ISSN: 1742-6596

Journal of Physics

Conference Series

The International Conference on Physics and Mathematics for Biological Science 2019 31 August – 1 September 2019, Jember, Indonesia

1465

Volume 1465

Accepted papers received: 27 January 2020
Published online: 23 March 2020

Editor:
Martin L

The open access *Journal fo conference proceedings*
iopscience.iop.org/jpcs

IOP Publishing

PAPER • **OPEN ACCESS**

The International Conference on Physics and Mathematics for Biological Science 2019

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1465** 011001

The International Conference on Physics and Mathematics for Biological Science 2019

Dwi Wahyuni

Editor in Chief of International Conference on Physics and Mathematics for Biological Science 2019
E-mail: dwiwahyuniwiwik.fkip@unej.ac.id

On behalf of the organizing committe, we would like to thank all of the participants who have taken part in "The International Conference on Physics and Mathematics for Biological Science 2019 (ICOPAMBS 2019)". This special undertaking is the 1st International conference organized by the Department of Mathematics and Basic Science, Faculty of Teacher Training and Education in University of Jember 31 August - 1 September 2019. It is carried out to welcome participants from various countries, from multitudes of interests comprising of Physical Science, Biomedicine, Biotechnology, and Applied Mathematics. Its ultimate mission is to become an annual international forum where civil society organization and representative, university students, academics and researchers, scholars, scientist, teachers and practitioners from all around the globe can share and exchange ideas germane to theoretical and practical knowledge about Physics, Mathematics, Biological Science, and their applications. The conference strives to present and discuss the latest trends on research contributing to the sharing of novel theoretical, methodological and empirical insights and better understanding in the area of Physics, Mathematics, Biological Science, and science education. The conference encompasses the following themes: (1) Physical Mathematics, Computational Physics, and applications, (2) Mathematical modelling for Material Physics, semiconductor materials, and Applications, (3) Bioinformatics and Computational for Biomaterials, (4) Graph Theory, Combinatorics, and Applications, (5) Applied Statistics, (6) Polimer, Biomaterials and applications, (7) Mathematical modelling for Biological Sciences, (8) Environmental science, Biotechnology, and applications (9) Geophysics and Earth Sciences, (10) Development of Sofware engineering for Physics, Mathematics and Biological Sciences

The participants of this ICOPAMBS 2019 were 203 participants consisting research students, academics and researchers, scholars, scientist, teachers and practitioners from many countries. The selected papers to be published on IOP Conference Series: Journal of Physics are 78 papers.

On behalf of the organizing committee, finally we gratefully acknowledge the support from the University of Jember of this conference. We would also like to extend our thanks to all lovely participants who have been joining this unforgettable and valuable event.

Dr. Dwi Wahyuni, M.Kes

THE COMMITTEES

Honorary Advisory Committee:

Assoc Prof. Moch. Hasan, Ph.D	Rector of the University of Jember
Assoc Prof. Zulfikar, Ph.D	Vice Rector of University of Jember
Assoc Prof. Wachyu Subchan, Ph.D	Vice Rector of University of Jember
Prof. Dr. M. Sulthon Masyhud, M.Pd	Vice Rector of the University of Jember

Organizing Committee:

Dr. Dwi Wahyuni, M.Kes	Chairperson
Arif Fatahillah, S.Pd, M.Si	Secretary

Editorial Board

Prof. Dr. Suratno, M.Si	University of Jember, Indonesia
Prof. Dr. Joko Waluyo, M.Si	University of Jember, Indonesia
Prof. Dr. Indrawati, M.Pd	University of Jember, Indonesia
Bambang Supriadi, M.Sc	University of Jember, Indonesia
Zainur Rasyid Ridlo, S.Pd, M.Pd	University of Jember, Indonesia
Robiatul Adawiyah, S.Pd, M.Si	University of Jember, Indonesia
Ermita Rizki Albirri, S.Pd,M.Si	University of Jember, Indonesia
Lioni Anka Monalisa, S.Pd, M.Pd	University of Jember, Indonesia

Scientific Committee and Reviewers

Prof. Andrivo Rusydi,Ph.D	National University of Singapore
Prof. Dafik, M.Sc, Ph.D	University of Jember, Indonesia
Dr. Ramesh Nachimuthu	VIT University
Prof. Dr Endang Susantini, M.Pd	Universitas Negeri Surabaya
Dr Parmin, M.Pd	Universitas Negeri Semarang
Dr Drs. A. Mushawwir Taiyeb, M.Kes	Universitas Negeri Makassar

The committees of the International Conference on Physics and Mathematics for Biological Science would like to express gratitude to all Committees for the volunteering support and contribution in the editing and reviewing process.

PAPER • **OPEN ACCESS**

Peer review statement

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1465** 011002

Peer review statement

All papers published in this volume of *Journal of Physics: Conference Series* have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

Table of contents

Volume 1465

2020

Previous issue Next issue

The International Conference on Physics and Mathematics for Biological Science 2019 31 August – 1 September 2019, Jember, Indonesia

Accepted papers received: 27 January 2020
Published online: 23 March 2020

Open all abstracts

Preface

Papers

Natural Science

+ Open abstract View article PDF

OPEN ACCESS 012004

Mapping the potential pollution of fisheries industry wastewater in the Southern Coast of Jember Regency: Preliminary study on wastewater management planning

S Ariyunita and R N Listyawati

+ Open abstract View article PDF

OPEN ACCESS 012005

A potency of ELF magnetic field utilization to the process of milkfish preservation (*chanos chanos*)

Sudarti, B Supriadi, Subiki, A Harijanto, Nurhasanah and Z R Ridlo

+ Open abstract View article PDF

OPEN ACCESS 012006

The molecular phylogenetic of payangga (*G. margaritacea*), manggabai (*G. giuris*) and hulu'u from Limboto Lake based on cytochrome B sequences

U Nuha, M Amin and U Lestari

+ Open abstract View article PDF

OPEN ACCESS 012007

Process simulation of power screw failure on fatigue load using autodesk inventor

V Mustika, A Triono and R K K Wibowo

+ Open abstract View article PDF

OPEN ACCESS 012008

Diversity of freshwater crab (decapoda) in meru betiri national park

V E Susilo, Suratno, D Wowor and M N Abror

+ Open abstract View article PDF

OPEN ACCESS 012009

Diversity of freshwater shrimp (decapoda) from bandealit rivers meru betiri national park, East Java, Indonesia

