

ISSN: 1742-6596

Journal of Physics

Conference Series

3rd International Conference on Combinatorics, Graph Theory, and Network Topology 26-27 October 2019, East Java, Indonesia

1538

Volume 1538

Accepted papers received: 14 April 2020

Published online: 19 June 2020

Editor:
Martin L

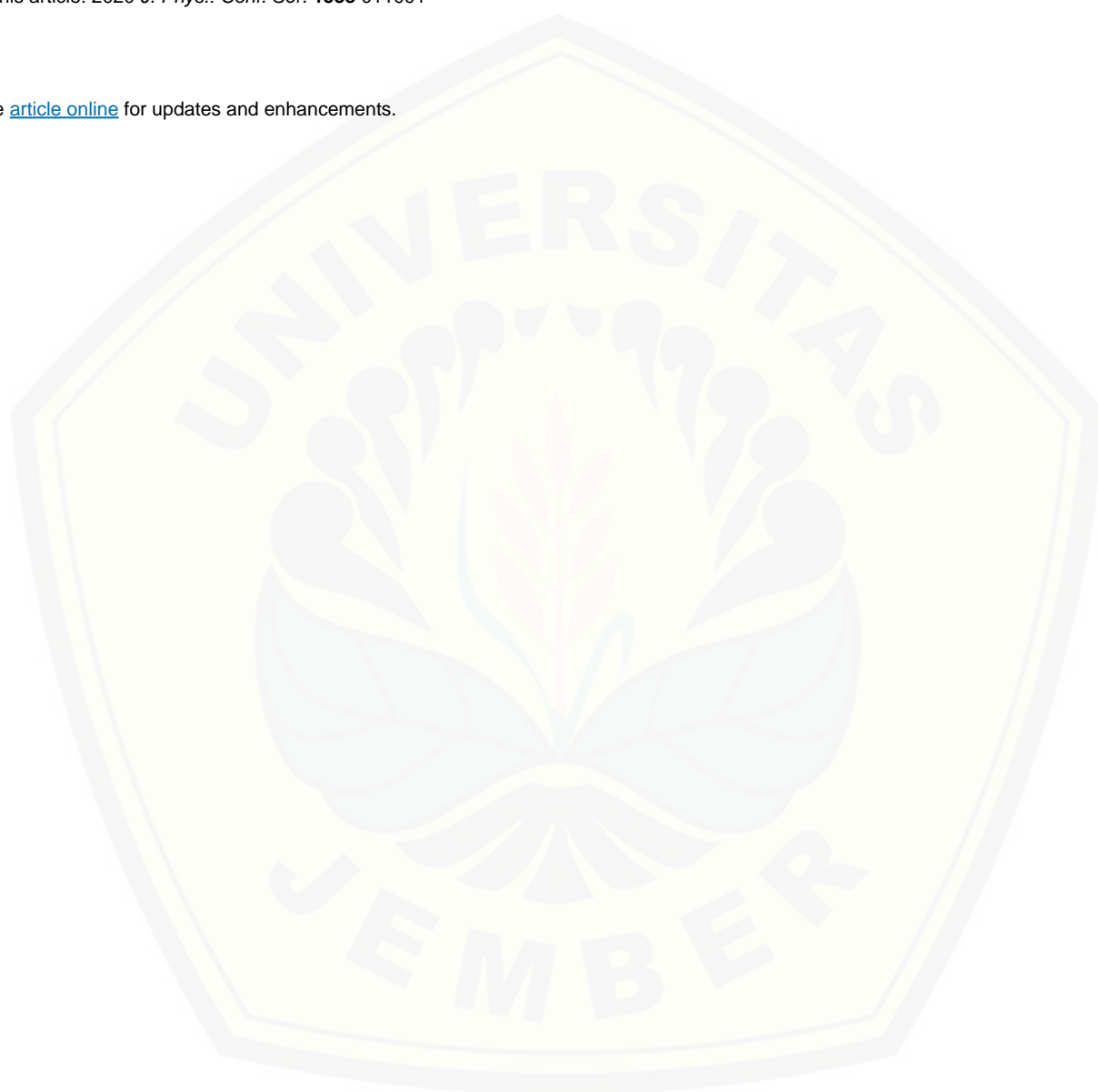
The open access *Journal of Physics Conference Series*
iopscience.iop.org/jpcs

PAPER • OPEN ACCESS

The Third International Conference on Combinatorics, Graph Theory, and Network Topology 2019

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1538** 011001

View the [article online](#) for updates and enhancements.



The Electrochemical Society
Advancing solid state & electrochemical science & technology

240th ECS Meeting ORLANDO, FL

Orange County Convention Center Oct 10-14, 2021



Abstract submission due: April 9

SUBMIT NOW

The Third International Conference on Combinatorics, Graph Theory, and Network Topology 2019

Dafik

Editor in Chief of International Conference on Combinatorics, Graph Theory, and Network Topology 2019

E-mail: d.dafik@unej.ac.id

We would like to express our gratitude to all participant who were joining “The Third International Conference on Combinatorics, Graph Theory, and Network Topology (ICCGANT)”. It is the 3rd International conference held by the CGANT Research Group held by University of Jember in cooperation with Indonesian Combinatorics Society (INACOBMS) on 26-27 October 2019. The conference is held to welcome participants from many countries, with broad and diverse research interests of mathematics especially combinatorial study. The mission is to become an annual international forum in the future, where, civil society organization and representative, research students, academics and researchers, scholars, scientist, teachers and practitioners from all over the world could meet in and exchange an idea to share and to discuss theoretical and practical knowledge about mathematics and its applications. The aim of the third conference is to present and discuss the latest research that contributes to the sharing of new theoretical, methodological and empirical knowledge and a better understanding in the area mathematics, application of mathematics as well as mathematics education. The themes of this conference are as follows:

(1) Connection of distance to other graph properties, (2) Degree/diameter problem, (3) Distance-transitive and distance-regular graphs, (4) Metric dimension and related parameters, (5) Cages and eccentric graphs, (6) Cycles and factors in graphs, (7) Large graphs and digraphs, (8) Spectral Techniques in graph theory, (9) Ramsey numbers, (10) Dimensions of graphs, (11) Communication networks, (12) Coding theory, (13) Cryptography, (14) Rainbow connection, (15) Graph labelings and coloring, (16) Applications of graph theory The topics are not limited to the above themes but they also include the mathematical application research of interest in general including mathematics education, such as: (1) Applied Mathematics and Modelling, (2) Applied Physics: Mathematical Physics, Biological Physics, Chemistry Physics, (3) Applied Engineering: Mathematical Engineering, Mechanical engineering, Informatics Engineering, Civil Engineering, (4) Statistics and Its Application, (5) Pure Mathematics (Analysis, Algebra and Geometry), (6) Mathematics Education, (7) Literacy of Mathematics, (8) The Use of ICT Based Media In Mathematics Teaching and Learning, (9) Technological, Pedagogical, Content Knowledge for Teaching Mathematics, (10) Students Higher Order Thinking Skill of Mathematics, (11) Contextual Teaching and Realistic Mathematics, (12) Science, Technology, Engineering, and Mathematics Approach, (13) Local Wisdom Based Education: Etnomathematics, (14) Showcase of Teaching and Learning of Mathematics, (15) The 21st Century Skills: The Integration of 4C Skill in Teaching Math.



