

THE IMPLEMENTATION OF *BLOCK CRAFT 3D* AS THE REALIZATION OF SDGS 2030: DESIGN MEDIA IN AN ATTEMPT TO IMPROVE SPATIAL CAPABILITIES STUDENT

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Article Info

Article History:

Received 01 August 2023

Revised 21 September 2023

Accepted 26 September 2023

Available online 27

September 2023

Abstracts

Low mathematical spatial reasoning is identified as a problem for students learning mathematics. In Indonesia, students' mathematical spatial reasoning is still rated as medium to low, according to theoretical analyses of several research findings. To enhance students' mathematical spatial reasoning on three-dimensional spatial geometry material, this study will evaluate the efficacy of STEAM-based mathematics learning using Block Craft 3D application learning media. The steps in research and development (R&D) using the ADDIE model are: (1) analyzing the need for media development; (2) designing media concepts; (3) realizing the media design that has been made; (4) attempting to determine whether the media made is suitable for its intended use; and (5) evaluating by measuring the achievement of media development goals. The research results indicated that STEAM-based learning with Block Craft 3D media would positively impact mathematics learning by enhancing students' spatial abilities on geometry content.

Keyword:

Blok Craft 3D, Geometry, SDGs, Spatial Ability, STEAM

Introduction

A nation's progress may be measured by its level of education. Science and technology advance is as a result of the advancement of education. Science includes mathematics, which helps us develop critical thinking skills for tackling problems in daily life. As a fundamental science in knowledge, mathematics plays a crucial function, according to Sari et al. (2016). It is a result of the advancement of the current technology that supports science, in addition to the fact that mathematics plays a significant part in many fields and tries to enhance human thought.

According to research conducted by the Program for International Student Assessment (PISA) in 2012, Indonesian students' proficiency in mathematics at the age of 15 was ranked 63rd out of 64 countries with an average score of 375, placing them second from the bottom of the list. According to Lestari and Annizar (2020), 600,000 15-year-old students from 79 different countries were evaluated as part of the PISA Survey 2018. According to survey findings, Indonesian students scored 379 on the mathematical aptitude scale, placing them

seventh from the bottom, whereas the average math and science score for OECD members was 489. These results demonstrate the extremely poor level of mathematical proficiency among Indonesian students. It indicates that Indonesian students' competence and use of mathematical communication, problem solving, and reasoning is still not at its best. Indonesia must thus evaluate its own performance and make necessary improvements in light of the PISA results to raise the math proficiency level among its students.

The ability to think spatially is one of several areas of aptitude highlighted in mathematics. Additionally, visual-spatial intelligence aids the comprehension of abstract ideas, particularly spatial perception, entails orientation spatial connections, and complicated abilities, and includes manipulation and mental rotation. Understanding left and right geometric forms, perspective, the capacity to cognitively change visual shadows, and the ability to relate spatial concepts to numbers are all necessary for visual-spatial intelligence. To acquire mathematics, this knowledge is necessary. According to Alimuddin & Trisnowali (2019), it is clear from the study of spatial abilities itself that these mental processes are necessary for seeing the spatial environment and envisioning geometric structures since high levels of imagination needed for these tasks. The capacity to mentally change visual representations, which is nothing other than brain effort, is just as important as the ability to mentally translate left-right and perspective notions with numbers.

Indicators of spatial visualization ability in research, according to Susilawati, Suryadi, & Dahlan (2017), namely:

1. Ability to imagine and illustrate geometric objects after undergoing rotation, reflection, and dilation
2. Ability to determine the image object that corresponds to a certain position of a series of spatial geometry objects
3. The ability to accurately predict real shapes in spatial geometry objects that exist in a certain perspective
4. Ability to determine images from simple objects attached to more complex images
5. Ability to build models related to spatial geometry objects
6. Ability to draw and compare logical relationships between the components of spatial shapes