V E Susilo, Suratno, N Fadillah, E Narulita and D Wowor

+ Open abstract View article PDF

OPEN ACCESS 012010

Optimizing lactobacillus growth in the fermentation process of artificial civet coffee using extremely- low frequency (ELF) magnetic field

Sudarti, S Bektiarso, S H B Prastowo, T Prihandono, Maryani and R D Handayani

+ Open abstract View article PDF

OPEN ACCESS 012011

The diversity of gastropoda in meru betiri national park

Suratno, V E Susilo, V Doviyana and N Mujiono

+ Open abstract View article PDF

OPEN ACCESS 012012

Implementation of environmental policy on solid waste management in Bondowoso Regency - Indonesia

Khoiron, A N Probandari, W Setyaningsih and H S Kasjono

+ Open abstract View article PDF

Applied Mathematics

OPEN ACCESS 012013

On *r*-dynamic local irregularity vertex coloring of special graphs

I N Maylisa, Dafik, A F Hadi, A I Kristiana and R Alfarisi

+ Open abstract View article PDF

OPEN ACCESS 012014

On *r*-dynamic vertex coloring of line, middle, total of lobster graph

L O Harjito, Dafik, A I Kristiana, R Alfarisi and R M Prihandini

+ Open abstract View article PDF

OPEN ACCESS 012015

On resolving domination number of special family of graphs

Y Wangguway, Slamin, Dafik, D A R Wardani and R Alfarisi

+ Open abstract View article PDF

OPEN ACCESS 012016

Risk management information systems assessment at the television broadcasting company

E Selviyanti and W Sardjono

+ Open abstract View article PDF

OPEN ACCESS 012017

Time series of mathematics education program, FKIP university of jember enthusiast through exponential smoothing method

S Setiawani, A Fatahillah and P Lailani

+ Open abstract View article PDF

OPEN ACCESS 012018

Super edge local antimagic total labeling of some graph operation

M Karimah, Dafik, Slamin, E Y Kurniawati and I H Agustin

+ Open abstract View article PDF

OPEN ACCESS 012019

On resolving domination number of friendship graph and its operation

S Kurniawati, Slamin, Dafik, D A R Wardani and E R Albirri

+ Open abstract View article PDF

OPEN ACCESS 012020

On total *H*-irregularity strength of graphs

M Hidayatul, Dafik, I H Agustin, R Nisviasari and E Y Kurniawati

+ Open abstract View article PDF

OPEN ACCESS 012021

On total *H*-irregularity strength of diamond ladder, three circular ladder, and prism graphs

D M O Suni, Dafik, I M Tirta, A I Kristiana and R Nisviasari

+ Open abstract View article PDF

OPEN ACCESS 012022

Resolving domination number of helm graph and it's operation

A N Hayyu, Dafik, I M Tirta, R Adawiyah and R M Prihandini

+ Open abstract View article PDF

OPEN ACCESS 012023

Modeling the relationship between public transportation and traffic conditions in urban areas : a system dynamics approach

W Sardjono, E Selviyanti and W G Perdana

+ Open abstract View article PDF

OPEN ACCESS 012024

Modeling of development of employee performance factors and dissemination

W Sardjono, E Selviyanti, W G Perdana and J Sudrajat

+ Open abstract View article PDF

OPEN ACCESS 012025

Modeling of development of performance evaluation on health information systems implementation

W Sardjono, E Selviyanti, W G Perdana and Maryani

+ Open abstract View article PDF

OPEN ACCESS 012026

The total *H*-irregularity strength of triangular ladder graphs

R Nisviasari, Dafik and I H Agustin

+ Open abstract View article PDF

OPEN ACCESS 012027

On the super edge local antimagic total labeling of related ladder graph

E Y Kurniawati, I H Agustin, Dafik and Marsidi

+ Open abstract View article PDF

OPEN ACCESS 012028

The locating dominating set (LDS) of generalized of corona product of path graph and any graphs

D A R Wardani, Dafik and I H Agustin

+ Open abstract View article PDF

OPEN ACCESS 012029

On rainbow antimagic coloring of some graphs

B Sulistiyono, Slamin, Dafik, I H Agustin and R Alfarisi

+ Open abstract View article PDF

OPEN ACCESS 012030

On rainbow antimagic coloring of some special graph

Z L Al Jabbar, Dafik, R Adawiyah, E R Albirri and I H Agustin

+ Open abstract View article PDF

Education

OPEN ACCESS 012031

Analysis of realistic mathematics learning approach on the students' problem solving skill and self-confidence on sequence and series materials

A Kosim, Sunardi and I M Tirta

+ Open abstract View article PDF

OPEN ACCESS 012032

The analysis of creative thinking skills of junior high school students in learning natural science on environmental pollution materials with different academic skills

N Maharani, Suratno and Sudarti

+ Open abstract View article PDF

OPEN ACCESS 012033

Problem solving analysis of rational inequality based on IDEAL model

A M Annizar, Masrurotullaily, M H D Jakaria, M Mukhlis and F Apriyono

+ Open abstract View article PDF

OPEN ACCESS 012034

Student worksheet based on inquiry with vee map to improve writing skills in physics learning

T R D Kusumawati, Supeno and A D Lesmono

+ Open abstract View article PDF

OPEN ACCESS 012035

Analysis metacognitive skills of junior high school students on nervous system material with different academic skills

E Jakiyah, Suratno and J Waluyo

+ Open abstract View article PDF

OPEN ACCESS 012036

Student worksheet based on inquiry with vee map to improve students' scientific reasoning ability in physics learning in senior high school

S N Indahsari, Supeno and Maryani

+ Open abstract View article PDF

OPEN ACCESS 012037

Design of assessment based on guided discovery to improve the quality of teachers' professionalism of mathematics

F A Hidajat and B I Hidajat

+ Open abstract View article PDF

OPEN ACCESS 012038

An analysis of students' written mathematical communication in learning limits of functions through dependent field and independent field cognitive style at the eleventh grade of SMAN 1 Surakarta

S N Hayati, P Sujatmiko and I Kurniawati

+ Open abstract View article PDF

OPEN ACCESS 012039

The development of ecosystem education game based on Baluran National Park for senior high school

D Alvionita, W Subchan and M Iqbal

+ Open abstract View article PDF

OPEN ACCESS 012040

Mathematics interactive CD media based on discovery learning on congruence material and its effect on the students' generalization thinking skills.

