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The Effectivity of Interactive E-Module to Increase the Students' Visual-Spatial Intelligence in Ionic

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ABSTRACT

This study aims to test the effectiveness of interactive e-modules to train students' visual-spatial intelligence on ionic bonding material in terms of the students' pretest and posttest results. The research design applied in this study was a one-group pretest-posttest design. Where using the learning outcomes test sheet as the instrument used in this study and tested on 15 students in senior high school. Analysis of the data from the research results showed that the learning outcomes test that had been carried outreached an average N-gain of 0.81 with a high score criterion to measure the students' visual-spatial intelligence. The normality test used to determine whether the distribution of the data was normal or not showed results with a significance level of 0.836 for the pretest and 0.436 for the posttest, both of which had a significance level of 0.05. This matter prove if the analyzed data is normally distributed. The homogeneity test used to determine if the data variances that has been collected is homogeneous or not, showed results with a significance value based on mean of 0.185. This matter indicating that data variances has the same or homogeneous. And the last test is the paired sample t-Test which gets the sig value. (2-tailed) of $0.000 < 0.05$, thus H_1 accepted and H_0 rejected so that there is a significant effect on giving treatment using interactive e-modules to train visual-spatial intelligence given to students.

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INTRODUCTION

Chemistry is a field that studies matter, the structure of matter, the properties of matter, reactions, and the energy required for matter to change (Chang, 2010). Because most studies of chemistry are about the structure that exists in a material such as chemical bonds, then chemistry has abstract concepts for students. So that in its application in learning chemistry, students experience difficulties in understanding and interpreting chemistry. In the chemistry subject itself, there are several new subject matter that students get in high school (SMA). One of them is chemical bonding material consisting of covalent bonds, ionic bonds, metal bonds, and molecular geometry. These four materials require a clear picture visualization so that students can demonstrate the structure and nature of each bond. Especially in ionic bonding materials that have an abstract sub macroscopic level. According to pre-research data conducted by Ilyasa and Dwiningsih (2020) who researched the "Unity-Based Interactive Multimedia Model to Improve Ion Bonding Learning Outcomes" from 25 students of Senior High School 1 Krian, there are as many as 52% of students who have difficulty in understanding this material (Ilyasa & Dwiningsih, 2020). This is in accordance with the opinion of Supardi and Putri who said that ionic bonding material has many concepts that have not been clearly visualized so that it makes it difficult for students to learn the material if only by imagining the material so that ionic bonding material is included in the category of material that is quite difficult for students to learn (Supardi & Putri, 2010). For students to more easily interpret ionic bonding material, a teacher is not only able to apply teaching methods that are suitable for the purpose, but also must be able to utilize and collaborate with available technology. Moreover, in this period, technology has developed significantly.

Starting from the era of the industrial revolution 3.0, technological developments have been developed to lead to the industrial revolution 4.0 where the existing technology is focused on digital technology. It is undeniable that technological advances have had a significant impact on people's lives. It also changes people's daily lifestyle ranging from work, socializing, to study. Humans as technology users must be able to make the best use of technology. The utilization of this technology can facilitate human work in everyday life. In the world of health, communication, transportation, finance, the education sector is no exception.

The development of technology in the field of education can produce innovations that help facilitate the learning process. One of the innovations that have developed is the increasingly varied media and learning resources. Current learning resources can also be accessed via the internet (online). Based on the results of observations that carried out in several senior high school in Sidoarjo, it is known that the learning resources used by students are in the form of printed books, worksheets, power points, and videos that have not been maximally and consistently used. This is because these learning resources are not always used by teachers in teaching and learning activities. In addition, some students still do not bring printed books or worksheets to be used for various reasons such as forgetting, being heavy, and not always being used.

Therefore, the selection of learning media and accurate learning resources is very important. To solve these problems, the solution chosen is to use an interactive E-module as a learning resource. E-module (electronic module) itself is a non-printed learning media device in digital form which is systematically arranged and students can use it independently so that problem solving can be done by the students themselves (Hamzah & Mentari, 2017). E-Modules can make the learning process more interesting and interactive, able to visualize material through pictures and videos, able to increase student interest in learning with a fresh appearance so that the material to be conveyed becomes easier to imagine (SMA, 2017). Another advantage of the interactive e-module itself is more efficient, not easily damaged or torn, so it is more durable, and only requires a small amount of cost than the print module in producing it (Abdullah, Ramadhan, & Linda, 2020). The interactive e-module has also met the criteria for a good learning media including how easy it is to operate (user friendly), contains instructions that are easy to understand and easy for students to respond to. Presentation of lesson materials, using language that can make students feel familiar with the module and also motivated to learn it.

