Formative Assessment as a Tool for Enhancing STEM Learning among Chemistry Students

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Abstract

Students' learning involving formative assessment is regarded as very crucial in every bit of the teaching and learning process. Even with the crucial nature of formative assessment, it is very much often neglected by stakeholders in education. They mostly concentrated on the summative evaluation held at the end of the studies to evaluate the student's mastery of the related subject matter. This is for the whole study period of time for obtaining certificates, completion of the study course, and for enrolment in the next level of learning. This paper utilized a qualitative study where the case study methodology was used involving a sample of thirty (30) form four chemistry students from government secondary schools. This study was carried out in two phases. The first phase was administering the instrument to the students. The second phase involved reviewing and analyzing students' answers to each question to determine their understanding of the chemistry form four topics. The instrument consists of 15 objective questions and five subjective questions. The instrument was validated by chemistry experts. A pilot study was conducted using different cohorts of form four chemistry students before the actual study. The reliability of this instrument was 0.78. The answers obtained from the sample were collected by the researcher and analyzed using frequency count and percentages. The findings revealed overall achievement of students as good results. Although majority of students were able to answer most of the questions correctly, there were small number of them who were unable to answer the questions correctly. The paper concludes that by adopting proper steps in formative assessment, students' understanding can be enhanced, and this eventually will contribute to enhancing student's interest to learn chemistry.

Keywords: Formative assessment; STEM; Chemistry students

Introduction

Background and Overview

Assessment is known to be a very important tool that is being used in education. On the whole, there are two major types of assessments which are summative and formative assessments. The summative assessment result is important as it is used for obtaining certificates, completion of the study course and for enrolment in universities (Tremblay et al., 2012). However, in education, it is not only about assessing the students and evaluating them with marks and test scores. It is more important that educators should look beyond the test results of students.

Benneth (2011) recommended that educators should focus more on what does the students' test scores shows them. When they can answer the question what does the test paper shows them? Then it is said that this formative assessment is transformed into summative assessment.

Formative assessment is identified as frequent assessment that is done interactively to assess students understanding and progress so that educators can discover the learning needs and makes some adjustment to their teaching. This enables teachers to prepare to teach according to the diverse student's expectations and needs. Educators use this formative assessment technique to increase student's outcomes (OECD, 2008; Paulo et al., 2011). The principle of this assessment can be applied at the school level of education and policy level. This can be done because of the ability of the formative assessment to meet the lifelong learning goals. It is proven that the student's level of achievement has increased tremendously after incorporating the formative assessment technique in learning (Ozan & Kıncal, 2018).

Rationale and Problem Statement

The real role of assessment in educations is to understand and establish what the students developed in their knowledge before the time of assessment. Educators should understand that assessment is a continuous process to discover students understanding and reshape students move forward with learning. This is the primary reason why the formative assessment has gained importance and started to be utilized in classroom settings (Masters, 2015).

Formative assessment is considered important in education due to the fact that it answers important questions in education and enables the educators to re-evaluate and re-structure their teaching for a better outcome. Examples of questions that can be answered by the formative assessment are: (1) Is learning taking place according to the right track? (2) What is the problem and how to solve it? (3) Up to what level can the learning go next? This will be beneficial for the educators to notice the ups and downs and organize their teaching more efficiently. STEM education is being the focus of the nation's education, one of the pillars of STEM education in science. Science education can be divided into chemistry, biology, and physics. Especially understanding chemistry plays remarkable roles in improving society's social, economic and political way of life, since the strong commitment to disciplinary strength in chemistry, results in the development of physical, biological science and technology. So, learning chemistry is a demanding task. Its abstract and complex nature continues to be challenging and unattainable to most of the students. The difficulties may lie in human learning as well as the nature of the subject.

This shows that chemistry as one of the STEM subjects is very important to be learned and understood by students as STEM education being the focus of a growing nation. Its abstract nature makes it difficult to be learned by most of the students despite its importance to the nation. In order to do that, the educator should always make sure that chemistry education and students' understanding are at the appropriate levels. Hence formative assessment should always be utilized by the STEM educators in school in teaching chemistry.

Aims and Research Questions

This article aims at describing formative assessment as a tool for enhancing STEM learning among chemistry students. In this regard, the following are the research questions that guide the study:

(1) Determine students' understanding of the chemistry form four topics;
(2) Analyze the percentage of students that were able to master the topics and those having difficulties in the topics.