A Widiatsih, I Baehaqi and D Ariyanto

+ Open abstract View article PDF

OPEN ACCESS 012041

Shifting of perfective metacognitive activities in solve math problems

I D Hastuti, Surahmat, Sutarto and Dafik

+ Open abstract View article PDF

OPEN ACCESS 012042

The development of think together about science in society (TToSS) learning model to increase critical thinking skill in science lesson

O Yuwentin, I K Mahardika, Nuriman, A A I A R Sudiatmika and I W Sugiartana

+ Open abstract View article PDF

OPEN ACCESS 012043

The correlation regression equations between metacognitive skills and concept gaining of science and biology of Indonesian students

B H Siswati and A D Corebima

+ Open abstract View article PDF

OPEN ACCESS 012044

Students' creative thinking skills in solving mathematical logic problem with open-ended approaches

M Kholil

+ Open abstract View article PDF

OPEN ACCESS 012045

The analysis of metacognitive skills and creative thinking skills in STEM education at senior high school for biotechnology

Kustiana, Suratno and D Wahyuni

+ Open abstract View article PDF

OPEN ACCESS 012046

Integrating GeoGebra into geometry space learning: a lesson from traditional cultural festival *tumpeng sewu*

L N Safrida, T B Setiawan, Susanto, E Yudianto, R Ambarwati and I W S Putri

+ Open abstract View article PDF

OPEN ACCESS 012047

Analysis of students critical thinking skills in junior high school on natural sciences based on the difference of learning styles

M Aini, Suratno and I N Asyiah

+ Open abstract View article PDF

OPEN ACCESS 012048

The profile of students' mathematical representation in constructing line equation concept

O C F Mulyono, Sunardi and Slamin

+ Open abstract View article PDF

OPEN ACCESS 012049

Anxiety: how was the process of the undergraduate students who were in visualization level in constructing the definition?

R C Purnomo, Sunardi, N Yuliati, E Yudianto, M Mahfut and C Sa'dijah

+ Open abstract View article PDF

OPEN ACCESS 012050

Error analysis of undergraduate students in solving problems on ring theory

N Fatmiyati, Triyanto and L Fitriana

+ Open abstract View article PDF

OPEN ACCESS 012051

The analysis of metacognitive in biology lesson to senior high school students with different learning interest

R J Riftana, Suratno and D Wahyuni

+ Open abstract View article PDF

OPEN ACCESS 012052

The analysis of students metacognitive in science with different learning environments on junior high school

N N Musyafaah, Suratno and Nuriman

+ Open abstract View article PDF

OPEN ACCESS 012053

The anxiety of students on deduction level in proving the geometry theorem

K Ni'mah, Susanto, Sunardi and Hobri

+ Open abstract View article PDF

OPEN ACCESS 012054

Creative thinking level of visual-spatial students on geometry HOTS problems

A N Aini, M Mukhlis, A M Annizar, M H D Jakaria and D D Septiadi

+ Open abstract View article PDF

OPEN ACCESS 012055

Analyzing types of interaction in nuclear magnetic spectroscopy online discussion forums that affects student learning outcomes

I W A Terra, S Wonorahardjo and S Suharti

+ Open abstract View article PDF

OPEN ACCESS 012056

Teachers' belief toward science and local wisdom's integration in mathematics instruction

A A Jingga and I Sujadi

+ Open abstract View article PDF

OPEN ACCESS 012057

Validity of physical learning module based on multiple representation and higher order thinking skills

I K Mahardika, I G Rasagama, L Indrianto, A Doyan and Supeno

+ Open abstract View article PDF

OPEN ACCESS 012058

The analysis of students' critical problem solving on circle-related questions using pesantren-based scientific approach

A Kriswanto, Susanto and M Irvan

+ Open abstract View article PDF

OPEN ACCESS 012059

Students' error analysis in solving geometry problems based on the mathematical anxiety under the theory of van hiele

A K Dewi, Sunardi, M Irvan, Hobri and F N Rohmah

+ Open abstract View article PDF

OPEN ACCESS 012060

An analysis of the students' anxiety in solving creative thinking problem on geometry according to van hiele's theory

F N Rohmah, Sunardi, M Irvan, Hobri and A K Dewi

+ Open abstract View article PDF

OPEN ACCESS 012061

Student profile in constructing concept of exponential through the problem posing

H Cahyohadi, Sunardi and M Irfan

+ Open abstract View article PDF

OPEN ACCESS 012062

Deduction level of undergraduate students' imagination in solving geometrical problem

M Mahfut, Sunardi, E Yudianto, R C Purnomo and F F Firmansyah

+ Open abstract View article PDF

OPEN ACCESS 012063

The students' perception of the teacher's apperception and its influence on students' initial knowledge

P R Musthofa and I Sujadi

+ Open abstract View article PDF

OPEN ACCESS 012064

The profile of student's creative thinking skills in mathematics problem solving in terms of adversity quotient

Nahrowi, Susanto and Hobri

+ Open abstract View article PDF

OPEN ACCESS 012065

The analysis of learning materials implementation using inquiry based learning method to enhance student's critical thinking skills in solving two dimensional problem

A M Y Wijaya, Hobri, T D Prastiti, Dafik and Suratno

+ Open abstract View article PDF

OPEN ACCESS 012066

Students' combinatorial generalization thinking skills in solving tessellation coloring pattern problems and its enhancement through problem-based learning

M Anwarudin, Dafik and M I Farisi

+ Open abstract View article PDF

OPEN ACCESS 012067

Cognitive description of students in mathematics learning through lesson study

H A Susanto, D Hidajat, Hobri and D D H Jatmiko

+ Open abstract View article PDF

OPEN ACCESS 012068

Inquiry-based physics textbooks with multi representation to practice hypothetico deductive reasoning for senior high school students

I K Mahardika, P O Wardani, Yushardi and A Prasetyaningsih

+ Open abstract View article PDF

OPEN ACCESS 012069

Characteristics of textbooks based on the sets(science, environment, technology, and society) of the respiratory system to improve the ability of junior high school students to multi-representations

I K Mahardika, M I M Y Rudiansyah, Yushardi, I G Kasagama and A Doyan

+ Open abstract View article PDF

OPEN ACCESS 012070

Analysis of students' critical thinking skills on social arithmetics with jumping task

Hobri, R Oktavianingtyas, D Trapsilasiwi, R P Murtikusuma and Q A'yun

+ Open abstract View article PDF

OPEN ACCESS 012071

Critical thinking dispositions in solving recreational mathematics problem: opposite corners

