

Proceeding of The First Annual Seminar on Trends in Science and Science Education 2014

ISBN 978-602-9115-37-6

PROCEEDING

First Annual International Seminar on Trends in Science and Science Education 2014

Organized by Faculty of Mathematics and Natural Sciences
State University of Medan

5th – 6th December 2014
Garuda Plaza Hotel - Medan

Editors :
Prof. Dr. Herbert Sipahutar, M.Sc.
Prof. Drs. Motlan, M.Sc., Ph.D.
Prof. Dr. Mukhtar, M.Pd.
Prof. Drs. Manihar Situmorang, M.Sc., Ph.D.
Alkhafli Maas Siregar, S.Si., M.Si.
Drs. Zulkifli Simatupang, M.Pd.



Penerbit :
Fakultas Matematika dan Ilmu Pengetahuan Alam
Universitas Negeri Medan
2015

Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Medan, Medan - Indonesia

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FROM THE EDITORS

The First International Seminar on Sciences and Science Education, ISOSE, organized by Faculty of Mathematics and Natural Science of State University of Medan, was held on 4 – 5 December 2014 in Medan, North Sumatera, Indonesia. The seminar particularly encouraged the interaction of research students and developing academics with the more established academic community in an informal setting to present and to discuss new and current work. The high quality of the papers and the discussion represent the thinking and experience of experts and practitioners, researches, lecturers and students in their particular fields and interests. The papers contributed the most recent scientific knowledge known in science and science education.

This proceeding contains all the paper presented in the seminar, consisted of 11 papers of Biological Sciences, 11 papers of Chemical Sciences, 3 papers of Mathematical Sciences, 14 papers of Physical Sciences and 39 papers of Science Education.

In addition to the contributed papers, an outstanding keynote presentation on National Curriculum 2013 was made by Prof. Dr. Syawal Gultom (formerly Rector of State University of Medan, Unimed), now as Head of Badan Pengembangan Sumberdaya Manusia Pendidikan of Department of Education and Culture of Republic of Indonesia. This presentation gives all participants a new and comprehensive perspective on the orientation of national education in the next era.

Two invited keynote presentations were given by Prof. Dr. Yaya Rukayadi from Department of Food Science, Faculty of Food Science and Technology and Laboratory of Natural Products, Institute of Bioscience, Universiti Putra Malaysia, Serdang, Selangor DarulEhsan, Malaysia who spoke on how to appreciate the nation through research javanese turmeric or temulawak (*Curcuma xanthorrhiza* ROXB.), and by Dr. Phattrawan Tongkumchum, Department of Mathematics and Computer Science, Faculty of Science and Technology, Prince of Songkla University, Pattani, Thailand who spoke about the applications of the weighted sum contrasts methods on graphing confidence interval for adjusted mean, their used for comparing two and several groups, and adjustment for covariates.

We would like to express our deep appreciation to Prof. Dr. Ibnu Hajar, Rector of State University of Medan for financial support by means of Dana DIPA Unimed FY 2014. We would like to express our deep appreciation to Prof. Dr. Motlan (Dean of FMIPA Unimed), all sponsors, all member of seminar committee, that make the seminar happen in a great success.

We thank all authors and participants for their contributions.

Medan, February 2015

Editors

TABLE OF CONTENT

FROM THE EDITORS	ii
FROM THE CHAIRMAN OF ISOSE 2014	iii
TABLE OF CONTENT	vi

Keynote Speaker

KS-001	Dasar Pertimbangan Penetapan Struktur Kurikulum 2013 <i>Prof. Dr. Syawal Gultom, M.Pd.</i>	1 - 10
--------	---	--------

Invited Speaker

IS-001	Confidence Intervals with Application to Environmental Studies in Southern Thailand <i>Phattrawan Tongkumchum</i>	11 - 21
IS-002	Appreciate the Nation Through Research Javanese Turmeric or Temulawak (<i>Curcuma xanthorrhiza</i> ROXB.): Xanthorrhizol an "Angel" Compound in the Rhizome of Temulawak and Its Applications <i>Yaya Rukayadi</i>	22