Based on the description of the explanation on the background, the author was inspired to develop research entitled "Effectiveness of Interactive E-Modules to Train Visual-Spatial Intelligence on Ionic Bonding Materials" to analyze the effectiveness of interactive e-modules on ionic bonding materials to train visual-spatial intelligence.

METHOD

In this study, research design with One-Group PreTest- PostTest was used. Where in this design a group of students is involved in working on pretest questions, then treated with the use of developed media, and finally working on post-test questions (Sugiyono, 2016). The success of the treatment that has been given can be measured by comparing the pre-test and post-test scores.

Learning outcomes are declared to increase if the n-gain value obtained is 0.7 with high criteria or 0.7 > g 0.3 with moderate criteria based on Table 1.

Table 1 Interpretation of N-Gain Score

N-gain Value (g)	Category
$g \geq 0,7$	High
$0,7 > g \geq 0,3$	Moderate
$g < 0,3$	Less

Interactive e-module is an electronic module developed with the Flip PDF Professional software application that contain a cover, introduction, learning objectives, table of contents, instructions for using the e-module, ionic bonding material, material summary, practice questions and learning videos, table of contents, and back cover.

The interactive e-module was tested on 15 students of class X at one of Senior High School in Mojokerto Regency with the object of research being the interactive e-module ion bond for SMA/MA class X semester 1. The method of data collection in this study was a test method using pretest and posttest sheets which each containing 10 questions..

The effectiveness of the interactive e-module of ionic bonding material can be measured from the increase in student learning outcomes resulting from calculations.

$$g = \frac{\%(So) - \%\ (Sp)}{100 - \%\ (Sp)}$$

g : the value of n-gain obtained
So : the value of post-test result
Sp: the value of the pretest

After the researchers analyzed the results of the study using the N-gain test, the data obtained were also analyzed using the normality test to determine the data that had been collected were normally distributed or taken from the normal population with a significance level value (α) 0.05 and paired sample t-test for seeing a significant difference in the average value between the paired pretest and posttest data. In this test the author makes two assumptions where:
Hypothesis:
H_0: There is no difference in the average pretest and posttest scores
H_1: There is a difference in the average pretest and posttest scores
With the criteria of rejection and acceptance based on the Paired Sample t-Test.
If the value of sig 2 tailed < 0.005, then H_1 accepted and H_0 rejected
If the value of sig 2 tailed > 0.005, then H_1 rejected and H_0 received

RESULT AND DISCUSSION

Result

Interactive e-module is an electronic module developed with the Flip PDF Professional software application that can be operated on all types of browsers on students' computers and mobile phones. This module features a cover, introduction, learning objectives, table of contents, instructions for using the e-module, ionic bonding material, material summary, practice questions and learning videos, table of contents, and back cover.

In this study, descriptive analysis data was produced in the form of n-gain test, normality test, and t-test using a software application. IBM SPSS Statistics to determine the effectiveness of interactive e-modules. One-Group PreTest-PostTest pre-experimental research design has 4 stages which are described as follows:

1. Sampling

The first thing to do is determine the sample to be given special treatment. The sample used will be classified into one research class where the data from the results of this sample research will be analyzed and used as a reference for the effectiveness of the previously developed E-Module. In this study, samples were selected from one of the high schools located in one of the districts in East Java, precisely in Mojokerto. 15 students of class X were taken to be tested using an interactive e-module on ionic bonding material.

2. Implementation of pretest

After the research sample is selected, the next step that must be done is to provide a pre-test question sheet containing 10 multiple choice questions with questions to practice spatial-visual intelligence. Students are given 20 minutes to work on the pretest questions. The achievement of visual-spatial abilities in students can be measured using visual-spatial indicators which are the main focus, namely rotation, symmetry and, interpretation of 3D molecular shapes into 2D (Achuthan, Kolil, & Diwakar, 2018). The pretest questions themselves contain questions that are equipped with pictures that help students visualize ionic bonding material.

