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Chemistry Learning Based on Kibas Asah Module (Wetland-Based Chemistry) Integrated AR-Sparkol on Buffer Solution Material: Students' Cognitive and Motivation Diagnostic

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a b s t r a c t

The learning process with a module based on local wisdom is the alternative way on how to make students' ability for analyzing and identifying be stronger, especially in learning chemistry and also their motivation. Chemistry learning does not only focus on material content but on how students can interpret content scientifically so that they have a broad and deep range of knowledge. This research was quantitative. It aimed to know the level of students' cognitive and motivation in learning chemistry where they were using a specific module. In this case, the kibas asah integrated Augmented Reality-Sparkol has been used. The research method used experimental research with the type of one-shot case study. The data collecting technique was a questionnaire, and it included a cognitive test and motivation. The data analyzing method was a descriptive statistics approach. The result showed that the level of students' cognitive through two tests in a different location. Its value was in a row of 0,77 and 0,70 with "high" criteria, and students' motivation value was 77,61 with strong criteria. These results showed that chemical learning based on the module was developed, and it can fix the quality of the students' cognitive and motivation deeply. That is, the concept of research is not oriented towards the product produced, but how the product has implications for learning chemistry holistically, becoming a source of scientific reference, honing skills in using technology, creativity, critical thinking, mental models, habituating scientific attitudes, and increasing their knowledge both in terms of chemical content or environmental based references (local wisdom).

1. Introduction

Environmental based learning is a solution in responding to how the environment can be a source of learning, this statement is termed (Leila, Maryam, & Seyyed, A Comparative Study in Green Chemistry Education Curriculum in America and China, 2013) as green chemistry education. This term is considered as a medium in recognizing the environmental problems that finally provide the opportunities and the perspectives for the involved parties to improve the quality of science curriculum (green chemistry) in the future (Leila, Maryam, & Seyyed, 2013). The development of this environmental-based learning is undoubtedly a challenge for teachers, and it is acutely felt by them (Klingshirn & Gray, 2009) who assess that the implementation of green chemistry has the potential to improve the self quality of humans in the future and it has a value of sustainability. Another view came from (Sadullah & Gilson, 2011), which added that the character of the students and even the system of education were greatly influenced by internal and external factors. So, planning, managing, and evaluating what has happened is a solution on how to make the learning environment effective (Leila, Maryam, & Seyyed, 2013).

With the statements above, talking about science, environment, technology, and other concepts (Legendre, 1993) divided into four ideas, namely monodisciplinary, multidisciplinary, pluridiciplinary, and transdisciplinary. Those concepts are considered suitable to be used as a learning strategy so that the students can organize the material content and have a lot of perspectives in learning (Danczak, Thompson, & Overton, 2017; Taber, 2000). (Florentina & Barbu, 2015) added that the interdisciplinary concept in which the density and breadth of information bank is a guarantee for the students because they have a lot of views which is not only about chemistry. It is similar to the statement that the integration of chemistry, geography, and ecology has a strong correlation and makes it easier for the students to explain the occurred phenomena (Florentina & Barbu, 2015). It means that the interdisciplinary approach does not only lead to the chemical concept skill but indirectly they also understand well about the other scientific concepts and the result of this integration can be an evaluation material for how well they know the knowledge that should be understood, their thinking pattern changes, and the quality of classroom teaching increases.

The idea of scientific collaboration such as chemistry that is correlated with local wisdom and the touch of technology through specific media is a unique way in encouraging the learning spirit of the students (Bybee & Fuchs, 2009; Hiliadi, 2016; Irwansyah, Yusuf, Farida, & Ramdhani, 2018; Koutromanos, Sofos, & Avraamidou, 2015; Kwan et al., 2018; Normalasarie., & Aulia, 2019; Su, 2011; Susanti, Hasanah, & Khirzin, 2018). That media can be a medium of communication between participants with the learned content (Herdini et al., 2018; Priyambodo, 2014; Priyambodo & Wulaningrum, 2017; Rui et al., 2017; Turkoguz, 2012). Reference (Stemler, 2001) revealed that the content analysis in the used learning media could be used as a method to diagnose their activity and ability to capture the material (Herdini et al., 2018; Insyasiska, Zubaidah, & Susilo, 2015). This media can be through books, reports, newspapers, magazines, songs, and (Huseyin, Seyhan, & Sinem, 2012) responded that the content analysis through textbooks or other teaching materials is a reliable way of knowing the attitudes and how the students communicate to the learned knowledge.

