

ISBN 978-602-72198-0-9

PROCEEDING
ICOS 2014

The 1st International Conference On Science

"Science Enhancement for Developing Countries"

FACULTY OF MATHEMATICS AND NATURAL SCIENCES
HASANUDDIN UNIVERSITY





Proceeding

The First International Conference on Science (ICOS-1)

Editors

Chief : Magdalena Litaay M.Mar.Sci, Ph.D

Member : Dr. Nurtiti Sunusi M.Si

Dr. Fachruddin M.Si

Reviewer

Prof. Dr Dahlang Tahir M.Si (Physics, UNHAS)

Sri Astuti Thamrin M.Stat, Ph.D (Mathematics & Statistics, UNHAS)

Paulina Taba M.Phil, Ph.D (Chemistry, UNHAS)

Dr. Eddy Soekendarsi M.Mar.Sci (Biology, UNHAS)

Publisher: Fakultas Matematika dan Ilmu Pengetahuan Alam UNHAS

Address: Jl. Perintis Kemerdekaan KM 10 Tamalanrea 90245 Makassar

Tlp (0411) 586016, Fax (0411) 588551

Email: ahaddade@fmipa.unhas.ac.id



PREFACE

Makassar city, the capital of South Sulawesi province known as one of the biggest cities in Indonesia and also having Hasanuddin University, the biggest university in eastern part of Indonesia, has plenty of natural resources and human resources. Having a strategic position at the center point of Indonesia, Makassar has been developing very rapidly, and has been contributing to the regional, national and even international economic development. Given this, science can play important roles and therefore is needed to support rapid development in various sectors.

With regard to this, cooperates with Ministry of Environment Indonesia, Atmospheric and Ocean Research Institute (AORI) Japan, University of Kebangsaan Malaysia (UKM), Alfred Wagener Institute (AWI) Germany, Queensland University of Technology (QUT) and Flinders University Australia, Faculty of Mathematics and Natural Sciences Hasanuddin University carried out “The First International Conference on Science (ICOS-1)” on November 19-20, 2014, in Hotel Clarion Makassar. The theme of ICOS-1 is “Science Enhancement for Developing Countries”. The conference attended by two hundred participants and came from Asia (Japan, Malaysia, Indonesia), Australia, and Europe.

There are approximately 97 research articles for oral presentations and 16 poster presentations, ranging from Biology, Statistics, Mathematics, Chemistry, Physics, Geophysics, Computer Science and Environmental Science. Of the 113 papers, there are approximately 79 papers were selected to be published in the proceedings of the ICOS-1 through the peer review process.

With regard to the delivery of the ICOS-1 in 2014 and the completion of the proceedings ICOS-1, 2014, allow us to thanks to: the authors for providing the content of the program, the conference participants who came from several public and private universities, the program committee and the senior program committee, who worked very hard in reviewing papers and providing feedback for authors to be included in the Proceedings of ICOS-1, 2014, the hosting organisation Hasanuddin University, our keynote and invited talk presentations including Ir. Muh Ilham Malik M.Sc, from Ministry of Environment Indonesia, Prof Koji Inoue from AORI Japan, Prof Mohammad B Kassim from UKM Malaysia, Dr.rer.nat Dominik Kneer from AWI Germany, Prof Dadang A. Suriamihardja and Prof Alfian Noor from Hasanuddin University, Prof Kerrie Mengersen from QUT and Dr. Darfiana Nur from Flinders University, Australia.

Hopefully is of benefit to all readers.