Biological Science

BS-001	Isolation of Heat Shock Proteins Gene (HSPs-gene) in the Silkworm, <i>Bombyx mori</i> (C301) <i>Masitta Tanjung, Maryani Cyccu Tobing, Syafruddin Ilyas, and Darma Bakti</i>	23 - 28
BS-002	Mating Behavior of Male Mice After MSG Administration during Intra Uterine to Mature Periods of Life <i>Herbert Sipahutar and Adriana Y.D. Lbn Gaol</i>	29 - 38
BS-003	Ecobiological Review of <i>Neolissochilus sumatranus</i> (Ikan Batak) (Weber and de Beaufort, 1916) In Asahan River, North Sumatera <i>Temala Alexander Barus, Hesti Wahyuningasih, Eva Marlina Ginting, and Charles PH Simanjuntak</i>	39 - 45
BS-004	The Growth of Orchid (<i>Dendrobium sp</i>) in <i>In Vitro</i> Giving with Coconut Water on Different Medium <i>Fauziyah Harahap</i>	46 - 53
BS-005	Diversity of Lichens on the Stands of Mahoni (<i>Swieteniamacrophylla</i>) Functioning as Shade Plants in Medan <i>Ashar Hasairin, Nursahara Pasaribu, Lisdar I. Sudirman, and Retno Widhiastuti</i>	54 - 60
BS-006	Studies on Species Diversity and Growth Rate of Mold in Musk Lime Pickle (<i>Citrofortunella microcarpa</i>) Food Society of Melayu <i>Mhd. Yusuf Nasution and Ashar Hasairin</i>	61 - 67
BS-007	<i>In Vitro</i> Selection Uplandrice Nias Island to Aluminium Resistant Character and Low pH through Somaclonal Variation and Gamma-Rays Irradiation <i>Syahmi Edi, Lazuardi and Idramsa</i>	68 - 77
BS-008	Cassava Leaves Battery as Alternative Energy Based on Environment Friendly Technology <i>M. Gade</i>	78 - 81
BS-009	Description of Endophytic Fungi of Plants Raru (<i>Cotylelobium melanoxyton</i>) Genus <i>Alternaria</i> <i>Uswatun Hasanah, Riwayati and Idramsa</i>	82 - 90
BS-010	The Effect of Biji Mete (<i>Scomberomorus commerson</i>) in the Feed to the Decline in Blood Cholesterol Level Hypercholesterolemic Male Mice (<i>Mus musculus</i>) <i>Rudi Kartika and Eddiyanto</i>	91

BS-011	Frequency Attendance of Makrozoobentos with Physics Factor and Chemistry in Territorial Water of Babura River <i>Masdiana Sinambela and Mariaty Sipayung</i>	92
BS-012	Inventory of Nematophagous Fungi in Sumatera Utara, Indonesia <i>Liana Dwi Sri Hastuti, Jane Nicklin and Ameilia Zuiyanti Siregar</i>	93
BS-013	Land Degradation in the Upstream of Deli Watershed in North Sumatera Based on Soil Erosion Rate Prediction and Soil Erosion Hazard Level <i>Sunihar Hutapea; Ellen Lumisar Panggabean and Endang Sari Simanullang</i>	94
BS-014	Diversity and Abundance of Insect Pollinators in Different Agricultural Lands in Jambi, Sumatera <i>Elida Hafni Siregar, Tri Atmowidi, and Sih Kahono</i>	95
BS-015	Biodiversity of Leaf-and Planthopper (Hemiptera: Auchenorrhyncha) on Rice Ecosystem at High Land Tapanuli Of North Sumatera-Indonesia <i>Binari Manurung, Puji Prastowo, and Erika Rosdiana</i>	96

Chemical Science

CS-001	The Binding Behaviour and Conformation of <i>Rhodobacter sphaeroides</i> TSPO in DDM and DPC Detergents <i>Nora Susanti, Joshua Sharpe and Krisztina Varga</i>	97 - 102
CS-002	Synthesis, Crystal Structure and Magnetic Properties of the Spin Transition System $[Fe(pq)_3](ClO_4)_2$ Complex <i>Iis Siti Jahro, Djulia Onggo, Bohari M. Yamin, Ibrahim Baba and Nandang Mufti</i>	103 - 109
CS-003	The Utilization of Tamarillo Peels as Matrix of Bacterial Cellulose-Based Nanopaper <i>Joshua and Saharman Gea</i>	110 - 114
CS-004	Isolation and Characterization of α -Cellulose of Rice Leaves <i>Yusnaidar, Basuki Wirjosentono, Thamrin, and Eddiyanto</i>	115 - 119
CS-005	Inhibitory Activity of Alkaloid of Extract Ethanol Ranti Hitam (<i>Solanum blumei</i> Nees ex Blume) Fruit ON Leukimia L1210 Cancer Cells Growth <i>Muruiaty Simorangkir, Ribu Surbakti, Tonel Barus and Partomuan Simanjuntak</i>	129 - 126
CS-006	The Isolation of Nanocrystalline Cellulose from Palm Empty Fruit Bunches <i>Mahyuni Harahap, Fenny Aulia, and Saharman Gea</i>	127 - 131
CS-007	Study of Rubber Seed Oils Hydrocracking into Biogasoline and Diesel Fraction Over the Combination Y-Zeolite and Ni Catalyst <i>Ary Anggara Wibowo, Salsabila Firdausyah, Siti Hajjah, Dina Dwiyanti, Junifa Layla Sihombing, Ahmad Nasir Pulungan</i>	132 - 140
CS-008	Compregnated Oil Palm Trunk (<i>Elaeis guineensis</i> Jacq.) with 20% Dammar Resin (<i>Agathis dammara</i>) <i>Nurfajriani, Leni Widiarti, and Basuki Wirjosentono</i>	141 - 144
CS-009	The Activity Values of Cla (Conjugated Linoleic Acid) Synthesized from Castor Oil by Using Visible Spectrofotometer with DPPH as Free Radical <i>Marham Sitorus and Bajoka Nainggolan</i>	145 - 147
CS-010	Preparation, Characterization and Activity Assay of NiO-CoO-MoO/Zeolite-Y Catalyst on Hydrocracking of Cashew Nut Shell Liquid in Fixed-Bed Reactor <i>Ahmad Nasir Pulungan, Junifa Layla Sihombing, Hafni Indriati Nasution, Ratu Evina Dibyantini, Rini Selly, Wega Trisumaryanti, and Triyono</i>	148 - 154
CS-011	Effect of Temperature and Composition Zeolite on the Performance Membrane-Zeolite for Separation of Ethanol-Water by Pervaporation <i>Ridwanto, Rahmat Nauli, Ani Sutiani, and Anny Sartika Dauly</i>	155 - 163
CS-012	Biofuel Production from Hydrocracking MEFA of Rice Bran Oils Over Natural Zeolit Supported Ni and Ni-Mo Metals <i>Junifa Layla Sihombing, Jasmidi, Nurmalis, Ahmad Nasir Pulungan, and Ratna Sari Dewi</i>	164
CS-013	Preparation of Kraft Lignin Based Polyol from Pulp Mill Black Liquor through	165