Even the activities of students can be indirectly identified and can be measured like interviews, observations, personal experience, visual text, etc. (Lubis & Ikhsan, 2015; Wahid & Anra, 2017). That is, the application of teaching materials by integrating the various scientific content (Beyer & Davis, 2008; Vesterinen & Aksela, 2009) and technology (Su, 2011) is a solution in teaching the students (Swanson, Watkins, & Marsick, 1999).

The increasing of students' motivation can be triggered by how far the technology contribution teaches them (Aksela, 2005; Ferguson, 2001; Ghavifekr & Rosdy, 2015; Rohaan, Taconis, & Jochems, 2009; Shihusa & Keraro, 2009). Then, they need a new experience that can open their understanding of the unique learning method based on information communication technology (ICT) (Daniel & Pedro, 2016). The result of research from (Daniel & Pedro, 2016) showed that the integration of Augmented Reality (AR) adds value to the teaching and learning process of the students. Thus, it is indirectly triggering the development of competency and learning motivation of the students (Lund, B., Harald, 2016; Taçgin, Uluçay, & Özüağ, 2016; Yuliono, Sarwanto, & Rintayati, 2018). AR is considered as a system of technology combination that combines objects with a real environment virtually, and its application is very interactive to the users so that the integration of AR technology is important to be promoted (Alkhattabi, 2017; Chen, 2006; Dünser et al., 2012; Irwansyah et al., 2018; Lund, B., Harald, 2016; Suwarna, 2014; Taçgin et al., 2016; Wahid & Anra, 2017; Yang et al., 2018). In line with (Azuma, 1997), it is said that the application of AR makes the process of human understanding becomes more actual and highly contextual. Even the Augmented Reality technology (Fjeld et al., 2007; Maier & Klinker, 2009; Medicherla, Chang, & Morreale, 2010; Redó et al., 2010; Singhal et al., 2012)is very popular in the researches related to the education and technology (Bacca, Baldiris, Fabregat, & Graf, 2014). It is strengthened by (Sudarwan & Khairil, 2011) that stated the presence of material with a touch of technology can enhance memory and broaden the knowledge of the participants; thus, it can trigger their learning motivation.

In addition to the motivation, the technology, and the character of chemical learning that already described above, cognitive structure also becomes a part of knowledge that can not be separated (Harsh et al., 2017; Lubis & Ikhsan, 2015; Pande & Chandrasekharan, 2017; Shihusa & Keraro, 2009; Taçgin et al., 2016). (Ozge & Sinem, 2011) assumed that each student has different methods, techniques, and learning organizations. The indication of a cognitive structure can assess the students' long-term memory and its relationship to the chemical material content (Shavelson, 1974), (Ozge & Sinem, 2011). The gap that occurs is that they are required to try to remember as much as the knowledge they have learned while the cognitive structure has been isolated by the learning system that does not support (Harsh et al., 2017; Levy & Wilensky, 2009; Potgieter & Davidowitz, 2011). Finally, their cognitive ability becomes weak so that the lack of the depth concept becomes a factor that must be eliminated (Tsai & Huang, 2002).

Based on the analysis above, it is expected that the chemical learning on the buffer solution material through the kibas asah module that is integrated with Augmented Reality-Sparkol (Alkhattabi, 2017; Behmke et al., 2018) can trace the cognitive tendency (Taçgin et al., 2016) and motivation (Shihusa & Keraro, 2009) of the students in learning chemistry. The elements in the module are the chemical content itself, the environment, and the touch of AR technology that can contribute to improving the quality of teaching and learning chemistry; therefore, the improvement of the learning outcomes such as cognitive and motivation of the students can be gradually realized. It is because of the pace of the globalization era that is every second requires every human being to be able to feel the future quickly. The learning based on this module has the potential to be an initial innovation in removing the thought of the difficulty of science learning in society. In other words, this module is a new technology or way of dealing with problems in the learning aspects (Hamzah, 2012).

