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Development of Visual-Spatial Thinking Ability Test Instrument Based on Pattern Batik Ceplok-Ceplok Jatipelem Jombang

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ABSTRACT

Visual-spatial thinking ability is an important ability for students in understanding and solving geometry problems. This study aims to develop a test instrument for students' visual-spatial thinking ability based on pattern batik Ceplok-Ceplok Jatipelem Jombang. This research is a development research (R&D) with the Tessmer model which consists of preliminary, self evaluation, expert reviews, one-to-one evaluation, small group evaluation, and field test evaluation stages. The subjects of this study were 27 students of class IX MTs Negeri 3 Jombang. The data collection techniques used were questionnaires, interviews, and walkthroughs through test instruments and validation sheets. Analysis of the test results was carried out with the Rasch model approach assisted by Ministep software. The results obtained 4 items of descriptive questions that fulfill (1) Validity of the test instrument shows valid indicators; (2) Reliability of respondents is categorized as sufficient, items are categorized as excellent, and the relationship between the two is categorized as good; (3) The level of difficulty of the test instrument varies at the easy, medium, and difficult levels. (4) The differentiating power of the questions is categorized as good and very good to use. So, it shows that the test instrument to measure the ability of visual-spatial thinking based on pattern batik Ceplok-Ceplok Jatipelem Jombang on geometric transformation material satisfies the criteria worthy to be used. This study opens up opportunities for further research by testing the instrument on a larger scale, exploring its effectiveness, and developing instruments for different materials.

Keywords: *Development, Ethnomathematics, Geometric Transformation, Test Instrument, Visual-Spatial Thinking*.

Pengembangan Instrumen Tes Kemampuan *Visual-Spatial Thinking* Berbasis Batik Motif Ceplok-Ceplok Jatipelem Jombang

ABSTRAK

Kemampuan *visual-spatial thinking* menjadi kemampuan yang penting bagi peserta didik dalam memahami dan memecahkan masalah geometri. Penelitian ini bertujuan untuk mengembangkan instrumen tes kemampuan *visual-spatial thinking* peserta didik berbasis batik motif Ceplok-Ceplok Jatipelem Jombang. Penelitian ini merupakan penelitian pengembangan (R&D) dengan model Tessmer yang terdiri dari tahap *preliminary, self* *evaluation*, *expert reviews*, *one-to-one evaluation*, *small group evaluation*, dan *field test evaluation*. Subjek penelitian ini ialah 27 peserta didik kelas IX MTs Negeri 3 Jombang. Teknik pengumpulan data yang digunakan adalah dengan teknik angket, wawancara, dan *walkthrough* melalui instrumen tes dan lembar validasi. Analisis hasil uji coba dilakukan dengan pendekatan model Rasch dibantu oleh software Ministep. Hasilnya diperoleh 4 butir soal uraian yang memenuhi (1) Validitas instrumen tes menunjukkan indikator valid; (2) Reliabilitas responden berkategori cukup, item berkategori istimewa, dan hubungan keduanya berkategori bagus; (3) Taraf kesukaran instrumen tes bervariasi pada tingkatan mudah, sedang, dan sulit. (4) Daya pembeda soal termasuk kategori baik dan sangat baik digunakan. Sehingga, menunjukkan bahwa instrumen tes untuk mengukur kemampuan *visual-spatial thinking* berbasis batik motif Ceplok-Ceplok Jatipelem Jombang pada materi transformasi geometri memenuhi kriteria layak untuk digunakan. Penelitian ini membuka peluang untuk penelitian lebih lanjut dengan menguji instrumen dalam skala yang lebih besar, mengeksplorasi keefektifannya, dan mengembangkan instrumen untuk materi yang berbeda.

Kata Kunci: *Etnomatematika, Instrumen Tes, Pengembangan, Transformasi Geometri, Visual-Spatial Thinking*.

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1. Introduction

Studies conducted by the Program for International Student Assessment (PISA) 2022 show a decrease in student math scores in Indonesia. The acquisition score of students in Indonesia in mathematics only shows 366 (scale 0-800), which is below the average score of 472 in OECD countries (OECD, 2023). If looking at the trend of Indonesia's math scores in the last few years shows a continuous downward trend. This indicates the need to pay more attention to aspects of math learning. Given that mathematics is a basic science that requires the ability to think logically, critically, and structurally (Hidayatulloh et al., 2024; Indrawati, 2023; Sachdeva & Eggen, 2021). One of the important abilities for students to master in understanding and solving math problems is visual-spatial thinking.

Visual-spatial thinking is the ability to understand, process, and manipulate information in visual form in the mind (Jannah et al., 2024). It involves the ability to understand the relationship between objects, images, and possible spaces in three dimensions. According to Haas (2003), visual-spatial ability shows how students use their visual abilities, use material concepts in geometry learning, use strategies in problem solving, and find and use patterns. Students will be able to understand the subject matter easily and help in solving math problems, especially in materials that require imagination.