The findings of a study based on a variety of academic sources on students in several Indonesian schools indicated that students' spatial abilities are still in the middle and low ranges. Sefianti's research (2015) found that students' spatial capabilities are still lacking, which is demonstrated by the fact that no student was able to respond to some questions correctly; the majority of those who did so were only able to answer a portion of the questions; the remaining students left the answer sheet blank. According to the research by Fajri, Johar & Ikhsan (2017), Three students experienced problems with the connection dimension, five students had problems with the orientation ability dimension, and only two out of ten students had problems with the spatial ability component. It also indicates that students struggle to connect visual features on the building side of space and cannot predict the form of space when seen from various angles. The research by Hafizin, Tendri, and Kusumawari (2018) yields similar results, which claims that students' spatial abilities in the categories of spatial perception, spatial visualization, mental rotation, spatial relationship, and spatial orientation, which are all included in the spatial ability component with two-dimensional and three-dimensional objects, are enough to medium.

The majority of students have intermediate spatial abilities, according to a study done at Kediri Wali Barokah junior high school, one of the schools in Kediri City, according to mathematics teacher Lilik Djuwariyah. Students have trouble conceptualizing the construction of curved side spaces, such as tubes and balls, because they still don't fully grasp the idea of building flat circles. It is just one example of the conceptual challenges they face when thinking about space from various angles. Lilik said the same thing regarding his time from 1999 to

2021 spent teaching math at SMPN 2 Kediri. According to Lilik, students' spatial visualization skills, which require complicated multistep processing of the given information, are considered to be adequate but still require development. This was discovered when 7 out of 10 students had trouble figuring out a question regarding combining multiple-room structures.

Academic success, particularly in mathematics, is correlated with spatial ability. The majority of students at all levels misinterpret geometry ideas, according to research by F. Karakus and M. Peker (2015). Following a literature search, it is discovered that the majority of media creators include geometry and spatial abilities in 3D and other learning media. The use of media in mathematics teacher is expected to enhance spatial capabilities. Therefore, It is strongly advised to employ learning media as a physical and virtual help and as a bridge between teachers and students to facilitate a more effective and efficient knowledge of the subject matter. (Sakinah & Dwiningsih, 2018), Bar-el & Ringland (2020) explained that game-based learning, also known as the use of games in education, has grown in popularity among teachers and is now an established approach for enhancing student understanding of learning and teacher-student interaction.

Minecraft is a well-liked internet game among children and teachers. Players can freely engage and interact with a 3D environment consisting of blocks or other objects in the virtual game known as Minecraft, which takes the shape of a cube in a 3D virtual world. More than 176 million copies of the game have been sold globally since its debut in 2011. According to Buffington & Rosengrant (2020), Minecraft is an open-world game that gives players the freedom to do whatever they want in a 3D environment. Even though Minecraft was the medium utilized in the learning process detailed in the journal, the program has a limitation when employed in a classroom setting: it is a paid download. Moreover, the Minecraft program has two modes: Creative and Survival Mode. Students may experiment with building anything out of blocks in a 3D world by utilizing the creative mode. However, students can only utilize Survival Mode to fend off hostile attacks and cannot use it to explore in Minecraft world.

Because the Minecraft software paid, users and students may only use it in trial mode, where only survival mode is available and creative mode is blocked. As a result, there are several additional alternatives to Minecraft Education, like Block Craft 3D. In this instance, the Block Craft 3D program is free, even though its components are not as comprehensive and intricate as those in Minecraft. Additionally, the Block Craft 3D application may meet students' demands for learning in the classroom, which is in line with the STEAM learning approach's primary objective of enhancing spatial abilities.

Understanding science and technology is a must for everyone in the age of globalization. This necessitates that different parties be able to acquire talents connected to the growth of abilities in the technological area. Of course, every curriculum revision the government has undertaken in the area of education has aimed to improve students' technological literacy. One of the educational innovations in Indonesia that aim to produce people who can build a science and technology-based economy, according to Mu'minah & Suryaningsih (2020), is STEAM learning. The STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning approach combines several academic fields—specifically, science, technology, engineering, art, and mathematics—into a single, cohesive learning strategy. Learning in the previously known (STEM) fields of science, technology, engineering, and mathematics (art) via the integration of these disciplines into the curriculum is known as STEAM. (Mu'minah and Suryaningsih, 2020)

Through thinking and investigating activities in problem-solving based on five linked disciplines, students may develop ideas and concepts based on science and technology using STEAM as a learning strategy. If problem solving is done using concept from various disciplines, it will result in a very suitable solution based on concepts from others as well as solving mathematical problems (Nurhikmayati, 2019). As a result, problem solving becomes

much more interesting, effective, and efficient. The application of ideas and concepts from meta-disciplines is what makes STEAM a learning strategy that aims to enhance students' cognitive, emotional, and psychomotor skills in the face of technology advancements (Nurhikmayati, 2019).