S Hussen, L A Monalisa, R P Murtikusuma, L N Safrida, E Oktavianingtyas, E A Nurdin and A D P Rini

+ Open abstract View article PDF

OPEN ACCESS 012072

Design of *PISA*-liked problem which used *jember fashion carnival* context to train students' analytical thinking

D D Septiadi, M Kholil, Masrurotullaily, F Apriyono and A N Aini

+ Open abstract View article PDF

OPEN ACCESS 012073

An analysis of students' difficulties in conjecturing process of block paving problems

Sutarto, Dafik, I D Hastuti and Surahmat

+ Open abstract View article PDF

OPEN ACCESS 012074

Development of structured modules to improve the mathematical understanding of the circle concept in class VIII Mataram 17 junior high school

Mahsup and Y S Anwar

+ Open abstract View article PDF

OPEN ACCESS 012075

HOTS student worksheet to identification of scientific creativity skill, critical thinking skill and creative thinking skill in physics learning

S Astutik, I K Mahardika, Indrawati, Sudarti and Supeno

+ Open abstract View article PDF

JOURNAL LINKS

Journal home

Information for organizers

Information for authors

Contact us

Reprint services from Curran Associates

PAPER • **OPEN ACCESS**

Deduction level of undergraduate students' imagination in solving geometrical problem

To cite this article: M Mahfut *et al* 2020 *J. Phys.: Conf. Ser.* **1465** 012062

Deduction level of undergraduate students' imagination in solving geometrical problem

M Mahfut[1], Sunardi[2], E Yudianto[2], R C Purnomo[1] and F F Firmansyah[1]

[1]Master Student in the Department of Mathematics Education, University of Jember
[2]Department of Mathematics Education, University of Jember

Corresponding author: mahfut25@gmail.com

Abstract. This research aims to know the imagination process on Mathematics' undergraduate students who had deduction level in solving Geometrics' problem. This research is qualitative which the subjects in the research were 2 students that one female and one male. To know the imagination process, subjects were asked to solve two Geometrics' problems. Analysis was done to determine the indicators of imagination that appeared for each subjects. To improve the data accuration, the researcher used triangulated data method for the data collection method, such as observation, students' worksheet, and interview. The result showed that there were differencies that appeared for each subjects.

1. Introduction

Imagination is someone's ability to draft the picture or idea about an event which they have never seen or experienced before in their thought[1]. Liang et al., divided imagination into two. They are reproductive and creative imagination, composed those two types into some indicators, such as transformation, crystallization, effectiveness, elaboration, exploration, intuition, innovation, productivity, and sensitivity[2].

This research about imagination in education is not the first time, as the example are the researches which were conducted [2,3,4,5,6]. Those researches showed the importance of imagination in solving a problem, especially in Mathematics. It was caused by the immateriality of content in Mathematics or it only existed in people's thought. Alphen said that someone would not be able to understand the history or even problem in Mathematics orally if that person did not have imagination[7]. Based on some saying from the experts before, it can be inferred that imagination is important thing in understanding Mathematics. One of Mathematics' branches is Geometrics. It studies about geometry.

Van Hiele is an influential person in Geometrics. He leveled someone's geometrics' ability into 5 stages. One of the stages is deduction. Haviger and Vojkůvková explained that someone who was in deduction level could give geometrical evidence deductively[8]. Moreover, that person could understand and applied the use of definition, theorem, and axiom. This article will explain the process of undergraduate students' imagination in deduction level in solving geometrical problem. Therefore, this research aims to explain the imagination process of undergraduate students in solving geometrical problem.

2. Basic Theory

Imagination

Imagination as a new way to provide "natural house" for something that is in thought[9]. While imagination is people ability to draft the picture or idea in their thought about an event that they have ever seen or experienced before[1]. It was clarified by Wibowo et al., who explained that imagination is an ability to shape ideas in solving problem[6]. Imagination is a basic in building creative thinking and promoting innovation[2]. Imagination developed people creative ideas become product or object based on those ideas [10]. Imagination can make people travel world, solve problem, and develop new skill which is within their selves [11]. Imagination affects someone's idea, language, and experience every day[12, 13, 14, 15, 16, 17]. Based on the previous explanation, it can be concluded that imagination is someone ability to shape the picture or idea in solving a problem.

Liang et al., divided imagination into two types; they are creative and reproductive imagination. Creative imagination is an ability to manage received objects and compile them by using any ways. Meanwhile, reproductive imagination is an ability to maintain simple impression from object. Reproductive imagination is had by people in various levels[2]. From both types of imagination, some indicators were composed. It is in Table 1.

Table 1. Indicator of Imagination

Type of Imagination	Indicator	Explanation
Creative Imagination	Intuition	Individual can associate with the target object soon.
	Sensitivity	Individual is able to issue or move feelings during creation process.
	Productivity	Individual can produce lots idea about an object.
	Exploration	Individual can explore or imagine something that never has been known.
	Innovation	Individual can create anti-mainstream or idea that never has been made.
Reproductive Imagination	Focus	Individual is able to shape structure or shape from an idea through focus.
	Effectiveness	Individual is able to build effective ideas about object or target theme.
	Transformation	Individual can do a task by changing what they had known in any disciplines.
	Crystallization	Individual is able to express abstract ideas by using concrete examples.
	Dialectics	Individual is able to develop idea or object by using logic analysis.

Van Hiele's Theory

Van Hiele is influential person in Mathematics. He divided someone's ability in Geometrics into 5 stages, such as; level 0 (visual), level 1 (analysis), level 2 (informal deduction), level 3 (deduction), and level 4 (Rigor). Haviger and Vojkůvková explained that students who were in deduction level

were able to differentiate whether the needed condition or enough condition[18]. They identified characteristics which were implied by others. They understood the use of definition, theorem, axiom, and evidence. The researchers found some indicators on deduction level students, they are ability to correct (clarify) ambiguous problem to proper language, reasoning and answering to verify the problem, ability to understand Mathematics' terms such as axiom, definition, theorem, and evidence, and implicit understanding about postulate of Euclidean Geometry[19, 20. 21, 22, 23, 24].