Improving students' visual-spatial thinking abilities can be done by providing opportunities for students to work on various visual-spatial thinking ability test questions. This test instrument can be given by teachers when conducting a test or assessment process. This is in line with Magdalena et al. (2023) that to measure the ability of students, it can be done with assessment activities using test instruments. On the other hand, teachers need to build students' routines in doing a test in order to develop the habit of certain skills or abilities. Therefore, the importance of the availability of a good visual-spatial thinking ability test instrument and has met the requirements of its suitability so that it can be used by teachers in learning.

In the formulation of test questions, it should use a context that is close to the lives of students. The use of certain approaches in preparing questions can be the basis for making questions so that they are interesting and close to the students' lives (Aini et al., 2023; Solihin & Habibie, 2024). Among the various approaches available, mathematics and culture or what is called ethnomathematics will be an interesting approach for students (Prastica et al., 2024). In line with Solihin & Habibie (2024) that the method of integrating culture in education not only attracts learning interest, but also enriches the learning experience. One form of ethnomathematics study that can be applied in test instruments is the pattern batik Ceplok-Ceplok Jatipelem Jombang.

Based on preliminary studies conducted by researchers through the learning process and assignment of geometric transformation material in the even semester of the 2023/2024 academic year. Students tend to have difficulty in understanding and solving problems related to abstraction or visualization that demand imagination abilities, such as when there is a problem of transforming a geometry object. To find out the competence of students in the aspect of mathematical visualization, the existence of a visual-spatial thinking ability test instrument is important. In line with Harnum (2022) dan Jannah et al. (2024) that visual-spatial thinking will show how students think in the form of images and solve geometry problems creatively and innovatively. In addition, based on the observation results, there is enthusiasm of students when faced with a mathematical context that involves problems related to local culture. Students tend to be more motivated and actively involved when the material or evaluation given is related to the surrounding environment. This indicates that local wisdom can be an interesting stimulus to be developed in evaluation tools.

Many studies are related to the development of mathematical ability test instruments based on ethnomathematics studies. Some of these studies, which are Sukmawati et al. (2022) eported the development of a mathematical literacy evaluation instrument based on an ethnomathematics-based Multiple Intelligences perspective met the valid criteria for use, Aini et al. (2023) reported the development of a mathematical critical thinking skills test instrument based on PjBL STEM with an ethnomathematics approach meeting feasible and valid criteria, Diana & Fitriani (2024) reported the development of a mathematical literacy test instrument based on East Javanese cultural ethnomathematics is feasible and good to use, Galingging et al. (2024) reported the development of a mathematical creative thinking ability assessment instrument based on Banten local wisdom is valid and feasible to use as a training resource, and Qurani (2024) eported that the development of an algebraic thinking ability test instrument based on Madurese cultural ethnomathematics has met good quality. However, research on the development of this test instrument that focused on visual-spatial thinking ability and based on ethnomathematics studies is currently still very rare. In fact, visual-spatial thinking ability plays an important role in the aspect of imagining mathematical materials and problems. Therefore, this research focused on developing a test instrument for visual-spatial thinking ability based on ethnomathematics study of pattern batik Ceplok-Ceplok Jatipelem Jombang. This research examines the development of evaluation tools for students' visual-spatial thinking abilities in solving mathematical problems. The results of this study can theoretically add to the literature related to the development of test instruments that can measure students' visual-spatial thinking abilities based on ethnomathematics studies.

2. Research Method

This research uses the development research method (R&D) with the Tessmer model (2013) of formative evaluation research type. This research was conducted at MTs Negeri 3 Jombang in two study groups of Class IX with research subjects totaling 27 students in class A as well as non-subjects in class B. The stages of this research are shown in Figure 1.

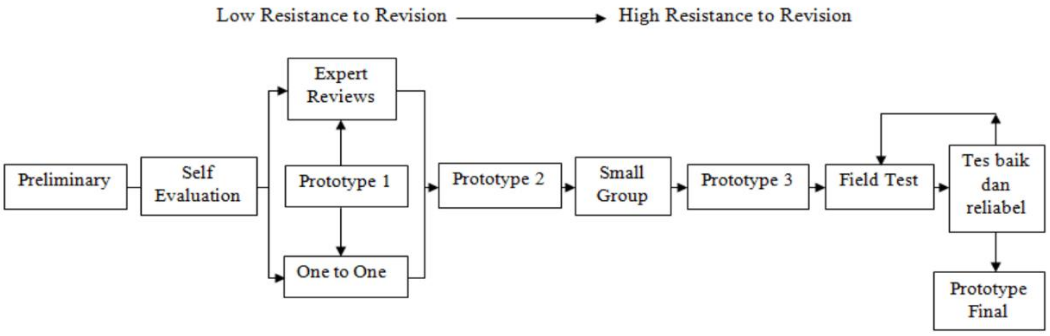


Figure 1. Test Instrument Development Flow of Tessmer Model (2013)