3. Giving treatment

Treatment is done by providing interactive e-modules as a learning resource for students. Because e-modules can be accessed via laptops or mobile phones, the first thing to do is to share interactive e-module links with students. All students have mobile phones, therefore the teaching treatment with e-modules is carried out using mobile phones. Teaching and learning activities with interactive e-modules were carried out for 2 meetings with a duration of 40 minutes for each meeting. The enthusiasm of students during learning takes place is very high. This can be seen from enthusiasm of students to ask about the features of interactive e-module such as opening image, video, and link that available in interactive e-module. This is because students have never experienced learning using interactive e-modules before. The interactive module does not only contain ionic bonding material in the form of writing but is also equipped with an animated video of the formation of an ionic compound. This is expected to be able to help students properly visualize the formation of ionic compounds which have been abstract so far because there are no animated videos in printed books. In addition, the interactive e-module is also equipped with a video link learning and practice questions that can be directly accessed by students with an internet network. Pictures of the formation of ionic compounds can also be zoomed in or zoomed out by students so that students will not have difficulty seeing the details of the images presented. The following is an example of one of the images in the interactive e-module of ionic bonding material.

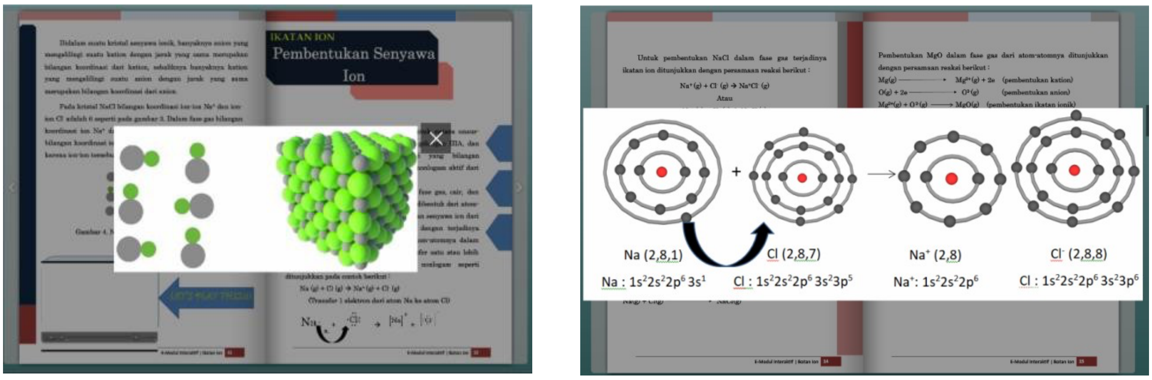

Figure 1 Example of an Expandable E-module

It can be seen from the picture that the developed e-module has been equipped with an image that can be enlarged to make it easier for students to understand the material that they have considered abstract.

4. Implementation of post-test

A post-test is done for measuring the development of student learning outcomes and students' visual-spatial abilities after using interactive e-modules that are used to evaluate student learning outcomes. The questions tested in the posttest are have the same number of questions items and indicators as the questions tested in the pretest. The allocation of time used in working on the posttest questions is also the same as the pretest, which is 20 minutes. At this stage, data is obtained which will later be analyzed together with the pretest to be used as a measure of increasing the ability of students. After the pretest and posttest data are generated, the next step is to analyze the learning outcomes of students by testing the data obtained with the N-gain test; normality test; and t-test.

N-Gain Test

To compare the gain scores obtained by students with the highest possible gain scores that students can get, it is necessary to analyze the N-gain test (Sugiyono, 2016). This is done to determine the normal distribution of the pretest-posttest data obtained. N-gain score interpretation is shown in Table 2.

Table 2 Interpretation of N-Gain Score

Name	Pretest	Posttest	N-Gain	Criteria
MQ	50	100	1	High
MAL	40	80	0.67	Moderate
NDA	20	100	1	High
NAR	30	80	0.71	High
NLM	30	90	0.85	High
NKNS	50	80	0.6	Moderate
PBD	70	100	1	High
RSBPS	50	90	0.8	High
RAKN	40	80	0.67	Moderate
RRSP	40	90	0.83	High
SZK	40	90	0.83	High
SIF	50	90	0.8	High

VAA	30	70	0.57	Moderate
ZIN	60	100	1	High
ZCM	30	90	0.85	High
	Average		0.81	High

Based on Table 2, it can be seen that the N-gain score of 15 students was in the medium to high category with the score varying from 0.57-1, and if the average N-gain score was calculated, it was 0.81 with high criteria. This shows that the pretest and posttest value data are normally distributed with high criteria. Therefore, it can be concluded that the interactive E-module of ionic bonding material developed is effective in increasing the visual-spatial intelligence of students.