3. Methods

Subject

To achieve the expected aim in this research, undergraduate students of Mathematics education department of Jember University which have deduction level based on van Hiele's test was chosen. It was started from giving van Hiele's test to 140 undergraduate students. The result showed there were 14 students in level 0 (pre-visualization), 21 students in level 1 (visualization), 39 students in level 2 (analysis), 61 students in level 3 (informal deduction), and 5 students in level 4 (deduction), while there was no student in level 5 (rigor). 2 students who were in deduction level were chosen as the research subject. The selection was based on some aspects such as fluent communication, flexible time, and the subject's willingness to be involved in research.

Data Collection

Data collection in this research was done through test and interview. There are two test methods that used by van Hiele to select research subject and Geometrics problem test. Van Hiele's test that used was taken from Usiskin that had been translated to Bahasa Indonesia by Sunardi at 2010. Then, the second test was Geometrics problem test. In this test, the subject had been given two problems of Geometrics, then they were asked to solve those problems, and the result of their works was followed by interviewing the subject. Interview was done after the subject had done the given problem about Geometrics. The questions referred to interview guidelines that had been made and validated. The process of research from the test up to interviewing the subject was documented in the form of audio-visual. It was done to simplify the researchers in analyzing the result of this research.

Data Analysis

The first step in analyzing the data was writing the dialogue in interview between the researchers and the subject. It was done to simplify the process of data analyzing. Analysis was done based on the result of subject's work, dialogues in interview, and subject's attitude when solving the problem. those three elements were combined, so that it was obtained which indicators that appeared on those subjects.

4. Results and Discussion

Researches about imagination had been done, one of them is a research by Liang et al., which entitled The Exploration of Indicators of Imagination. In this research, Liang divided the imagination's indicators became 10 and this research is one of the references for this research[2]. The next one is the research by Wibowo et al., which entitled Characteristics of Students Sensory Mathematical Imagination in Solving Mathematics Problem. In that research, Wibowo explained about the students' characteristics which had sensory imagination in solving Mathematics problem. Subject of that research was VII grade students. This research used different indicator from the one that used by Wibowo, and also the subjects of this research were given test to find out subject's van Hiele's level. The subjects were who had deduction level[6].

Imagination process on undergraduate students who was in deduction level based on the indicators that appeared when the subjects did the problems about geometry. Subjects in this research were one female undergraduate student which called as S1 and one male undergraduate student which called S2. Those two subjects were undergraduate students who were in deduction level based on van Hiele's test. Next, those subjects were given 2 Geometrics' problems which can be seen in Table 2.

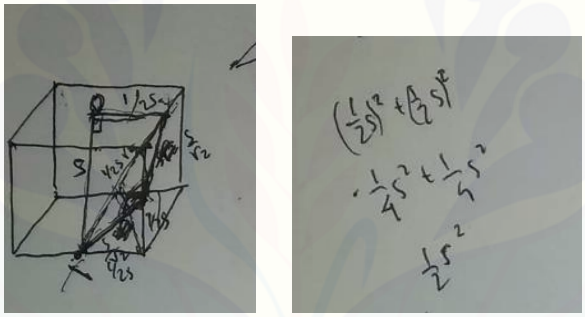
Table 2. Geometrics' Problem

Number	Problem
1	There is ABCD.EFGH cube. Midpoint of the AB, BF, and FG side were symbolized with X, Y, Z. Determine the dimensions of ∠ XYZ!
2	There is ABCD.EFGH cube. Measure the projection's length from DE line to BDHF area!

After the subjects finished the given problems, the interview was done to them. It was done to dig up the information about their imagination process.

S1's Imagination Proses

The steps of finishing the problem by S1 was started from reading the problem, then S1 illustrated the problem in question number 1 became a picture. After that, S1 thought solution of that problem and applied it. The solution from S1 could not solve the problem, so that S1 re-read the problem and repeated the steps from the beginning. S1 illustrated the problem became a picture and searched another solution. She did it repeatedly. Concept of sinus and cosine were given since the subject did not find the solution, yet. After that, S1 searched the third solution and applied it. Unfortunately, S1 found a dead end so that she could not finish it.



(a) (b)

Figure 1. S1 Answers to The First Problem

S1 started the second problem by reading it, then she illustrated the problem became a picture. After that, S1 thought the solution of that problem and applied it. The solution could not solve the problem, so that S1 re-read the problem and repeated the steps from the beginning. S1 illustrated the problem became a picture and searched the solution. Projection concept was given as help for S1 since she could not find the solution, yet. After that, S1 searched the third solution and applied it. Through this solution, S1 could solve the given problem. After finishing the problem using the found solution, S1 obtained other solution and it could solve the problem, too. Based on those two solution, S1 was able to decide which solution was more effective for the problem.

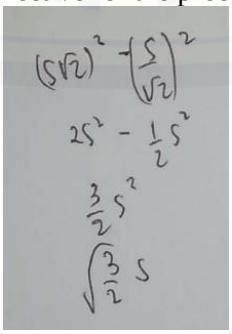


Figure 2. S1 Answers to The Second Problem

The indicators that appeared when S1 solved problem number 1 were intuition and focus. In ths research, intuition meant that the subject was able to find the solution soon after reading the problem. S1's intution could be seen when doing the problem number 1. Soon after S1 read the problem, she immediately applied the idea. Focus in this research meant that subject was able to construct the idea. S1's focus could be seen when she started the problem when she searched what she needed first to solve the problem.

The appeared indicator when S1 solve the problem number 2 was crystallization, intuition, dialectics, productivity, transformation, effectiveness, and focus. Nuthall and Old stated that intuition is important component in decision-making and underlie human asset[25]. In this research, intuition was solution that appeared soon after reading the problem. S1's intuition in solving problem number 2 could be seen when she finished reading the problem, she applied the idea. Crystallization of S1 could be seen when she played her hands to help herself imagining the problem and when she used cake box as geometry in problem. S1's dialectics could be seen when a question was given to S1 as could be seen in Table 3.

Table 3. S1's Dialogue Interview

People	Question
Researcher	Which one is the slanted angle of that triangle?
S1	(Saw the box and move her fingers) It is wrong, $DP^2 = ED^2 - EP^2$ so, $\left(S\sqrt{2}\right)^2 - \left(\frac{S}{\sqrt{2}}\right)^2 \rightarrow 2S^2 - \frac{1}{2}S^2 \rightarrow \frac{3}{2}S^2$

S1's productivity was appeared at the end of solving. After she successfully finished the problem, she obtained other ways that more effective from the first way (effectiveness). Not only one way, but he also found two other ways besides the way she used to solve the problem. Next, transformation indicator on S1 could be seen from the combination of concept she used, such as Pythagoras, multiplication, one-line projection to area, division, and many more. Focus in this research meant that subjects were able to construct a structure from the idea they obtained. S1's focus could be seen when she started to solve the problem. She searched what she needed to solve it first.