There were 250 participants in ICCGANT 2019, consist of 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 **114** 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.

Prof. Drs. Dafik, M.Sc., Ph.D.



THE COMMITTEES**Honorary Advisory Committee:**

Assoc Prof. Moch. Hasan	Rector of the University of Jember
Assoc Prof. Zulfikar	Vice Rector of the University of Jember
Assoc Prof. Wachyu Subhan	Vice Rector of the University of Jember
Prof. M. Sulthon	Vice Rector of the University of Jember

Organizing Committee:

Prof. Dafik	Chairperson
Ika Hesti Agustin	Secretary

Editorial Board

Arika Indah Kristiana	University of Jember, Indonesia
Ridho Alfarisi	University of Jember, Indonesia
Rafiantika Megahnia Prihandini	University of Jember, Indonesia
Ermita Rizky Albirri	University of Jember, Indonesia
Robiatul Adawiyah	University of Jember, Indonesia
Elsa Yuli Kurniawati	University of Jember, Indonesia
Rosanita Nisviasari	University of Jember, Indonesia
Dwi Agustin Retno Wardani	IKIP PGRI Jember, Indonesia

Scientific Committee and Reviewers

Joe Ryan	University of Newcastle, Australia
Yuqing Lin	University of Newcastle, Australia
M. Venkatachalam	Kongunadu Arts And Science College, India
Edy Tri Baskoro	Institut Teknologi Bandung, Indonesia
Guillermo Pineda-Villavicencio	Federation University Australia, Australia
Slamin	University of Jember, Indonesia
Ali Ahmad	Jazan University, Saudi Arabia
Roslan Hasni	Universiti Malaysia Terengganu, Malaysia
Kiki A. Sugeng	University of Indonesia, Indonesia
Rinovia Simajuntak	Institut Teknologi Bandung, Indonesia
Hilda Assiyatun	Institut Teknologi Bandung, Indonesia
Lilie Susilowati	Universitas Airlangga, Indonesia
Diary Indriati	Universitas Sebelas Maret, Indonesia
Syaiful Bukhori	University of Jember, Indonesia
Antonius Cahya Prihandoko	University of Jember, Indonesia
Bambang Sujanarko	University of Jember, Indonesia
Khairul Anam	University of Jember, Indonesia

The committees of the Second International Conference on Combinatorics, Graph Theory, and Network Topology 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.* **1538** 011002

View the [article online](#) for updates and enhancements.



The Electrochemical Society
Advancing solid state & electrochemical science & technology

240th ECS Meeting ORLANDO, FL

Orange County Convention Center Oct 10-14, 2021



Abstract submission due: April 9

SUBMIT NOW

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 1538

2020

◀ Previous issue Next issue ▶

**3rd International Conference on Combinatorics, Graph Theory, and Network Topology 26-27
October 2019, East Java, Indonesia**

Accepted papers received: 14 April 2020

Published online: 19 June 2020

Open all abstracts

Preface

OPEN ACCESS 011001

The Third International Conference on Combinatorics, Graph Theory, and Network
Topology 2019

+ Open abstract  View article  PDF

OPEN ACCESS 011002

Peer review statement

+ Open abstract  View article  PDF

Combinatorics

OPEN ACCESS 012001
On total edge irregularity strength of tadpole chain graph $Tr(6, n)$

E Nurdini, I Rosyida and Mulyono

+ Open abstract  View article  PDF

OPEN ACCESS 012002

The sigma chromatic number of the Sierpiński gasket graphs and the Hanoi graphs

A D Garciano, R M Marcelo, M J P Ruiz and M A C Tolentino

+ Open abstract  View article  PDF

OPEN ACCESS 012003

















Sigma chromatic number of graph coronas involving complete graphs

A D Garciano, M C T Lagura and R M Marcelo

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more,

+ Open abstract  View article  PDF



-
- OPEN ACCESS** 012004
 Twin chromatic indices of some graphs with maximum degree 3
 J D Tolentino, R M Marcelo and M A C Tolentino
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012005
 Colour segmentation of Gram-Negative bacteria using graph Quadratic Form and Random Walker
 B D Satoto, I Utoyo and R Rulaningtyas
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012006
 The modification of caesar cryptosystem based on binary vertices colouring
 K A Santoso, I H Agustin and R M Prihandini
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012007
 Characteristic polynomial of anti-adjacency matrix of directed cyclic friendship graph
 N Anzana, S Aminah, S Utama and D R Silaban
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012008
 The matrix Jacobson graph of fields
 S Humaira, P Astuti, I Muchtadi-Alamsyah and A Erfanian
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012009
 On the set chromatic number of the join and comb product of graphs
 B C L Felipe, A D Garciano and M A C Tolentino
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012010
 On Ramsey (P_3, C_7) -minimal graphs
 G A Muttaqin, D Rahmadani, Purwanto and I M Sulandra
 + Open abstract  View article  PDF
-
- OPEN ACCESS** 012011
 On Ramsey (P_3, C_6) -minimal graphs for certain order
 F Nisa, D Rahmadani, Purwanto and H Susanto
 + Open abstract  View article  PDF
-



- OPEN ACCESS** [Digital Repository Universitas Jember](#) 012012
On spectra of square edge-corona graphs
S R Zulkarnain and Rinurwati
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012013
Application of the local antimagic total labeling of graphs to optimise scheduling system for an expatriate assignment
W Utami, K Wijaya and Slamin
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012014
Local super antimagic total vertex coloring of some wheel related graphs
S A Pratama, S Setiawani and Slamin
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012015
Odd harmonious labeling on squid graph and double squid graph
F Febriana and K A Sugeng
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012016
Unicyclic Ramsey (P_3, P_n) -minimal graphs obtained from trees in the same class
D Rahmadani, H Assiyatun and E T Baskoro
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012017
On the super \mathcal{H} -decomposition local antimagic total labeling of subdivision graph
S L Fauziah, Dafik, I H Agustin and R Alfarisi
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012018
Elegant labeling of some graphs
R M Prihandini, Dafik, I H Agustin, R Alfarisi and R Adawiyah
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012019
The upper bound of vertex local antimagic edge labeling on graph operations
Ika Hesti Agustin, Dafik, Marsidi and E Y Kurniawati
[+](#) [Open abstract](#) [View article](#) [PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).