The preliminary stage is the stage of preparation and initial analysis carried out by researchers to identify problems, collect references, preliminary studies in the field, and design research. The next stage is the self-evaluation stage where the product that has been developed is then evaluated by the researcher. The design results in the first prototype developed based on self-evaluation with analysis and synthesis of geometric transformation material, pattern batik Ceplok-Ceplok Jatipelem Jombang, and indicators of visual-spatial thinking ability (Haas, 2003). The first prototype product is shown in the following link: https://bit.ly/vstability_instrumentprototype1. The product was then validated by experts on the aspects of work instructions, content, and language along with one-to-one testing for students. The prototype test instrument was tested in small group and field tests. Comments, suggestions, and trial results at a series of stages are used as a basis for revising the design of the prototype test instrument for students' visual-spatial thinking ability.

The data collection techniques used were questionnaires, interviews, and walkthroughs. The data were collected through an evaluation process involving the participation of experts and students. The data were then analyzed using the Rasch model assisted by Ministep software to determine validity, reliability, difficulty level, and differentiating power, as Ministep was chosen for its ability to provide a more in-depth and accurate analysis (Aini et al., 2023; Sari & Mahmudi, 2024; Sihombing et al., 2024). Testing criteria adopted from Sumintono & Widhiarso (2015) are shown in Table 1, Table 2, and Table 3.

Table 1. Validity

Indicator	Value
Outfit Mean Square (MNSQ)	0.5 < MNSQ < 1.5
Outfit Z- Standard (ZSTD)	-2.0 < ZSTD < +2.0
Point Measure Correliation (Pt Mean Corr)	0.4 < Pt Measure Corr < 0.85

Table 2. Item & Person Reliability Qualifications

Item Reliability & Person Reliability Values	Qualification
< 0.67	Weak
0.67 – 0.80	Sufficient
0.81 – 0.90	Good
0.91 – 0.94	Excellent
> 0.94	Special

Table 3. Alpha Cronbach Qualifications

Alpha Cronbach Values	Qualification
< 0.5	Poor
0.5 – 0.6	Not Good
0.6 – 0.7	Sufficient
0.7 – 0.8	Good
> 0.8	Excellent

3. Results and Discussion

This research develops a test instrument to measure students' visual-spatial thinking ability. The research results are discussed based on the Tessmer model stages, with data analysis and findings presented for each stage.

3.1 Preliminary Stage

The preliminary stage begins with identifying problems that will be solved through the development of a product, where researchers conducted a comprehensive needs analysis covering student learning challenges in geometry, curriculum requirements, and teaching materials, particularly in geometric transformations. The analysis revealed that students struggle with applying geometric concepts to real-world problems, as highlighted by Ahmadi et al. (2024), that found difficulties in solving geometry transformation problems related to everyday life. To identify this difficulty can be known easily by educators if they have an instrument related to the visual-spatial thinking ability of students. The existence of a visual-spatial thinking ability test instrument is very important, because it can help educators in understanding the level of ability possessed by students. With this information, educators can design and provide appropriate treatment for certain indicators in the learning process, so that learning can be more focused and effective. Based on observations in the field, the high enthusiasm of students when faced with mathematical contexts involving problems related to local culture. The integration of local wisdom into the learning curriculum can increase relevance. In line with Hidayati et al. (2020) and Qomaria & Wulandari (2022), the enthusiasm of students is high when learning integrates elements of local wisdom. The researcher then collected references related to this research, namely about the research of the researcher.

3.2 Self Evaluation Stage

At this stage, researchers analyzed and synthesized the material of geometry transformation, pattern batik Ceplok-Ceplok Jatipelem Jombang, and the ability of visual-spatial thinking so as to produce prototype I. Analysis of geometry transformation material produces topics that exist in geometry transformation material at the junior high school/MTs/equivalent level, namely translation submaterial, reflection submaterial on the $x-$axis, $y-$axis, center point $O(0,0)$, line $y=x$, line $y=x$, line $x=k$, and line $y=h$, rotation submaterial at the center of rotation $O(0,0)$ with the magnitude of special angles, and dilation submaterial at the center of dilation $O(0,0)$. Meanwhile, the analysis of ethnomathematics studies shows that the pattern batik Ceplok-Ceplok Jatipelem Jombang almost covers the entire geometry transformation material, which includes the concepts of translation, reflection, and rotation. The coverage of the problem context for almost the entire material will make it easier for researchers to develop complex test instruments. The appearance of the batik motif Ceplok-Ceplok Jatipelem Jombang which is used as the context of the test instrument problem is shown in Figure 2.

