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To cite this article: Hamidah and J W Kusuma 2020 *J. Phys.: Conf. Ser.* **1657** 012036

View the article online for updates and enhancements.

Analysis of student learning styles and geometry thinking skills: During the covid-19 pandemic

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Abstract. In social restrictions due to the current pandemic, there is a change in the learning system and changing learning styles. So it has the potential to affect mathematical abilities, especially geometry thinking skills. The problems are: 1)how the learning styles tendencies of students during the pandemic, 2)how the students 'geometric thinking abilities viewed from the level of geometry according to van Hiele, 3)how the students' geometric thinking abilities viewed from their learning styles, and 4)are their association of student learning styles with the level of geometry ability according to van Hiele. This research conducted at the University of Bina Bangsa in mathematics education, totaling 38 students. The method in this research is mixed methods. For quantitative data were analyzed using chi-square test and contingency test, while qualitative data were analyzed using flow models. The study found that during the covid-19 pandemic, the students tend to use auditory learning style and it is known that there is an association between student learning style and geometric ability level according to Van Hiele. Furthermore, it is known that the higher level of geometry ability of students, the higher indicators of ability to think geometry they have.

1. Introduction

In social restrictions due to the current co-19 outbreak, there has been a change in learning systems. The online learning system becomes a compulsory choice that is applied even on a national scale. The problem is that each student has a learning style that is different from one another. Furthermore with the change in the current learning system, it has the potential to cause students' comprehension to change due to adjustment factors. A person's learning style is collaboration with the way a person absorbs and processes all information obtained [1]. Furthermore, according to Jamani when there is a contrast in the learning styles of students and the teaching styles of lecturers, students are likely to be distressed, bored and inability to focus in class, get mediocre results, become confused about the courses, curriculum and themselves [2].

The online learning system that is implemented at this time requires teachers to be able to maximize the learning process so that they can embrace all learning styles of students, both visual, auditory, and kinesthetic. For this reason, this research was conducted to determine the effect of the learning process in the co-19 pandemic towards student learning styles, which in turn have an impact on students' learning abilities and outcomes.

In addition to having different learning styles, each person also has a variety of thinking abilities. According to van Hiele's theory, to understand geometry, there are five levels of thinking, including level 0 (visualization), level 1 (analysis), level 2 (natural deduction), level 3 (deduction), and level 4 (rigor) [3]. While the ability to think geometry, Hoffer divides it into 5 skills, namely: visual, verbal, drawing, logic, and applied [4]. According to a Rofii statement is geometry occupies a unique position

in the mathematics curriculum because many of the concepts contained in it. While from a mathematical point of view, geometry provides approaches for problem-solving [5]. Then Mdyunus stated that the attainment of concepts at the elementary level is of utmost importance since it becomes the foundation in the transition to further learning at the secondary level [6].

However, based on the results of research from several previous studies on Van Hiele's theory [7] shows that the level of thinking of one's geometry, according to Van Hiele's theory, is still relatively low. Furthermore, the facts in the field show that the learning outcomes of geometry courses are still low compared to other subjects. From the final examination data of Bina Bangsa University mathematics education students in the academic year 2018/2019, there were 37.5% of students not graduating in Geometry courses. It is known that students who do not graduate are due to the lack of mastery of the material and then have an impact on the understanding of student concepts that are not yet optimal.

For this reason, this research was carried out at Bina Bangsa University, namely the 4th semester students majoring in mathematics education, totaling 38 students. The problems and objectives of this research are to analyze and describe: 1) how the learning styles tendency of students during the COVID-19 pandemic, 2) how the students 'geometric thinking abilities are evaluated from the level of geometry according to van Hiele, 3) how the students' geometric thinking abilities in terms of learning styles, and 4) is there an association of student learning styles with the level of geometry ability according to van Hiele. The benefits of the results of this study are expected to be a source of information for other researchers in developing research on learning models that have great potential in maximizing the online learning process to be able to optimize the ability of students to think geometry by paying attention and considering student learning styles. Other benefits are expected to contribute to contributing understanding or positive ideas to improve the quality of education in the co-19 pandemic that is beneficial for students, lecturers, citations, and researchers.

2. Experimental Method

The method in this study is a mixed method that combines quantitative and qualitative methods. The study was conducted in classes 4A and 4B, namely 4th semester students majoring in mathematics education at Bina Bangsa University in March-May 2020 with the consideration that students were being taught in geometry courses. The data collection technique is to use a student learning style questionnaire, the first test is the VHGT test, the second test is the geometry thinking ability test, and the interview test.