2. Method

This carried out the study is quantitative research with a descriptive statistical approach (Rosana & Setyawarno, 2017). This research adopted an experimental research method with a type of one-shot case study (Sugiyono, 2016). The selected sample was divided into two sample distributions, namely a limited test, and extensive tests. The sampling technique used was purposive sampling, where the sample location was in SMAS PGRI 2 Banjarmasin and SMAN 4 Banjarmasin, South Kalimantan. The schools were chosen as the implementation target of the module based on Kibas Asah which is integrated with augmented reality-Sparkol due to various considerations such as the environment of the school, the accreditation level of the school, and the consultation of the various parties so that the chosen location was considered as very representative in the application of the used module.

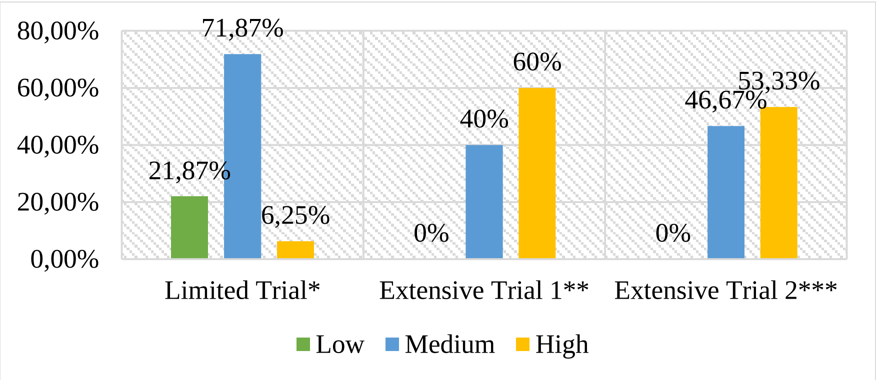
The data collection technique used was the questionnaire technique (cognitive test and motivation questionnaire), which was given to the students. The data analysis technique used was descriptive statistics by knowing the average score of the students during the cognitive test. The cognitive test was divided into two conditions, which were before and after the learning process, while the motivation questionnaire was given after the learning process was implemented. The N-Gain Test was the test conducted on the comparison of their pretest-posttest scores to find out the improvement of the students (Meltzer, 2002).

3. Result and Discussion

This research did not only focus on the product but also how the product can contribute and have an impact on the students' perspective in understanding the chemical material. Research conducted by (Behmke et al., 2018) stated that the integration of Augmented Reality (AR) technology in the concept of chemistry learning could visualize chemical molecules at the 2D to a 3D level so that students' knowledge is much more in-depth and increased. It is in line with (Wahid & Anra, 2017) that chemistry learning with technological media such as augmented reality stimulates students' interest and motivation in learning; thus, chemical material is not just knowing, but they also can further interpret the material content. Another study from (Alkhattabi, 2017) revealed that integrating AR does not only enhance knowledge, but it also makes students more active, the learning becomes more productive, and the students have more memorable scientific experiences. It means that the development of an innovation product in education describes that the orientation of innovation (integration of technology based on augmented reality) that has been done is how far the developed product be able to influence and contribute in learning, where changes in the students' mindset, especially in chemical material are essential parts of the learning context especially chemistry which is idealized with sub-microscopic understanding (Alkhattabi, 2017; Avargil, Bruce, Amar, & Bruce, 2015; Behmke et al., 2018; Bottani & Vignali, 2019; Lund, B., Harald, 2016; Sufidin, Kadaritna, & Rudibyani, 2017; Taçgin et al., 2016).