Figure 2. Pattern Batik Ceplok-Ceplok Jatipelem Jombang

Visual-spatial thinking indicators used in this study were adapted from Haas (2003). In dealing with geometry transformation problems, visual-spatial thinking ability can be seen through several processes. Through imagining indicators, students imagine and determine the results of mirroring an object. Conceptualizing helps students analyze the process and identify forms that are not the result of geometry transformation, problem-solving encourages students to develop strategies for solving mirroring problems, and pattern seeking helps them find patterns and determine the next transformation of an object. From the synthesis of the analysis results mentioned earlier, it produces a latticework of visual-spatial thinking test instruments shown in Table 4 which is used as the basis for developing test instruments.

Table 4. Latticework of Visual-Spatial Thinking Ability Test Instrument

Indicator	Question indicator	Cognitive Level
Imagining	Presented with descriptions and images of kawung patterns from Batik Jombangan Motif Ceplok-Ceplok Jatipelem, students analyze and abstract their ideas or thoughts from the existing kawung motif into the form of images on the cartesian plane appropriately.	C6
Conceptualizing	Presented with a description and picture of the kawung pattern of Batik Jombangan Ceplok-Ceplok Jatipelem, students analyze and interpret the concept of geometry transformation that can be used in forming the kawung motif. Also, students provide reasons or statements that show the use of geometry transformation concept in the kawung pattern.	C5
Problem-Solving	Presented with descriptions and images of kawung patterns from Batik Jombangan Motif Ceplok-Ceplok Jatipelem, students find and abstract on the Cartesian plane the geometry transformation patterns of the presented problem related to kawung patterns.	C6
Pattern seeking	Presented with descriptions and images of kawung patterns from Batik Jombangan Ceplok-Ceplok Jatipelem, students use the processes of analysis, interpretation, reasoning, prediction, evaluation, and reflection in solving geometry transformation problems on Kawung patterns with the right solution.	C5

The latticework of test instruments is based on indicators of visual-spatial thinking ability (Haas, 2003) which are then developed based on the cognitive level of Bloom's taxonomy (Nafiati, 2021), researchers here use cognitive levels on questions with levels C5 (evaluate) and C6 (create). Bloom's taxonomy is used in the development of test instruments because it is more relevant in measuring the indicators of test questions. This test instrument allows students to answer based on individual creativity, can be done with the concept of translation, reflection, rotation, or mixture. The test instrument was designed according to the rules of description questions developed based on the latticework, resulting in the prototype I test instrument with question numbers 1, 2a, 2b, and 2c.

3.3 Expert Reviews Stage

This stage aims to produce prototype II through input from external parties. Expert reviews (expert assessments) are used as a basis for revising and improving prototypes (Fahmi et al., 2021). This expert assessment is carried out by providing a validation sheet for the visual-spatial thinking ability test instrument consisting of grids, questions, and scoring guidelines to validators consisting of mathematics education lecturers and mathematics teachers at the junior high school/MTs/equivalent level. The validation process is carried out many times until the product reaches suitability with the indicators of students' visual-spatial thinking ability. Comments or suggestions for revision are shown in Table 5.

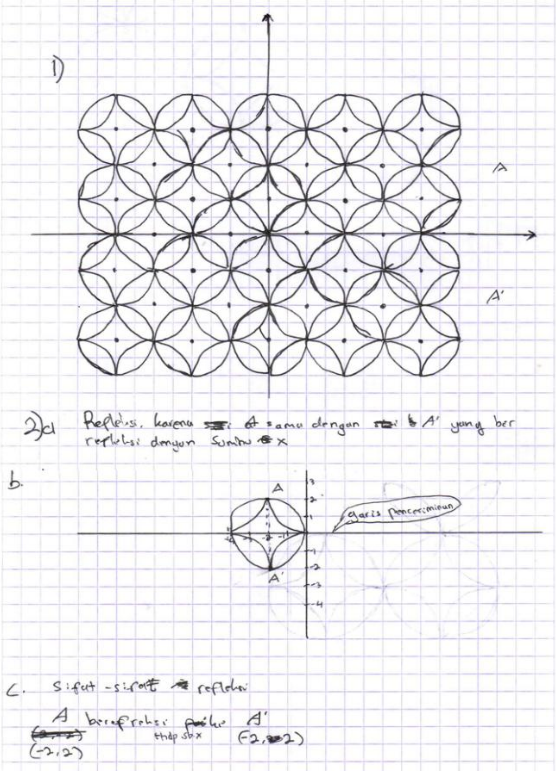
Table 5. Comments/Suggestions from Validators

Instrument	Comments/Suggestions Revision
Test grids	1) Indicator questions should directly lead to the purpose of the problem
Test questions	1) The general instructions require sentence correction
	2) The batik picture is not wide enough and too angled
	3) The sentence structure regarding the general description of batik is too convoluted
	4) The test problem should direct the sketch drawing
	5) Provide a linkage marker in question number 2 to make it easier for students to understand
Scoring guidelines	1) Need to provide alternative answer keys
	2) Scoring guidelines for imagining indicators need improvement

Validator comments/suggestions were used to make improvements to prototype I, so that prototype II was obtained. Researchers made revisions to the entire test instrument. This is in line with Andini & Mukhlis (2023) and Pandra et al. (2024) that improvements make test instruments better.