The student learning style questionnaire instrument with a Likert scale consists of 30 statements, each with 10 statements for each visual, auditory, and kinesthetic aspect. The questionnaire was given online on March 10, 2020. The first test instrument, the van Hiele Geometry Test (VHGT), was developed by The Cognitive Development and Achievement in the Secondary School Geometry Project (CDASSG). The VHGT test is a PG test with 25 questions given online on March 11, 2020. The second test instrument is the geometry thinking ability test which consists of 7 questions that are adjusted to the geometry skill indicators to be investigated, namely: 1) visual, 2) verbal, 3) drawing, 4) logic, and 5) applied that have been tested for validity and reliability. The second test is given to students who have been selected as research subjects based on the results of the first test, by selecting 1 student at each level of geometry thinking ability according to van Hiele. The second test was given online on March 18, 2020 for 90 minutes. Next the interview is structured but open based on student learning styles and geometric thinking skills. Interviews were conducted after completing the first test and the second test.

Data analysis uses stepwise qualitative-quantitative data analysis, so the analysis is carried out on qualitative data, and then quantitative data analysis is followed. For quantitative data analyzed with chi-square test and contingency test, while qualitative data were analyzed with a flow model consisting of three stages[1], namely data reduction, data presentation and conclusion drawing, and verification. The stages of the study are presented in figure 1.
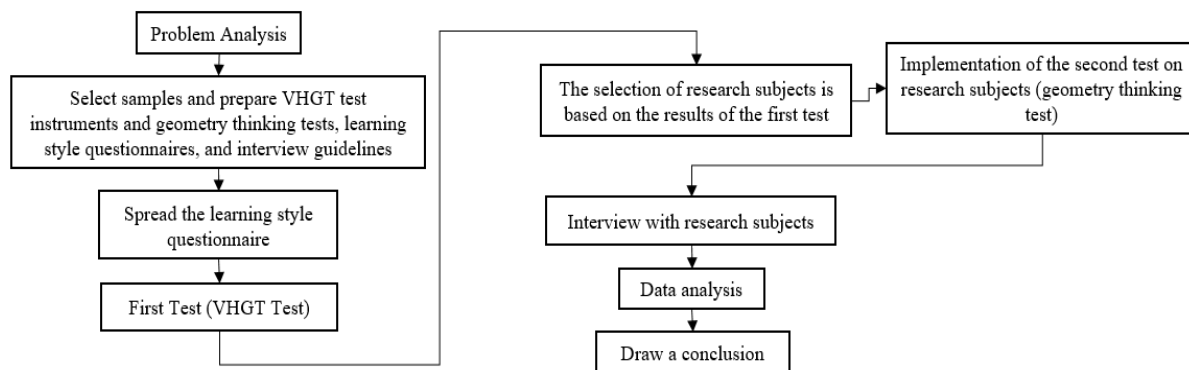
Figure 1. Research Stages

3. Result and Discussion

3.1. Trends in Student Learning Styles During the Covid-19 Pandemic Period

Student learning style questionnaire was given on Tuesday, March 10 2020 with 38 respondents. Data were then grouped based on visual, auditory, and kinesthetic learning styles:

Table 1. Learning Style Questionnaire Results

Learning Style	Number of students	Percentage (%)
Visual (V)	16	42.11
Auditorial (A)	19	50
Kinesthetic (K)	3	7.89
total	38	100

Based on table 1. it is known that learning during the pandemic shows the learning styles of students are diverse but tends to auditory learning styles. Of the 38 students who were the subjects of the study, there were 19 or 50% of students who had an auditory learning style, but not a few of them studied with a visual style that is 16 or 42.11% of the remaining students which were only 3 students with a kinesthetic learning style.

Based on the results of interviews with TSF (students with a visual learning style) stated that online learning via WAG makes the material easier to understand because the learning process has many written instructions and leaves a trail that can be read many times. The results of interviews with KAP (students with an auditory learning style) stated that KAP does not like reading. According to him, learning with WAG requires him to read many times to understand the material while ZOOM can ask questions directly, and there are direct answers.

Learning in this pandemic period lecturers tend to use ZOOM, so it is advantageous to use because the majority of students have an auditory learning style. This shows the importance of the environment in the learning process, as Ozdemir said that the environment can have a considerable effect on the students learning performance [8]. Another case with LGH (students with kinesthetic learning styles), according to him, is more comfortable to process information if there is a direct practice, for example, using the GeoGebra application in understanding about ellipses. According to him, the learning process with lectures or discussions requires an arduous effort to understand the material. Students with kinesthetic learning styles are only 7.89%, inversely proportional to Jamani's study showed that the preferred learning style is kinesthetic learning style, and they prefer kinesthetic over other learning styles, followed by reading, writing, oral, and visual [2] .