Based on the analysis before, S1's imagination process in solving the problem was illustrated and could be seen in Figure 3.

S2's Imagination Proses

2 started doing the first problem by reading the problem. Then, he S2 guessed the answer. S2 searched a way to prove the answer. S2 guessed that the answer for number 1 were 90º, 120º, and 135º. For 90º angle, S2 could not find its proof, and also S2 thought that the searched angle was not perpendicular angle, but obtuse angle. Next, S2 illustrated the problem in the form of dimension 2. Based on the picture, S2 assumed that the formed angle was 135º then the concept of geometry was given. After that, S2 realized his fault then re-thought the way to solve the problem. Next, S2 found that if the angle of XYZ was rotated would be as same as XYF angle, so that S2 concluded that XYZ angle was 120º.

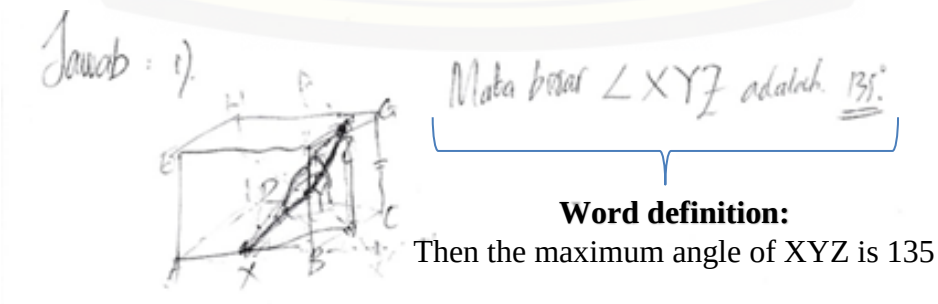


Figure 3. S2 Answers to The First Problem

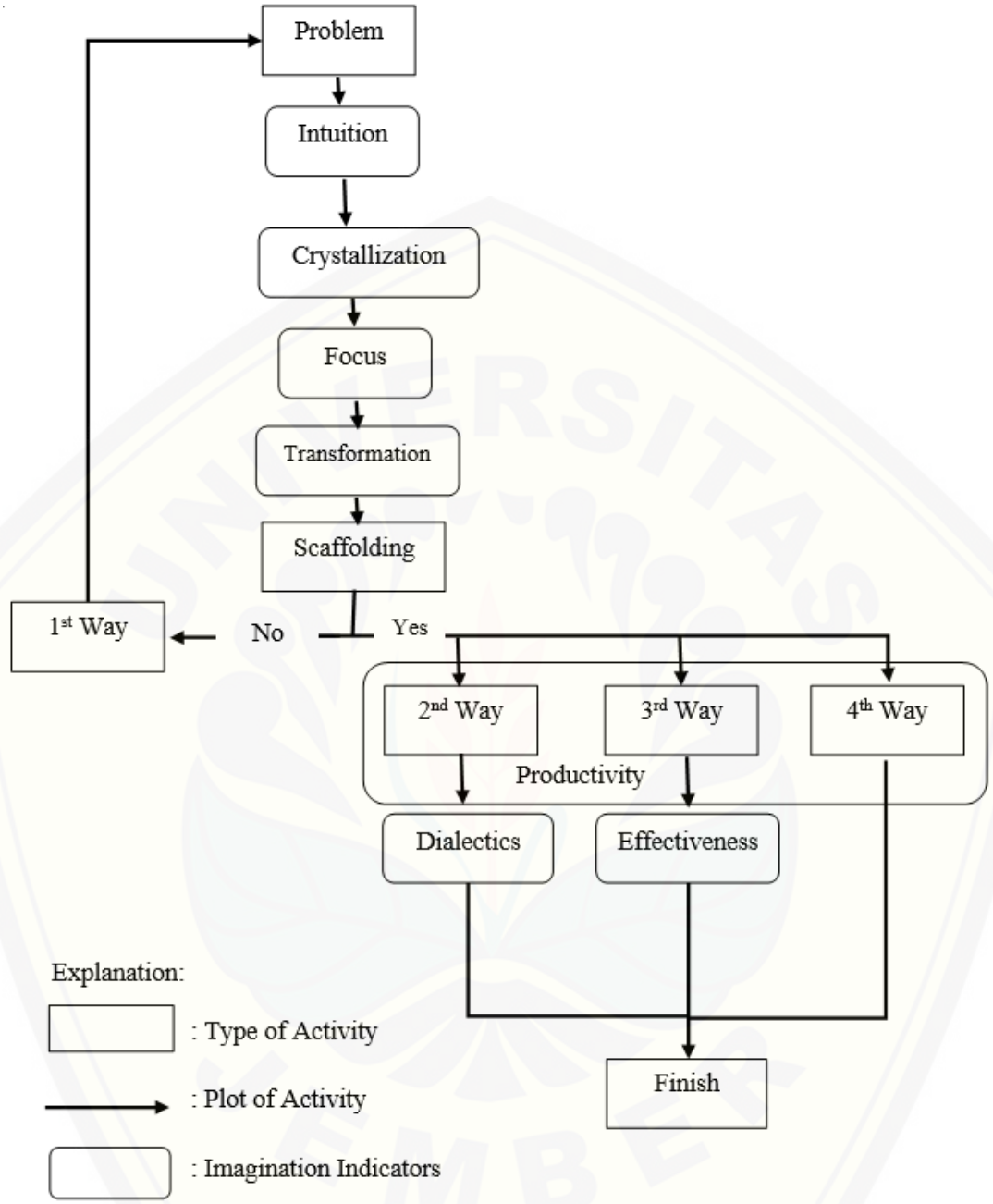
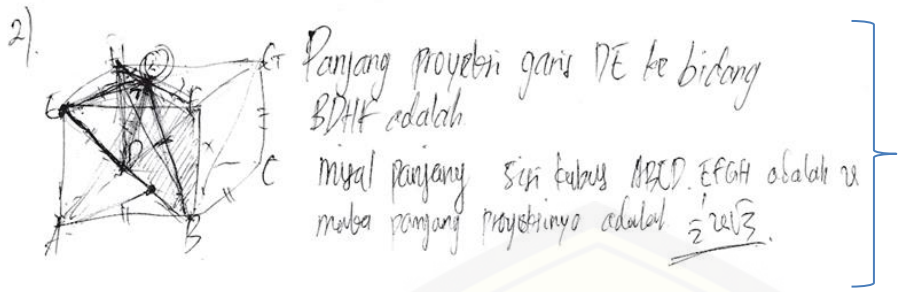


Figure 4. S1's Imagination Process in Solving the Problem

In problem number 2, S2 had difficulty because he forgot the projection material. Therefore, projection concept was given as a help. After S2 remembered the concept, S2 re-read the problem and then started to solve the problem. S2 started to construct the geometry that illustrated in the problem then S2 guessed the probable answer. S2 started to imagine the point of projection from DE line to BDHF area. After he found the projection point, S2 imagined the shaped area which the area was right triangle area. In the second problem, many ways were explained by S2. Those ways using pythagoras and the rule of sinus and cos which was varied by various angle.