3.4 One-to-One Evaluation Stage

After the visual-spatial thinking ability test instrument was validated, the test instrument was tested on several students at MTs Negeri 3 Jombang. Three students were selected as part of the non research subjects in the one-to-one test. The suggestions received at the one-to-one stage included that the test questions were good, but needed to be improved on the work instructions to make them easier to understand, the images on the questions were less clear or blurry so they needed to be considered during the printing process, and the processing time needed to be increased to at least 30 minutes. The example of student work at the one-to-one evaluation stage is shown in Figure 3.



Translation:
Reflection, because A equals A' which reflects with the $x - axis$.

Line of reflection.

Properties of reflection
A reflects with respect to the $x - axis\ A'$.

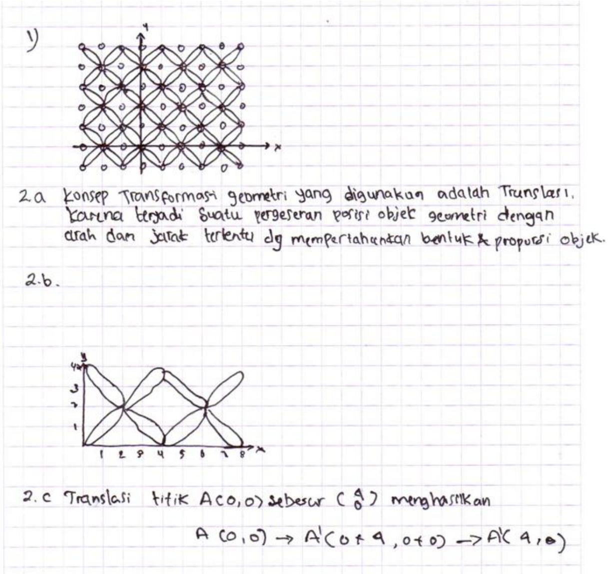
Figure 3. Sample of Student Work at the One-to-One Evaluation Stage

3.5 Small Group Evaluation Stage

Small group trials are conducted when the product is declared valid or feasible for use by expert validators and has gone through revisions from the one-to-one stage. Researchers tested the visual-spatial thinking ability test instrument with limited students. This trial has a limited number of participants, usually ranging from 4 - 5 students (Arikunto, 2020). Researchers distributed test sheets to 5 non-subject students for feasibility testing, so that the instrument could be used at the field trial stage. The main purpose of small group trials is to gain experience in collecting data and implementation time, as well as to determine the level of consistency of research instruments and identify problems that may arise when conducting field trials. At this stage no significant obstacles were found, so that the prototype III test instrument could be used at the field trial stage.

3.6 Field Test Evaluation Stage

Prototypes that have been validated, tested in small groups, and revised (prototype III), then tested on trial subjects. The research trial subjects were students of class IX MTs Negeri 3 Jombang, totaling 27 students. The test activity was carried out for 30 minutes, students showed enthusiasm for the problem because it used the context of local wisdom. The implementation of the use of local wisdom context in learning has an influence on the enthusiasm, involvement, and development of students' abilities in learning for the better (Amaliyah et al., 2023). The example of student work at the field test evaluation stage is shown in Figure 4.



Translation:
The concept of geometry transformation used is translation because there is a shift in the position of geometry objects with a certain direction and distance while maintaining the proportions of the object.

The translation of point $A(0,0)$ by $\binom{4}{0}$ results.

