www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Development of Innovative Learning Assessment Modules on Augmented Reality-Based Space Building

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Abstract

Learning assessment aims to monitor the progress of the learning process and check the fulfillment of competence against learning outcomes to provide value for the learning process and results. The Augmented Reality (AR) learning assessment module aims to test students' competence in geometrical material. AR is needed to help students visualize 2-dimensional shapes into three dimensions. The purpose of this research is to develop an innovative learning assessment module based on augmented reality systems to test student competencies. This type of research is Research and Development (R & D). The sample of this research is the seventh-grade students of SMP N 01 Kalirejo in Central Lampung Regency. The model used is an adaptation of Plomp, which includes preliminary examination, prototyping and assessment. The results of this study are that the instrument has met the requirements of validity and reliability and even has practical value in its use. This will provide positive benefits for an objective, measurable, and comprehensive assessment process on the final ability of student learning outcomes. Utilization of learning media using AR can stimulate students' mindset in critical thinking. AR learning media can visualize abstract concepts for understanding and structure an object model that allows AR as a more effective medium.

Keywords
assessment; building space; augmented reality

I. Introduction

Assessment is an attempt to obtain data/information from the learning process and outcomes as a basis for making decisions about how well the performance of students is compared to certain learning objectives/criteria/achievements. After obtaining the results of the assessment, an assessment process is carried out (Basuki and Hariyanto, 2014).

Learning assessment aims to monitor the progress of the learning process, check the fulfillment of competence against learning outcomes so as to provide value for the learning process and results. In addition, teachers and students can also find out how well the student's performance is compared to certain learning outcomes. Based on the results of the pre-survey conducted on the spatial learning assessment module, there is no real and technology-based assessment module. Students feel less interested if the tests used for assessment are only limited to paper and pencil tests (ppt). Whereas in general students have used Android in their daily life.

So that the development of technology-based assessment modules in testing student competencies is considered necessary. In testing student competencies, several modules will be given for several competencies. To move to the next module/competency, they are tested until they reach the specified criteria. So that students who have intelligence above average can complete faster. The assessment module that will be developed is based on

DOI: *https://doi.org/10.33258/birci.v5i4.7096*

Augmented Reality (AR) which is useful for increasing students' understanding of the visualization of the items being tested. So that students' understanding of understanding the concept of spatial structure and displaying a learning assessment module in the form of items of spatial structure becomes more interesting. Another advantage of the test module is that it can be accessed by students anywhere so that maximum learning outcomes are expected. A good learning media is the one which can adapt various student learning styles in order to achieve the learning goals – one of them is digital flipbook. It is an electronic learning media in which text, audio and visuals are included. Flipbook is one of the classic animations made by a piece of paper, mostly found in the form of 'thick' book, and each paper aims to describe something – its appearance is designed in some specific ways so that the within objects may move or pop-up when opened (Nafiah in Afwan, B. et al, 2020).

The Augmented Reality (AR) learning assessment module that was developed aims to test students' competence in geometrical material. AR is needed to help students visualize 2-dimensional shapes into 3 dimensions. Because with AR building 3-dimensional space can be seen from various positions. In testing student competencies, several instrument modules will be given to measure several competencies. To move to the next module/competency, students are tested until they reach the predetermined criteria. So that students who have intelligence above average can complete faster.

In the assessment of three trials (1) the score of student learning outcomes in the cognitive domain of the paper and pencil test is lower than the paperless test, on the three tests, (2) the independence score in the paper and pencil test is also lower than the independent test. paperless, on three tests. This shows that the use of technology has a positive effect on students during the test (Wijayanta, Muslim, and Buditjahjanto, 2015).

Based on the results of the pre-survey in the field, it was found that the assessment instrument module used was still limited to the paper and pencil test (ppt). In general, students have used handphone (HP) technology in their daily life. So that the development of an AR technology-based assessment instrument module in testing student competencies is considered necessary. Ownership of cellphones in students is a capital to support this research. Because to work on assessment instruments based on AR technology, it is enough just to use a cellphone. Thus, the purpose of this study is to develop an innovative learning assessment module based on augmented reality systems to test student competencies.