	Oxypropylation Reaction <i>Abubakar, Basuki Wirjosentono, Thamrin, and Saharman Gea</i>	
CS-014	Characterization and Utilization of Bentonite Sabang of Aceh (Indonesia) as Fillers Polymer Nanocomposite <i>Saharman Gea, Julinawati, and Basuki Wirjosentono</i>	166
CS-015	Efficiency and Selectivity Improvement of the Silica Chitosan Hybrid by pH Optimilization in Simultan Heavy Metals Mg(II) and Ni(II) Adsorbtion Using Solid Phase Extraction Method <i>Lisnawaty Simatupang</i>	167
CS-016	Natural Rubber Modification: Graft-Copolymerization of Cyclic Natural Rubber by Free Radical Reaction with Maleic Anhydride <i>Eddiyanto, Alkhafi Maas Siregar, and Winsyahputra Ritonga</i>	168

Mathematical Science

MS-001	An Active Constrained Based Approach for Solving Problems for Positioning New Products Under Risk <i>Nerli Khairani</i>	169 - 178
MS-002	An Integrated Optimization Model for River Water Quality to Estimate Wastewater Removal <i>Syafari</i>	179 - 188
MS-003	An Improved Approach for Solving the Plant Cycle Location Problem <i>Agusman</i>	189 - 192

Physical Science

PS-001	A Comparison of Methods for Testing Homogeneity of Average Temperature and Precipitation Series <i>Marzuki Sinambela and Esty Suryaningsih</i>	193 - 200
PS-002	Mapping for Groundwater Potential Based on Resistivity Data Interpretation in Pamah Paku Kutambaru Langkat Regency <i>Hengki Sembiring and Rita Juliani</i>	201 - 209
PS-003	Lithology of Ketuken Watershed in Langkat <i>Rochayanti N R Simatupang and Rita Juliani</i>	210 - 217
PS-004	Anthrophegenic Causes Analysis on Heavy Metal Pollution in River Water and Sea Water in Middle Tapanuli Regency North Sumatera <i>Rahmatsyah, Eddy Marlianto, Mester Sitepu, and Motlan</i>	218 - 227
PS-005	Morphological Analysis and Content Elements of Limestone from Village Sulkam Langkat Using Scanning Electron Microscope (SEM) <i>Rita Juliani, Timbangan Sembiring, Mester Sitepu, and Motlan</i>	228 - 238
PS-006	Influence of Concentration and Post-Heating to the Crystal Size and Optical Properties of ZnO Thin Films <i>Nurdin Siregar, Eddy Marlianto, Saharman Gea, and Nurul Taufiqu</i>	239 - 248
PS-007	Synthesis and Characterization Optical Properties of Cu ₂ O Nanoparticles with Coprecipitation Method Based Concentration Variations Precipitator <i>Pintor Simamora, Juan R. S., and Berton M. Siahaan</i>	249 - 259
PS-008	Thermal Analysis and Structure of Nano Composite Palm Oil Boiler Ash <i>Eva Marlina Ginting and Nurdin Bukit</i>	260 - 269
PS-009	Effect of Rice Husk Ash and Palm Oil Boiler Ash as a Mixture on Concrete Porosity <i>Karya Sinulingga and Satria Mihardi</i>	270 - 278
PS-010	Geoelectric Investigation Schlumberger Configuration of Limestone Distribution in Cangap Kerabangen Area Kutambaru Subdistrict Langkat Regency <i>Rappel Situmorang and Sovian S.T. Sigiro</i>	279 - 288
PS-011	To Determine the Geothermal Fluid and to Identify Geothermal Stones Mineral at	289 - 296

	Geothermal Area Tinggi Raja Simalungun, North Sumatera Province Using 2D Resistivity Imaging and XRD <i>Muhammad Kadri and Eko Banjarnahor</i>	
PS-012	Correlation of Spectral Reflectance Characteristic Based on Spectrometer Cropcam MSR 16R and Satellite Image Landsat TM (Study Case In Medan-Indonesia) <i>Togi Tampubolon</i>	297 - 305
PS-013	Sensitivity of Breaks for Additive Seasonal and Trends (BFAST) Method to Detect the Vegetation Changes Based on the Choice of Vegetation Indices and Land Cover Types <i>Yahya Darmanwan, Esti Suryaningsih, and Lamtupa Nainggolan</i>	306 - 314
PS-014	Influence of Sintering Time on the Properties of High Temperature Superconductor BPSCCO Based <i>Eidi Sihombing</i>	315 - 319
PS-015	Resistance Analysis of Rock and Mineral Under Surface by Using Geoelectric Method in the Village of Dolok Marawa Simalungun Distric <i>Abd Hakim S and Marausaha Simanjuntak</i>	320

