. One of the advantages of AR is the ability to visualize three-dimensional (3D) objects. 3D visualisation refers to the techniques that allow concepts, data, and instructions to be displayed as 3D models rather than 2D sketches. For example, Singhal, Bagga, Goyal and Saxena [58] created an AR application to help students learn about chemical components. The periodic table was represented by the programme using fiducial markers. Students may choose a marker and lay it over a predetermined spot on the table, which would activate a 3D model of the chemical element in question.

Qassem Lamees Mahmoud, Mohd Said Al Hawai, Hessa Al Shehhi, Shayma Al Zemerly M Jamal and Ng [59], who built a monitor-based AR application with fiducial markers to teach chemistry by allowing students to mix two or multiple markers, thus combining two or multiple chemical elements. The application would calculate the chemical reaction in real time and display it as a 3D animated model. Research findings by Nor Farhah, Noor Dayana and Noraffandy [60], the creators of Mobile Augmented Reality (MAR) showed that MAR significantly improved student visualization in the topic of Chemical Bonding.

Other advantage of AR is it provides students with an important and innovative learning experience. Learning is made easier with AR [61-62]. The creation of applications that utilize AR can be used as interactive educational tools and can help students understand the concepts taught [63]. Among the AR advantages including its potential to help students' cognitive processes, especially in the visual spatial process [64]. For instance, it is necessary to develop teaching media integrated with technology that can visualize chemistry abstract concepts.

According to Huda Wahida, Fauziah, Harryizman, Ali Yusni, Haslina and Norida [65], AR has a lot of advantages and great potential to enhance understanding of concepts and contents. Therefore, these advantages can be applied to the topic of chemical bonding to help students overcome misconceptions caused by their inability to visualise bonding. Besides, AR also allows for detailed visualization and object animation, through which students can view and interact with the 3D images during learning processes. AR's relevance in academic contexts is supported by the fact that it can be used without the utilization of expensive technology. When properly implemented, AR plays an effective role in improving the learning achievements of non-high-scoring students [66]. At the same time, AR application allows students to complete the learning process on their own, save the teacher's time without explaining the concept repeatedly. Hence, AR can be used as a useful tool for learning because of its interactivity and 3D visualisation capability. As a result, AR has the potential to contribute to students' learning.

CONCLUSION

The needs analysis evaluates the problems and issues that occur in the teaching and learning of matriculation chemistry subject. In general, the students and lecturers regard the chemical bonding as having the highest difficulty among all topics in matriculation chemistry syllabus due to visualization of abstract concept. Therefore, identifying students' learning difficulties on the chemistry topic is important because it can be used as a reference for determining appropriate learning approaches, methods, and media to address these learning difficulties.

However, there are still some limitations to this study. First, this study was conducted to examine the problems of chemistry topics in semester one matriculation syllabus only. Therefore, it is recommended that future researchers could extend the study to the topics of semester two matriculation program. This is to get feedback on the matriculation chemistry topic as a whole. Furthermore, this needs analysis study only involved Four Semester System (SES) students as sample. In the future, this study could be extended to Two Semester System (SDS) students, so that the results of the study are more comprehensive.

As information technologies transform, educators have always looked to adopt new technologies into their classroom to enhance student learning experience. AR is one of the growing technologies that have a great pedagogical potential and have been increasingly recognized. In conclusion, most of the students and lecturers need new teaching approaches that can make educational environments more productive, pleasurable, and interactive than ever before.

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