Figure 4. Sample of Student Work at the Field Test Evaluation Stage

The results of students' answers were analyzed using the Rasch model assisted by Ministep software to determine the level of validity, reliability, difficulty level, and differentiating power. An instrument can be said to be valid if it is able to measure what it wants to measure (Makbul, 2021). The output of the Ministep software is the item statistics table: entry order shown in Figure 5.

```
TABLE 14.1 \\Mac\Home\Desktop\Book7.prn          ZOU477WS.TXT  Feb 27 2025 19: 6
INPUT: 27 Person   4 Item  REPORTED: 27 Person  4 Item  4 CATS   MINISTEP 4.8.2.0
--------------------------------------------------------------------------------
Person: REAL SEP.: 1.70  REL.: .74 ... Item: REAL SEP.: 4.19  REL.: .95

         Item STATISTICS:  ENTRY ORDER

------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT    |  OUTFIT   |PTMEASUR-AL|EXACT  MATCH|      |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+----------+----------+-----------+-----------+------|
|     1     68     27      .63    .30|1.06   .32|1.20   .69|  .78   .81| 50.0  55.0| 1    |
|     2     95     27    -2.05    .37|1.28   .87| .95   .11|  .59   .58| 66.7  67.2| 2a   |
|     3     82     27     -.61    .31| .98   .03| .90  -.19|  .73   .72| 66.7  59.5| 2b   |
|     4     54     27     2.02    .35| .90  -.20| .65  -.59|  .89   .86| 66.7  64.7| 2c   |
|------------------------------------+----------+----------+-----------+-----------+------|
| MEAN    74.8   27.0      .00    .33|1.06    .3| .92    .0|           | 62.5  61.6|      |
| P.SD    15.3     .0     1.50    .03| .14    .4| .19    .5|           |  7.2   4.7|      |
------------------------------------------------------------------------------------------
```

Figure 5. Output Entry Order

Based on the validity criteria put forward by Sumintono & Widhiarso (2015) that an item can be said to be valid if it meets at least one criterion. The recapitulation of the results in the entry order table in Picture 3 shows that all items meet the item criteria, so it can be seen that test instruments number 1, 2a, 2b, and 2c are valid. From the entry order table in Picture 5, it can also be seen in this instrument that the question in item 2c has a value of 2.02 which means the question is categorized as difficult, item 1 has a value of 0.63 which means the question is categorized as medium, while items 2a and 2b have a value of -0.61 and -2.05 which means the question is categorized as easy. From this analysis, this test instrument varies because there are three levels of difficulty categories. After analyzing the validity and level of difficulty, the distinguishing power of items 1, 2b, and 2c obtained very good results, while item 2a obtained good results.

The next step is to test the reliability of the instrument to get steady instrument results. The Cronbach Alpha value is used in the summary statistics table to see the reliability of item and person interactions (Sumintono & Widhiarso, 2015). The test results are shown in Figure 6 and Figure 7.

```
     SUMMARY OF 27 MEASURED (EXTREME AND NON-EXTREME) Person
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      11.1       4.0         .84     .96                                |
|  SEM        .6        .0         .43     .07                                |
| P.SD       3.1        .0        2.20     .38                                |
| S.SD       3.1        .0        2.25     .39                                |
| MAX.      16.0       4.0        5.07    1.95                                |
| MIN.       6.0       4.0       -2.44     .73                                |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.12 TRUE SD    1.90  SEPARATION  1.70  Person RELIABILITY  .74 |
|MODEL RMSE   1.03 TRUE SD    1.95  SEPARATION  1.89  Person RELIABILITY  .78 |
| S.E. OF Person MEAN = .43                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .76  SEM = 1.51
STANDARDIZED (50 ITEM) RELIABILITY = .98
```

