Mathematical communication skills of students through GeoGebra-assisted ELPSA approach

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Abstract. The purpose of this study was to see the development of students' mathematical communication skills between those who obtained the ELPSA learning model assisted by GeoGebra and those who obtained the conventional learning model (direct-instruction). This study uses a quasi-experimental method. The results showed that the achievement and improvement of mathematical communication skills of students who obtained the ELPSA learning model assisted by GeoGebra better than those who obtained the direct-instruction model. The GeoGebra-assisted ELPSA learning model can be used as an alternative in developing mathematical communication skills, especially in the transformation geometry material in secondary schools.

1. Introduction
Communication skills are an important part of mathematics and mathematics education. The communication process helps build mathematical meanings and ideas [1]. When students are challenged to think logically about mathematics, then communicate the results of their thinking to others both verbally and in writing, then they are essentially learning meaningfully so they have confidence. Students with good communication skills can ensure the validity of their ideas in problem-solving.

Developing mathematical communication skills on the topic of transformation geometry in secondary schools requires a learning approach that is supported by technology. This is in line with the opinion Hernández et al., [2], which suggests that technology is the key to issuing several aspects and shows an understanding of mathematics for teaching.

One learning approach that can be used as an alternative to developing mathematical communication skills is the GeoGebra-assisted ELPSA learning approach. ELPSA (Experience, Language, Pictorial, Symbol, and Application) is a learning framework that is introduced as a sequence of learning processes that present mathematical ideas through experiences experienced, mathematical conversations, visual stimuli, symbolic notations, and the application of applied knowledge [3].

The ELPSA framework has been combined with several learning models to develop mathematical abilities. For example, the ELPSA framework in problem-based learning can improve student learning completeness [4]. In addition, the ELPSA framework has a significant effect on the ability of students to solve functional problems [5].
In this study the ELPSA framework is combined with GeoGebra to develop students' mathematical communication skills in the geometry material of secondary school transformation. This has logical reasons, because GeoGebra assistance in learning models can develop learning processes dynamically, geometry, and algebra [6]. The GeoGebra-assisted learning process has a significant effect on the development of mathematical problem-solving abilities [7]. Even the combination of problem-based learning assisted by GeoGebra can improve students' metacognitive abilities [8], can improve students' mathematical reasoning abilities [8], can improve students' mathematical reasoning abilities [9] and can help to understand important concepts in three-dimensional geometry material [10].

The objectives of using geogebra in learning include: first, to stimulate students' motivation to be interested in the material being taught; secondly, as a means of providing an understanding of material concepts taught to students visually. The material used as research material is transformation material. Geometry transformation material is deemed suitable to be conveyed by the GeoGebra-assisted ELPSA approach, because the components in the ELPSA learning design are very supportive for the delivery of transformation material, for example when delivering the material part of reflection, learning begins with the teacher exploring the experiences (Experiences) of students when reflecting- then students communicate with language (Language) itself the relationship between the distance of objects to the mirror and the distance of the image of the mirror, which leads to mathematical terms. Furthermore, through pictures (Pictorial) on the Cartesian coordinates, students find conclusions in the form of abstract symbols (Symbols) about the shadow of a point if reflected on the line. To improve mathematical thinking skills, students apply (Application) knowledge about reflection by working on more challenging problems. GeoGebra software is used as a tool to make it easier to demonstrate visually. In the form of questions, transformation material is also seen to be able to measure students' mathematical communication skills.

The formulation of the problem of this study are: First, is there a difference in the achievement of students' mathematical communication abilities between those using the GeoGebra-assisted ELPSA approach and those using conventional methods? Second, is there a difference in the improvement of students' mathematical communication skills between those using the GeoGebra-assisted ELPSA approach and those using conventional methods?