Literature Review

Types and Purpose of Assessment

Black (2010) and Ozan and Kıncal (2018) opined that formative assessment was shown to be the most influential assessment strategy for students' high-performance level of achievement in education. In Malaysia, the National Education Philosophy can be generated through the process of teaching and learning. The education system in Malaysia is a continuous process that aimed to develop potential individually and as a whole (Ministry of Education, 2013).

Over the decade, science, technology, engineering, and mathematics (STEM) has been a very popular topic among researchers from various parts of the world. STEM is derived from the acronym Science, Technology, Engineering and Mathematics (Khalik et al., 2019; Jamal et al., 2017; Kennedy & Odell, 2014; Hershbach, 2011; Whallen & Shelly, 2010; and Morrison et al., 2009). Hence, STEM education is brought upon by the western countries so much earlier from the era of world-War II (Banks & Barlex, 2014).

According to former United States (US) president, Barack Obama, STEM plays a major key role in economic growth (Banks & Barlex, 2014). STEM has been focused most vigorously due to its exposure to the nation's economics (Blackley & Howel, 2015). This is also supported by Atkinson and Mayo (2010) that STEM becomes a milestone in America's economic competitiveness. The same point has been discussed as the need for reformation in the education of STEM is crucial for a competitive economy of a nation (Corlu et al., 2014).

According to Paulo et al. (2011), the most widely used assessment in schools is the summative assessment. Summative assessment is held at the end of the studies to evaluate the students' mastery of the content taught for the whole program of study in a given period of time. Apart from this, summative assessment is widely used to evaluate students and categorize students according to their scores. This system also can be seen during the selection of students for public universities, funded schools, and boarding schools. Not only in a national setting but summative assessment is used in international education as well, such as in the Program for International Student Assessment (PISA). The result obtained from PISA is used to compare the development of education among the participating countries (OECD, 2008).

According to Masters (2015), educators supposedly should focus on the intrinsic point, what assessment is shown to educators beyond the marks. It should serve as a tool to reveal students' progress in learning. An article titled "The Bridge between Today's Lesson and Tomorrow's," have described the purpose of formative assessment (Tomlinson, 2014). According to that article, assessment should be aligned with daily lesson plans. Hence, it is encouraged to develop formative assessment daily and unlike summative assessment which is administered periodically (Thiers & Preston, 2015).

All the assessments administered in schools can be seen as formative assessments. This can be done if educators change their focus point into discovering the real purpose of assessment. All the traditionally known assessments such as exams can be transferred into the formative assessment. This is possible if educators look into the students' exam results and identify the

gap in their students' understanding. This identified gap should be used by the educators to restructure the teaching of that particular topic to cater for a better understanding of their students (Masters, 2015).

Rational of Formative Assessment

A person is said to be learning more effectively when learns from a mistake. If the final assessment grade adversely affects the students, it will be hard to implement the strategy for students to learn by making mistakes. Hence, more formative assessments should be carried out in schools. This will make it easier as no marks will be rewarded for this assessment. Students will be more experimental in formative assessment, and this enables the students to challenge their pre-conceived knowledge and develop their desired higher cognitive skills (Surgenor, 2010).

The same rationale of formative assessment has been spread by various researchers. In the year 1994, according to Brown and Knight (1994), assessment without marks (ungraded) became the norm that enabled students to discover their freedom in studies by experimenting as well as being active and adventurous. This will help students to gain knowledge by exploring their studies. Ghaicha (2016) reiterated that students' participation can be maximized enduring formative assessment by clearly define for them the benefits of the assessment in improving their final marks. The finding from a research study conducted by Jeong et al. (2020) on formative assessment on students' motivation in a flipped STEM education revealed that there is a greater improvement in students' motivation most especially if the STEM activities involved using log record and feedback adaptive assignment. Hence, the use of effective formative assessment in STEM education could overcome the drawbacks encountered during the traditional instruction strategy of teaching for better sustainable STEM Education.