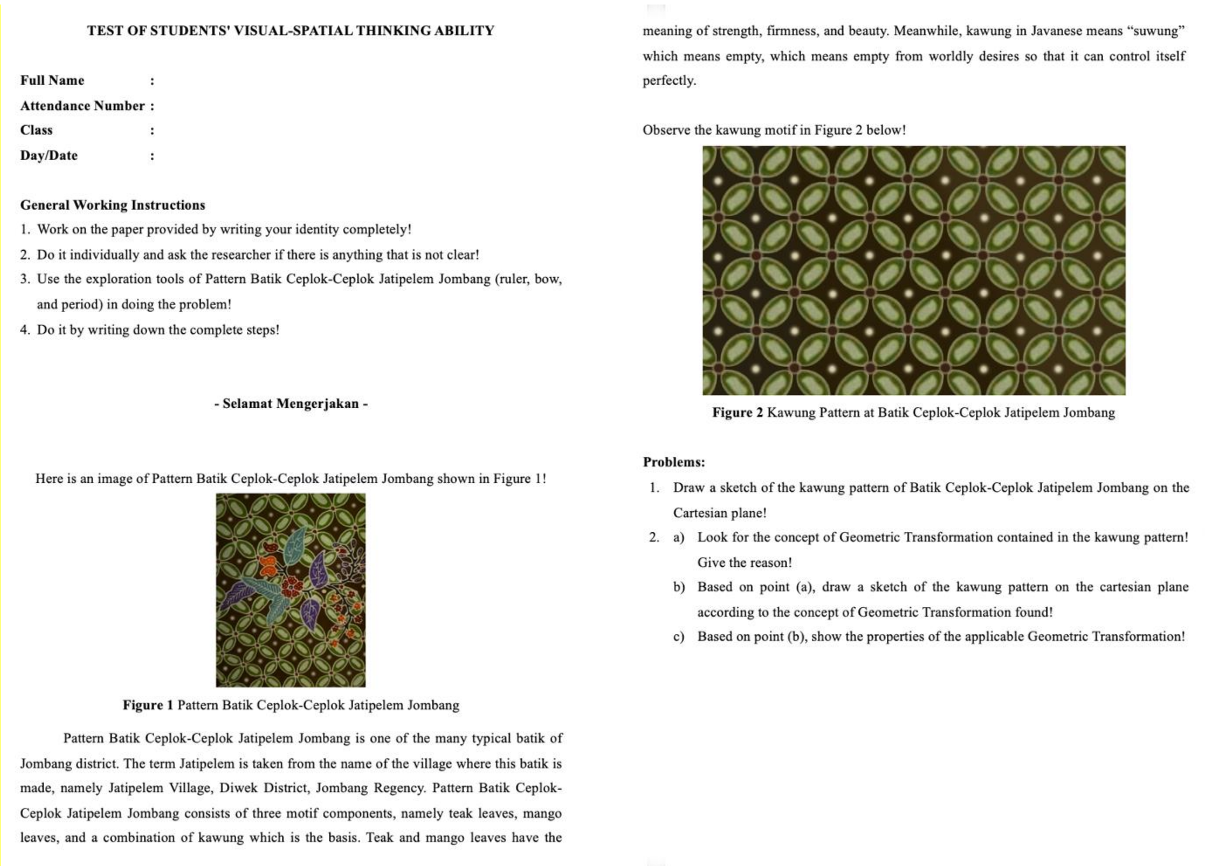
Figure 6. Output Summary Statistics (Part 1)

```
     SUMMARY OF 4 MEASURED (NON-EXTREME) Item
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      74.8      27.0         .00     .33      1.06    .26    .92    .01 |
|  SEM       8.8        .0         .87     .02       .08    .23    .11    .27 |
| P.SD      15.3        .0        1.50     .03       .14    .40    .19    .47 |
| S.SD      17.7        .0        1.74     .04       .17    .46    .22    .54 |
| MAX.      95.0      27.0        2.02     .37      1.28    .87   1.20    .69 |
| MIN.      54.0      27.0       -2.05     .30       .90   -.20    .65   -.59 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .35 TRUE SD    1.46  SEPARATION  4.19  Item   RELIABILITY  .95 |
|MODEL RMSE    .33 TRUE SD    1.47  SEPARATION  4.41  Item   RELIABILITY  .95 |
| S.E. OF Item MEAN = .87                                                     |
-------------------------------------------------------------------------------
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000
```

Figure 7. Output Summary Statistics (Part 2)

Based on Figure 6 and Figure 7, we can see the consistency of the instruments (items) and respondents as well as the interaction between instruments and respondents. The recapitulation of the summary statistics table shows that the respondent's reliability is in the sufficient category, the reliability of the item shows excellent, and the relationship between the two is good. Reliability serves as an indicator that shows the extent to which the measurement results of an instrument can be trusted and consistent (Saputri et al., 2023). High item reliability indicates that the instrument can measure the intended construct stably and accurately. Meanwhile, sufficient respondent reliability indicates that despite variations in participants' abilities or responses, the instrument can still capture differences well.

Based on the results of all stages up to the field test, a test instrument for students' visual-spatial thinking abilities with 4 valid and reliable questions was obtained. 2 items have an easy difficulty level, 1 medium item, and 1 difficult item. Meanwhile, the distinguishing power of the visual-spatial thinking ability test instrument shows 3 very good items used and 1 good item used. The final product of the test instrument for students' visual-spatial thinking ability is shown in Figure 8.



TEST OF STUDENTS' VISUAL-SPATIAL THINKING ABILITY

Full Name :
Attendance Number :
Class :
Day/Date :

General Working Instructions

1. Work on the paper provided by writing your identity completely!
2. Do it individually and ask the researcher if there is anything that is not clear!
3. Use the exploration tools of Pattern Batik Ceplok-Ceplok Jatipelem Jombang (ruler, bow, and period) in doing the problem!
4. Do it by writing down the complete steps!

- Selamat Mengerjakan -

Here is an image of Pattern Batik Ceplok-Ceplok Jatipelem Jombang shown in Figure 1!

Figure 1 Pattern Batik Ceplok-Ceplok Jatipelem Jombang

Pattern Batik Ceplok-Ceplok Jatipelem Jombang is one of the many typical batik of Jombang district. The term Jatipelem is taken from the name of the village where this batik is made, namely Jatipelem Village, Diwek District, Jombang Regency. Pattern Batik Ceplok-Ceplok Jatipelem Jombang consists of three motif components, namely teak leaves, mango leaves, and a combination of kawung which is the basis. Teak and mango leaves have the meaning of strength, firmness, and beauty. Meanwhile, kawung in Javanese means "suwung" which means empty, which means empty from worldly desires so that it can control itself perfectly.