OPEN ACCESS [Digital Repository Universitas Jember](#) 012020

On the local (adjacency) metric dimension of split related wheel graphs

E R Albirri, Dafik, I H Agustin, R Adawiyah, R Alfarisi and R M Prihandini

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS 012021

On the local antimagic vertex coloring of sub-devided some special graph

Dafik, I H Agustin, Marsidi and E Y Kurniawati

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS 012022

Properties of cartesian multiplication operations in complete fuzzy graphs, effective fuzzy graphs and complement fuzzy graphs

T Yulianto, N Hayati, I H Agustin, R Amalia, Faisol, Kuzairi and B Irwansyah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS 012023

On the local multiset dimension of graph with homogenous pendant edges

R Adawiyah, Dafik, I H Agustin, R M Prihandini, R Alfarisi and E R Albirri

[+](#) Open abstract [View article](#) [PDF](#)

Applied Sciences

OPEN ACCESS 012024

Implementation of xgboost for classification of parkinson's disease

G Abdurrahman and M Sintawati

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS 012025

Effect of addition waste bottle and fly ash variation to compressive strength environmentally friendly paving block

A I N Diana and D Desharyanto


[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS 012026

The application of the factor analysis method to determine the performance of IT implementation in companies based on the IT balanced scorecard measurement method

W Sardjono, E Selviyanti and W G Perdana

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy. 012027 

Evaluation model of knowledge management systems implementation using factor analysis and regression analysis at the corporation

W Sardjono, E Selviyanti and W G Perdana

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012028

Properties of content semimodules

Z Ni'mah, M Hafiyusholeh and W D Utami

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012029

Enviromental housing planning with rainwater harvesting system as clean water resources using 3D in Sumenep regency

S Fansuri and N Zainah

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012030

Navigation and guidance control system of UNUSAITs AUV based on dynamical system using ensemble kalman filter square root

T Herlambang, Subchan and H Nurhadi

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012031

Measurement of maturity of small medium agroindustry business processes in Jember, Indonesia

W Utami, N G Khrisnabudi, L Farida, M Apriono, E S Utami, Sudarsih, T A Gumanti and D A R Wulandari

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012032

Fitting the rice production model using generalized additive mixed model and generalized estimating equation with shiny web application

A S Darmawan, D Anggraeni and I M Tirta

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012033

Modification of Chaos Game with variation of compression ratio

K D Purnomo, M H Dewi and B Juliyanto

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012034

Estimation of Whole Blood(WB) and Anti-Hemophilic Factor using Extended Kalman Filter in PMI Surabaya

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.



A Muhith, T Herlambang, M Y Anshori, R Rizqina, D Rahmalia and Hermanto

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012035

Trajectory Estimation of Autonomous Surface Vehicle Using Extended Kalman Filter

T. Herlambang, D. Adzkiya and H. Nurhadi

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012036

Profitability estimation of a Company in PT.ABCD using extended kalman filter

M Y Anshori, T Herlambang, D F Karya, A Muhith and R A Rasyid

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012037

The commutator of raising and lowering operators for angular momentum to the free particle's hamiltonian

A F Sugihartin, B Supriadi, Subiki, V Rizqiyah, N Rizky and F Utami

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012038

Complete solutions of particle in three dimensional box with variations in main quantum number

B Supriadi, L Nuraini, A S R Maulani, D D Damayanti, A F Sugihartin and M I Baihaqi

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012039

Analysis of the relationship between the distance barriers GaAs and GaAs with the transmission coefficient and the reflection coefficient

B Supriadi, N Rizky, Yushardi, N C Agustin, S Epingtingiyas and M S Makmun

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012040

Numerical simulation of mass in core decay of radioactive substance Thorium-232 series

Yushardi, B Supriadi, D S Tresnowati and Z R Ridlo

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012041


The effect of lerak foam and kapok as a silencer on lightweight concrete

Dwi Nurtanto, Hernu Suyoso, Ahmad Hasanuddin, Zahra Hikmah Hayati and Mukhlisin

[+ Open abstract](#) [View article](#) [PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).



- OPEN ACCESS** [Digital Repository Universitas Jember](#) 012042
Using factor analysis and regression analysis to develop mathematic modeling to support online application implementation in transportation business
W Sardjono, E Selviyanti and W G Perdana
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012043
Analysis of magic table in completin of closed flow circuits
B H Antoro, B Supriadi, T Prihandono, M R Muttaqin, N H Azizah and S Epingintiyas
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012044
Comparison between Neural Network (NN) and Adaptive Neuro Fuzzy Inference System (ANFIS) on sunlight intensity prediction based on air temperature and humidity
D Rahmalia, T Herlambang, A S Kamil, R A Rasyid, F Yudianto, L Muzdalifah and E F Kurniawati
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012045
Measuring maturity level of information technology governance at the television broadcasting company
Erna Selviyanti and Wahyu Sardjono
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012046
Modelling of an electromagnetic wave radiation exposure on a smartphone by using the mat lab program
S H B Prastowo, T Prihandono, N Fadilah, S Bahri and A Ariyani
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012047
Optimal control of microalgae growth using linear quadratic regulator method with firefly algorithm optimization
Suci Yongki Setyowati and Mardlijah
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012048
The base matrix of hermitian operator order $n < 4$
S Epingintiyas, B Supriadi, T Prihandono, B H Saputra, M S Makmun and B H Antono
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012049
This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).
Estimation of crude oil price using unscented kalman filter 

D F Karya, M Y Anshori, R Rizqina, P Kattias, A Muhih and T Herlambang

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012050

Bias correction and statistical downscaling of earth system models using quantile delta mapping (QDM) and bias correction constructed analogues with quantile mapping reordering (BCCAQ)

F Fauzi, H Kuswanto and R M Atok

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012051

Spatial extreme modeling using student t copula approach in Ngawi Regency

M Fauziyah, Sutikno and J D T Purnomo

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012052

Modeling the volatility of gross domestic product based on the volatility of money supply, inflation, interest rate, and exchange rate using the fractional cointegration model

A Abdullah, H Kuswanto, D D Prastyo and Suhartono

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012053

The performance evaluation of the bivariate EWMA control chart using CARL distribution and EPC

Selly Acita, Muhammad Mashuri and Dedy Dwi Prastyo

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012054

Three-parameter bivariate gamma regression model for analyzing under-five mortality rate and maternal mortality rate

G H Wenur, Puhadi and A Suharsono

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012055

Analyzing the roles of the construction sector by using multiplier analyses: the cases of Indonesia and Japan

Ubaidillah Zuhdi

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012056

The comparison of exponentially weighted moving variance and double moving average-S control charts based on heuristic ranked set sampling

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.



R J M Putri, M Mashuri and Irhamah

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012057

The simulation of weathering processes in three different types of oil

N Millah, K Nugraheni and I Anggriani

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012058

Three form fourier series estimator semiparametric regression for longitudinal data

Kuzairi, Miswanto and I Nyoman Budiantara

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012059

Recognition of person's character through the shape of signature using Radial Basis Function Neural Network (RBFNN) method

Faisol, Ahmad, Halumatus Sakdiyah, Qurratul Aini, Kuzairi and Tony Yulianto

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012060

Sentiment analysis for Indonesia hotel services review using optimized neural network

D Apriliani, T Abidin, E Sutanta, A Hamzah and O Somantri

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012061

Semiparametric regression curve estimation for longitudinal data using mixed spline truncated and fourier series estimator

A W Wening, I N Budiantara and I Zain

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012062

On the modeling of the new student acceptance status through science and technology written test using bernoulli mixture model

D P Shiela Novelia, Ismaini Zain, Nur Iriawan and W Suryaningtyas

[+ Open abstract](#)[View article](#)[PDF](#)

OPEN ACCESS

012063

Analysis of factors affecting competition in bottled drinking water sales in Madura

T Yulianto, Fatmawati, Windarto, M Rohmaniyah, Faisol and M F F Mardianto

[+ Open abstract](#)[View article](#)[PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).