Word definition:
The length of DE's line projection to BDHF area is
If the length of ABCD.EFGH cube side is x, then the length of projection is $\frac{1}{2}\sqrt{3}$

Figure 5. S2 Answers to The Second Problem

The appeared indicators on S2 when she solved the first problem were intuition, sensitivity, productivity, innovation, focus, effectiveness, transformation, crystallization, and dialectics. Intuition on S2 could be illustrated when he guessed the probable answer. At that time, S2 guessed XYZ angle was between 90º, 120º, and 135º. That intuition was important component of decision-making and underlie human's asset[25]. Sensitivity indicator was appeared because S2 was curious when he solve first and second problem. It made S2 tried harder to solve the problem. It is explained in the interview with S2 that can be seen in the Table 4.

Table 4. Interview Dialogue with S2

People	Question
Researcher	How was your feeling when you were solving the problem?
S2	I was curious. I will search the solution until success if I have Mathematics' problem and I could not solve it.

The next indicator was crystallization. Crystallization is individual ability to expresses abstract ideas to concrete example[2]. In this research, crystallization can be interpreted as subject's attitude in imagining cube into real shape (box, room, and etc.). On S2, crystallization was marked by playing his ballpoint and moved it to the room (assumed the room as cube) and imagining the line in the first problem. Transformation was individual ability to do the task by using familiar information from any disciplines[2]. On S2, transformation indicator appeared when S2 solving the problem, when S2 combined some mastered materials to solve the problem. However, there was a mistake in that process so that a help in the form of geometry's concept was given to S2. After that S2 re-investigated his work and did a mistake in finishing process so that he repeated the process. It was one of imagination indicator which was dialectics. Productivity indicator appeared when S2 solved the first problem. It was marked by the way S2 solved the problem not using just single way. The ways used were the rule of cosine and by rotating XYZ angle became XYF angle, so that he found that XYZ angle was 120º. The solution from S2 by rotating XYZ angle became XYF angle could be said as new way because it was never done by people, even only S2 who thought about this way. For S2, this way was the most effective way because it did not need more material and also it was faster in finishing (effectiveness). The way done by S2 proved that innovation indicator was appeared in this research. S2's focus could be seen when S2 was able to find needed thing to solve the problem.

On the second problem, the indicator that appeared on S2 was intuition, sensitivity, productivity, innovation, focus, effectiveness, transformation, and crystallization. On the second problem, the process that was done by S2 was as same as the first problem. The activity was started by reading the problem, then S2 guessed the probable answer (intuition). However, on the second problem, S2 forgot about the projection so that the material about projection was given at first. Next, S2 read the problem and guessed the probable answer again. After that, he constructed the construction of geometry on the problem. S2 imagined the room he occupied as cube and S2 started fidgeting his fingers to help him imagining the geometry of that problem (crystallization). S2 started to solve the problem. There were many ways that were stated by S2 for the second problem (productivity). Those ways were the concept

of cosine, Pythagoras function, and rule of cosine (transformation). From all those ways, S2 compared with any sides of cube so that he obtained various solutions. S2 thought that solved the problem using Pythagoras function with DE, EO, and DO sides was the most effective way. It was caused by that way was the simplest and it was still appropriate with projection concept (effectiveness). Innovation indicator was indicated by solving the problem using the rule of sinus and cosine.

Briefly, imagination process on S2 in solving the problem can be seen in Figure 6.