2. Research methods
This study uses a quasi-experimental method that aims to see the effect of ELPSA learning assisted by GeoGebra software on students' mathematical communication skills. As a control class the Direct Instruction learning model is used. The design used in this study is Quasi-Experimental Design Namely Nonequivalent Control Group Design as shown in Table 1.

| Class | Pretest | Treatment | Posttest |
|-------|---------|-----------|---------|
| R     | 0       | X         | 0       |
| R     | 0       |           | 0       |

Information:
R: Research sample class
X: The treatment given to the experimental group uses ELPSA learning assisted by GeoGebra
0: Pretest and Posttest students of the experimental class and the control class

The population of this study is all students of class XI odd semester 2019/2020 school year a high school in Bandung, as many as 4 classes. The sample chosen was class XI IPA 2 totaling 29 people as the experimental class using the ELPSA approach assisted by GeoGebra software and class XI IPA 1 totaling 32 people as the control class using the direct interaction model. This study uses test instruments that have been tested in order to obtain good validity and reliability.
3. Results and discussion

3.1. Results

The results of posttest data processing to determine differences in the achievement of mathematical communication skills of students who obtain ELPSA learning assisted by GeoGebra software with students who obtain conventional learning (direct instruction) are presented in Table 2.

Table 2. Analysis of posttest data analysis.

| Models                        | N  | Min | Max | Mean   | SD  |
|-------------------------------|----|-----|-----|--------|-----|
| Geogebra-Assisted ELPSA Approach | 29 | 10  | 99  | 75.31  | 20.79 |
| Direct Instruction (Conventional) | 32 | 22  | 93  | 53.34  | 18.66 |

Table 2 informs that based on overall learning factors, the posttest of mathematical communication skills of students who get the ELPSA approach assisted by GeoGebra software is better than students who get conventional learning, judging by the average value of students in the experimental class is 75.31 greater than students in the control class with an average value of 53.34.

Table 3 informs that the value of $Z_{	ext{count}}$ (0.6240)$ > Z_{	ext{table}}$ (0.32) means that there are differences in the achievement of mathematical communication skills between students who use ELPSA learning assisted by GeoGebra software and conventional learning models.

Table 3. Mann-whitney test of post-test data.

| $Z_{	ext{count}}$ | $Z_{	ext{table}}$ |
|-------------------|-------------------|
| 0.6240            | 0.32              |

The results of the Mann-Whitney analysis on the post-test data show that there are differences in the achievement of mathematical communication skills of students in the experimental class and the control class. With the achievement of mathematical communication skills of students better experimental class using the ELPSA model assisted by GeoGebra software than the control class using conventional learning.

The results of N-gain data processing to see the difference in mathematical communication ability of students in the experimental class and the control class are presented in Table 4. Based on Table 4, the average N-gain test for mathematical communication skills of students who get ELPSA learning by GeoGebra is greater than students who get conventional methods.

Table 4. Descriptive statistics of N-Gain data.

| Models                        | N  | Min | Max | Mean  | SD  | Criteria |
|-------------------------------|----|-----|-----|-------|-----|----------|
| Geogebra-Assisted ELPSA Approach | 29 | 0,10| 0,99| 0,74  | 0,21| High     |
| Direct Instruction             | 32 | 0,08| 0,90| 0,39  | 0,20| Medium   |

To see which class is better at improving mathematical communication skills, a Mann-Whitney test is carried out the results of which are presented in Table 5.

Table 5. Mann-Whitney test N-gain data.

| $Z_{	ext{count}}$ | $Z_{	ext{table}}$ |
|-------------------|-------------------|
| 0,5035            | 0,01              |

Table 5 informs that the value of $Z_{	ext{count}}$ (0.5035) $ > Z_{	ext{table}}$ (0.01) means that there is a difference in the improvement of mathematical communication skills between students who use ELPSA learning assisted by GeoGebra software and students who use conventional learning methods (direct-instruction). These results indicate that the improvement in mathematical communication skills of students who use the...
ELPSA learning model assisted by GeoGebra software is better than classes that use conventional learning models (direct-instruction).