II. Review of Literature

2.1 Assessment

Assessment is an effort to obtain data/information from the learning process and results as a basis for making decisions about how well the performance of students is compared to certain learning objectives/criteria/achievements. After obtaining the results of the assessment, an assessment process is carried out (Basuki, and Hariyanto, 2014). Performance assessments or in mathematics education subjects allow teachers to see students' competencies observed in real mathematics learning. Responding to this reality, it is necessary to develop an appropriate performance assessment instrument to assess student performance authentically (Yudha, Masrukan and Djuniadi, 2014).

Learning assessment refers to strategies designed to confirm what students know, demonstrate that they have met competency objectives, or to establish skills and make decisions about students' future courses. It is designed to provide evidence of achievement

to parents, other educators, the students themselves, and stakeholders (eg, employers, and other educational institutions). Learning assessments are assessments that become public and produce statements or symbols about how well students are learning. It often contributes to important decisions that will affect a student's future. Thus, it is important that the underlying logic and measurement of learning assessments are credible and defensible. With the help of their teachers, students can get assessments of learning assignments as an opportunity to demonstrate their competence, as well as the depth and breadth of their learning (Earl and Katz, 2006).

2.2 Augmented Reality

Augmented Reality is a technology that combines the real world with the virtual world, as if there is no boundary between the two. As a media that mediates between humans and computers and computers with humans and humans with humans, Augmented Reality technology can be developed into interesting applications that are used for various purposes and not only as a mere new technological update (Amelia, Wedi and Husna, 2022). AR technology can also bring about new environments by taking advantage of the addition of virtual environments (Wang, 2009).

This spatial AR system makes it easy for teachers to visually and really explain spatial structures to students and attract students' interest in learning the shapes of spatial structures. The overall rating of system users is 86.6% in the very good category (Yulisman and Yolanda, 2020). Augmented Reality or AR is a technology that achieves real-time integration of digital computer-generated content with the real world. AR allows users to see 2D or 3D virtual objects projected against the real world (Rendi, 2020).

2.3 Mathematics

Mathematics as a pure science by using various numbers and symbols as well as the relationship between numbers and operational procedures which include addition, subtraction, multiplication, and division. According to Sujono in Fathani, the notion of mathematics is "Mathematics is the science of logical reasoning and as an auxiliary science in interpreting various ideas and conclusions" (Fathani, 2009).

Mathematics is seen as a way of reasoning because it contains valid methods of proof, general formulas or rules or the nature of systematic mathematical reasoning. So mathematics is formed as a result of human thinking related to ideas, processes, and reasoning. “Mathematics is a language that represents a series of meanings from the statements we want to convey. Mathematical symbols are "artificial" which only have meaning after a meaning is given to them. Without it, mathematics is only a collection of dead formulas” (Suriasumantri, 2005).

Mathematics is useful for training a person's thinking power, which makes him creative in solving problems. Mathematics is indirectly a goal and not a tool in itself, because other branches of science use and also depend on mathematics (Astuti and Leonard, 2015)

III. Research Method

This type of research is *Research and Development* (R & D) which aims to develop an innovative learning assessment module based on an augmented reality system to test student competencies. In testing student competencies, several modules will be prepared for several competencies, to move to the next module/competency must be tested until they reach the specified criteria. So that students who have above average intelligence can

complete competency modules faster. Data analysis used descriptive statistics, by calculating scores based on student competency test responses in each assessment module innovative learning of Augmented Reality-based building.