Based on the research conducted, there has been found data that shows the module's implementation in the learning of chemistry. Kibas Asah Module (Wetland-Based Chemistry) integrated with Augmented Reality-Sparkol is an alternative way to stimulate the students' sensitivity and attention in the teaching of chemistry. Where the material of chemistry always gets assumptions and judgments as a difficult material to be understood and interpreted through the logic of the students. Besides starting with the premise, memorizing the chemical elements and the necessity of the depths reasoning of the taught concepts makes the student lack having excitement about the material of chemistry. The chemistry's content is a compulsory science other than mathematics that must be known because chemistry discusses much the environment and even humans themselves. Finally, learning with the material which is based on the background is a solution for the teachers to rise from negative issues about chemistry learning (Klingshirn & Gray, 2009). And, it was also confirmed by (Daniel & Pedro, 2016) regarding the integration of technological elements, it also supports the depth of the students in knowing the material.

Graph 1 below is the cognitive learning outcomes of the students that were conducted at XI MIPA 2 of SMAN 4 Banjarmasin as a limited test (UCT). This UCT was the initial stage carried out related to the chemical learning based on the Kibas Asah module. The data collection technique was carried out with cognitive tests through pre-test and post-test. Graph 1 shows the percentage of the students' cognitive learning outcomes from the limited test, extensive test 1, and extensive test 2. The recapitulation of the data below (graph 1) is the result of the calculation through the N-gain test to find out how far their learning outcomes improvement by using that Kibas Asah Augmented Reality-Sparkol integrated module for buffer solutions. For the limited test, it was found that there was 71.87% of the students having improvement in the learning outcomes in the "medium" category, 6.25% of the students in the "high" category, and 21.87% of the students in the "low" category.



Graph 1. The Percentage of Cognitive Learning Outcomes (N-gain Test)

Information:
Limited test * = XI MIPA 2 SMAN 4 Banjarmasin
Extensive test 1 ** = XI MIPA 2 SMAS PGRI 2 Banjarmasin
Extensive test 2 *** = XI MIPA 4 SMAN 4 Banjarmasin

This result becomes an evaluation material and guidelines for the researcher to carry out the diagnosis for the next test. It means that the next test aims to strengthen that the module has a full contribution in improving the students' cognitive learning outcomes. Thus, the result of the study can represent the success of the module in teaching the chemistry's material and minimizing other variables that have the potential to influence the research objective.

Extensive test 1* shows that 60% of the students experienced a significant improvement in the "high" category and 40% in the "medium" category. This result is much different than the previous test, so it is assumed that the chemistry’s learning based on the Kibas Asah module gives a lot of contribution to the students' cognitive improvement.

This result is strengthened in the extensive test 2 *** where the improvement in the "high" category was 53.33% and in the "medium" was 46.67%. This data clearly explains that the students were able to know the chemistry’s material (buffer solution), it means that the Kibas Asah module integrated with Augmented Reality-Sparkol can explore the substance of the buffer solution as a whole so that they slowly think more scientifically and deeply. This is because aside from the chemistry's content in the module, the deepening of the local wisdom of South Kalimantan (wetland) and AR-Sparkol technology that was presented made the chemistry's learning became more engaging, interactive, communicative, and left a unique learning impression.

Moreover, the research by (Yuliono et al., 2018) revealed that AR media-based learning increases students' abilities from 22% to 70%, and 87% of students expressed that their learning desire is increased. Other researchers strengthen that the implementation of the concept of AR in learning increases the students' cognitive up to C3 level, which is from 34.72% to 80.56% and C4 level, which is from 28.33% to 73.33%. This is very relevant to the research of (Lund, B., Harald, 2016) that in addition to being practical and interactive, AR also has the potential to increase the students' understanding of concepts to be more scientific and contextual, so they have a broad range of knowledge. Furthermore, according to (Yang et al., 2018), they revealed that AR-based chemistry learning makes the students have a much better understanding of identifying various properties of chemical elements and compounds, where it adds value in terms of chemistry learning. Spatial ability and knowledge of content have also increased through 3D-based learning with AR (Behmke et al., 2018). The effectiveness of the learning process is a guarantee that the difficulty of chemistry can be eliminated little by little, and it improves the mindset and the science learning patterns of the students.