- OPEN ACCESS** [Digital Repository Universitas Jember](#) 012064
Forecasting competition for sales of local and national bottled drinking water in madura using fuzzy sugeno method
T Yulianto, Fatmawati, Windarto, A Halim, Faisol, Suprianto and A K Dharmawan
[+](#) [Open abstract](#) [View article](#) [PDF](#)

Education

- OPEN ACCESS** 012065
The development of student worksheets: questions of PISA model to analyze the ability of mathematical literacy in junior high school
Sutama, S Narimo, S Anif, H J Prayitno, D P Sari and M Adnan
[+](#) [Open abstract](#) [View article](#) [PDF](#)

- OPEN ACCESS** 012066
The sustainability concept of Riau cultures through development of mathematics learning devices based on Riau folklore at elementary schools
S Rezeki, D Andrian, A Wahyuni and H Nurkholisah
[+](#) [Open abstract](#) [View article](#) [PDF](#)

- OPEN ACCESS** 012067
The effect of emotional intelligence, learning discipline and peer interaction on mathematics learning outcomes of state junior high school students in Samarinda
Azainil, K R Amalia, Sugeng, A Dimpudus and Ramadiani
[+](#) [Open abstract](#) [View article](#) [PDF](#)

- OPEN ACCESS** 012068
Mathematics creativity skill of student in junior high school based on students thinking style
F Isyrofinnisak, T A Kusmayadi and L Fitriana
[+](#) [Open abstract](#) [View article](#) [PDF](#)

- OPEN ACCESS** 012069
Scaffolding profile in solving geometry problems in terms of van Hiele level
H S Rahman, Susanto, Hobri, M Irfan, R Karimah' and A U Albab
[+](#) [Open abstract](#) [View article](#) [PDF](#)

- OPEN ACCESS** 012070
Student's problem solving abilities in Project Based Learning (PjBL) based on Learning Community (LC)
A K A Faozi, Hobri, M Fatekurohman, K Aini and D Yuniar
[+](#) [Open abstract](#) [View article](#) [PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).



- OPEN ACCESS** 012071
Profile of students' creative and innovative thinking in solving open-ended mathematics problems about the coffee plantation
A U Albab and Y Wangguway
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012072
The analyze of students' creative thinking skills on Lesson Study for Learning Community (LSLC) based on Science, Technology, Engineering, and Mathematics (STEM) approach
D Yuniar, Hobri, A C Prihandoko, K Aini and A K A Faozi
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012073
The influence of mathematics academic potential and learning motivation of Papuan college students in Jember on academic achievement
Y Wangguway and A U Albab
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012074
Student's higher-order thinking skills on creative problem solving based on caring community
C F Lestari, Hobri, M Fatekurohman, D Lutvita and F Y W Ningrum
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012075
The students' mathematical communication skill on caring community-based learning cycle 5E
K Aini, Hobri, A C Prihandoko, D Yuniar, A K A Faozi and Asmoni
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012076
Student's higher order thinking skills on problem solving based on jumping tasks
D Lutvita, Hobri, D S Pambudi, C F Lestari and F Y Wahyuningrum
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012077
Students' metacognitive ability in solving quadrilateral problem based on adversity quotient
R Damayanti, Sunardi, N Yuliati, R Karimah and A U Albab
[+](#) [Open abstract](#) [View article](#) [PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our [Privacy and Cookies policy](#).



- OPEN ACCESS** [Digital Repository Universitas Jember](#) 012078
The students' mathematical reasoning ability based on problem based learning model
M P Sari, Susanto, N Yuliati, E N Imamah and N I Laily
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012079
The effect of problem based learning model on junior high school students' higher order thinking skills
E N Imamah, Sunardi, E Yudianto, M P Sari and N I Laily
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012080
The profile of students conceptual understanding and procedural knowledge in solving geometry problems based on van hiele levels
N I Laily, Sunardi, N Yuliati, E N Imamah and M P Sari
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012081
Scientific approach learning implementation based on lesson study for learning community in solving sequence and series and its effect to student creative thinking ability
E Guswanto, Susanto, Hobri, P A Inawati and A R Sya'Roni
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012082
Students' mathematical communication skills of the straight line equation based on gender in junior high school
H Aliyah, T A Kusmayadi and L Fitriana
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012083
Analysis of students' verbal and written mathematical communication error in solving word problem
M A Mulyda, A M Annizar, V R Hidayati and M Mukhlis
[+](#) [Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012084
Student's mathematical creative skill using interactive application media based on collaborative learning
P A Inawati, Hobri, D S Pambudi, E Guswanto and A R Sya'roni
[+](#) [Open abstract](#) [View article](#) [PDF](#)

Analysis of higher order thinking skills of SMP students in completing the problem of the numbers through the application of problem based learning

Imelda and D Anzelina

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012086

Male students' visual reasoning in solving mathematical problem

Darmadi, Sanusi, E Wihardjo, Karim, Suprianto and S Prayitno

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012087

The analysis of research-based learning implementation and its affect to the students' metacognition skill in solving a resolving domination number of a graph

Y Wangguway, Slamini, Dafik, I N Maylisa and S Kurniawati

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012088

The students' problem solving abilities in science, technology, engineering and mathematics (stem) based on lesson study for learning community (lslc)

F Y W Ningrum, Hobri, Susanto, Dafik, D Lutvita and C F Lestari

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012089

The analysis of problem-based learning implementation and its effect on students creative innovative skills in solving rainbow antimagic coloring based on cognitive style

Z L Al Jabbar, Dafik, A F Hadi, Y Wangguway and B Sulistiyono

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012090

The influence of research-based learning implementation in improving students' combinatorial thinking skills in solving local irregularity vertex r-dynamic coloring

I N Maylisa, Dafik, A F Hadi, Y Wangguway and L O Harjito

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012091

The analysis of output based learning implementation in improving students creative and innovative thinking skills in solving H -Irregularity

D M O Suni, Dafik, I M Tirta, Y Wangguway and M H Mukaromah

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012092

The analysis of problem based learning implementation and its influence to the students generalization thinking skills on solving r-dynamic vertex coloring



L O Harjito, Dafik, A I Kristiana, I N Maylisa and Y Wangguway

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012093

The analysis of the implementation inquiry based learning to improve student mathematical proving skills in solving dominating metric dimension number

A N Hayyu, Dafik, I M Tirta, Y Wangguway and S Kurniawati

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012094

Improving creative problem solving performance of mathematics students by digital multimedia in graph theory course

S Wahyuningsih, D Satyananda and A Qohar

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012095

The analysis of the implementation of project based learning and its influence to the student deductive reasoning based on cognitive style on solving super edge local antimagic total labelling

M Karimah, Dafik, I M Tirta, Y Wangguway and Z L A Jabbar

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012096

Students' creative-innovative thinking skill in solving rainbow antimagic coloring under research based learning model

B Sulistiyono, Slamini, Dafik, Y Wangguway and Z L Al Jabbar

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012097

The analysis of the discovery learning implementation and its affect to the students conjecturing skills in solving a resolving domination number

S Kurniawati, Slamini, Dafik, Y Wangguway and A N Hayyu

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012098

The shadow reckoning problem from ancient society as context for learning Trigonometry

A D Fachrudin, R Ekawati, A W Kohar, S Widadah, I B Kusumawati and R Setianingsih

[+ Open abstract](#) [View article](#) [PDF](#)**OPEN ACCESS**

012099

This site uses cookies. By continuing to use this site, you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.