Science Education

SE-001	Impact of Phet Simulation Media to Minimize Quantity Misconceptions Students in Learning Dynamic Electrical Material <i>A.Halim, Azzarkasyi and Ibnu Khaldun</i>	321 - 327
SE-002	Misconception on Biology Materials Among Biology Teachers and Science Students of Senior High School in North Sumatra <i>Adriana Y.D. Lbu Gaol and Herbert Sipahutar</i>	328 - 337
SE-003	Misconception Reduction Effectiveness in Physics Learning Through Laboratory Working Methods in the Concept of Temperature and Heat <i>A.Halim, Qusthalani and Ibnu Khaldun</i>	338 - 343
SE-004	The Effect of Problem Based Learning Model Toward Students' Science Process Skills in Senior High School <i>Turnip Betty, Simanjuntak Mariati Purnama, and Purba Erikson</i>	344 - 350
SE-005	The Development of Media Device on Problem Based Learning Applied Microbiology <i>Hasruddin and Mahmud</i>	351 - 358
SE-006	The Effectiveness of Using Developed Problem Based Learning Tools on General Physics II of Physics Student, State University of Medan <i>Jurubahasa Sinuraya, Sehat Simatupang, and Ida Wahyuni</i>	359 - 367
SE-007	Application of Resource Based Learning Model for Improving Learning Outcomes Student in the Cube and Beams Matter in Class VIII SMP Negeri 5 Stabat T.A. 2013/2014 <i>Asrin Lubis</i>	368 - 378
SE-008	The Difference of Mathematical Problem Solving Achievement of Public Junior High School Based on Learning Approach <i>Ani Minami</i>	379 - 386
SE-009	The Effect of Cooperative Learning Model Type Group Investigation on Student's Achievement of Static Fluid in Class XI of SMA Negeri 1 Perbaungan A.Y. 2013/2014 <i>Derlina and Rikcy Almeda</i>	387 - 393
SE-010	Effect of Cooperative Learning Model Type Numbered Heads Together (NHT) Assisted Animation Media of Student Learning Outcomes <i>Mariati Simanjuntak and Rebecca Sianturi</i>	394 - 402
SE-011	Effect of Project Based Learning Model with KWL Worksheet on Divergent Thinking in Solved Physics Problems <i>Satria Mihardi and Karya Sinulingga</i>	403 - 409
SE-012	The Improvement of the Mathematical Problem Solving Ability at MTSN 2	410 - 419

	Through Realistic Math Approach <i>Muhammad Arif Hidayat</i>	
SE-013	The Influence of Inquiry Training Learning Model Toward Students' Achievement on the Topic of Heat in Class X Semester II MAN Kisaran A.Y. 2013/2014 <i>Sehat Simatupang and Ika Nurjannah Sirait</i>	420 - 428
SE-014	Analysis Implementation of Practical Appropriate with Standard of Competency Biological Lesson and the Application at Class X in SMA Negeri 11 Medan Tembung in Academic Year 2009/2010. <i>Venisha E.A. Pardede and Tri Harsono</i>	429 - 436
SE-015	Analysis of Competency and Performance of Secondary Teachers: Case Study at Five Cities/Districts in South Sumatra <i>Umi Chotimah, Zahra Alwi, and Farida</i>	437 - 445
SE-016	An Intensive Study of Teaching Model of Quantum Physics at Study Program of Physics Education in University <i>Mara Bangun Harahap</i>	446 - 452
SE-017	The Effectiveness of Laboratory Experiment Method to Increase Activity and Student's Achievement on Teaching Salt Hydrolysis <i>Ramlan Silaban, Agustina M.L. Tobing, and Irving Josafat Alexander</i>	453 - 460
SE-018	Contribution of Formal Thinking Ability on the Concept Mastery of Kinematics <i>Sondang R Manurung</i>	461 - 469
SE-019	The Use of Equation Worked Examples for Solving Electrochemistry Problem <i>Erdawati</i>	470 - 477
SE-020	The Effect of Predict Observe Explain Strategy (POE) on Students Activity and Learning Outcome on Human Respiratory System Sub Topic in Grade XI Science Program at SMA Negeri 15 Medan Academic Year 2013/2014 <i>Suyedi Hendra Yanto and Syahmi Edi</i>	478 - 484
SE-021	The Difference Between the Ability of Students in Solving Problem by Applying Cooperative Learning Type STAD With and Without the Help of Geogebra <i>Sinta Dameria Simanjuntak</i>	485 - 493
SE-022	Effect of Creative Learning Techniques and Reasoning Ability Toward Student Achievement in Physics <i>Purwanto</i>	494 - 507
SE-023	Improving Speaking Ability of the Students in English Lessons by Using Learning Model TPS (Think Pair Share) in Class V SD Immanuel Medan <i>Naeklan Simbolon, Fridawati R. Tambunan</i>	408 - 517
SE-024	The Application of Quantum Model Learning to Improve Student Learning Motivation on Science Subject State Class V SD 064 978 Medan Denai <i>Nani Barorah Nasution</i>	518 - 523
SE-025	Group Investigation Assisted E-Learning: Assessing the Impact of Interactive Media on Student's Learning Achievement and Critical Thinking <i>Wenny Pintalitna and Herbert Sipahutar</i>	524 - 532
SE-026	A Gametogenesis Module Development in POE (Prediction, Observation and Explanation) Oriented Model <i>Hafizah Ilmi Sufa and Meida Nugrahalia</i>	533 - 539
SE-027	Scientific Creativity in Learning Biology in Senior High School Tebing Tinggi City, North Sumatra <i>Widya Arwita</i>	540 - 546
SE-028	Application of Cognitive Theory of Content on Learning Ability to Increase Physical Science Using Generic Injection Needle Kit <i>Nur Maulita</i>	547 - 556
SE-029	The Perceptions of Global Warming and Environmental Benefits of Biodiesel for Sustainable Energy Among High School Students in Jakarta <i>Desnita</i>	557 - 565
SE-030	Ability Profile of Multiple Representations (MR) Students of Teacher Prospective on Static Electricity Topic	566 - 571