Principles of Formative Assessment

Educators gain insights from conducting formative assessments in their teaching and learning. This helps both the teachers as well as students to discover students' understanding and enable them to work together to enhance their understanding even better. All over the world, educators will try to conduct their lesson in a way that even the last bench student in their classroom shows a fruitful outcome. But it is understood that teaching is a very complex process to develop perfections. At times, even the best educators tend to make mistakes. But according to much research done, educators who follow the 10 principles of formative assessment produce a fruitful outcome in a STEM education (Tomlinson, 2014) as outlined below;

1. Helping Students to Understand the Role of Formative Assessment
2. Begin with Clear to Know, Understand and Do
3. Making Room for Student's Difference
4. Providing Instructive Feedback
5. Making feedback user-friendly
6. Assessing Persistently
7. Engage Students with Formative Assessment
8. Looking for Patterns
9. Planning Instructions around Content Requirements and Student Need
10. Repeating the Process

In a STEM education setting, the classroom uses an interdependent system among few pillars. This pillar affects each one and another positively and negatively. The pillars are 1) the learning environments; 2) the formative assessment usage; 3) educational curriculum quality; 4) planning and development of instructional design as well as 5) the implementation process. This shows that the use of formative assessment in education is one of the essential pillars for a fruitful outcome.

Methodology

The study employed a descriptive study carried out in two phases. The first phase was the administration of the instrument to the students. The second phase involved reviewing and analyzing student's answers to each question to determine their understanding of the chemistry form four topics. The following sub-headings described the actual methodology of the study.

Sampling Techniques

A total of 30 students as the total number of students (population) from a government secondary school in Johor are the samples that participated in this study through purposive sampling. Purposive sampling is the technique of sampling, which enables the researchers to choose the sample based on their judgment that is suitable for the study among all the populations (Black, 2010). Based on this, all the students were involved since the number is manageable. Hence, all the 30 students of form four chemistry students from this school were used as the sample in this study.

Instrument

The instrument was a test involving objective and subjective questions. Students were required to answer this instrument in the form of an assessment. This instrument consists of 15 objective questions and five subjective questions. Questions in this instrument were developed by incorporating elements of Science, Technology, Engineering and Mathematics (STEM) and also Higher Order Thinking Skills (HOTS). All nine chapters of the form four chemistry syllabus were covered in this instrument.

Validity and Reliability

This instrument was validated by three chemistry experts who went through the content. The validators checked the relevancy of the questions to the syllabus and the standard nature of the questions in measuring the objectives of the study. A pilot study was conducted involving form four chemistry students from a government secondary school that was not participating in the actual study. The reliability of this instrument was 0.78. It is in the acceptable range (Saunders, et al., 2012) and can be used for this study.

Data Analysis

The answers obtained from the sample were collected by the researcher and analyzed using frequency count and percentages. From the objective answers, students' understanding of that particular topic was noted. How many students were able to master the topics and how many students having difficulties on those topics were noted. The ability of students to interrelate STEM elements was observed. For subjective answers, students' understanding and also misconceptions were noted.

Result and Discussion

The analysis was done separately for objective and subjective questions. The analysis was made based on the frequency and percentage. All these questions are consisting of a total of nine chapters. Hence the analysis was also done to observe the chapters in which difficulties were faced by students.

Analysis of Objective Questions

The result of students' answers to objective questions is shown in the following Table 1.

Table 1 Analysis of Student's Answers to Objective Questions

Chapters	Question		Answers				No answer
			A	B	C	D	
(1) Introduction to chemistry	17	F	1	*18	4	7	-
		%	0.03	0.6	0.13	0.23	
(3) Structure of Atom	13	F	-	7	*21	-	-
		%	-	0.23	0.77	-	
(4) Formula & Chemical Equation	1	F	*28	-	2	-	-
		%	0.93	-	0.07	-	
	2	F	-	*19	5	6	-
		%	-	0.63	0.16	0.2	
	16	F	*19	3	5	2	1
		%	0.63	0.1	0.16	0.07	0.03
(5) Periodic table	3	F	1	5	*20	4	-
		%	0.03	0.16	0.67	0.13	
	4	F	*27	-	3	-	-
		%	0.9	-	0.1	-	
(6) Chemical Bonding	15	F	3	*23	3	1	-
		%	0.1	0.77	0.1	0.03	
(7) Electrochemistry	5	F	-	5	2	23	-
		%	-	0.16	0.07	0.77	
	6	F	*25	1	-	1	2
		%	0.83	0.03	-	0.03	0.07
(8) Acid & Base	14	F	*25	-	5	-	-
		%	0.83	-	0.17	-	
(9) Salts	9	F	2	5	*20	2	-
		%	0.07	0.17	0.67	0.07	
	10	F	3	*27	-	-	-
		%	0.1	0.9	-	-	
(10) Industrial chemistry	11	F	3	*23	-	3	1
		%	0.1	0.77	-	0.1	0.03
	12	F	3	10	8	*8	1
		%	0.10	0.33	0.27	0.27	0.03