3.2. Results and discussion
Mathematics learning on the topic of transformation geometry with the GeoGebra-assisted ELPSA model is effective in improving the mathematical communication ability of students. This is in line with findings [4] which state that mastery learning can be achieved through this model. In terms of learning approaches the ELPSA framework prepares a structure to identify how mathematical concepts and understanding are obtained and developed [11]. This framework also provides opportunities for teachers to better understand how pedagogical practices and learning experiences are in line with the development of student concepts [12]. More specifically the ELPSA framework in mathematics class emphasizes how understanding certain material can be applied to new situations supporting students in deepening their understanding of triangle types [3].

The use of GeoGebra in learning reveals students' abilities in the use of mathematics and technology in problem solving [13]. GeoGebra technology assistance can be effectively used in the ELPSA model in terms of helping empirically in problem solving, this is relevant to the opinion Surya which states that GeoGebra assistance in learning can develop students' metacognitive abilities [8].

4. Conclusion
Based on the results of the study it can be concluded that the achievement and improvement of students' mathematical communication skills using the GeoGebra-assisted ELPSA approach is better than the achievement and improvement of students' mathematical communication skills using conventional learning models (direct-instruction). Thus, ELPSA-assisted GeoGebra learning has succeeded in developing students' mathematical communication skills in the geometry material of secondary school transformation.

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References
[1] Joyner J and Reys B 2000 Principles and Standards for School Mathematics: What’s in It for You? Teach. Child. Math. 7 26
[2] Hernández A, Perdomo-Díaz J and Camacho-Machín M 2020 Mathematical understanding in problem solving with GeoGebra: a case study in initial teacher education Int. J. Math. Educ. Sci. Technol. 51 208–23
[3] Febrilia B R A and Winarti D W 2018 Deepening students understanding of triangle topic through ‘application’component of ELPSA (Experience, Language, Pictorial, Symbol and Application) framework Journal of Physics: Conference Series vol 1088 p 12085
[4] Sukasno S, Friansah D and Purwasi L A 2018 PROBLEM-BASED LEARNING MODEL IN ELPSA FRAMEWORK ON MATHEMATICAL LEARNING PROCESS IN JUNIOR HIGH SCHOOL Infin. J. 7 183–90
[5] Nissa I C 2019 The Effect of the ELPSA Framework on Students’ Ability to Solve Function Problems Journal of Physics: Conference Series vol 1227 (IOP Publishing) p 12020
[6] Schaver Z 2019 The Effects of GeoGebra on Student Achievements, Critical Thinking/Problem-Solving Skills, and Engagement/Motivation in High School Mathematics
[7] Sembiring N B and Surya E 2019 Development of Mathematics Learning Tools Through Geogebra-Aided Problem Based Learning To Improve Solving Capability Mathematical Problems of High School Students 4th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2019) (Atlantis Press)
[8] Surya R E 2019 Development of Oriented Student Activity Sheets Problem-Based Learning Approaches Assisted by GeoGebra Software to Improve Metacognition Ability of Private
Vocational High School PAB 12 Saentis Development 10

[9] Kustiawati D, Kusumah Y S and Herman T 2018 Using of GeoGebra to Improve Mathematical Reasoning with the Problem-Solving Method First International Conference on Technology and Educational Science (European Alliance for Innovation (EAI))

[10] Budinski N, Lavicza Z and Fenyesi K 2018 Ideas for using GeoGebra and Origami in teaching regular polyhedrons lessons K-12 STEM Educ. 4 297–303

[11] Lowrie T and Patahuddin S M 2015 ELPSA as a Lesson Design Framework. Indones. Math. Soc. J. Math. Educ. 6 1–15

[12] Lowrie T, Logan T and Patahuddin S M 2018 A learning design for developing mathematics understanding: The ELPSA framework Aust. Math. Teach. 74 26

[13] Jacinto H and Carreira S 2017 Mathematical problem solving with technology: The technomathematical fluency of a student-with-GeoGebra Int. J. Sci. Math. Educ. 15 1115–36