According to this description, which is supported by research and actual facts, choosing the correct learning resources and learning strategies can help you enhance your spatial abilities, which is one of the crucial qualities to support the SDGs (Sustainable Development Goals). The Block Craft 3D application, usage guidelines, question and answer tools, and STEAM (Science, Technology, Engineering, Art, and Mathematics) methodology will be used in this study to create learning materials, and the Block Craft 3D learning materials will include elements that can help students' spatial abilities.

Methods

This study employs the ADDIE approach for development research (Analysis, Design, Development, Implementation, and Evaluation). This study's output takes the form of learning materials for the Block Craft 3D program. "Research and development methods are research methods used to produce certain products and test the efficacy of these products," claims Sugiyono (2016: 297). Since ADDIE's development flow is cyclical, we used one cycle for this investigation. These phases' goals are as follows: Analyze, At this point, the key task is to examine articles on STEAM, Minecraft Education, and spatial ability. Moreover, researcher also identify the problems of students spatial capability in Wali Barokah senior high school in Kediri. The next stage is Design. At this point, a design for the learning material created is compiled. The output of this stage takes the shape of learning media, which includes spatial geometry content, assessment tools, and is followed by learning design as a step in implementing media. The Development phase is by using the product framework, expert validation and explaining how to use the media. The implementation stage is the product will be used in classroom instruction. Due diligence includes media expert evaluation prior to product trials. The usefulness of Block Craft 3D as a learning resource for geometry was then evaluated as a trial in 10 students of the second grade in Wali Barokah senior high school. The las step is Evaluation. Evaluation is a process to determine whether each stage of the actions taken and the outcomes produced are consistent with the original goals. Evaluation seeks to ascertain the product's quality both during and following deployment. An evaluation will be made based on the implementation stage or trial stage.

To determine validity media used expert validation done by lecturers in IAIN Kediri mathematics expert in learning media and learning materials. On the validation sheet for media experts and material experts used criteria very valid, quite valid, less valid and invalid for assessing media feasibility on each of the items assessed. The assessment results of each expert are then percentaged with the following formula (Sugiyono, 2008):

$$\bar{X} = \frac{\sum X}{N} \times 100\%$$

Description:

\bar{X} = average score of indicators

$\sum X$ = sum of total scores of indicators

N = number of indicators (Maximum Value)

The percentage of the results of the experts' assessment is then used to classify the level of validity of manipulative learning media. Based on the following table:

Table 1. The Grading Scale for Validation Sheet

Validity Criteria	Level of Validity
81.0 % - 100.0 %	Very valid; does not require revision
61.0 % - 80.9 %	Quite valid, usable but needs revision
41.0 % - 60.9 %	Less valid, it is recommended not to be used because it needs major revisions
21.0 % - 40.9 %	Invalid, should not be used

Source: Sugiyono (2017)

The effectiveness of learning media is obtained from the results of question work by students and the results of response questionnaires by students by calculating the percentage of grades and the whole result of the problem work by the students.

