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Validity and Practicality of Geogebra Application-Based Mathematics Learning Tools to Train Visual-Spatial Intelligence

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Abstrak

Perangkat pembelajaran jarak jauh yang efektif harus dapat melatih kecerdasan spasial peserta didik untuk membantu mereka mengembangkan kemampuan visualisasi. Sehingga, penelitian ini bertujuan melihat kevalidan dan kepraktisan perangkat pembelajaran jarak jauh berbasis aplikasi GeoGebra. Penelitian pengembangan (R&D) ini menggunakan pendekatan pengembangan tiga fase berdasarkan Teori Plomp, yang dibagi menjadi tiga tahap: penelitian pendahuluan, pembuatan prototipe, dan penilaian. Kuesioner validasi dan praktikalitas digunakan untuk mendapatkan data penelitian dan dianalisis dengan statistik kualitatif deskriptif. Hasil analisis data menunjukkan bahwa perangkat pembelajaran matematika dievaluasi dengan kategori "Sangat Valid". Hal ini berdasarkan penilaian dari tiga orang validator dimana nilai rata-rata total kevalidan RPP adalah 4,28 yang termasuk dalam kategori "sangat valid", sedangkan nilai rata-rata total kevalidan LKPD adalah 4,24 yang juga termasuk dalam kategori tersebut. Selain itu, LKPD dan RPP yang dikembangkan juga dinilai "praktis". Hal ini didasarkan pada penilaian tiga validator yang menghasilkan nilai akhir rata-rata kepraktisan RPP sebesar 85, yang termasuk dalam kategori "A", yang berarti bahwa RPP yang berfungsi sebagai perangkat pembelajaran dapat digunakan tanpa modifikasi, dan nilai rata-rata kepraktisan LKPD secara keseluruhan adalah 84,57, yang menempatkannya dalam kategori "B", yang menunjukkan bahwa LKPD tersebut dapat digunakan sebagai perangkat pembelajaran dengan sedikit modifikasi. Hal ini berarti bahwa perangkat pembelajaran berbasis Geogebra adalah bahwa perangkat yang dapat diandalkan untuk membantu guru dalam mengembangkan keterampilan matematika dan visualisasi spasial peserta didik.

Abstract

An effective distance learning tool must be able to train students' spatial intelligence to help them develop visualization skills. Thus, this study aims to see the validity and practicality of GeoGebra application-based distance learning tools. This development research (R&D) uses a three-phase development approach based on Plomp Theory, which is divided into three stages: preliminary research, prototyping, and assessment. Validation and practicality questionnaires were used to obtain research data and analyzed with descriptive qualitative statistics. The results of the data analysis showed that the mathematics learning tools were evaluated with the "Very Valid" category. This is based on the assessment of three validators where the total average value of the validity of the lesson plan is 4.28 which is included in the "very valid" category, while the total average value of the validity of the LKPD is 4.24 which is also included in the category. In addition, the LKPD and lesson plans developed were also considered "practical". This is based on the assessment of three validators who produced an average final value of the RPP's practicality of 85, which is included in the "A" category, which means that the RPP that serves as a learning device can be used without modification, and the overall average value of the LKPD's practicality is 84.57, which puts it in the "B" category, which indicates that the LKPD can be used as a learning device with minor modifications. This means that Geogebra-based learning tools are reliable tools to assist teachers in developing learners' mathematical and spatial visualization skills.

INTRODUCTION

In December 2019, Wuhan, China reported the first case of the coronavirus, or COVID-19, which has since spread to other countries, including Indonesia (Purba et al., 2021). The Indonesian government began taking action in January 2020, by implementing health checks for citizens who would enter Indonesia from countries affected by the outbreak (Djalante et al., 2020). However, in March 2020, the number of positive COVID-19 cases in Indonesia began to

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increase rapidly and the government issued social restriction policies/Pembatasan Sosial Berskala Besar (PSBB) in some areas. Despite this, the number of cases and deaths from COVID-19 in Indonesia remains high and the government continues to issue new policies to address the pandemic (Pujowati & Sufaidi, 2021). Currently, the Indonesian government is conducting massive vaccinations to reduce the number of cases and deaths from COVID-19 in the country.