Table 1. Limited Test Data

No.	Learning outcomes	Category	Class Frequency of Limited Test	
			Pre-test	Post-test
1.	93-100	Very good	0	1
2.	84-92	Good	0	0
3.	75-83	Enough	0	6
4.	<75	Less	32	25
	Total		32	30

Table 1 above is a reinforcement of the percentage data of limited tests in graph 1. Thirty-two students got a score below 75 (pre-test), and in the post-test, there was only one student who got good category score in a range of (93- 100). In other words, their cognitive diagnosis in the next test is an appropriate decision to find out how far the contribution of the Kibas Asah AR-Sparkol module in improving the students' cognitive.

Table 2 is a representation of the students' cognitive learning outcomes improvement through N-gain analysis. The data still also has a correlation with the previous graph 1, which shows the module's contribution to the chemistry's learning in the buffer solution material. The table 2 shows that there were two students who got > 0.70 N-gain score in the limited test (UCT*), then 18 students in the extensive test 1 (UCL1**), and 16 students in the extensive test 2 (UCL2***). The comparison of the chemistry's learning progress in each test looks very significant. Even though in the UCL1** and the UCL2*** have a difference, which was 4, but this result is considered as a high achievement since the implementation of the Kibas Asah module integrated with augmented reality-sparkol is a new way in understanding the chemistry. In other words, 50% or more, the module gives more contribution to the students in learning chemistry.

Table 2. The Interval of Limited Test N-gain

No.	N-gain interval	Category	The Frequency of Test Class		
			Limited Test	Extensive Test 1	Extensive Test 2
1.	> 0.70	High	2	18	16
2.	0.30-0.70	Medium	22	12	14
3.	< 0.30	Low	8	0	0
	Total			30	32

Table 3 is a comparison of the pre-test and post-test scores in the UCL1** and UCL2***. This data also strengthens the achievement of the used module by looking at the progress of the students from their scores. Slightly leaving the score of UCT* because the previous data presentation clearly shows that UCT* is not only as of the initial stage of module analysis for the students, but UCT* also becomes the research evaluation material to carry out the next step in order to obtain more specific, precise, scientific and representative data.

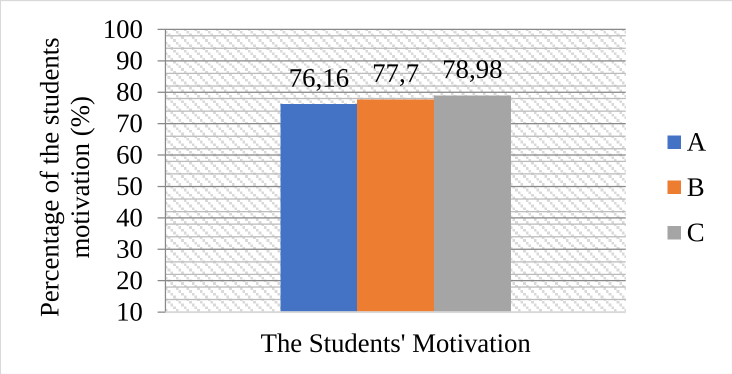
Table 3. Extensive Test Result (cognitive test)

No.	Learning outcomes	Category	Class Frequency of Extensive Test 1		Class Frequency of Extensive Test 2	
			Pre-test	Post-test	Pre-test	Post-test
1.	93-100	Very good	0	1	0	0
2.	84-92	Good	0	11	0	10
3.	75-83	Enough	0	18	3	19
4.	<75	Less	30	0	27	1
	Total		30	30	30	30

Specifically, for the post-test score, there was a student in the UCL1** who got a score in the interval of 93-100, namely Vonny Wulan Sari, with a score of 100. It means that Vonny got a perfect score in the test on the buffer solution material. In the UCL2***, there was only one student who got a score of less than <75, namely Ridwan Maulana, with a score of 67. This score of 67 is considered to be good progress because of their perspective on the difficulty of learning chemistry, and also, in this case, they studied chemistry through the Kibas Asah module. Of course, the score of 67 actually becomes another view for the teachers that learning chemistry based on this module is enough to reach their mindset in interpreting the buffer solution material.