Result and Discussion

Findings

Based on the research and development of the ADDIE model conducted in 5 stages, the following results can be obtained:

a) Analyze

At this stage, the main activity carried out is to analyze journals relevant to topics such as Spatial Ability, Minecraft Education, and STEAM. The purpose of this analysis is to gain deep insight into the selection of media that are being developed to improve students' specific abilities. To conduct journal analysis, researchers specifically search and identify journals that have keywords related to the main activities of developing this medium. The time range that the search focuses on is 2018 to 2022, as that period includes the latest and most relevant information in this field.

b) Design

The learning media will be designed to cover and integrate spatial geometry material comprehensively. In addition, this media will also include relevant question instruments to measure understanding and mastery of spatial geometry concepts by students. The results of this stage are in the form of learning media and as a step in implementing media, which contains learning media Block Craft 3D based on STEAM, compile media validation sheets, material validation sheets, student response questionnaires, questions to be tested and making videos and guidebooks for using Block Craft 3D media. This aims to support the implementation process of Block Craft 3D media in accordance with the goal of improving students' spatial abilities.

c) Development

In this step it is carried out implementation of media design in the form of learning media for the Block Craft 3D application, videos and manuals containing the use of learning media for the Block Craft 3D application. After realizing the design learning media conducted validation test media and materials by mathematics education lecturers IAIN Kediri.

The media of Block Craft 3D is shown in the below figure,



Figure 1. Inventory Menu



Figure 2. The Example Menu



Figure 3. The Maps Menu

Media expert validation results obtained percentage of assessment score of 87.5%, the learning material component of 97.2%, the learning method component of 100%, the learning source component of 100%, and the component of learning activities with a score of 96.4% based on the findings of the material expert validation. Thus that is a very excellent interpretation of 96.22% for the average validation result of the media and material experts.

d) Implementation

After researchers tested Block Craft 3D media on 10 students of the second grade of Wali Barokah senior high school in Kediri, here are the results of work from 2 study groups containing 5 students in each group, the results is presented in the figure below:



Figure 4. Group 1

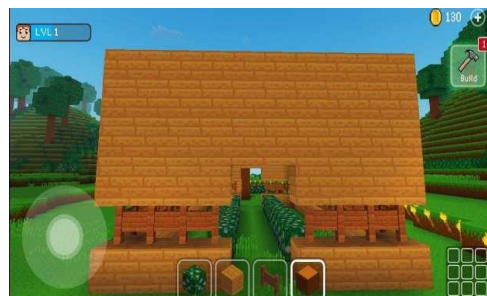


Figure 5. Group 2

After media implementation conducted, students are given questionnaire sheets to describe student response to media learning that has been carried out and giving questions as a test of the effectiveness of learning media. Result From the student response questionnaire of 86% with good categories and grades from the questions given 100% of students have achieve scores above the passing standard.

e) Evaluation

Concerning the evaluation through material expert validation, the material expert said that Media Block Craft 3D has facilitated students in improving spatial abilities in spatial geometry materials. However, the problem instrument in the use of media has not explained the entirety of the spatial geometry material in second grade of senior high school. Thus, although the direction of using Block Craft 3D media to facilitate students

in spatial abilities that are covered in geometry material, it is even better than the question instrument is further developed regarding exploration in geometry material related to student learning outcomes in the 2013 curriculum or Merdeka Belajar.

Analysis

The development of Media Block Craft 3D is based on two primary components: expanding spatial possibilities and the STEAM methodology. It was said in the preceding sentence that Block Craft 3D can help students develop their spatial skills. Researchers can demonstrate this by looking at the results of students' responses to the questions related to the markers of spatial aptitude in the preceding sentences. According to Susilawati, Suryadi, and Dahlan (2017), there are several indicators of spatial visualization skill in research, including:

a) Ability to imagine and illustrate geometric objects after undergoing rotation, reflection, and dilation

1) Rotation

Rotation is a transformation that changes the position of an object by surrounding it at a certain point. Suppose a student has a flat shape, like a triangle, and they want to rotate the triangle 90 degrees clockwise. In Block Craft 3D, students can build the triangle using cube blocks and then use rotation commands to change the position of the triangle clockwise. Students can try different angles of rotation and see how the position of the triangle changes according to the rotation performed.

2) Reflection

Reflection is a transformation that reflects an object on a specific axis. Suppose the student has an interesting building structure and wants to make a symmetrical copy of the structure. In Block Craft 3D, students can use the desired axis of symmetry (for example, vertical axis or horizontal axis) to reflect the building as a whole. Students can experiment with different reflection axes and see how the building reflects itself.