* correct answer. F : frequency %: percentage

According to Table 1, the overall achievement of students shows good results where more than half of the students were able to answer for a total of fourteen questions correctly. This can be due to the reason that the questions are relatively from moderate to the easy level of difficulty and most of the students who participated are from the upper group with a score range of 60% and above. Out of the fifteen questions, only question 12 have the least number of (which are eight out of 30) students who were able to answer. This is because question 12 is from the hard level of difficulties with a *p*-value of 0.3.

Although the majority of students were able to answer most of the questions correctly, there were still some of students who were unable to answer the questions. It is the responsibility of the teachers to study why that small group of students were unable to answer the question and create a suitable learning method to overcome this so that all the students can understand the concepts in STEM education correctly. This will help to achieve Malaysia's vision of creating a scientific society. A detailed analysis according to the chapters has been made and discussed below.

Analysis According to Chapters

The first chapter is introduction to chemistry. In this chapter, students learned what is chemistry and the professions related to chemistry. The question was tested on students' knowledge of STEM profession which is related to the chemistry field of study. A total of 12 students were unable to relate profession that has a chemistry work nature.

In the second chapter, students were tested on isotopes and atomic structures. A total of seven students were unable to answer them correctly. From their answer, it was confirmed that they did not understand the basic atomic structure. This is due to their alternative conception of this topic (Chiu, 2007). According to Chiu (2007), students always tend to get confused at the term nucleon number and the number of neutrons. This involves the students' microscopic level of understanding. Students tend to have an alternative conception at this level due to their inability to distinguish between macro and micro-level (Bucat, 2014; Meijer, 2011 and Chandrasegaran et al., 2007).

Formula and chemical equation chapter tested with a total of three questions. One question tested students' knowledge on molecular formulae, one question tested on a calculation using mole and another question tested students' skills on writing chemical equations. Previous studies show that there is an alternative conception in this topic (Nakhleh, 1992; José & Williamson, 2005; Stojanovska et al., 2014). All these three questions tested a student's symbolic level of representation. Students faced difficulties in recognizing symbolic representation as well as get confused between symbols of atoms and molecules (Stojanovska et al., 2014). One of the student's responses during the interview was that "*Instead of $3N_2$, in a chemical equation, one can write 6N*" which wrong way of expressing three mole of Nitrogen gas. In the study on chemical equations, students need to learn from the macroscopic level (observing experiments) and then should be taught in-depth to the microscopic level by teachers. Unfortunately, most of the textbooks as well as teachers teach up to macroscopic level and neglecting the microscopic which develops an alternative conception among students (Stojanovska et al., 2014).

Question three and four tested students' knowledge of the elements in the periodic table. Studies have shown that students pose alternative conceptions in the topic of the periodic table (Demircioglu, 2009). Students assumed that valence electron was a method of arranging the

elements in the Periodic Table. Students were confused on the concept of element arrangement with ways in grouping elements, which uses valence electron to indicate the elements group in the Periodic Table (Demircioglu, 2009). One of the questions tested students' knowledge in locating the catalyst in the periodic table. Some students answer this wrongly. It can be either they wrongly identify the catalyst or are unable to identify the correct group of the periodic table.

One question tested students' knowledge in chemical bonding. This test students on the microscopic level where students need to know about the bonding between two atoms. Microscopic learning solely depends on the teacher's explanation. Hence alternative conception tends to occur in this topic due to oversimplified explanation of bonding in teaching materials such as two circles are drawn to show an atom and a line in between them representing the bonding (Kay & Yiin, 2010). Students tend to get confused when they are using the same representation to learn various bonds. This is aligned with a previous study that stated that the "*textbook uses the same representation to teach ionic bonding and covalent bonding*" (Stojanovska et al., 2014).