Yours faithfully,
Prof Dr. Hanapi Usman M.S
Dean of Faculty Mathematics and Natural Sciences
Hasanuddin University



TABLE OF CONTENTS

COVER i

PREFACE iii

TABLE OF CONTENTS iv

KEYNOTE SPEECH

Muh Ilham Malik and Gunawan. Indonesian Policy on Hazardous Substances, Hazardous Waste, Contaminated Site Remediation and Domestic Waste Management 1-9

Mohammad B Kassim. Extending the Photo Response of Titanium Dioxide Photo Electrode with Ruthenium-tungsten Dye-sensitiser 10

Dadang A. Suriamihardja. Understanding Economic Sustainability from Thermodynamic Viewpoint 11-20

Koji Inoue, Irma Andriani and Zainal Arifin. *Oryzias* Fishes: Important Scientific Resources in Sulawesi 21-27

Kerrie Mengersen. Bayesian Modelling and Analysis of Big Data 28

Alfian Noor. Exploring Sponge Role in Alleviating Metal Pollution of Coastal Marine Environment: Some Experimental Results in Eastern Indonesia 29-33

Dominik Kneer, Simona Laukaityte, Leonardo Calderon Obaldia and Ruth Lewo Mwarabu. The Impact of Climate Change on Coral Reefs, and the Mitigation Potential of Sea Grasses 34

Darfiana Nur and James Totterdell. Bayesian Hidden Markov Model for Homogeneous Segmentation of Simian Vacuolating Virus (sv40) 35



ORAL PRESENTATION

I. BIOLOGY

- B.1. Asriyanti,** Magdalena Litaay, Eva Johannes, Indah Raya. The Effect of Fe³⁺ Ion Addition towards The Omega-3 (DHA) Production on Phytoplankton *Chlorella vulgaris*
..... 36-42
- B.2. Rahmi Rozali.** Selection of Isolates of Azotobacter Sp. Rhizosphere of Plants Cocoa and Ability in Dissolving Phosphate
..... 43-48
- B.3. Eka Sukmawaty.** Testing of *Bacillus Thuringiensis* Subsp. *Aizawai* Toxin, *Beauveria bassiana* Conidia and Mix Cultured to Armyworm (*Spodoptera Litura*)
..... 49-55
- B.4. Mu'minah,** Baharuddin, Hazarin Subair, Fahrudin. Production of Exopolysaccharide (Eps) Isolated From Bacterial Potato Rhizosfer on Several Sources of Carbon
..... 56-63
- B.5. Haerunnisa,** Ahmad Yani, Lismawati. Study of Relationship and Similarities Test Tawes Fish *Barbonymus gonionotus* and Nilem Fish *Osteochilus hasselti* in Tempe Lake through and Methods Morphometric Meristic.
..... 64-73
- B.6. Kafrawi,** Baharuddin, Enny L. Sengin, Ade Rosmana. Exploration of Free-living Rhyzobacteria from Shallot in Sulawesi Island and their Phosphate Solubilizing Activity
..... 74-82
- B.7. Zulkifli Razak,** Muhammad Arif Nasution, Suryawati Salam. Seed Technology Adoption Grafting Seed of Passion Fruit (*Passiflora Edulis*)
..... 83-87



B.8. Mashuri Masri. Molecular Identification of Bacterial Symbiont Macroalgae <i>Sargassum polycystum</i> Producing Enzymes L-Asparaginase.	88-95
B.9. Magdalena Litaay, Risco B. Gobel, Dody Priosambodo, Syahribulan, Zaraswati Dwyana, Nur Haedar, Elsy Pabalik. The Tropical Abalone <i>Halitosis Asinina</i> L, Screening For Antimicrobial Activity of its Bacterial Symbiont.	96-103
B.10. Isna Rasdianah Aziz. Potency of <i>Pseudomonas Aeruginosa</i> as Bioremediation Using Diazinon	104-108
B.11. Dody Priosambodo, Dominik Kneer, Harald Asmus, Neviaty P. Zamani, Karen von Juterzenka, Magdalena Litaay, Eddy Soekendarsi. Community Analysis of Burrower Shrimp in Bone Batang Seagrass Bed South Sulawesi	109-119
B.12. Adriani Mutmainnah, Eddyman W. Ferial, Muhtadin. The Structure of Seagrass Community in Barrang Lompo Island, Makassar South Sulawesi	120-128
B.13. Andi Ilham Latundra, Indah Raya, Raymond Kwangdinata, Isran Asnawi Abd. Karim, M.Syahrul. Production of Biodiesel Based on Microalgae <i>Tetraselmis chunii</i> and <i>Chlorella vulgaris</i> Lipids Used Ultrasonic Method.	129-142
II. STATISTICS	
S.1. Georgina Maria Tinungki. Determining Estimation on Semi Parametric Regression on Measurement Error	143-151
S.2. Poppy Indrayani, Yasuhiro Mitani, Ibrahim Djamaluddin, HiroIkemi. Construction of a Geospatial Data Sharing and Mutual-Use using by GIS Technology	152-157
S.3. Muhammad Arif Tiro. Occupation and Profession of Statisticians	158-167