3) Dilation

Dilation is a transformation that changes the size of an object by multiplying or dividing its length by a certain factor. Suppose the student wants to create two identical cubes, but one of them is twice as large as the other. In Block Craft 3D, students can build two cubes of different sizes and use dilation commands to resize one of the cubes. Students can experiment with different dilation factors and understand the size differences between the two.

b) The ability to determine the image object that corresponds to a certain position of a series of spatial geometry objects

In Block Craft 3D, spatial geometry objects can be represented by various shapes of three-dimensional buildings that can be built using cube blocks. The ability to pinpoint image objects corresponding to specific positions of a series of spatial geometry objects involves understanding how these objects interact in a three-dimensional environment. Example: Determining the appropriate flower garden in the land formation.

Students create a greenhouse-style flower garden as part of the inquiry tool. Their task is to put the blocks together in such a way as to produce a beautiful greenhouse. The use of three materials in various block crafts where students not only focus on the selection of materials for the growth of planted flowers but also the placement of each item is some criteria that may be set. To fulfill these requirements, students must use their capacity for seeing and illuminating the positions of spatial geometric objects. They have to consider the spatial relationships between the buildings as well as the three-dimensional viewpoint.

In the process, students will learn about spatial geometry concepts, such as relative position, space, and interactions between objects in three dimensions. In addition, they will

also hone their problem-solving skills and creativity in designing aesthetically pleasing and functional city formations.

- c) The ability to accurately predict real shapes in spatial geometry objects that exist in a certain perspective

This ability refers to the ability to visualize and understand how a three-dimensional object will look when viewed from a particular point of view or perspective. It involves the ability to imagine and project three-dimensional objects into two-dimensional images, as well as understanding how the shape and size of objects will change when viewed from various points of view.

In the instrument problem, students want to build a greenhouse in Block Craft 3D and see it from a different perspective. They knew that this greenhouse was block-shaped and wanted to see how the shape and size of the greenhouse would change depending on the point of view they chose. Some of the steps they can take are:

- 1) Make a greenhouse sketch: Students can make a greenhouse building design in the form of a sketch in the grid/boxes prepared by researchers
 - 2) Build a greenhouse: Students can use cube blocks to build a block-shaped greenhouse in Minecraft.
 - 3) Choosing Perspective: They can move to different positions in the game and observe the greenhouse from different perspectives. For example, they can see it from below, above, or on the side.
 - 4) Observing Changes in Shape and Size: When looking at greenhouses from different perspectives, students will notice that the shape and size of greenhouses change. The greenhouse could appear bigger from below but smaller from above.
 - 5) Predicting Images in Perspective: Students can try to visualize how a greenhouse will look in a two-dimensional image viewed from a specific point of view. For example, they can try drawing a greenhouse from an oblique perspective or unique point of view.
- d) Ability to determine images from simple objects attached to more complex images

By employing fundamental components or straightforward things as the basis for construction in Block Craft 3D. It entails having the capacity to spot straightforward components imaginatively put together and organized to create more complex and attractive structures or things in a 3D environment.

In this case, students want to create a unique greenhouse in the game Block Craft 3D. They can use basic blocks such as cubes, flowers, and roof blocks as simple elements. Some of the steps they can take are:

- 1) Identify Basic Elements: Students identify the basic elements or blocks they will use in making greenhouses, such as cubes as walls, flowers as flowers in the palace, and roof blocks as the roof.
 - 2) Plan the Design: Students plan the palace design they want to build. For example, they can think about the size and shape of the greenhouse, the position of the flowers in the greenhouse, and additional parts such as windows and grass.
 - 3) Start Building: With the basic elements already identified, students begin to build the basic structure of the palace, such as walls, flowers, and grass, using these basic blocks.
 - 4) Creativity in Drafting: Students use their creativity in arranging these basic blocks to form more complex parts of the building, such as arched roofs and additional decorations.
 - 5) Finishing Touch: After most of the building is completed, students can add additional details and decorations to beautify and enhance the look of the greenhouse.
- e) Ability to build models related to spatial geometry objects

The ability to build models related to spatial geometry objects refers to the ability to create physical or visual representations of three-dimensional objects in the form of models. It involves the ability to identify and understand the shape, size, and spatial

relationships of spatial geometry objects, then reproduce them in the form of observable and learnable models.