Normality test

After getting the results of N-Gain, then the researchers conducted a further test of normality which was analyzed with Kolmogorov-Smirnov Test using software IBM SPSS Statistics.

Normality test is to determine if the data that has been collected is normally distributed or taken from a normal population. Kolmogorov-Smirnov Test can be said to be normally distributed if the obtained significance value (α) 0.05 are shown in Table 3 below.

Table 3 Normality Test

		Pretest	Posttest
N		15	15
Normal Parameters	Mean	42.0000	88.6667
	Std. Deviation	13.20173	9.15475
Most Extreme Differences	Absolute	.160	.225
	Positive	.160	.175
	Negative	-.128	-.225
Kolmogorov-Smirnov Z		.620	.870
Asymp. Sig. (2-tailed)		.836	.436

From Table 3 above, it can be seen that the significant data of the two criteria (visual-spatial pretest and posttest visual-spatial) obtained from the Kolmogorov-Smirnov Test obtained (Asymp. Sig. (2-tailed)) of 0.836 for the pretest and 0.436 for the posttest, both of which have significance level 0.05. From these results, it was concluded that the visual-spatial pretest and posttest data were normally distributed.

Homogeneity Test

After getting the results of normality test, then the researchers conducted a further test of homogeneity test also was analyzed using software IBM SPSS Statistics. Homogeneity test is to determine if the data variances that has been collected is homogeneous. Homogeneity Test can be said to be homogeneous if the obtained significance value (α) based on mean more than/equal 0.05 are shown in Table 4 below.

Table 4 Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	1.843	1	28	.185
	Based on Median	1.522	1	28	.228
	Based on Median and with adjusted df	1.522	1	25.626	.229
	Based on trimmed mean	1.841	1	28	.186

The significance value (2-tailed) based on Mean was obtained 0.185 > 0.05 indicating that pre-test post-test result data has the same or homogeneous variance.

Paired Sample T-Test

After the data was found to be normally distributed, a further paired sample t-test was carried out which was used to see the significant difference in the average value between the paired pretest and posttest data. In this test the author makes two assumptions where:

H_0: There is no difference in the average pretest and posttest scores

H_1: There is a difference in the average pretest and posttest scores

With the criteria of rejection and acceptance based on the Paired Sample t-Test.

If the value of sig 2 tailed < 0.005, then H_1 accepted and H_0 rejected

If the value of sig 2 tailed > 0.005, then H_1 rejected and H_0 accepted

The results of the calculation of the Paired Sample t-Test can be seen as follows.

Table 5 Paired Samples Test Results

		Pretest - Posttest
Paired Differences	Mean	-46.66667
	Std. Deviation	12.90994
	Std. Error Mean	3.33333
t		-14.000
df		14
Sig. (2-tailed)		.000

The significance value (2-tailed) was obtained 0.000 < 0.05 indicating if H_1 accepted and H_0 rejected, it can be concluded that there is a significant difference between the pretest and posttest data. This proves that there is a significant effect on giving treatment using interactive e-modules to train visual-spatial intelligence given to students.

Discussion

Analysis of the N-Gain score test that has been carried out is used to determine how much influence the use of interactive e-modules has on teaching and learning activities. The results of the data obtained will be analyzed using the N-Gain score formula (Hake, 1999). Based on the results obtained on the N-Gain score, it is known that the pre-test and post-test with visual-spatial intelligence obtained an N-Gain score with criteria ranging from moderate to high with an average value of 0.81. This means that the use of interactive e-modules in ionic bonding studies affects increasing visual-spatial intelligence. In the normality test analysis, the data from the pre-test and post-test were normally distributed after testing with the Kolmogorov-Smirnov test. From Homogeneity test can include that pre-test post-test result data has the same or homogeneous variance.

