Relationship between intelligence quotient, gender, learning outcomes and geometry thinking levels

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Abstract. The purpose of this study was to obtain an overview of the relationship and influence of IQ, gender, and learning outcomes on the geometric thinking levels. This research was designed with a correlational model based on 32 students randomly selected from a mathematics education department at one of the universities in Indonesia. The test instrument used was "Van Hiele Geometry Test" which was compiled on the CDASSG Project. The findings in the study are that there is a correlation between IQ, gender, and learning outcomes with a geometric thinking levels but not significant. But there is a significant influence IQ, gender, and learning outcomes on the geometric thinking levels.

1. Introduction
Geometric thinking ability is important. Geometric thinking includes the definition and classification of geometric objects, explanations of relationships, images, reasoning, visualization, and evidence produced in relation to these objects and relationships [1]. The foundation of geometric thinking in this study is based on The van Hiele Theory. Pierre van Hiele (1909-2010) & Dina Van Hiele-Geldof (1911-1958) as montessori secondary school teachers in the Netherlands were disappointed by the low geometric of some students, this was due to the failure of communication between students and teachers. According to him learning consists of three elements, namely teachers, students, and teaching materials. If one of them is problematic then creates the wrong conditions, so in his dissertation Pierre van Hiele developed the theory of The Child's Thought and Geometry, while his wife developed a theoretical model involving five levels of thought development in geometry [2]. Van Hiele's theory assumes: geometric learning discontinues with different levels of thinking; level hierarchy; sequential, invariant, the progress depends on learning not age, and the teacher can reduce lessons to low levels; understanding at the previous level can reach the next level of understanding; each level has its own language; two people at different levels do not understand each other [3].

Research reports on the geometric thinking ability have more than 150 articles. Among them concerning the study of the geometric thinking levels, learning studies that can facilitate geometric thinking, and correlational studies. In previous studies, it was examined the geometric thinking levels in gifted students learning geometry, the result despite the age of younger gifted students, but van Hiele's overall level was higher than ordinary students entering high school geometry subjects [4]. While the level of geometric thinking of mild mental retardation students shows students are still at level 0 even the pre-visualization level [5]. Mild mental retardation students according to the American Association on Mental Deficiency IQ scores 50-70. Intelligence Quotient (IQ) is a term from the grouping of human
intelligence that was first introduced by Alferd Binet, a psychologist from France in the early 20th century. These IQ are related to reasoning ability and abstract thinking [6]. There is a relationship between gender and the level of geometric thinking even though it is not significant [7]. Ismail (2018) reports that there have been serious phenomena for some time, namely gender inequality at the university level [8]. So Musdalifah et al recommends that the character between men and women need to be better understood by the teacher [9].

Correlational studies on students in Turkey were conducted by Yenilmez & Korkmaz [10], the result was geometric self-efficacy significantly different in mathematics achievement, gender and grade level and also showed that geometric self-efficacy and the geometric thinking levels were statistically positive but weak. While correlational research on prospective teacher students by Aksu [11] shows that van Hiele's geometry levels, geometric self efficacy and attitude towards geometry are able to predict geometric knowledge significantly. So in this paper an overview of the relationship and the influence of IQ, gender, and learning outcomes is explained on the geometric thinking levels.

2. Method
This research method follows research Yenilmez & Korkmaz [10] about "Relationship Between 6th, 7th and 8th Grade Students' Self-Efficacy Towards Geometry and Their Geometric Thinking Levels". However, sample selection followed correlational research on prospective teacher students by Aksu [11]. So that this study was designed on the correlational model based on 32 students selected by purposive random sampling from a department of mathematics education at one of the universities in Indonesia. The number of female students is 19 people and many male students are 13 people who study the second semester. The limitation of this study is that participants were only 32 students of mathematics education prospective teachers who were chosen purposively sampling.

The population of this study was all IQ scores, gender, learning outcomes, and the geometric thinking levels of the students in the mathematics education department at one of the universities in Indonesia. Samples were taken using the purposive random sampling technique, namely IQ scores, gender, and learning outcomes on the level of geometric thinking of students in the population. The instrument of this research is a written test with paper and pencil. This study uses the "Van Hiele Geometry Test" instrument compiled in the CDASSG Project by Usiskin (1982) [12]. IQ score data obtained from the information of the student concerned. While the learning outcome data is obtained from the analytic geometry lecturer, the researcher himself. Then the data were analyzed using IBM SPSS Statistics 23 software.

3. Result and Discussion
In this section the results and discussion of the study are explained. Based on the data obtained in the study, then the data was processed using SPSS 23 software to analyze the correlation and regression between the independent variables (IQ, learning outcomes, and gender) and the dependent variable (level of thinking geometry). Following are the correlation data obtained.

Table 1. Correlational between the independent variables (IQ, learning outcomes, and gender) and the dependent variable (geometry thinking levels)

|                  | IQ   | Gender | Learning Outcomes |
|------------------|------|--------|-------------------|
| van Hiele Levels | .330 | .451   | -.273             |
| Sig. (2-tailed)  | .065 | .010   | .131              |
| N                | 32   | 32     | 32                |

Table 1 shows the correlation between the independent variables (IQ) and the dependent variable (geometric thinking levels) is 0.330 and sig. 0.065> 0.05 so it is not significant. Correlation between independent variables (gender) and dependent variable (geometry thinking levels) is 0.451 and sig. 0.010 <0.05 so it is significant. Correlation between independent variables (learning outcomes) and dependent variables (geometric thinking levels) are -0.273 and sig. 0.131> 0.05 so it is not significant.
Table 2. Model summary

| Model | R     | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------|----------|-------------------|---------------------------|
| 1     | .605a | .366     | .298              | 1.13850                   |

a. Predictors: (Constant), IQ, Learning Outcomes, Gender

Table 2 shows in the Model Summary Table, obtained $R = 0.605$ means the magnitude of the influence of the independent variables IQ, learning outcomes, and gender on the dependent variable level of student geometry thinking is 0.605 and corrected to 0.366. To be more accurate, predictions of influence can be based on the value of Adjusted R Square, which is the value of R Square that has been more adjusted and is usually the most accurate. It can be seen that the Adjusted R Square value is 0.298.