Two questions tested students' knowledge in the chapter on electrochemistry. According to a study done by Aziz et al. (2021), a topic of electrochemistry has also been stated as the topic that contains alternative conceptions among Malaysian students. The alternative conception noticed among students in this study are students assumed that ions move through the cell toward the plus pole and also students assumed that only electrons can migrate through a solution (Schmidt et al., 2007). Neglecting the micro-level during teaching also contributes to the high number of alternative conceptions in the micro-level (Stojanovska et al., 2014).

A small group of students shows alternative conceptions on the topic of acid and base. This aligns with the previous research done by Demircioglu (2009). Students hold the alternative conception that H_2SO_3 is a strong acid because it contains two hydrogen atoms in its molecular compound. Since, there are more hydrogen atom, its acidity becomes stronger. Students focus on the number of hydrogen atoms to determine the acidity of a compound (Demircioglu, 2009).

Some students face difficulties in the chapter on salt. This can be seen with their alternative conception over the topic in this study that aligns with the research done by Chandrasegaran et al. (2007). In this topic, it was noted that some of the students were unable to choose the correct molecular formula of the identified salt. Most of the students chose Ba_2SO_4 for barium sulphate. Students faced difficulties in recognizing symbolic representation and got confused between symbols of atoms and molecules (Stojanovska et al., 2014).

The last topic that was being tested was industrial chemistry. One of the questions that least students answered correctly tested their ability in remembering elements added in stainless steel. Only eight students managed to answer correctly. This is mainly not due to misconception but the factor of memorization. This topic requires students to memorize a lot of elements. Hence the ability for students to answer this question depends on the student's ability to memorize.

Analysis of Subjective Questions

The subjective part consists of five questions. The result of students in this part is shown in Table 2.

Table 2 Analysis of Student's Answers for Subjective Questions

Questions		Able to answers	Unable to answer
1	(a)	12	18
	(b)	16	14
2	(a)	3	27
	(b)	2	28
3	(a)	28	2
	(b)	15	15
4	(a)	25	5
	(b)	16	14
5	(a)	17	13
	(b)	18	12

Compared to objective questions, subjective questions show a greater number of students unable to answer correctly. The gap difference between the students able to answer and unable to answer is small. All four questions are at a moderate level of difficulty and one question is at a high level of difficulty. For that particular question, more students were unable to answer correctly. The following are elaborations on Questions 1 to 5.

The first question tested students' knowledge about radioactive isotopes and their properties. The students who were unable to answer correctly shows that they were unable to relate the theory learned in the topic on matter. They still get confused in between the properties of radioactive isotopes. This is because students are unable to distinguish between macro and micro-level (Bucat, 2014; Meijer, 2011; Chandrasegaran et al., 2007) that were learned in this topic and applied to this question.

The second question tested on concentration and solubility is among the topics with high levels of alternative conception (Setiowati et al., 2018; Demircioglu, 2009). This is aligned with the result of this study. When the water is added twice the initial volume, the concentration of sugar will behalf. But many students fail to understand this theory where some answers noted that students made mistakes between concentration and number of moles. This is aligned with the research done by Krause and Tasooji, (2007). Students experiencing misconceptions assumed that the solubility value was calculated from the mole of salt under saturation conditions. The correct concept of solubility was the number of salt moles dissolved in a litre of solvent and yielded a saturated solution (Setiowati et al., 2018).

The third question requires students' knowledge in molecular formula and concept of mole as there are calculations to be carried out. The answers of students reveal that students tend to confuse the numbers used to write coefficient and atomic numbers. This is aligned with previous research that gave an example of students answer, "*Instead of $3N_2$, in a chemical equation, one can write 6N*" (Stojanovska et al., 2014).

The fourth question tested students on the topic of chemical reactions and equations. Some of the students' answers revealed that they were unable to write the chemical equations correctly. A high level of alternative conception is found in this topic (Kay & Yiin, 2010). This study shows that students were unable to understand the chemical reaction up to the atom and molecule formation before and after the reactions. Students usually get confused in the representation of chemical formula writing (Stojanovska et al., 2014).

The fifth question tested students' knowledge of changes in physical properties. This aligns with the research done by Nakhleh (1992), Ozmen and Kenan (2007) as well as Skamp (2009). In these questions, it was found that some of the students still did not understand the process of sublimation. Student's microscopic level of understanding was also tested here where students were required to draw the arrangement of the molecule before and after the reaction process. Some of the students who answered wrongly have drawn the arrangement. Students did not draw the arrangement far apart instead drawn it in a smaller size. This is aligned with previous research that found out students thought that "*particles of a substance are shrinking during heating of that substance*" (Stojanovska et al., 2014). This show that they have an alternative conception at the microscopic level for this topic.