When large-scale social restrictions (PSBB) are in place, the pattern of learning in schools changes. Schools were temporarily closed to prevent the spread of the coronavirus and learning was done online (Suryaman et al., 2020). Teachers provided materials through online platforms such as Zoom, Google Classroom, and others, students are expected to follow the online learning from home and do the assignments given. However, not all students have equal access to technology and the internet, so some students may experience difficulties in following online learning (Jenna Gillett-Swan, 2017). In addition, some students may also have difficulty in learning independently due to lack of support from parents or because home conditions are not conducive to learning (Dewi, 2021). However, in this pandemic situation, schools and governments are working as hard as they can to support pupils in learning.

There is a need for innovation in distance learning to improve the effectiveness and efficiency of learning. One innovation that can be used is to use the GeoGebra application (Gusniarti, 2014). GeoGebra is an open-source application used for learning math and related sciences. This application allows students to learn in an interactive and visual way, thus making learning more fun and easy to understand (Majerek, 2014). It can also be used to solve math problems and evaluate student learning outcomes. In addition, GeoGebra can also be used for collaboration between students and teachers, thus making the learning process more interactive (Dahal et al., 2022). By using this application, students can learn in a more fun and effective way, so as to improve student learning outcomes in distance learning.

The use of GeoGebra in distance learning requires the preparation of a good learning plan. A good learning plan should include learning Tools, learning materials, learning methods, learning resources, and evaluation (Nzaramyimana, 2021). Learning Tools must be clear and in accordance with the competencies to be achieved and learning materials must be prepared by considering the basic concepts to be taught and must be able to be explained using GeoGebra (Eviliasani et al., 2022). Learning methods must be developed by considering the characteristics of students and must be able to increase student learning activities (Dunlosky et al., 2013). Learning resources must be prepared by considering the availability of learning resources available and must be accessible to students (Okongo et al., 2015). Evaluation should be developed by considering the learning Tools and should be able to measure students' learning outcomes (Pepen, 2020). With a good learning plan, distance learning using GeoGebra can be done effectively and efficiently. Proper utilization of GeoGebra with distance learning strategy compiled in a learning learning tools can help students in train their abilities and intelligence, one of which is visual spatial intelligence (Yerizon et al., 2021).

Visual-spatial intelligence is the ability to perceive, analyze, and use visual information in space, it includes the ability to understand spatial concepts such as size, shape, orientation, and relationships between objects (Gumilar & Nandi, 2018). People with visual-spatial intelligence tend to do well in fields such as architecture, design, art, and navigation. Some of the tests used to measure visual-spatial intelligence are shape tests, orientation tests, spatial perception tests, and spatial problem-solving tests (Kara et al., 2022). Visual-spatial intelligence can be developed through practice and experience, such as doing fun activities like putting together puzzles, sketching, or playing spatial games (Hakim et al., 2021).

Data on visual-spatial intelligence in Indonesia is not widely available. However, some studies show that visual-spatial intelligence in Indonesia tends to be lacking compared to other countries. This could be due to the lack of activities that stimulate visual-spatial intelligence in school learning, as well as a lack of experience in fields that demand visual-spatial intelligence. However, some activities that stimulate visual-spatial intelligence such as fine arts, design, architecture and navigation are starting to develop in Indonesia (Gani et al., 2017). One of them is research conducted by (Wijaya et al., 2019), that the level of visual-spatial of 93 students who became research subjects 21.5% had a low level of visual-spatial intelligence, 30.1% had moderate visual-spatial intelligence, and 48.4% had high visual-spatial intelligence . The data from the study states that 10 out of 77 students still have very low visual-spatial ability, 65 out of 77 students have below average and only 2 out of 77 students only have good visual-spatial ability (Triutami et al., 2021). This low visual-spatial ability needs to get attention by academics, and according to the assumptions of researchers, the development of learning tools based on geogebra applications that are able to train visual-spatial abilities.