Table 3. Anova\(^a\)

| Model | Sum of Squares | df | Mean Square | F     | Sig. |
|-------|----------------|----|-------------|-------|------|
| 1     | Regression     | 20.926 | 3 | 6.975 | 5.381 | .005\(^b\) |
|       | Residual       | 36.293 | 28 | 1.296 |       |      |
| Total | 57.219         | 31 |     |       |      |      |

a. Dependent Variable: van Hiele Levels
b. Predictors: (Constant), IQ, Learning Outcomes, Gender

Table 3 shows in the ANOVA Table, Sig. = 0.005 <0.05, meaning that the independent variables (IQ, learning outcomes, and gender) have a significant effect on the dependent variable (geometric thinking levels).

Table 4. Coefficients\(^a\)

| Model | Unstandardized Coefficients | Standardized Coefficients | t     | Sig. |
|-------|------------------------------|---------------------------|-------|------|
|       | B                            | Std. Error                | Beta  |      |      |
| 1     | (Constant)                   | -4.147                    | 2.833 | -1.464 | .154 |
|       | Learning outcomes            | -.022                     | .010  | -.332 | -2.167 | .039 |
|       | Gender                       | 1.044                     | .420  | .384  | 2.485 | .019 |
|       | IQ                           | .047                      | .024  | .310  | 1.970 | .059 |

a. Dependent Variable: geometric thinking levels

Table 4 shows from the Coefficients table a linear regression model is obtained, namely: Geometry thinking level = -4.147 - 0.022 * Learning outcomes + 1.044 * Gender + 0.047 * (IQ). Coefficients also provide information on the influence of each independent variable (IQ, learning outcomes, and gender) on the dependent variable (Geometry thinking level). When viewed from the influence of independent variables, information is obtained that based on the table IQ provides information that is not significant to the level of geometric thinking because of the sig value. = 0.065> 0.05. Whereas IQ is only a requirement for learning geometry. So there is a need for learning that can facilitate geometrical thinking. The geometric understanding of gifted students mathematically depends on several components: the level of understanding of Van Hiele in students about geometric understanding, the level of logical reasoning ability, and the quality of basic geometrical knowledge [13].

4. Conclusion
The conclusions of this study are as follows:
a. There is a correlation between IQ, gender, and learning outcomes and the geometric thinking levels, but not significant.
b. There is a significant influence IQ, gender, and learning outcomes on the geometric thinking levels. Suggestions from the results of this study are as follows:
a. Based on the results of the study it was found that there was a correlation between the geometric thinking levels and IQ, but it was not significant. This happens because IQ is only a condition of learning geometry. So there is a need for learning that can facilitate students to increase the level of thinking geometry.
b. Based on the results of the study it was found that there was a significant correlation between the geometric thinking levels and gender. So that lecturers need to pay attention to gender in the learning process.

5. References
[1] National Council of Teachers of Mathematics, editor 2000 Principles and standards for school mathematics
[2] Fuys D. English Translation of Selected Writings of Dina van Hiele-Geldof and Pierre M. van Hiele.
[3] Van Hiele PM 1959 The child’s thought and geometry. English translation of selected writings of Dina van Hiele-Geldof and Pierre M. van Hiele 243-52.
[4] Mason M 1997 The van Hiele Model of Geometric Understanding and Mathematically Talented Students Journal for the Education of the Gifted 21 1 38-53
[5] Shomad ZA, Kusmayadi TA 2017 The Van Hiele geometry thinking levels of mild mental retardation students In Journal of Physics: Conference Series 943 1 012014.
[6] Misbach IH 2008 Antara IQ, EQ, dan SQ Pelatihan Nasional Guru Se-Indonesia Universitas Pendidikan Indonesia Jakarta
[7] Sudihartinih E and Wahyudin 2019 Analysis Of Students’ Self Efficacy Reviewed By Geometric Thinking Levels And Gender Using Rasch Model Journal Of Engineering Science And Technology 14 1 509-519
[8] Ismail L 2014 Factors influencing gender gap in higher education of Malaysia: A University of Malaya sample Kuala Lumpur: Faculty of Education, University of Malaya.
[9] Asis M, Arsyad N, and Alimuddin 2015 Profil kemampuan spasial dalam menyelesaikan masalah geometri siswa yang memiliki kecerdasan logis matematis tinggi ditinjau dari perbedaan gender Jurnal Daya Matematis 3 1 78-87
[10] Yenilmez K and Korkmaz D 2013 Relationship Between 6th, 7th and 8th Grade Students’ Self-Efficacy Towards Geometry and Their Geometric Thinking Level Journal of Science and Mathematics Education 7 2 268-283
[11] Aksu A D 2013 Predicting the Geometry Knowledge of Pre-Service Elementary Teachers Cumhuriyet International Journal of Education-CIJJE 2 3 15-27
[12] Usiskin Z 1982 Van Hiele Levels and Achievement in Secondary School Geometry CDASSG Project
[13] Mason MM, Moore SD 1997 Assessing readiness for geometry in mathematically talented middle school students Journal of Secondary gifted education 8 3 105-10.

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