	<i>Nurliana Marpaung and Liliasari</i>	
SE-031	Low Achievement of Indonesian Student in PISA and TIMSS Test Results and the Related Factors <i>Ridwan Abdullah Sani</i>	572 - 588
SE-032	The Effect of Guided Discovery Based Learning Model Towards Students Learning Outcomes of Chemistry on Redox Reaction Concept <i>Anna Juniar, Dede Suriyani, Praviil Mistryanto, and Debby Masteriana</i>	589 - 595
SE-033	A New Breakthrough in Chemistry and Management <i>Wesly Hutabarat</i>	596 - 604
SE-034	Evaluation of Sports Training Program Guidance Center Student (PPLP) North Sumatra <i>Sabaruddin Yunis Bangun</i>	605 - 615
SE-035	The Characteristics of Theology of Moslem Batak Toba in State University of Medan <i>Ranli Nur, Usman Pelly, Hasan Bakti Nasution</i>	616 - 625
SE-036	Pengembangan Model Pembelajaran Hybridlearning Mata Kuliah Pengantar Sosiologi di Universitas Negeri Medan <i>Trisni Andayani</i>	626 - 630
SE-037	Pre Competency Test Standardization on Program of Field Experience HAT Competency-Based Graduate Education Through Item Analysis <i>Pargaulan Siagian, Elvo Napitupulu, Arifin Siregar, Hudson Sidabutar</i>	631



SE-008

THE DIFFERENCE OF MATHEMATICAL PROBLEM SOLVING ACHIEVEMENT OF PUBLIC JUNIOR HIGH SCHOOL BASED ON LEARNING APPROACH

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ABSTRACT

This paper is the result of a study to investigate the difference of the students' achievement in mathematical problem solving (MPS) based on learning approach. The research is static and quasi-experimental group posttest only. The population was all of students of upper and middle level public Junior High School in Bandung, West Java, Indonesia. One school of each level and two classes of each school were involved as samples. The research also investigate students' mathematical prior knowledge (MPK) either in upper or in the middle level school. One way Anova and two way Anova are used to analyze the data. The research results are: (1) The students in PBL classroom get better achievement in MPS test than the students in conventional one; (2) There is no interaction between PBL and MPK towards MPS; (3) There is no interaction between learning approach and school level.

Keywords: *Mathematical problem solving, problem-based learning.*

INTRODUCTION

Since the eighteens, mathematical problem solving (MPS) has become the focus of many experts, researchers, and practitioners of mathematics education in many countries. In Indonesia, it is involved as one of goals of learning and teaching mathematics at all levels of school (MoE of Indonesia, 2006). It is due to the view that MPS is considered as the heart of mathematics. In fact, everything learned in mathematics was dedicated to solving a variety of problems. In short, the main goal of doing mathematics is problem solving and through solving problems students construct their new knowledge and grasp mathematical concepts.

According to TIMSS's evaluation (Mullis, et al., 2008), Indonesian eight grade students achievement in problems solving is categorized very low. Deeply speaking, in Geometry they only get 19%, meanwhile the international achievement is 32%. In algebra, they get 8% while the international achievement is 18%. The data indicates that the students are lack of problem solving ability. Inherently to the above findings, prior investigation on eighth grade at one public school in Bandung shows that they are incompetent in mathematical problem solving. Precisely, they only get 39%.

Researchers hypothesized that students' low achievement in mathematical problem solving due to the teaching approach the teachers applied (Schoenfeld, 1994). Mathematical

classrooms are still dominated by direct instruction (conventional teaching learning) with less emphasis on applying mathematics to daily life. Students do not have enough experiences seeing how problems be solved and in turn doing it themselves. In short, students are rarely engaged in solving problems. Instead, they only be able imitating their teachers solving routine exercises. This is what Arends (2008) claims as passive processes of learning.