The next process is to analyze the descriptive results quantitatively. On the other hand, Learning by using visualization media is an accurate way that can be used to understand the concept of ionic bonds. The impact of using suitable learning media will also be an alternative way for students to frame concepts independently so that they can strengthen their representational skills (Baloyi, Ojo, & Van Wyk, 2017). This is also because there are some students who have low visuospatial intelligence so it will be difficult to understand the concept. To be able to easily understand chemical concepts, students are required to have representational abilities. Where according to (Chandrasegaran, Treagust, & Mocerino, 2007) representational ability is the ability used to visualize things that cannot be sensed by the eye and cannot be touched.

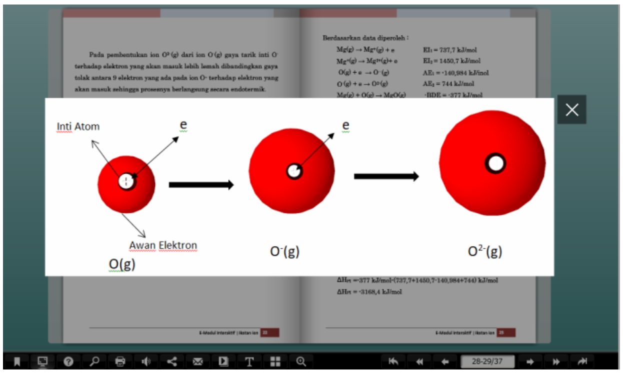

Figure 2 Implementation of Representational Capabilities

Figure 2 shows one of the advantages of the interactive e-module that was developed, namely by implementing representational capabilities, making it easier for students to visualize how the size of the electron cloud in oxygen changes from O(g) to O^{2-}(g) which has been abstract for students.

One of the most important things that are required to exist in the learning process according to Piaget's constructivism theory is to pay attention to the activeness and involvement of student when the learning process takes place (Suprihatiningrum, 2013). This can be achieved by making the best use technology that has been developed. The use of technology media can increase the effectiveness of learning if it is supported by active learning (Dwiningsih, Sukarmin, Muchlis, & Rahma, 2018). The definition of active learning by (Kemendikbud, 2014) is learning that is carried out interactively, inspiring, fun, and motivating student. But, not all learning media in chemistry that currently exist can make an active learning. So, interactive e-module is very suitable to be used for built active learning in classroom, especially in chemistry major.

The process of ionic bond formation in chemical bonding materials has abstract characteristics because it is included at the microscopic level or cannot be observed. This will make it difficult for students to understand the material of ionic bonds. Therefore, the use of multimedia in the interactive learning process can cause latency effects, where it is possible to obtain stronger concepts, accompanied by an increase in visuospatial intelligence (Fernandes & Yamanaka, 2019). As found by (Syarifuddin & Dwiningsih, 2020) shows an increase in the average pretest score of 31.9 while the posttest average is 86.8 with limited trials to 12 students of class X MIPA 5 MAN Sidoarjo using Android-based interactive multimedia on ionic bonding material. This is in line with the results of the paired sample t-test analysis on the visual-spatial pretest-posttest which obtained significant results 0.000 < 0.05 so that it can be concluded that there is a significant difference between the pretest and posttest data. For the average pretest value obtained from the interactive E-module trial to improve visual-spatial intelligence, it was obtained a value of 42.8 while the average posttest value was 88.7. These results indicate an increase in student learning outcomes to improve visual-spatial intelligence by using interactive e-modules on ionic bonding material.

CONCLUSION

Three tests used to measure the effectiveness of the developed interactive e-module showed good results. N-Gain test obtained results of 0.81 with a high category. The normality test used to determine whether the distribution of the data was normal or not showed results with a significance level of 0.836 for the pretest and 0.436 for the posttest, both of which had a significance level of 0.05. This matter prove if the analyzed data is normally distributed. The homogeneity test used to determine if the data variances that has been collected is homogeneous or not, showed results with a significance value based on mean of 0.185. This matter indicating that data variances has the same or homogeneous. And the last test is the paired sample t-Test which gets the sig value. (2-tailed) of $0.000 < 0.05$, thus H_1 accepted and H_0 rejected so that there is a significant effect on giving treatment using interactive e-modules to train visual-spatial intelligence given to students. Based on the three data tests carried out, it can be concluded that the interactive E-module of ionic bonding material developed is effective in increasing the visual-spatial intelligence of students.

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