GeoGebra application has an important role in training students' visual-spatial intelligence (Vagova, et al., 2019). GeoGebra is an open-source application used for learning mathematics and related sciences, this application can be used to solve math problems and evaluate student learning outcomes (Suprapto et al., 2021). In addition, GeoGebra can also be used for collaboration between students and teachers, making the learning process more interactive (Dahal et al., 2019). GeoGebra can be used to teach math concepts related to geometry, trigonometry, and functional analysis, it provides visual tools that can be used to create geometric figures, plot graphs, and analyze mathematical functions (Ruthven et al., 2009). By using GeoGebra, students can understand math concepts visually and interactively, so as to improve students' visual-spatial intelligence. GeoGebra can also be used to teach spatial concepts such as size, shape, orientation, and relationships between objects, it can help students to understand spatial concepts visually and strengthen their visual-spatial ability (Renata, et al., 2019).

Taking a look at other comparable studies on the creation of educational resources that help train students' visual-spatial skills, such as work by Khoriyani who created educational resources in the form of geogebra application-based media to enhance spatial visual abilities (Khoriyani, 2022), research by Asri et al who developed teaching materials in the form of E-modules for visual-spatial abilities (Asri & Dwiningsih, 2022), and research by Koesmadi ddk who developed teaching materials in the form of Zliqubo-based media to improve children's visual-spatial abilities (Koesmadi et al., 2021). Based on the three studies above, it is still rare for research to develop teaching materials in the form of lesson plans and LKPD to train students' visual-spatial abilities, especially junior high school students who have different characteristics from high school and elementary school students.

Research on the validity and practicality of Geogebra-based learning tools is a new and important contribution to the field of mathematics education. Although the Geogebra application has been used in teaching mathematics in various countries, this research provides a special focus on the validity and practicality of using the application in improving students' mathematics skills at various levels of education. This research also contributes to the development of mathematics learning technology, because Geogebra application can be used as an effective tool in learning mathematics that is more interactive and fun. The novelty of this research also lies in the use of a quantitative research approach with valid and reliable data collection methods to measure students' mathematics skills, thus providing accurate and accountable results. In this case, this research provides an important contribution to the development and improvement of the quality of mathematics learning in the digital era.

GeoGebra has great potential as a solution to train visual-spatial skills in distance learning. This is because it can be used to create geometric images, plot graphs, and analyze mathematical functions (Yerizon et al., 2021). This potential needs to get attention in learning mathematics because visual-spatial ability is a basic ability that must be possessed by someone in learning mathematics. therefore this research will focus on developing learning tools in the form of lesson plans and LKPD based on the geogebra application to train the visual-spatial abilities of junior high school students.

METHOD

With the intention of developing a distant learning tool to train students' visual spatial intelligence, this study uses the GeoGebra application. The Learning Implementation Plan (RPP) and Learner Worksheet are two learning device products that will be created for this project (LKPD). This sort of research is research development, according to the description.

Development research is a type of research technique used to create specific products and evaluate their efficacy. The Plomp's Theory development model employed in this work contains three phases: preliminary research phase, prototyping stage, and assessment phase (Arbi et al., 2018). However, in this study Assessment phase was not implemented in detail due to the pandemic outbreak. in detail, due to the COVID-19 pandemic outbreak. The assessment that was not carried out in this study is an assessment of the results of the development of learning Tools after completion of field testing, namely: 1) assessment of learners' response to the developed device, 2) assessment of the results of syntax implementation observations, 3) assessment of the results of the syntax implementation observation results, 3) assessment of the results of observation of activity of students, and 4) assessment of the results of observation of students' visual spatial intelligence. visual spatial intelligence of students.

The test sample was administered in an online course at SMPN in Sungai Penuh City. Field note sheets and validation sheets were the tools utilized to collect the data. The field note analysis technique is used to reduce the data so that only the information required to understand how the device was made is left. The analysis of the learning device's validity is performed by calculating the average of each category and each aspect in the validation sheet, from which the total average of the validator's evaluation of each device will be determined. The cumulative average of the validator's evaluation of each learning device will subsequently be found in the validation sheet. The average calculation uses the following formula.