Other research finds that mathematical prior knowledge (MPK) gives contribution to students' mathematical problem solving ability (Krulik & Reys, 1980). The finding is in line with Arslan and Altun (2007) whose stated that the lack of ability of students in solving mathematical problem is due to the poor of mathematical prior knowledge and the incompetency of choosing and applying the knowledge they have to handle the tasks.

It is then relevant to realize and implernent the ways of teaching which give students opportunities and time to be engaged in constructing new skills and knowledge and involved in solving mathematics problems as some researchers and institution recommend (MoE of Indonesia, 2006; Kilpatrick, et.al., 2001; NCTM, 2000; Schoenfeld, 1994).

Arends (1994), Ronis (2008) believe that an innovative and potential approach of teaching which endorse and enable students constructing and reinventing their new knowledge is problem-based learning (PBL). Through PBL, students in the small group are encouraged and facilitated to be actively engaging in solving problems. Using previous knowledge and experience, they try to sharpen their mathematical skills by solving real, challenging, open-ended, and contextual problems.

This research implement PBL with the purpose to enable students reach mathematical problem solving abiiti. So, the research questions are:

1. Is there the difference of the students' MPS achievement between students in PBL classroom and the students in conventional classroom?
2. Is there in interaction between learning approach (PBL and conventional one) and MPK towards the students MPS?
3. Is there interaction between learning approach (PBL and conventional one) and school level towards the students MPS?

Aspect of mathematical problem solving that will be measured is based on NCTM (2000), they are modelling a situation or daily life problem mathematically, hoose or apply appropriate strategy, and explain until interpret solution to initial problem.

METHODOLOGY

The study is a quasi-experimental design with non-equivalent control group posttest only. The population is all of upper and middle level public junior high school students in Bandung,

Indonesia. As samples, two classrooms are taken from each school level: one is for experimental group with PBL instruction, another one is for control group with direct (conventional instruction). Totally, there are 145 students took part in this study, i.e. 71 students are included in PBL classroom, and 74 students belong to conventional classroom.

At each classroom, the students are divided into 8 groups. There are 5 students in each group which consisted of students from mixed ability (high, middle and low MPK) to examine the interaction between learning approach and MPK.

Five experts validated teaching material and mathematics problem solving instrument before being tried-out to students of other equivalent school. All item of the test was valid with Cronbach Alpha reliability 0.76.

Data are collected using a set of instrument. The instrument is a problem solving post-test designed by the investigator for the purpose of this study. The test is given to experiment classroom as well as to conventional one for comparison purposes. An item of the test is presented below.

Problem 1: The trip of the boat

There is a boat which is sailed from Port A in the North straight to Port B in the South along 20 km. The boat turn to the East as far as 24 km to reach Port C. From Port C, the travel of a boat continue straight to Port D in the South along 12 km. Find the distance from Port A to Port D.

RESULTS

Data is analysed by using Statistics Package for Social Science (SPSS) version 19 based on instruction, previous knowledge, and school level. Test of normality and homogeneity of variance gave significant result either for MPS score based on learning approach, MPS score based on learning approach an MPK, or MPS score based on learning approach and school level. Kolmogorov-Smirnov is used to test the normality of the data, and analyses of variance is used to test homogeneity of data at 5% level of significance.

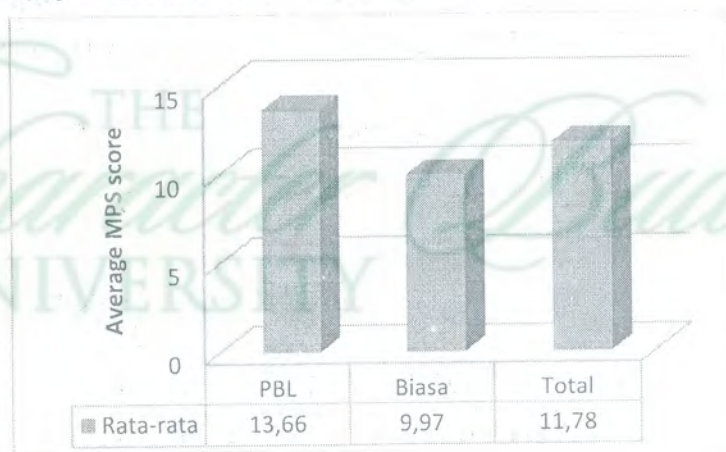


Figure 1. The Difference of Students' Mathematical Problem Solving Achievement.

The Difference of Students' Mathematical Problem Solving Achievement Based on Learning Approach. Figure 1 describes mathematical problem solving average score based on learning approach. The students in PBL classroom received average of MPS score 13,66 (approximately 54%), while students in conventional classes earned an average score 9,97 (about 24%). The test of the hypothesis is significant at 0,05. It means there is significant difference MPS students' achievement between the students in PBL classroom and their counterpart in conventional one.

Interaction between Learning Approach and MPK towards MPS Achievement. Two-way Anova is used to test the existence of interaction between learning approach and MPK towards MPS ability. The result is there is no common effect between learning factor with MPK towards students MPS achievement in both groups. The students MPS average score based on learning approach and MPK is presented in Figure 2.