Observe the kawung motif in Figure 2 below!

Figure 2 Kawung Pattern at Batik Ceplok-Ceplok Jatipelem Jombang

Problems:

1. Draw a sketch of the kawung pattern of Batik Ceplok-Ceplok Jatipelem Jombang on the Cartesian plane!
2. a) Look for the concept of Geometric Transformation contained in the kawung pattern! Give the reason!
   b) Based on point (a), draw a sketch of the kawung pattern on the cartesian plane according to the concept of Geometric Transformation found!
   c) Based on point (b), show the properties of the applicable Geometric Transformation!

Figure 8. Test Instrument (Final Prototype)

The advantages of this development research are that all steps of the planned Tessmer model development have been carried out, the assessment process is carried out by experts and students. In addition, the analysis has been carried out with the Rasch model approach until the results are obtained in the form of a valid and reliable test instrument for students' visual-spatial thinking abilities. In general, the test instrument has met all the criteria and is declared suitable for use as a guideline for measuring students' visual-spatial thinking ability. The development of instruments that have been carried out by researchers in the form of visual-spatial thinking ability test questions consisting of 4 items becomes an instrument that is feasible to use widely. This is in accordance with the statement of Nurhasanah et al. (2024) that to get an instrument that is of high quality and feasible to use, it is necessary to validate and analyze empirically. A good question is a question that can pay attention to the ability to think of students (Diana & Saputri, 2021). In this context, integrating culture-based or ethnomathematics elements into mathematics problems can significantly enhance students' engagement in working on these problems. Research has shown that ethnomathematics-based learning provides meaningful learning that can attract students' interest in mathematics by linking mathematical concepts to cultural backgrounds and real-life situations (Garba, 2024; Sabon & Telussa, 2024). By incorporating cultural contexts, students can develop a deeper understanding of mathematical principles while appreciating their cultural heritage (Dari & Jatmiko, 2024; Serepinah & Nurhasanah, 2023). Moreover, culturally relevant mathematical problems have been found to increase students' ability to solve problems, as they make abstract concepts more understandable and accessible (Maharani & Waluya, 2023; Sriwanti & Sukmawarti, 2022). In this study, researchers also paid attention to the cognitive level of Bloom's taxonomy when developing test instruments. The implication of the research results for mathematics learning is that it is one of the reference guidelines in developing mathematics assessment instruments and in developing students' visual-spatial thinking abilities.

There are four main indicators in visual-spatial thinking ability, namely imagining, conceptualizing, pattern seeking, and problem solving (Haas, 2003). In principle, visual-spatial thinking ability is a cognitive skill that allows individuals to understand, manipulate, and represent information in visual form in the mind. According to Faridah & Muzakki (2024) and Lowrie et al. (2021), visual-spatial thinking ability is very important in learning mathematics because it helps students understand abstract concepts. This ability is also closely related to high-level mathematical problem solving, especially in the field of applied mathematics. Research results show that students who have good spatial abilities tend to excel in solving problems that require structural understanding (Fitriana & Lestari, 2022). Strengthening visual-spatial thinking abilities in mathematics learning needs to be a major concern for teachers. In the learning process, providing a more interactive and explorative learning experience has been shown to improve students' spatial abilities (del Cerro Velázquez & Morales Méndez, 2021; Koparan et al., 2023). By improving these visual-spatial thinking abilities, students will be better prepared to face academic and workplace challenges that increasingly rely on visual-spatial thinking abilities in various professions that emphasize the implementation of applied mathematics.

4. Conclusion

This study produced a test instrument of visual-spatial thinking ability of students on geometry transformation material based on pattern batik Ceplok-Ceplok Jatipelem Jombang which is feasible to use because it has passed a series of development processes of the Tessmer model and fulfills the elements of Rasch model analysis testing. This study produced a visual-spatial thinking ability test instrument with 4 valid questions based on the values of $0.5 < MNSQ < 1.5$, $-2.0 < ZSTD < +2.0$, and $0.4 <$ Pt Measure Corr < 0.85. The reliability test showed that respondent reliability was in the sufficient category, with a person reliability value 0.74. Item reliability showed excellent, with item reliability value 0.95. The relationship between the two was good, with a Cronbach Alpha value 0.76. The test instrument consists of easy difficulty on item 2a and 2b, medium difficulty on item 1, and difficult difficulty level on item 2c. Meanwhile, the differentiating power shows that item 2a is good and 1, 2b, and 2c is very good. So, it shows that the test instrument to measure the ability of visual-spatial thinking based on pattern batik Ceplok-Ceplok Jatipelem Jombang on geometric transformation material satisfies the criteria worthy to be used. This research opens opportunities for further studies to test visual-spatial thinking instruments on a larger scale, explore their effectiveness in enhancing students' abilities, and develop instruments for different materials, aiming to expand educational knowledge and benefits.

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