Calculating the average of each indicator of learning device indicators (lesson plans and LKPD) from all validators by using the formula :

$$RI_i = \frac{\sum_{j=1}^{n} V_{ji}}{n}$$

Description
RI_i= Average of i-th indicator
V_{ji}= Score of the results of the jth expert assessment of the i-th indicator
n= Number of experts

Calculating the average of each aspect of learning Tools in the form of lesson plan and student worksheet using the formula:

$$\mathrm{RA_i} = \frac{\sum_{j=1}^{n} \mathrm{RI_{ji}}}{n}$$

Description
RA_i= Average score of the i-th aspect
RI_{ji}= Average of jth indicator against i-th aspect
n= Number of indicators in the i-th aspect

Calculating the total average validity of learning Tools in the form of lesson plan and student worksheet using formula:

$$\mathrm{VR} = \frac{\sum_{i=1}^{n} \mathrm{RA_i}}{n}$$

Description
VR= Average total validity
RI_{ji}= Average score of the i-th aspect
n= Number of aspects

Then the total average value of the validity of the learning Tools (lesson plan and student worksheet) is adjusted to the the interval of the validity level of the lesson plans and LKPD as follows as follows Tabel 1.

Table 1. Criteria for Learning Tools Validity

Interval Score	Validity Category
$4 \leq RTV \leq 5$	Very Valid
$3 \leq RTV < 4$	Valid
$2 \leq RTV < 3$	Less Valid
$1 \leq RTV < 2$	Invalid

Source : Muslim et al., (2021)

The practicality of the learning tools developed in this study can be known through four general assessment criteria for learning tools, namely with the value code as follows.

Table 2. Criteria for Practicality of Learning Tools

Value Code	Description
A	Can be used without modifications
B	Usable with minor modifications
C	Usable with major modifications
D	Unusable

Source : Muslim et al., (2021)

RPP and LKPD learning Tools are said to be practical if the validator states that the learning device is coded with a value of A or B. Determination of the practicality assessment category of this learning device refers to the highest assessment obtained from at least 2 validators. If there are three validators giving different scores, then revisions are made until at least 2 validators give the same score.

RESULT AND DISCUSSION

Result

The development methodology employed in this study is based on Plomp's Theory, which involves three stages: preliminary research, prototyping, and assessment. An analysis of each step based on the collected field note data is provided below.

Preliminary Research

After discussions with the mathematics teacher of SMPN 3 Sungai Penuh, information was obtained that learning during the pandemic was carried out using an online system, where teachers had used several technologies, such as Zoom and Google Classroom. The tools and materials used are learning videos uploaded on YouTube and learning modules uploaded on Google Classroom. The problem that has been identified by researchers during discussions is the learning tools used in learning. The average SMPN 3 Sungai Penuh teacher still uses conventional lesson plans or face-to-face learning models at school, which have not been integrated with online learning. The lesson plans used are only used as proof of professionalism as a teacher. At the beginning of the new school year, teachers are required to immediately make learning tools and most teachers assume that during this pandemic, learning at the beginning of the new school year will probably be done face-to-face. As a result, lesson plans (RPP) are made using a conventional model.

Prototyping Stage

The research's prototyping phase, which has two stages—the product design stage and the product production stage—is the manufacturing phase. Two tasks are completed during the designing stage: the Learning Implementation Plan (RPP) and Learner Worksheet (LKPD).

The LKPD preparation that will be used is created utilizing the GeoGebra program to develop students' visual spatial intelligence in accordance with the syntax of the direct learning paradigm. Figure 1 illustrates the elements that make up the RPP & LKPD in this study.

Figure 1. RPP & LKPD Display

Assessment Phase

The results of the development of the device are then assessed by experts in experts in their fields before being practiced with students. This assessment is carried out based on two predetermined criteria criteria, namely valid and practical only. Data on the validity of learning Tools in this study, obtained from the results of validation conducted by validators on the development of the Learning Implementation Plan (RPP) listed in table 3 below.