B Mustofa, Mardiyana and I Slamet

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012100

The analysis of algebra creative thinking skill based on strong mathematical habit of mind

S W P Nugroho, Riyadi and Triyanto

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012101

Students' mathematical reasoning ability viewed from self-efficacy

D I Jumiarsih, T A Kusmayadi and L Fitriana

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012102

Students' mathematical communication abilities in solving geometry problems viewed from learning styles

A N Sholihah, Riyadi and Triyanto

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012103

The written mathematical communication ability of junior high school students in solving set problems

N Azizah, B Usodo and D R S Saputro

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012104

Investigation of the students' number sense in seventh grade

S A Marga, T A Kusmayadi and L Fitriana

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012105

Analyzing students' representation ability: viewed from reflective-impulsive cognitive style

D Septiani, Riyadi and Triyanto

[+ Open abstract](#)[View article](#)[PDF](#)**OPEN ACCESS**

012106

Mathematical connections ability of junior high school students viewed from mathematical resilience

S.Rohmah, T A Kusmayadi and L.Fitriana

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more,

[see our Privacy and Cookies policy](#)[PDF](#)

-
- OPEN ACCESS** 012107
The SOLO taxonomy: classify students' responses in solving linear program problems
L F Claudia, T A Kusmayadi and L Fitriana
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012108
PCK (*Pedagogical Content Knowledge*) profile of mathematics education students at Universitas PGRI Yogyakarta
B Wicaksono and N M S Dwipa
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012109
Students' metacognitive ability in contextual teaching and learning of mathematics based on jumping task
M Khoirudin, Hobri, M Irfan, E Guswanto and D Purwandi
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012110
The development of mathematical problem based on Higher Order Thinking Skill (HOTS) on comparative material by implementing PBL and its effect on the teacher's creative thinking skill
A Widiatsih, D A R Wardani, U Royhana, F Djamali and B J Septory
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012111
The effect of comic-based realistic mathematics approach on students' learning motivation and conceptual understanding
T N Sipayung, S D Simanjuntak, A Wijaya and S Sugiman
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012112
The effect of Islamic interactive media by using adobe flash CS6 on students' learning outcomes of class 7 in one-variable linear equation material
U Fariyah and S N Fadilah
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012113
The implementation of research based learning and the effect to the student metacognition thinking skills in solving H -irregularity problem
M Hidayatul, Dafik, I M Tirta, Y Wangguway and D M O Suni
[+ Open abstract](#) [View article](#) [PDF](#)



Development of *Remedial* mathematics learning based on *Lesson Study for Learning Community* against problem solving

D Purwandi, Susanto and Hobri

[+ Open abstract](#)



[View article](#)



[PDF](#)

Combinatorics

OPEN ACCESS

012115

Scheduling algorithms for an expatriate assignment using vertex coloring of graph

N O Adiwijaya and Slamir

[+ 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

The effect of problem based learning model on junior high school students' higher order thinking skills

To cite this article: E N Imamah *et al* 2020 *J. Phys.: Conf. Ser.* **1538** 012079

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

The effect of problem based learning model on junior high school students' higher order thinking skills

E N Imamah¹, Sunardi¹, E Yudianto¹, M P Sari¹, N I Laily¹

¹Department of Mathematics Education Postgraduate, University of Jember, Indonesia

E-mail: evhireyvh@gmail.com

Abstract. The facts indicate that students' higher order thinking skills at second grade of SMPN 1 Jember is relatively low. They were only learning with assignments in class and did not use theory to solve their problems. Therefore, we conduct a research on mathematical learning through Problem Based Learning model to find out the effect of students' higher order thinking skills. The method used in this study is a mixed method. The quantitative method is used to analyze student learning achievement and students' higher order thinking skills. This experimental research have two classes which are control class and experimental class that contain 32 students each class. The result showed that Problem Based Learning model had a positive effect on higher order thinking skills. It can be seen from the percentage of higher order thinking skills of control class was 40,63% and experimental class 90,62%.

1. Introduction

Education experiences changes along with the development of communication and technology. Learning pattern should also change in order to be relevant with the challenges and opportunities occur in real life. Education is expected to be able to be implemented in daily life. The problems occur in daily life can be presented in mathematics learning in school context. Nowadays, learning models are very various and enables educators to choose one of the most suitable learning models to improve students' thinking abilities at school. Besides that learning ability, the students should have the ability of adaptation, learning, innovation, and character. One of the learning models that can be seen its effectiveness toward the students' thinking skill is Problem Based Learning.

Problem Based Learning is a cooperative learning model that uses real life problems as the context for the students to learn about critical thinking and problem solving skills [1–3]. PBL is a learning that gives the students exposure to practical problems as the foothold in learning or in other words, students' learn through problems [4]. The problems given are based on an authentic real life situation which has various possible solutions to one problem [5]. Regard to what obtained from the process of PBL, individual becomes a good problem solver by using their higher-order thinking skills [6]. PBL, in comparison to other learning models is a learning model and a complex constructivist which provides great opportunities to the development of learning autonomy [7]. PBL can help the students to develop cognitive competences [8]. From the explanation above, it can be known that PBL is a learning model that implements real life problems and is one of the cooperative learning methods that develops the students' thinking skills so that it can be used as a learning model to see its effect on higher-order thinking skills.