The population in this study is the students of SMP N 01 Kalirejo in Central Lampung Regency. Meanwhile, the trial sample was limited to seventh grade students of SMP N 01 Kalirejo in Central Lampung Regency. The model used is an adaptation of Plomp (2013) which includes *preliminary research, prototyping* and *assessment* stages as follows

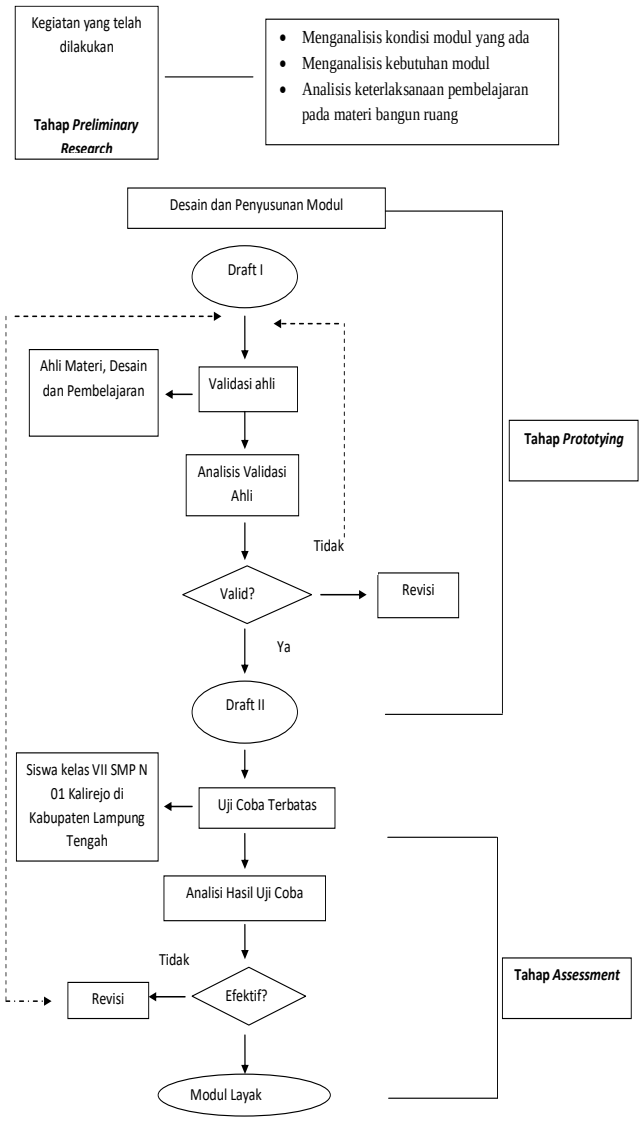

Figure 1. *Research Stages*

Explanation of the stages of research to be carried out, namely 1) *Preliminary research stage:* this stage is carried out to analyze the competencies and indicators needed for assessment, and analyze the implementation of mathematics learning assessments, especially on building materials, 2) *Prototyping*: includes designing/designing an Augmented Reality (AR) based learning assessment instrument that produces *Draft I.* Furthermore, *Draft* I is validated by material, design and learning experts.revision *expert judgment* resulted in *Draft II.* 3) Assessment Phase*: Draft 1I was* tested on a limited scale, to produce an innovative learning assessment module based on augmented reality systems that is feasible to use.

IV. Result and Discussion

The development of technology-based assessment modules in testing student competencies is deemed necessary. In testing student competencies, several modules will be given for several competencies. With the help of their teachers, students can get assessments of learning assignments as an opportunity to demonstrate their competence, as well as the depth and breadth of their learning (Earl and Katz, 2006). Therefore, the questions in the assessment must reflect the competency standards that have been determined. So, in the development of the module requires the determination of the grid on the assessment. The following is the grid in the innovative learning assessment module on spatial shapes,

Table 1. Grid of the spatial learning assessment module

NO	Aspect	Indicator	No Item
1	Identifying the properties of cubes, prisms, and pyramids and their parts	Mentioning the elements of a cube , blocks, prisms, and pyramids include edges, side planes, plane diagonals, space diagonals and diagonal planes	1, 2, 3, 4, 5, 6, 7,
2	Making nets of cubes, blocks, prisms and pyramids	Magnets of cubes, cuboids, prisms and pyramids	8, 9, 10, 11, 12
3	Calculating the surface area and volume of cubes, cuboids, prisms and pyramids	Find the formula for the surface area of cubes, cuboids, primes and pyramids	13, 14
		Calculating the surface area of cubes, cuboids , prisms and pyramids	15, 16
		Determine the volume formulas for cubes, cuboids, prisms, and pyramids	17, 18
		Calculating the volumes of cubes, cuboids, prisms and pyramids	18, 20