Table 3. Results of Validation of RPP Validity

Assessment Aspect	Indicator	Score	Decision
Objective	Suitability with learning Tools, suitability with the level of development of students, and suitability of the formulation of indicators	4.24	Very Valid
Content	Suitability of material, indicators with KD, Tools with KD, suitability of learning models and educator activities	4.23	Very Valid
Time	Timeliness and appropriateness of educator activities in each activity	4.12	Very Valid
Language	Ease of understanding, appropriateness of EYD and systematic language	4.33	Very Valid

Source : Muslim et al., (2021)

According to Table 3, the average assessment aspect for the purpose line is 4.24, the average assessment aspect for the content line is 4.23, the average assessment aspect for the time line is 4.12, and the average assessment aspect for the language line is 4.33, all with the category "Very Valid." Along with the validation of the lesson plan, the learner worksheet (LKPD) also underwent a validity test, the results of which are shown in Table 4 as follows.

Table 4. Results of Validation of LKPD Validity

Assessment Aspect	Indicator	Score	Decision
Format	Attractiveness, clear numbering, space and layout, and font type/size	3.87	Valid
Content	The suitability of the material and steps of the learning model with geogebra	4.11	Very Valid
Material	Problems/questions in accordance with the geogebra-assisted learning model	4.12	Very Valid
Language	Grammatical correctness, clarity of instructions, and communication style	4.15	Very Valid

Source : Muslim et al., (2021)

According to Table 4, the average assessment aspect on the format line is 3.87, the average assessment aspect on the content line is 4.11, the average assessment aspect on the material line is 4.12, and the average assessment aspect on the language line is 4.15, all with the category "Very Valid."

The examination also includes a look at how useful the tools are for learning geometry. Table 5 below shows the findings of the analysis of the applicability of learning tools in the form of lesson plans and LKPD.

Table 5. Results of Practicality Analysis of Learning Tools (RRP & LKPD)

Learning Tools	Average Final Score	Category	Decision
RPP	86.2	A	Can be used without revision
LKPD	83.4	B	Usable with minor revisions

Based on Table 5 which contains the results of the analysis of the practicality of the learning Tools developed, it can be seen that the average final score of the practicality of the lesson plans given by three validators is 86.2, which when viewed with the practicality assessment category is included in the value A, meaning that the lesson plans that have been developed can be used without revision. While the average final value of the practicality of the LKPD given by three validators, which is 83.4, which when viewed with the practicality assessment category is included in the value B, meaning that the LKPD that has been developed can be used with minor revisions.

Discussion

It is important to assess the quality of learning tools in terms of validity and practicality because these factors determine how effective the tool will be in achieving the intended learning outcomes and how useful it will be in real-world settings. Validity refers to the extent to which a tool measures what it is intended to measure, while practicality refers to the extent to which a tool is feasible and efficient to use in a given setting (Goodwin & Leech, 2003). Together, these factors ensure that the learning tool is both accurate and relevant, and can be effectively integrated into instruction. Without assessing these factors, it is difficult to know whether a learning tool is truly effective and useful, which can ultimately impact the learning of students.

Based on the results of data analysis, it can be concluded that the results of expert assessment of lesson plans (RPP) and LKPD found that the lesson plans (RPP) developed were categorized as Very Valid and the LKPD developed were categorized as Valid.

The validity of the lesson plan and LKPD is assessed from the indicators of Tools, content, time, and language. The validity based on the development Tools obtained a score of 4.24 with very valid criteria. this indicates that the developed lesson plans and LKPD have fulfilled the elements of suitability for learning Tools, suitability for the development level of students, and suitability for the formulation of learning indicators. this is in accordance with the theory which states that valid lesson plans and LKPD must have clear and specific learning Tools (Bahri et al., 2023). Learning Tools are conditions that must be achieved by students after participating in the learning process (Parwata & Sudiatmika, 2020). Learning Tools must be in accordance with the competencies that must be mastered by students and written in the form of clear and specific sentences (Box, 2018). Learning Tools must be obtained from curriculum analysis and must refer to the competency standards that must be achieved by students (Nur & Sulistyani, 2018).

Clear and specific learning Tools will facilitate the learning and evaluation process, thus ensuring that the lesson plan can be used to facilitate an effective and efficient learning process (Munna & Kalam, 2021). Because clear and specific learning Tools can provide clear direction and make it easier for teachers to develop appropriate learning plans and make it easier for students to understand what to learn (Sutarto et al., 2020). With clear learning Tools, students can know what to achieve after the learning process is complete and teachers can know whether the learning Tools have been achieved or not (Rusliah et al., 2021).