S.4. Endang Wahyu Handamari, Kwardiniya Andawaningtyas, Sobri Abusini. Comparison of Naïve Bayes Classifier and Back Propagation Method to Determine Suitable Contraception	168-174
S.5. Shane E. Perryman. Mapping the Unkown: Measuring Change at The Microbial Level Using Molecular Method and Multivariate Statistics.	175-183
S.6. Suci Astutik, Henny Promoedyo, Solimun. ZIG Model on Intermittent and Positively Skewed Rainfall Data	184-190
S.7. Aswi, Sukarna. Spatial Pattern of 2013 Dengue Incidence in South Sulawesi	191-198
S.8. Indah Mulia Sari, Sri Astuti Thamrin, Armin Lawi. Piecewise Exponential Frailty Model on Survival Data using Bayesian Approach	199-210
S.9. Rima Ruktiari, Sri Astuti Thamrin, Armin Lawi. A Weibull Regression Model Using Additive Frailties on Survival Data	211-218
S.10. Fachrul Nawawi, Erna Tri Herdiani, Nurtiti Sunusi. Estimating Vector Autoregressive - Generalized Space Time Autoregressive Parameter with Seemingly Unrelated Regression	219-225
S.11. Sukarna, Aswi. On the Non-Negativity of Probability Density Functions	226-231
S.12. Yusran, Erna Tri Herdiana, La Podje Talangko. Application of Hotelling's T^2 Control Chart Based on the Mean Square Successive Difference in Monitoring Makassar City's Weather Conditions	232-238
S.13. Giarno, Erna Tri Herdiani, Nurtiti Sunusi. Term of Combination and Recombination in Time Series	239-246

III. MATHEMATICS

M.1. Aidawayati Rangkuti. Expectation Value in Risk Decision Making	247-251
M.2. Endah RM Putri, Lukman Hanafi, Zakiyyah AM. Finite Difference Method for Pricing European Option Under the Heston Model	252-257



M. 3. Chairul Imron, Sentot Didik S. The influence of Reynolds Number on the Drag Coefficient of a Circular Cylinder	258-262
M.4. Dwi Ratna Sulistyningrum, Budi Setiyono. The Defect Detection on Bullet P production using Edge Detection and Euclidian Distance.	263-267
M.5. Marjono, C.A. Ferima. Estimation of Least Upper Bound on the Modulus of Starlike Function Coefficients.	268-271
M.6. Sabri, Ilham Minggu. Students' Difficulties in Mathematics Proofs	272-280
M.7. Naimah Aris. Regularity of Global Attractor for a Quasilinear Parabolic Equations with M -Laplacian Type	281-289
M.8. Nur Erawaty. Equivalence Rational Matrices at Infinity	290-298
M.9. Selvi Rajuati Tandiseru. Development of Teaching Materials Based Local Culture in Improving the problem Solving Ability of Students' mathematical	299-305
M.10. Syafruddin Side. Solution of Poisson Equation with Boundary Element Method	306-314