This study uses content validity to determine whether the instrument can be used validly or not in collecting field data information. A test is said to have high content validity if the questions asked can be considered to represent the entire content of the field of science being taught. Content validity is the validity that is estimated through testing the feasibility or relevance of the test content through rational analysis by a competent panel or through expert judgment (Azwar, 2015). Furthermore, the content validity through expert judgment is continued using the Aiken's V formula, which is one of the statistics that shows the content validity of the item.

Table 2. Results of Expert Judgment Validation on Innovative Learning Assessment Instruments Construct Space

No	Aspects Assessed	Validator			S	V	Key
		1	2	3			
1	Clarity of instructions for filling out the instrument	4	4	4	12	1	Valid
2	Consistent presentation of questions/tests	4	4	4	12	1	Valid
3	Proportion of difficulty level of questions	3	2	4	9	0.75	Valid
4	Appropriateness of practice with learning objectives	3	4	4	11	0.916667	Valid
5	Forms of building space according to its characteristics	4	4	4	12	1	Valid
6	Ease of meaning/understanding items	4	1	4	9	0.75	Valid
7	Readability/ease in reading	3	4	4	11	0.916667	Valid
8	Standard notation/letter format and layout	4	4	4	12	1	Valid
9	Ease of answering	4	4	4	12	1	Valid
10	Time efficiency in doing	4	2	3	9	0.75	Valid
11	Using standard Indonesian	3	2	4	9	0.75	Valid
12	Avoid directing respondents' answers in answering	4	2	4	10	0.833333	Valid

After conducting content validity through *expert judgment*, the next step is to test the instrument on seventh grade students of SMP N 01 Kalirejo in Central Lampung Regency. The test on the instrument aims to obtain an assessment module that is in accordance with the conditions in the field. In addition, a good instrument is an instrument that has met the validity and reliability.

Validity means the extent to which the accuracy and accuracy of a measuring instrument in carrying out its measuring function. Validity is the accuracy of the data

measuring instrument in filtering the data to obtain the required information. A measuring instrument is said to be valid if it can measure what is being measured.

Table 3. Validity Results of the Innovative Learning Assessment Module Construct Space

Item	**Pearson Correlation**	**Sig**	**Info**	**Item**	**Pearson Correlation**	**Sig**	**Info**
Question 1	0.545	0.000	Valid	Question 11	0.591	0.000	Valid
Question 2	0.577	0.000	Valid	Question 12	0.407	0.000	Valid
Question 3	0.584	0.000	Valid	Question 13	0.503	0.000	Valid
Question 4	0.492	0.000	Valid	Question 14	0.545	0.000	Valid
Question 5	0.550	0.000	Valid	Question 15	0.468	0.000	Valid
Question 6	0.385	0.000	Valid	Question 16	0.484	0.000	Valid
Question 7	0.520	0.000	Valid	Question 17	0.566	0.000	Valid
Question 8	0.600	0.000	Valid	Question 18	0.526	0.000	Valid
Question 9	0, 636	0.000	Valid	Question 19	0.546	0.000	Valid
Question 10	0.469	0.000	Valid	Question 20	0.391	0.000	Valid

Reliability is a coefficient that shows the level of constancy or consistency of the measurement results of a test using the same measuring instrument for different people or at different times but under the same conditions. Consistency is related to the error rate of test results in the form of scores. The magnitude of the reliability index is at least 0.70 this is because the greater the reliability index, the smaller the measurement error (Djemari Mardapi, 2012)

Table 4. Results of the Reliability of the Innovative Learning Assessment Module Building Space

No	Aspects	Cronbach's Alpha	N of Item	Type
1	Identifying the properties of cubes, prisms, and pyramids and their parts	O,822	7	Reliable
2	Making nets of cubes, blocks, prisms and pyramids	0, 782	5	Reliable
3	Calculating surface area and volume of cubes, blocks, prisms and pyramids	0,814	8	Reliable

Based on the results of the analysis above, the instrument in the study has met the validity and reliability, then the instrument was developed using technology based on Augmented reality. The developed application is assessed to see its effectiveness by expert judgment. The following are the results of the expert's assessment.