The validity of the lesson plan and LKPD is also assessed from the indicators of Tools, content, time, and language. The validity based on content, material, and language, the development obtained a score of 4.23, 4.12, and 4.33 with very valid criteria. this indicates that the developed lesson plans have fulfilled the elements of suitability with the material, indicators with KD, Tools with KD, suitability with the learning model used and the suitability of the educator activities developed. In addition, paying attention to the appropriate time and ease of language used has been assessed by experts to be considered very valid. this is in accordance with the theory which states that valid lesson plans must have the right content, material, and language in accordance with the learning Tools (Handican & Setyaningrum, 2021). The content of the lesson plan must refer to the applicable curriculum and cover all competencies that must be mastered by students (Manalu, 2016). Learning materials must be arranged logically, systematically, and in accordance with the competencies that must be mastered by students (Magdalena et al., 2020). The language used must be clear, easy to understand, and in accordance with the cognitive level of students (Nuryasana & Desiningrum, 2020). The material taught must be in accordance with the learning Tools and competencies that must be mastered by students, otherwise the lesson plan will lose meaning and will not be effective in achieving learning Tools (Filgona et al., 2020). The language used must be clear and easy for students to understand, so that students can understand the material well and can achieve learning Tools well (Hossain, 2015).

With lesson plans whose content, materials and language are in accordance with the learning Tools, it will facilitate the learning and evaluation process, thus ensuring that the lesson plans can be used to facilitate an effective and efficient learning process (Pratiwi, 2012). Learning Implementation Plans (RPP) whose content, material and language are in accordance with the learning Tools will make it easier for teachers to develop appropriate learning plans and make it easier for students to understand what to learn and facilitate the evaluation process (Rosadi, 2021).

The practicality of the lesson plans and LKPD meets the elements that can be used with minor revisions. this indicates that the lesson plans developed have met the practical elements by the expert. This is in accordance with the theory which states that practical lesson plans and LKPD must have learning methods and media that are efficient and effective in achieving learning Tools (Syafitri & Tressyalina, 2020). Learning methods must be in accordance with the learning Tools and competencies that must be mastered by students (Taniredja & Abduh, 2016). Learning media must be appropriate to the cognitive level of students and available according to learning needs (Handican & Setyaningrum, 2020). Effective and efficient learning methods will facilitate the learning and evaluation process, thus ensuring that the lesson plans and LKPD can be used to facilitate an effective and efficient learning process (Wahyu et al., 2021). Learning media that are appropriate to the cognitive level of students and available according to learning needs will facilitate the learning and evaluation process, thus ensuring that lesson plans and LKPs can be used to facilitate an effective and efficient learning process (Haleem et al., 2022).

Practical lesson plans and learner worksheets will make it easier for teachers to develop appropriate lesson plans and make it easier for students to understand what to learn and facilitate the evaluation process (Nyoman Diah Krisna Larasati et al., 2021). Practical lesson plans and LKPDs will make it easier for teachers to implement effective and efficient learning methods and media, so that the learning process will be more effective and efficient (Dunlosky et al., 2013).

Based on the results of this dissection, the researcher can assume that further research is needed regarding the effectiveness of the developed lesson plans and LKPD so that the potential effects can be seen if applied in real learning.

CONCLUSION

The mathematics learning device of direct learning model with distance learning strategy using GeoGebra application to train participants' spatial visual intelligence is rated "Very Valid". This is based on the assessment of three validators who produced a total average value of the validity of the RPP of 4.28 which is included in the "very valid" category, and the total average value of the validity of the LKPD of 4.24 which is included in the "very valid" category.The mathematics learning device of direct learning model with distance learning strategy using GeoGebra application to train participants' spatial visual intelligence is considered "practical". This is based on the assessment of three validators who produced an average final score of the practicality of the lesson plan of 85 which is included in the "A" category, which means that learning Tools in the form of lesson plans can be used without revision, and the average final score of the practicality of LKPD of 84.57 which is included in the "B" category, which means that learning Tools in the form of LKPD can be used with minor revisions.

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