Higher Order Thinking Skill (HOTS) as a skill occurs when someone links information stored in memory with new information, then delivered the combined information to reach the goals or needed



answer [9]. HOTS involves the students to link their learning and other outside elements taught to be connected with them. Thinking skills are divided into two categories: higher order thinking skills (HOTS) and lower order thinking skills (LOTS) [10]. LOTS consists of the first three aspects of bloom's taxonomy including remembering, understanding, and applying [11,12]. In HOTS, Bloom's Taxonomy that can be used are analyze, evaluate, and create [13]. Teachers can play the roles by using a variety of questions in order to demand the use of higher-order thinking in the classroom while recognizing the difficulties faced by students in solving problems related to HOTS [12]. Higher-order thinking skill is an important aspects in teaching and learning especially in higher education institutions [14]. From the above explanation it can be concluded that thinking skills are divided into two namely LOTS and HOTS. HOTS is a thinking skill that is carried out using Bloom's taxonomy which are analyze, evaluate, and create. Research conducted by Verdina shows teaching and learning that can improve Higher Order Thinking Skills are able to improve ability in problem solving and critical thinking. So that critical thinking is also included in high-level thinking. Therefore, the research conducted by Suntutia by using the Research Based Learning model can be analyzed to determine the ability to think at a high level of students [11]. Research conducted by Meke found that PBL using manipulative material has a positive effect on student performance looking at cognitive variables in understanding problems (remembering and understanding), and solving problems (analyzing and evaluating) procedural knowledge and conceptual knowledge [15]. From the research conducted previously, it shows PBL had a positive impact on students' thinking. Therefore the research conducted using the PBL model. From the above research it can be seen that PBL has an impact on students' procedural and conceptual thinking. Researcher use the PBL model to determine the impact on students' high-level thinking. This research was conducted at 1 Jember Junior High School in class VIII. The HOTS effects can be seen through PBL learning model, therefore the researcher wanted to know the effect of the Problem Based Learning tools on higher-order thinking skills on the students of SMPN 1 Jember.

2. Method

The method used in this research was mixed method research. According to [16], a mixed method is the research method that is combining qualitative and quantitative methods. This type of research is experimental research conducted in the experimental class and the control class. the experimental research method is a research method used to look for the effect of certain treatments on others under controlled conditions. The research was conducted at SMPN 1 Jember with class VIII students as the respondents in the odd semester of the 2019-2020 school year. In the experimental class and the control class each consisted of 32 students.

The research began with the tools validation, then the tools trial on a group of students until it ended in administering the test and giving a questionnaire to the experimental class that was given treatment. The population in this research amounted to 64 which were divided into 2 classes, namely the experimental class and the control class.

Data collection methods used were test and observation. The test in this research consisted of two higher-order thinking skills questions. The test was carried out to measure the students' higher-order thinking skills. The administration of students' learning achievement test was a data collection technique regarding students' learning achievement after the Problem Based Learning model was applied. The Observation method was used to find out the percentage of learning implementation by using problem based learning model.

The data analyzed in this research were the data of learning achievement test given to two classes. The preliminary data analysis were obtained from the last daily test scores through normality test of both classes. The data obtained were normal therefore the homogeneity test was performed of both classes. Two classes were homogeneous therefore the experimental and control classes were selected randomly. Due to the homogeneous data obtained from the homogeneity test, therefore the hypothesis test used t-test. T-test was carried out to know whether or not the treatment had an effect to the

experimental class. The decision criteria was that H_0 was rejected if the significant value was lesser than 0.05 on the test.

3. Results and Discussion

The preliminary data collections were obtained from the daily test on function chapter to do the normality test. After the preliminary data were proven to be normal then the homogeneity test was carried out. If the two classes were proven to be normal and homogeneous then the treatment was given to one of classes by applying problem based learning method and the other class was taught by using the learning which has been using by the teacher. This was done to know the influence of problem based learning model implementation on the students' higher order thinking skills. The final data were obtained from the test of both classes with 3 essay questions. Because the preliminary data were normal and homogeneous then the t-test was done to know if there was a difference between two classes.

3.1 Normality test

Data on daily test scores for function material is used as preliminary data to determine the normality of the two classes. Test for normality using IBM SPSS software version 25.

Table 1. Normality test result from the daily test

	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
Test scores	0,082	32	0,200

The table above was the results of normality test on the data of two classes in this research. The data were obtained from the daily test of the previous material. According to [17] that Normality test showed that two groups were normally distributed if the significant value was higher than 0.05. On the table 1 showed that the significant value was 0.200 which meant that two classes were normal. Both classes are declared normal, meaning that both classes have normally distributed data.

Table 2. Normality test result from the post test

	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
Test scores	0,102	32	0,200

The table above was the results of normality test on the data of two classes in this research. The data were obtained from post test. On the table 1 showed that the significant value was 0.200 which meant that two classes were normal. Both classes are declared normal, meaning that both classes have normally distributed data. Therefore, in order to process the next step for the post test that to see whether the values of both classes are homogeneous, it used a homogeneity test.

3.2 Homogeneity test

When two classes were said to be normal then the homogeneity test was done to know whether or not two classes had the similar ability or homogeneous. The homogeneity test used IBM SPSS version 25 software.

Table 3. Homogeneity test result

Levene	df1	df2	Sig.
Statistic			
1.932	1	62	0.170

The homogeneity test was used to determine whether or not two classes to be investigated were homogeneous. The results of homogeneity test of the students were obtained from the daily test scores on the previous material with the significant value of 0.170. According to [17] that if the significant value was higher than 0.05 then the data were homogeneously distributed. The results of homogeneity test that were done in two classes proved to be homogeneously distributed. Because both classes

proved to be homogeneous, it could be used for this research. One class for the experimental class and the other for the control class.

Table 4. Homogeneity test result form the post test

Levene Statistic	df1	df2	Sig.
1.773	1	62	0.188

The results of homogeneity test of the students were obtained from the daily test scores on the previous material with the significant value of 0.188. Both classes have proven homogeneous values. Both homogeneous classes mean both classes have homogeneous variance. Because both classes proved to be homogeneous, the next step was to do the t-test to see the differences in values from both classes.

3.3 T-tes

The initial data were tested by using IBM SPSS version 25, the initial data were normal and homogeneous, so that the final t-test was distributed by using the same software.

Table 5. T-test result
Levene's Test for Equality of Variances

		F	Sig.	t	Df	Sig.(2-tailed)
Test	Equal variances assumed	1.773	.188	-9.278	62	.000
	Equal variances not assumed			-9.278	57.389	.000

Regarding the results of t-test, the students' learning achievement in solving questions of higher order thinking skill got a significant value of 0,000. According to the statement pointed by [18], if the significant value was 0,000 then there was a difference between the experimental class and the control class.

In the test of learning achievement, 3 problems containing 3 levels of higher order thinking skill were given. The first problem was about an analysis-level question by linking the daily problems to related material. The second problem given was an evaluation-level question. Moreover, the last problem given was a creating-level question of higher-order thinking skill. In the first and second problems, the maximum score counted for each was 30 and the score given to the third problem was 40. Figure 1 showed that the numbers of students who had the minimum analytical skills were categorized into higher-order thinking skill.

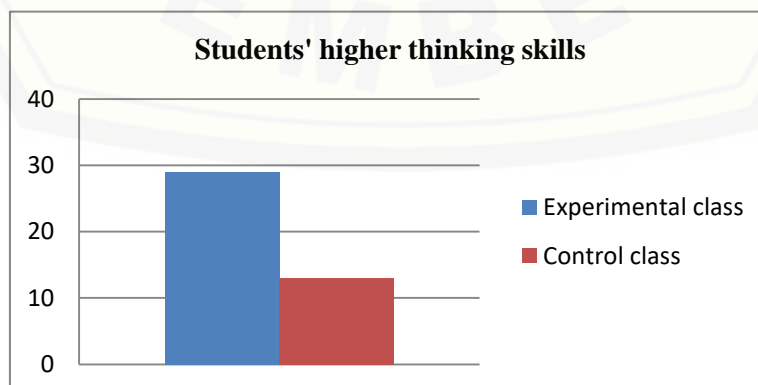


Figure 1. Comparison of students' higher thinking skills in the experimental class and the control class

There were differences found in two classes as shown on Figure 1, the result gained by experimental class was higher than the control class. It can be seen on Figure 1 above who revealed that those having higher-order thinking skill consisted of 29 students in the experimental class, while the control class covered 13 students with higher-order thinking skill.