Table 5. *Expert Judgment* on the AR-Based Spatial Building Assessment Module

No	Aspects Assessed	Validator			S	V	Key
		1	2	3			
1	Appropriateness of assessment items with indicators	4	3	4	11	0.916667	Valid
2	Accuracy of language use	4	2	4	10	0.833333	Valid
3	Application effectiveness	3	2	4	9	0.75	Valid
4	Usefulness of application	4	3	3	10	0.833333	Valid
5	Ease of use of application	4	2	3	9	0.75	Valid

Assessments from experts show that the development of an augmented reality-based spatial assessment module is feasible and effective. This can be used as innovative learning because by using a manual system of course students will feel bored and have difficulty understanding the material. For this reason, it is necessary to have a new system, namely the Augmented Reality-Based Augmented Reality-Based Learning Application system.

Augmented Reality-based 3D spatial model which is used as a learning medium is able to create a new, more interactive atmosphere in learning mathematics which usually seems boring (Rusnandi, Sujadi, and Fauzyah, 2015).

Building space is one of the subject matter in mathematics (Afthori et al, 2019). Each type of shape has its own shape and formula for area and volume, so many students don't feel interested in studying geometry. Students find it difficult and do not know for sure what the shape of each of these shapes is. To meet these demands, in line with the development of science and technology, the use of learning media is a solution. The more diverse and interactive technology, one of which comes by utilizing AR technology (Mutia et al., 2019).

Advances in technology and information have a broad impact on various aspects of life and livelihood, including the field of education (Atmaja & Murtadho, 2021). AR can be used to help visualize abstract concepts for understanding and structure an object model (Mukti, 2019). Some AR applications are designed to provide users with more detailed information than real objects. Utilization of learning media using AR can stimulate students' mindset in critical thinking. AR learning media can visualize abstract concepts for understanding and structure an object model that allows AR as a more effective medium (Sujadi, et al., 2015). Learning to build spaces, students are more interested in using 3D media because students can be invited to learn while playing, so students are more active in learning (Hardiyanti et al., 2020). In addition, the development of Android-based AR in 3D spatial modeling learning is stated to be very feasible and has a significant effect on problem solving abilities (Untari, Hasanah, and Wardana, 2022).

Furthermore, AR technology can also bring about a new environment by taking advantage of the addition of a virtual environment (Wang, 2009). Augmented Reality is a technology that allows real-time integration of computer-generated digital content with the real world. AR allows users to see 2D or 3D virtual objects projected against the real world (Rendi, 2020).

V. Conclusion

Learning assessment aims to monitor the progress of the learning process, check the fulfillment of competence against learning outcomes so as to provide value for the learning process and results. The Augmented Reality (AR) learning assessment module that was developed aims to test students' competence in geometrical material. AR is needed to help students visualize 2-dimensional shapes into 3 dimensions.

The results of this study are that the instrument has met the requirements of validity and reliability and even has practical value in its use. This will provide positive benefits for an objective, measurable, and comprehensive assessment process on the final ability of student learning outcomes. Utilization of learning media using AR can stimulate students' mindset in critical thinking. AR learning media can visualize abstract concepts for understanding and structure an object model that allows AR as a more effective medium.

The limitation of this research is that it is still simple, where the development of the instrument is carried out only for the field of Mathematics. Therefore, more broadly, this model research needs to be developed in other areas of expertise with a larger number of samples as well as with more authentically relevant rubric criteria and scoring weighting, so that the performance assessment instrument developed can meet the requirements of more significant validity and reliability, and the level of practicality of using the instrument is better.

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