Discussion

Based on both the objective and subjective analysis, although only a small number of students have answered wrongly, teachers play the role to identify this group of students to help them resolve their alternative conception in the order that they can learn and become the scientific society.

Hence based on the identified topics of problems, teachers should conduct an appropriate teaching strategy, particularly for these students. Since most of the alternative conceptions occurred due to the abstractness of chemistry, teachers should use technology-based teachings such as using models, animations, and computer software (José & Williamson, 2005).

According to Buzan and Abbott (2005), the use of a graphic organizer can be a simple tool to elicit alternative conceptions and enhance students' understanding. The thinking skills of a student could be sharpened by using graphic organizers such as mind maps in chemistry education. A mind map is used to represent the context that students gained by observation, discussion and reading. By doing this, any wrong ideas or understanding of students can be identified.

Most of the teachers focus on teacher-centred learning which is largely implemented in Malaysia that follows the British education system. This emphasizes more exam orientated and rote teaching. Students are trained to answer examinations without focusing on constructivist learning (Coll & Taylor, 2001).

Hence teachers should implement more constructivist learning theories to overcome this issue of alternative conception. Students should give opportunities to conduct experiments for themselves and discuss the finding among their peers. Classroom discussion based on arguments or counter-arguments on chemistry concepts can facilitate students' conceptual understanding (Osman & Sukor, 2013).

Students who hold alternatives conceptions have a high resistance to modifying their pre-existing ideas, even after classroom teaching as well as the completion of the learning process teaching chemistry concepts and relating them to everyday life can help concept retention. Inquiry-based teaching should be conducted to engage the students in the teaching and learning processes (Osman & Sukor, 2013).

Dalziel (2010) have proved that Predict-Observe-Explain (POE) approach can be used to elicit alternative conception. This approach is used in chemistry teaching, where students need to predict what will happen next according to the problems given to them. Later students observe

the outcome and correlate it with their prediction. If the prediction is wrong, students are encouraged to find the answer to why it is wrong and learn what does happen. In this way, their wrong understanding can be identified and at the same time, students can learn the real process that happened which eventually build up their understanding even better.

Researchers suggest that the use of analogies, illustrations, concrete examples, explanations and demonstrations can enhance the understanding of the students. After teaching session, students should be trained by exposing to problem-solving question so that sharpens their understanding even better rather than just test on the application of formulae. An example of analogies that can be used in chemistry is during the teaching of mole. A parable is used in teaching mole. But according to Orgill and Borden (2005), the use of analogies shows the better result with certain conditions to be fulfilled. The conditions are stated below:

- The analogy has to be intelligible
- The relation between the analogical situation is familiar to the student
- The concept that is framed has to be clearly seen
- They have to be used for a long period of time.

Conclusion

Summary and Implications

By adapting few steps as mentioned above, the understanding of the students can be enhanced. A better understanding will be the tool in the elimination of alternative conceptions. A better understanding will be used to proper usage of chemical symbols found in chemistry. All of this eventually will be fruitful to increase the student's interest in chemistry. A good understanding, knowledge, high interest and motivation will develop the shift of students towards chemistry and liking STEM subjects. This can be a start to accomplish Malaysia's vision of achieving the proportion 60:40 for STEM and non-STEM subjects.

Limitations and Future Directions

Future researchers can use the data obtained as guidance and carry out more detailed researches to enhance the benefits of formative assessments. The study is limited to only one school with a total of thirty (30) students. Hence, the need for utilizing large sample of participant for better generalization.

Significance and Contribution in Line with Philosophy of LSM Journal

The outcome of this study would guide teachers to distinguish between the students who master those certain topics and the students who are still facing difficulties in that topic. They can discover the areas that their students might need more help to overcome the alternative conceptions. Teachers can use the gathered data to re-structure their lesson plan and instructional design to conduct their classes more efficiently. Students can use this result to evaluate their understanding level of certain topics. From there they can identify the areas that they need to put more effort to increase their understanding. Students can learn the importance of integrating STEM in studies which will help them face the real-world situations

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