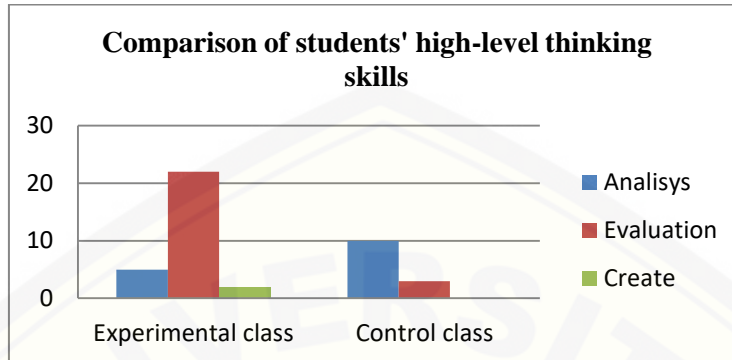


Figure 2. Comparison of students' high-level thinking skills in the experimental class and the control class

The experimental class showed that the students with higher-order thinking skills covered 29 students in which they were different from 5 students with analysis level, 22 students with evaluation ability, and 2 students with creating ability. Whereas in the control class, there were 13 students who possessed higher-order thinking skills, 10 students with analysis level, 3 students with evaluation level, and none of them were at the level of creating.

3.4 Students' activities

In the experimental class, students work and ask question each other and the nuances of caring grow between one another's friends. The activities of students asking questions and explaining and exchanging opinions in groups are presented in the following figure 3, (taken from one group as a sample).

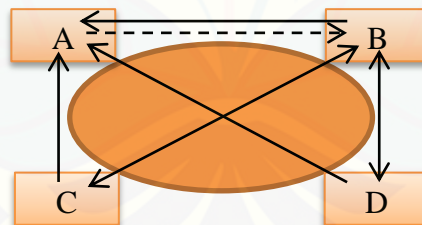


Figure 3. students' activities at experimental class

Group discussion in the experiment class went smoothly where Student B was the focal point of brainstorming and explained to students who did not understand. In the Experiment class it was also seen that Student D and Student C were very enthusiastic in helping explain to Student A. This shows that students were able to collaborate each other.

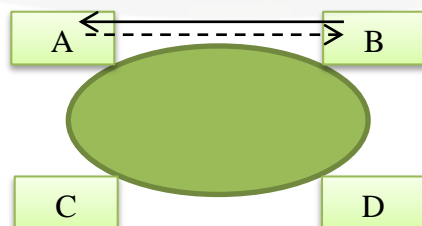


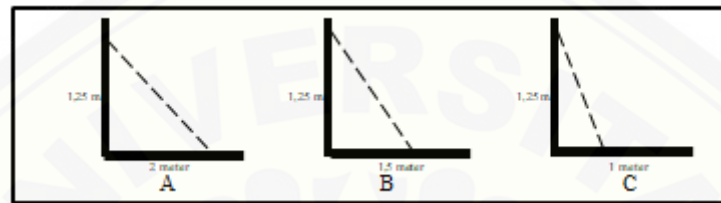
Figure 4. students' activities at control class

Discussions in the control class only occur in students A and B. Students C and D do not understand the material but do not ask friends who understand. Other students simply copy their friend's answer without understanding the answers. Overall, the group discussion that occurred in the control class only aimed to answer the problem given by ignoring whether their groupmates had understood it or not.

3.5 Students' result

Problems given to students in the form of 3 problems in higher order thinking are as follows :

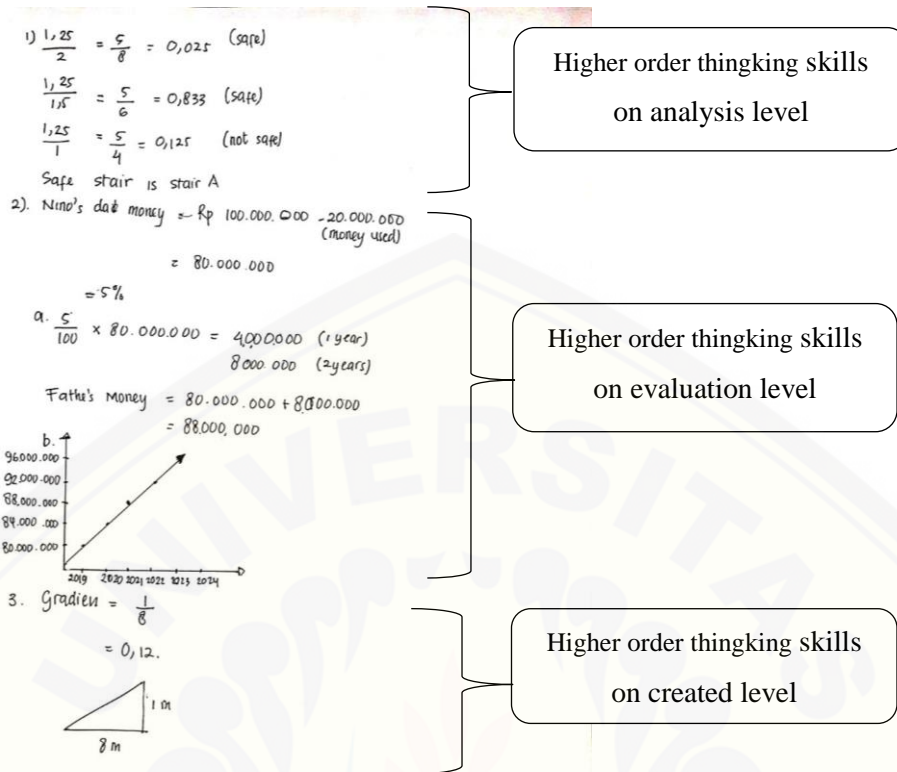
- 1) The picture below is the position of the stairs that are used for the needs in the shop. Which of the stairs above is safest to use? what distinguishes stairs A to C? The slope / gradient of the stairs may not exceed 0.875



- 2) Nino's father has Rp.100,000,000.00. He wants save part of the money after 2 years. The interest offered is 5% annually. Because there is a need at home, Nino's father's money was used in the amount of Rp. 20,000,000.00.
 - a. Try to predict how much money Nino's father after 2 years? (Interest used on bank A is a single interest with the same increase every year).
 - b. Draw a straight line equation according to the problem above!
- 3) Every hospital has a road that is passed by a wheelchair user, as shown below. Make a design or sketch of the road by paying attention to safety for road users. The slope requirements on the road must not exceed 0.15 and the height of the road must be at least 1 meter.

In the first problem, it can be solved using analysis, the second problem using a evaluation levels and the third problem using the level of creating.