The good category of the post-test score in the UCL1** in table 3 were 11 students and ten students in the UCL2***. There were not a few students in that range of score, which got a score of 83 or even 92. Although the score on the N-gain interval was in the medium category, their score completeness was assessed as being successful in achieving the indicator of the buffer solution material. These scores become the basis that negative perceptions about the chemistry's content can be eliminated, and learning chemistry with this module can be a solution to accommodate the issue.

Motivation in learning science is also considered as necessary; however, triggering the spirit of enthusiasm and motivation is a difficult thing to do for the teachers today. There needs to be a trigger so that the learning outcomes are not just achieved but memorable and profound for the students. (Daniel & Pedro, 2016) argued that the contribution of technology is one of many ways to trigger the growth of the students' learning motivation. (Hamzah, 2012) stated clearly that educational technology is a new way of analyzing problems and thinking about innovation forms in dealing with them. The technological presentation also strengthens the participants' memory in learning and expanding their knowledge because of visual and verbal elements (Sudarwan & Khairil, 2011). It means that motivation is one of the essential parts to be concerned by the teachers, especially in learning chemistry that departs from the perception mentioned before.



Graph 2**.** The Percentage of the Students' Motivation Levels in Learning Chemistry Based on the Kibas Asah Module Integrated with Augmented Reality-Sparkol.

Information:
A = XI MIPA 2 SMAN 4 Banjarmasin
B = XI MIPA 2 SMAS PGRI 2 Banjarmasin
C = XI MIPA 4 SMAN 4 Banjarmasin

Graph 2 above is the percentage of how the students' motivation is in the learning buffer solutions based on the Kibas Asah module integrated with the augmented reality-sparkol. The data above shows that there is an improvement in the motivation in each sample (A, B, C). Sample A is the students in the limited test (UCT*), while A and B are in the extensive test of 1, and 2 (UCL1**, UCL2**). The UCT obtained 76.16% of the students' motivation, while 77.70% and 78.98% respectively for the UCL1** and the UCL2***, and all the percentage is in the "strong" category. If observed, the range of motivation data above has just a slight difference between them. If it is related to the achievement of the previous cognitive learning outcomes, in which the UCT* in the post-test and N-gain (71.87%) is in medium category with the motivation data above, it is revealed that learning chemistry based on the Kibas Asah module integrated with AR-Sparkol has affected the students' mindset in learning chemistry. It is not limited in the UCT*, but the three stages of the module implementation starting from UCT*, UCL1** until UCL2*** have improved the students' perceptions about the importance of knowing and implementing the chemistry in the environment. On the other hand, the touch of AR-Sparkol technology becomes a new color and breath in learning chemistry, so the complexity of the module is considered to be very capable in achieving many elements in learning chemistry either in the chemistry's content itself, the environment, or the technology.

The above results are strengthened by the research of (Alkhattabi, 2017) that the integration of Augmented Reality (AR) increases the students' attention, interest, and motivation in the learning process by a percentage of 96%. In addition, 78.5% of students felt enthusiastic and excited because the use of AR in learning is an innovative method, and 89.3% of the students rated the use of AR as very applicable. That means AR is an applicative and innovative technology that strongly supports the learning process in the classroom. This is in line with (Lund, B., Harald, 2016), which stated that AR is able to change the perspective of the students to be more scientific and broad, where the use of AR is considered to be very interactive, educative, and collaborative in learning. Even (Irwansyah et al., 2018) emphasized that the use of AR is a work that is very relevant to the learning objectives, is effectively solving problems, and is flexible. As a result, the achievement is not only on the good cognitive but also on their motivation as the human resources to face the dynamic globalization era.

4. Conclusion

The recapitulation of research data and all parts of the existing stages concludes that the Kibas asah module (chemistry based on wetland) integrated with augmented reality-sparkol in the buffer solutions has a significantly contributing to the learning of chemistry. The cognitive learning outcomes achievement and the students' motivation are the authentic evidence of how important the environmental study and the touch of technology are in becoming part of chemistry learning. Thus, chemistry learning can produce superior, competitive, charactered, creative, and innovative human beings.

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