3.2. Ability Student Geometric Thinking From the VHGT Level

The second test was carried out on March 18, 2020, with 7 respondents. Students chosen by one student randomly from each learning style and one student from each level of the VHGT test. The time given to

take the test is 80 minutes and is individual. The results of the geometry thinking ability test will be triangulated again with the results of the interview to obtain in-depth information. The summary of the results can be seen on table 2.

Table 2. Summary of Geometry Thinking Test Results in Terms of Learning Style and VHGT Test Level

Learning Style and VHGT Level	Indicator of Geometry Thinking Ability				
	Visual	Verbal	Draw	Logic	Applied
Visual (TSF)	√	x	√	√	x
Auditorial (KAP)	√	√	x	√	√
Kinesthetic (LGH)	x	√	√	√	x
Level 0 (ZP)	√	√	√	x	x
Level 1 (MHS)	√	x	√	√	x
Level 2 (MFA)	x	√	√	√	√
Level 3 (SW)	√	x	√	√	√

Based on table 2. it is known that at level 0 and level 1, students have 3 indicators of geometric thinking abilities, including at level 0, namely visual, verbal, and drawing, and at level 1, namely visual, drawing, and logic. At levels 2 and 3, students have 4 indicators of geometric thinking ability, including level 2, namely verbal, drawing, logic, and applied and at level 3, namely visual, drawing, logic, and applied. Based on table 2. it is known that students with visual learning styles can think geometry visually, drawing, and logic. Furthermore, students whose auditory learning styles can think of geometry visually, verbally, logically, and applied. Students with kinesthetic learning styles can think geometry verbally, drawing, and logic. As Lengkana said that that students with auditory learning styles at the time of presentation in front of the class, causing long-term memory storage that Affects the ability to connect concepts [9].

3.3. Geometric Thinking Ability of Students in Terms of Learning Style
Based on table 2. it is known that students with visual learning styles can think geometry visually, drawing, and logic. Furthermore, students whose auditory learning styles can think of geometry visually, verbally, logically, and applied. Students with kinesthetic learning styles can think geometry verbally, drawing, and logic. This shows that students with an auditory learning style have four indicators of geometric thinking ability that is more than other learning styles. Lengkana's statement that students with auditory learning styles at the time of presentation in front of the class, causing long-term memory storage that affect the ability to connect concepts [9]. However, 42.11%, ie, almost half of all students have a visual learning style with the ability to think visual geometry, drawing, and logic. Lengkana also stated that visual thinking can be a bridge from abstract-verbal to clear form so that there is a development of thinking and understanding of concepts related to problem-solving [9].

3.4. *Association of Student Learning Styles with Geometry Ability Level According to Van Hiele*
The VHGT test results obtained are then classified based on the results of the learning style questionnaire:

Table 3. The Contingency of Learning Styles and VHGT Levels

		VHGT level				total
		0	1	2	3	
Learning Style	Visual (V)	8	6	1	1	16
	Auditorial (A)	2	3	9	5	19
	Kinesthetic (K)	1	1	1	0	3

Based on table 3, namely the learning style contingency table with the level of geometry ability according to van hiele a statistical test will be performed to determine its association. The results are as follows:

Table 4. Test Statistics Association of Learning Styles With VHGT Level

Information	Score	Interpretation
the probability	0.028	There is an association between
x^2 count it	14,13	student learning styles and the
x^2 table	12.59	level of geometry ability
C (contingency)	0.27	according to van hiele

From table 4. it is known that there is an association between student learning styles and the level of geometry ability according to van hiele. If examined according to table 3. shows that the majority of students' abilities with an auditory learning style are at a higher level compared to other learning styles. This is not following the Lengkana's opinion about the students with visual learning styles have a higher level of mastery of concepts than hearing and kinesthetic, because students can pay attention to presentations by students and educators [9]. Moreover, make mind mapping thoughts that help students visually see relationships and patterns of new information.

In this study, it was found that students with an auditory learning style have geometry thinking skills, as written in table 2. Characteristics of an auditory learning style that is processing information in a nonvisual form such as verbal explanation, a discussion, and listening carefully to the info being conveyed by others. This is in line with online learning during the COVID-19 pandemic that invites students to understand the material by listening and listening.

Another finding is, due to online learning during the pandemic, students tend to like the auditory learning process or listen to explanations and discussions directly. This is supported by the results of the association, namely that the students' enjoyment with an auditory learning style shows that most of the students are at a higher level of geometrical thinking ability. This is also supported by table 2, which shows that students with an auditory learning style have four indicators of geometric thinking abilities that are more than other learning styles.

4. Conclusion
Based on the result and discussion above, it can be concluded that during the covid-19 pandemic, the students tend to use auditory learning style and it is known that there is an association between student learning style and geometric ability level according to Van Hiele. Furthermore, it is known that the higher level of geometry ability of students, the more indicators of ability to think geometry they have.

5. Acknowledgments

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