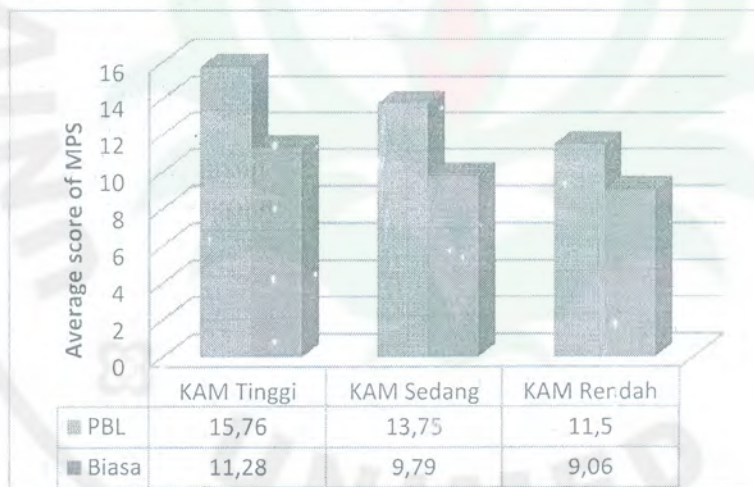


Figure 2. Students MPS Average score based on learning approach and MPK

Interaction between Learning Approach and School towards MPS. Statistical test of hypothesis about interaction between learning factor (PBL, Conventional) and level of school (upper, middle, lower) is not significant. So, we concluded that there is no interaction between learning factor and school level towards students MPS achievement.

Analys and Discussions on Students Performance. Many students get high score in solving problems test that measure their representation ability as a part of understanding the problem, i.e., sketch the picture/graph associated with the words problem such as for problem 1 such that they easily represent that sketch into mathematical models. Example of the student representation ability is presented in Figure 3. This student belongs to experiment classroom.

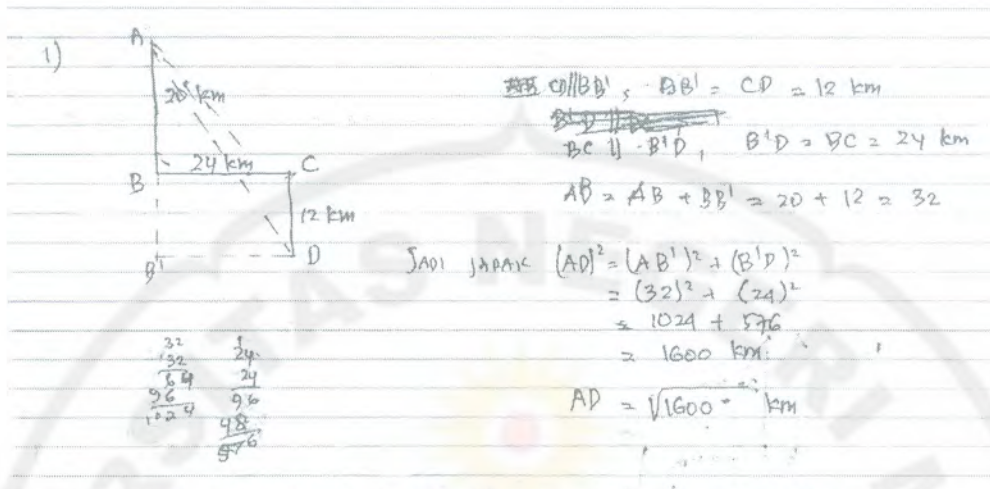


Figure 3. The Student Performance on Problem 1 of MPS.

Although a large amount of the students get high score for problem 1, but some of the them get low score for this problem. Actually, many students do not make the sketch (the graph) or other representation so it is harder for them to arrive at the right solution.

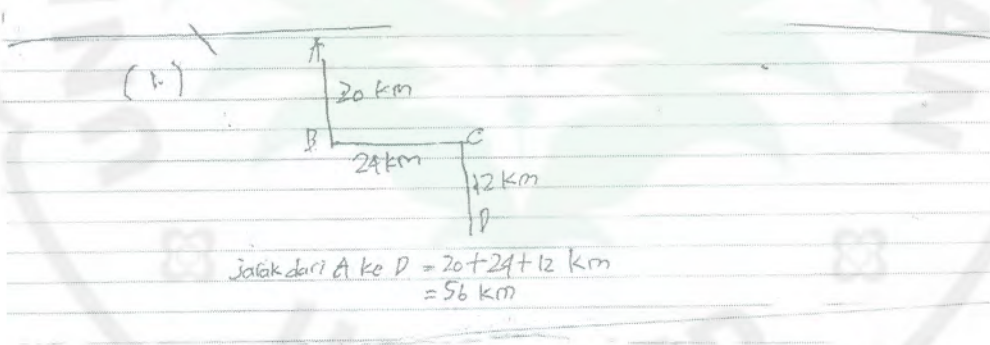
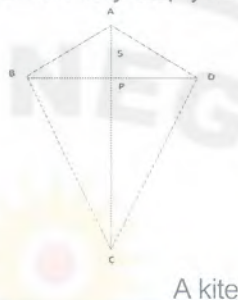


Figure 4. Another Student Performance on Problem 1 of MPS

It can be seen from Figure 4, the student gives the graph but the solution for the problem is not comprehensive enough so they do not know what must to do next. It indicate that some of the students have grasped the concept of Pythagorean completely, but they forget about how to find square root number such that it hard for them to finish the problem. The fallacy is not due to the instrument since it has validated by five education experts. Moreover, the teacher has implement instruction properly. Probably the student counts for the fallacy. So, the researcher asked this student why his work was so bad and the answer is he do not like mathematics. So, the next research maybe should include attitude aspect. Like or dislike towards mathematics is influenced by the fact that the students are rarely engage in problem solving activity (Wilson 1997), such that the knowledge is not store in longterm memory and hard to retrieve whenever needed (Hiebert & Carpenter, 1992; Carpenter Lehrer 1999).