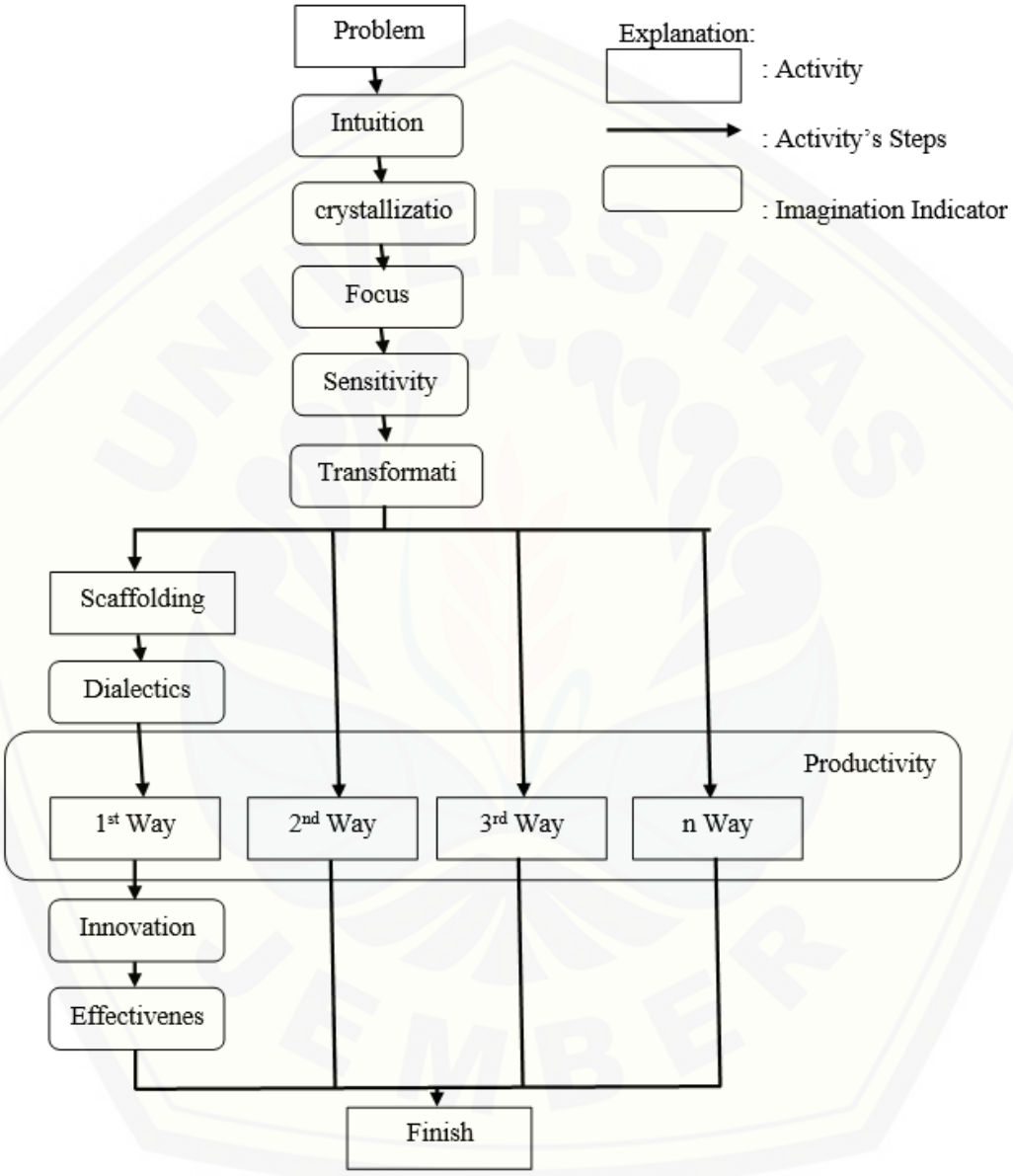


Figure 6. S2's Imagination Process in Solving Problem

5. Conclusion

Imagining process of the S1 was started by intuition, and it was continued by crystallization, focus, transformation, dialectic, productivity, and effectiveness. While, for the S2, imagining process was started by intuition indicator, then it was continued to crystallization, focus, sensitivity, transformation, dialectic, productivity, innovation, and effectiveness. Imagining process of both subjects can be said as the same. It comes from the indicators that appeared from both subject are

same, however sensitivity did not appear on the first subject. Besides the same indicators, the sequence of indicators that appeared on both subject can be said as the same

Acknowledgment
The Authors acknowledge to the Mathematics Education Dept. of Educational Faculty, Jember University for supporting this project.

References

[1] Samli A C 2016 From Imagination to Innovation Empower *Mark. Econ. through Innov. Entrep* 115–24
[2] Lian C, Chang C C, Chang Y and Lin L J 2012 The exploration of indicators of imagination Turkish Online *J. Educ. Technol* **11** 366–74
[3] Nemirovsky R and Ferrara F 2009 Mathematical imagination and embodied cognition *Educ. Stud. Math* **70** 159–74
[4] Chapman O 2008 Imagination as a tool in mathematics teacher education *J. Math. Teach. Educ* **11** 83–8
[5] Wilke J 2006 Using Imagination in the Math Classroom **39** 15–8
[6] Wibowo T, Sutawidjaja A, Rahman A and Made I 2017 Characteristics of Students Sensory Mathematical Imagination in Solving Mathematics Problem *Int. Electron. J. Math. Educ.* **12** 609–19
[7] Van Alphen P 2011 Imagination as a transformative tool in primary school education *RoSE - Res. Steiner Educ* **2** 16–34
[8] Haviger J and Vojkůvková I 2015 The van Hiele Levels at Czech Secondary Schools *Procedia - Soc. Behav. Sci* **171** 912–8
[9] Kotsopoulos D and Cordy M 2009 Investigating imagination as a cognitive space for learning mathematics *Educ. Stud. Math* **70** 259–74
[10] Eckhoff A and Urbach J 2008 Understanding imaginative thinking during childhood: Sociocultural conceptions of creativity and imaginative thought *Early Child. Educ. J* **36** 179–85
[11] Wang C C, Niemi H, Cheng C L and Cheng Y Y 2017 Validation of learning progression in scientific imagination using data from Taiwanese and Finnish elementary school students *Think. Ski. Creat* **24** 73–85
[12] Adams J 2004 The imagination and social life *Qual. Sociol* **27** 277–97
[13] Aristotle F 2004 Scientific Imagination in the *Middle Ages Perspect. Sci*. **12** 394–423
[14] Mountain V 2007 Educational contexts for the development of children's spirituality: Exploring the use of imagination *Int. J. Child. Spiritual.* **12** 191–205
[15] Wang C C, Ho H C and Cheng Y Y 2015 Building a learning progression for scientific imagination: A measurement approach *Think. Ski. Creat.* **17** 1–14
[16] Puga I and Easthope R 2017 The sociological imagination
[17] Racanière S, Weber T, Reichert D P, Buesing L, Guez A, Rezende D, Badia A P, Vinyals O, Heess N, Li Y, Pascanu R, Battaglia P, Hassabis D, Silver D and Wierstra D 2017 Imagination-augmented agents for deep reinforcement learning Advances in *Neural Information Processing Systems*
[18] Haviger J and Vojkůvková I 2015 The van Hiele Levels at Czech Secondary Schools *Procedia - Soc. Behav. Sci.* **171** 912–8
[19] Burger W F and Shaughnessy J M 1986 Characterizing the van Hiele Levels of Development in *Geometry J. Res. Math. Educ.* **17** 31
[20] Musser G L, Burger W F and Peterson B E 2011 Mathematics for Elementary Teachers *A Contemporary Approach (United States of America: John Wiley & Sons, Inc)*
[21] Yudianto E, Sunardi, Sugiarti T, Susanto, Suharto and Trapsilasiwi D 2018 The identification of van Hiele level students on the topic of space analytic geometry *J. Phys. Conf. Ser*. 983

[22] George W 2017 Bringing van Hiele and Piaget Together: A Case for Topology in *Early Mathematics Learning J. Humanist. Math.*
[23] Watan S and Sugiman 2018 The Van Hiele theory and realistic mathematics education: As teachers' instruction for teaching geometry *AIP Conference Proceedings*
[24] Rofii A, Sunardi S and Irvan M 2018 Characteristics of Students' Metacognition Process At Informal Deduction Thinking Level in Geometry Problems *Int. J. Emerg. Math. Educ.*
[25] Nuthall P L and Old K M 2018 Intuition, the farmers' primary decision process. A review and analysis *J. Rural Stud.* **58** 28–38