- f) Ability to draw and compare logical relationships between the components of spatial shapes

The ability to draw and compare logical relationships between the components of spatial shapes, when associated with Block Craft 3D use, refers to the ability to design, construct, and visualize three-dimensional geometric objects in the game Block Craft 3D. In this context, students can draw a visual representation of the space they want to build in Block Craft 3D, and then they compare logical relationships between the components in the built space.

In this case, students build models of cubes and triangular prisms in the game Block Craft 3D using cube blocks and ladder blocks. After building the model, students identify the main components or elements of each building space. For example, in a cube, the main components are six equal sides and eight interconnected corner points. While in a triangular prism, the main components are the triangular base and the rectangular-shaped sides connected to the base. Next, students compare the logical relationships between these components in two spatial constructs. For example, they may realize that in a cube, each side corresponds to three other sides, and each angle corresponds to the others. Meanwhile, in a triangular prism, each side of the triangle corresponds to the other two sides of the triangle. The two sides are quadrangular. At the end of the lesson, students can conclude from the comparisons they have made. For example, they may realize that a cube has more logical relationships between its components than a triangular prism.

The 3D Media Block Craft has met the requirements of the STEAM approach, namely Science, Technology, Engineering, Art, Mathematics. In terms of science, researchers have developed problem instruments in the Block Craft 3D media connected to components of science. According to the question, choosing flowers for a bouquet should take into the building materials used as well as other external elements (such as flower development). Thus, Block Craft 3D media used the science factor. In terms of Technology, academics describe how gaming apps and games are used in the learning process to engage students and make learning activities more active. The Technology use in this case is the Block Craft 3D application that facilitates students to complete case studies given by the teacher and can improve students' spatial abilities.

The Engineering aspect of Block Craft 3D media is the process of students operating the Block Craft 3D application and exploring the case studies provided so that students can find solutions/answers. Based on the structure they will be making, students are allowed to select the form and color they like. In addition, when students build buildings they have designed previously by combining colors from selected materials and paying attention to the shape and aesthetics of the building, in this case, students have applied aspects of Art in the STEAM approach. Students have used the calculation procedure in mathematics by taking into account a number of factors that have been made necessary for the question instrument. Students must also determine how many block crafts are required to construct a building design using all the block crafts used. The Block Craft 3D program may also assist pupils in comprehending the shape of an object or area as seen from various angles or points of view. It has to do with math, namely space geometry. As a result, the value of Block Craft 3D media for enhancing classroom instruction may be attributed to five STEAM aspects.

Conclusion

This research is included in research and development using the ADDIE method (Analyze, Design, Development, Implementation, and Evaluation), namely the development of valid, practical and effective learning media. From the results of the research that has been done, it can be concluded that:

- a) This research has succeeded in developing learning media using the Block Craft 3D application adopted from Minecraft Education to improve students' spatial abilities. The results of the development stages are as follows:
 - 1) The analysis stage in media development requires 2 analyses, namely journal analysis (journals related to students' spatial abilities in Indonesia and media related to spatial abilities that have been developed)
 - 2) The design stage in the design of learning media includes the formulation of the objectives of making learning media according to student needs
 - 3) The development stage includes the application of the initial product development stage of learning by applying the product and the expert validation stage
 - 4) The implementation stage in the form of Block Craft 3D media was tested on students
 - 5) The evaluation stage is in the form of material expert validation guidelines, spatial analysis instrument question guidelines and evaluation results from material experts related to the media used related to the material and learning process in the classroom
- b) This research has successfully developed a learning design in media use in the Block Craft 3D application. The results of the development stages are as follows:
 - 1) Developing this learning design requires designing question instruments in implementing Block Craft 3D and the STEAM approach as an element of the learning process.
 - 2) The implementation stage of questions and design sketches in Block Craft 3D media has been implemented in 10 grade VIII students of Kediri Wali Barokah junior high school to improve spatial skills.

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