Problem 6

Look at the picture of a kite below. Every edge of the kite are made of bamboo, so do their diagonal. The length of vertical diagonal of the kite is 40 cm, and the horizontal one is 24 cm. A button is put at every 5 cm at each side of a kite. Compute how many button at least you need for these purpose. You must write every step you need to get the solution.



The student get difficulty in solving problem 6 (the last problem). It is interesting, for this problem the achievement of the students in experiment classroom is not higher than the achievement of the students in conventional one., i.e., average score of MPS for the students in experiment classroom is 1,97 of 4. Meanwhile, average score of MPS for for the students in conventional classroom is 2,01 of 4 (See Table 2). Example of student performance in problem 6 is presented in Figure 5 and Figure 6.

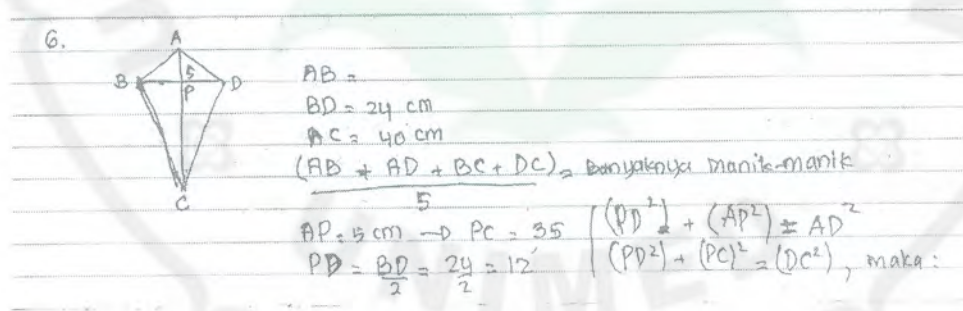


Figure 5. The Student Performance on Problem 6 of MPS

Figure 1 indicates that this student actually can finish the problem but he has no time anymore to do it. His time has out to solve five other problems.

The performance of the student in Figure 6 is almost perfect, only slightly fallacy he made, that is, he doesn't chek wether his proposed solution is right. This student is lack of aspect number 4 of problem solving steps, i.e., reflection or looking back Polya (1981). In this experiment, this aspect include in aspect 3.

Overall, the performance of MPS of students who get PBL approach belongs to middle category. In the other side, the performance of MPS of the students who get conventional learning belongs to low category (the score is under ideal average score, ideal average score is 4).

$$\begin{aligned}
 6. \quad (AD)^2 &= 5^2 + (12)^2 \\
 &= 25 + 144 \\
 &= 169 \\
 AD &= 13 \\
 \\
 DC^2 &= 12^2 + 35^2 \\
 &= 144 + 1225 \\
 &= 1369 \\
 DC &= 37 \\
 \\
 K &= (AD \times 2) + (DC \times 2) \\
 &= (13 \times 2) + (37 \times 2) \\
 &= 26 + 74 \\
 &= 100 \\
 \text{Jadi, perlu manik-manik} \\
 &= \frac{100}{5} = 20
 \end{aligned}$$

Figure 6. Another Student Performance on Problem 6 of MPS

Average of Students' MPS Achievement Based on Learning Approach for each problem is presented in Table 2.

Tabel 2. The Average of Students' MPS Achievement Based on Learning Approach

Item	MPS*)	
	PBL	Conventional
1	3,00	2,36
2	2,19	1,77
3	3,17	1,49
4	1,34	1,34
5	1,97	1,12
6	1,97	2,01
Average	2,733	1,682

*)Ideal score = 4

At the end of the program, the study found weaknesses in students' mathematical problem solving ability involve lack of prior knowledge, poor mathematical understanding ability and strategy to overcome the problems. This is in line with Arslan & Altun (2007) and Napitupulu (2011).

CONCLUSIONS AND RECOMENDATION

Based on the findings we conclude that: a. The student in PBL classroom get better MPS achievement than their counterpart in conventional classroom, b. There is no interaction between learning factor and MPK towards students' MPS achievement, and c) There is no interaction between learning factor and MPK towards students' MPS achievement.

It can be recommended that: (a) PBL should be applied as an alternative mathematics teaching approach to develop junior high school students' mathematical problem solving ability, (b) In applying PBL, teacher should have adequate mastery on its characteristics of PBL such as creating real contextual problem, guiding discussion, give scaffolding appropriately, ensuring availability of resources, and keep time available such that learning process run well, and evaluate students performance holistically, and (c) Future researcher need to investigate further whether PBL approach gives also significant effect on other mathematical competencies such as mathematical connection, representation, communication, and reasoning.

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