Here are the answers of students who have created levels



Higher order thinking skills on analysis level

Higher order thinking skills on evaluation level

Higher order thinking skills on created level

Figure 5. Students' result

The results of student above can be seen that students are able to solve all three problems correctly. In problem 1 students can determine the safest stairs of the three stairs. In problem 2 students can determine the initial amount of savings and be able to draw a straight line equation according to the situation. The three students were able to design a stairs with a height of 1 meter with a predetermined gradient. This student has the ability to create. students who have the ability to create in this study are 2 students in the experimental class.

3.6 Discussion

This research was conducted to determine the effect of problem-based learning models on the students' higher order thinking skills in the material of straight-line equations. The results of this research showed that the implementation of problem-based learning had a significant effect on improving the students' higher order thinking skills. This research showed, the higher order thinking skills of the students in the control class were 37.5%, while in the experimental class were 84.37%. From the results of the research, the experimental class students showed that their higher order thinking skills were higher than the control class.

These results are the same as a study conducted by Budhi. This study aims to see the effect of students' ability to solve problem after PBL learning models. Hypothesis test results using the t-test showed that $p = 0,000$ with t count 3,993. Based on these results it can be concluded that there are differences in critical thinking skills between students who use problem-based learning or direct instruction. By looking at the average problem based learning and direct instruction groups it was found that problem based learning was greater than direct teaching because the average problem based learning was 22.73 while direct teaching was 19.50[18].

The research which conducted by Meke found that PBL using manipulative materials had a positive effect on student performance that can be seen on cognitive variables in understanding problems (remembering and understanding), solving problems (analyzing and evaluating), procedural knowledge and conceptual knowledge. PBL using manipulative material has given 91.93% in students

'ability to remember, 87.09% in students' ability to understand, 84.08% in students' ability to analyze and 69.15% in students' ability to evaluate. It can be concluded that the class using the problem based learning model affected students' higher order thinking skills[1].

4. Conclusion

The result of normality test that was performed by using IBM SPSS version 25 software obtained a significant value of 0.056 and the data was considered normal. Homogeneity test obtained a significant value of 0.188, then both classes were said to be homogeneous. The data of learning achievement test was done by t-test and had a significant value of 0,000, then the data differed in the two classes.

The result showed that Problem Based Learning model had a positive effect on higher order thinking skills. It can be seen from the percentage of higher order thinking skills of control class was 37,5% and experimental class 90,62%. In the experimental class the average value is 65.22 while in control class is 23,75. In the experimental class showed that students who have high-level thinking skills are 29 students with high-level thinking skills that are different from students who have a level of analysis that is 5 students, students who have an evaluation ability of 22 students, and who have the ability to create are 2 students . Whereas in the control class that has high-level thinking skills, 13 students with an analysis level of 10 students, an evaluation level of 3 students, and no students who are at the level of creating. In this study it was different from the study conducted by Meke who found PBL had a positive effect on cognitive variables, n this study found that PBL also had an effect on higher order thinking skills.

Acknowledgment

I gratefully acknowledge the support from Geometry Research Groups, FKIP-University of Jember Indonesia of the year 2019.

References

- [1] Meke K D P, Wutsqa D U, and Alfi H D 2018 The Effectiveness of Problem-based Learning Using Manipulative Materials Approach on Cognitive Ability in Mathematics Learning *J. Phys. Conf. Ser.* **1097** (1).
- [2] Yudianto E, Sugiarti T, and Trapsilasiw D 2018 The Identification of Van Hiele Level Students on the Topic of Space Analytics Geometry *J. Phys. Conf. Ser.* **983** (1) 012078
- [3] Sunardi S, Yudianto E, Susanto S, Kurniati D, Cahyo R D and Subanji S 2019 Anxiety of Students in Visualization, Analysis, and Informal Deduction Levels to Solve Geometry Problems *Int. J. Learn. Teach. Educ. Res.* **18** (4) 171–185
- [4] Nasution M L, Yerizon Y, and Gusmiyanti R 2018 Students' Mathematical Problem-Solving Abilities Through the Application of Learning Models Problem Based Learning *IOP Conf. Ser. Mater. Sci. Eng.* **335** (1)
- [5] Iqbal M, Yusrizal, and Abidin Z 2018 The development of learning instruments through the problem-based learning model to enhance students' creativity The development of learning instruments through the problem-based learning model to enhance students' creativity *J. Phys. Conf. Ser.*
- [6] Ersoy E 2014 The effects of problem-based learning method in higher education on creative thinking **116** 3494–3498
- [7] Darma I K, Candiasa I M, Sadia I W, and Dantes N 2018 The effect of problem based learning model and authentic assessment on mathematical problem solving ability by using numeric ability as the covariable The effect of problem based learning model and authentic assessment on mathematical problem solving abil 1–9
- [8] Drăghicescu L M, Petrescu A M, Cristea G C, Gorghiu L M, and Gorghiu G 2014 Application of Problem-based Learning Strategy in Science Lessons – Examples of Good Practice *Procedia - Soc. Behav. Sci.* **149** 297–301
- [9] Maulita S R, Sukarmin S, and Marzuki A 2019 The Content Validity: Two-Tier Multiple Choices

- Instrument to Measure Higher-Order Thinking Skills *J. Phys. Conf. Ser.* **1155** (1)
- [10] Kusuma M D, Rosidin U, Abdurrahman A, and Suyatna A 2017 The Development of Higher Order Thinking Skill (Hots) Instrument Assessment In Physics Study *IOSR J. Res. Method Educ.* **07** (01) 26–32
- [11] Verdina R, Gani A, and Sulastri 2018 Improving students' higher order thinking skills in thermochemistry concept using worksheets based on 2013 curriculum *J. Phys. Conf. Ser.* **1088**
- [12] Abdullah A H, Liyana N, Abidin Z, and Ali M 2015 Analysis of Students' Errors in Solving Higher Order Thinking Skills (HOTS) Analysis of Students' Errors in Solving Higher Order Thinking Skills (HOTS) Problems for the Topic of Fraction
- [13] Pratama G S and Retnawati H 2018 Urgency of Higher Order Thinking Skills (HOTS) Content Analysis in Mathematics Textbook *J. Phys. Conf. Ser.* **1097** (1)
- [14] Ahmad M Z S, Prahmana R C, Kenedi A K, Helsa Y, Arianil Y 2018 The instruments of higher order thinking skills
- [15] Muin A, Hanifah S H, and Diwidian F 2018 The effect of creative problem solving on students' mathematical adaptive reasoning *J. Phys. Conf. Ser.* **948** (1)
- [16] Sugiono 2017 Metode Penelitian Kombinasi (mix method) Bandung, Indonesia : *Alfabeta*
- [17] Miatun A and Muntazhimah M 2018 The effect of discovery learning and problem-based learning on middle school students' self-regulated learning *J. Phys. Conf. Ser.* **948** (1)
- [18] Budhi W and Suwarni S 2019 Effect of problem based learning on critical thinking ability on science *J. Phys. Conf. Ser.* **1175** (1)