IV. CHEMISTRY

C.1. Fathur Rahman Ma'rifatullah, Indah Raya, Hasnah Natsir. The Temperature Effect on Synthesis of <i>Hydroxyapatite Nanocrystal Through Precipitation Methode</i>	315-320
C.2. Indra Permata A.S., Indah Raya, Ahyar Ahmad. Synthesis and Characterization of Cu(II) and Zn(II) Complex and their Potency as Anti Tuberculosis	321-326
C.3. Kasmawaty Iswar, Indah Raya, Maming. Effect Stirring Time Variations of Synthesis Hydroxyapatite of Blood Shells (<i>Anadara Granosa</i>)	327-332
C.4. Lydia Melawaty, Alfian Noor, Tjodi Harlim, Nicole de Voogd. <i>Clathria reinwardtii</i> As a Zooremediator of Heavy Metal Manganese (Mn)	333-338
C.5. Firdaus, Dirayah Husain, HerlinaRasyid, Sukarti. Methylation of <i>p</i> -Coumaric Acid with Dimethyl Sulfate and Sodium Hydroxide as Catalyst	



.....	339-344
C.6. Diana Eka Pratiwi, Suriati Eka Putri. Characterization of Banana Peel Briquettes with the Variation of Binder Concentration	
.....	345-351
C.7. Isran Asnawi, Hasnah Natsir, Nunuk Hariani. Exploration of Lipolytic Enzymes Microbes from Lemo Susu Hot Spring, Pinrang, South Sulawesi, Indonesia	
.....	352-361
C.8. Syamsidar HS, Nurfaidhah Natsir. Bioremediation and Phytoremediation of Waste Oil Contaminated Soil using Biokompos with Sengon Plants	
.....	362-367
C.9. Sitti Chadijah, Andi Wahyu Trifany. Kinetics Delignification of Bagasse with Alkaline Peroxide Process.	
.....	368-375
C.10. Nunuk Hariani, Firdaus, Nursiah La Nafie, Nur Umriani Permatasari, Ajuk Sapar. A preliminary Study of Spons Species from Kapoposang Island, Spermonde Archipelago and Bioactivity Test of their Methanol Extracts	
.....	376-381
C.11. Aisyah, Rahmawati Azis, Yunizar. Synthesis of Fatty Acid Ethyl/ Methyl Ester from Candlenut Oil Utilizing Ultrasonic Device	
.....	382-387
C.12. Maming, Erny Rosmawati, Paulina Taba, Jabal Nur Basir, Indah Raya. Synthesis of Biomaterial Hydroxyapatite from Egg Shells and Its Potency as Material for Remineralization of Teeth	
.....	388-393
C.13. Muliadi, Deasy Liestianty, Zulkifli Tuara. Study on Toxicity of Ni ²⁺ ion to the Growth of Marine Phytoplankton <i>Dunaliella Salina</i> in Conwy Medium	
.....	394-399

V. ENVIRONMENTAL SCIENCE

ES.1. Dewi Yanuarita, M. Rijal Idrus, Irwanto. Communities Vulnerability of Spermonde Coral Islands	
.....	400-408
ES.2. Akbar Tahir, Farid Samawi, Yeis Pairunan, Masrul Jaya. Assessment of Pb Metal Concentrations on Water Column, Sediment and Organisms at Kayangan Island Waters of Makassar City	
.....	409-418



ES.3. Iradhatullah Rahim, Halima Tusadiyah, Muh. Iqbal Putera, Suherman, Asmaul Husna. The Utilization of An Agricultural Waste As A Source of Organic Matter of Nutrients in Maize
.....419-424

VI. COMPUTER SCIENCE

CS.1 Mohammad Isa Irawan, Daryono Budi Utomo. Optimization model of Planting Pattern Management Based on prediction of artificial Neural Network
.....425-446

CS.2. Marji, Dian Eka Ratnawati, Achmad Basuki. Random Search Method to Build the Software Special Diet Nutrition Patients (Running on Android)
..... 447-453

VII. PHYSIC

P.1. Syamsir Dewang, Bannu, Nurhasanah. Measurement of Radiation Dose on Radiodiagnostic X-ray machine with a Tube Voltage and Current Variations
.....454-461

P.2. Wira Bahari, Hariati, Sri Suryani. Characters of Temporal and Electric Potential Function from ECG for Patients with LVH Cardiac Abnormalities
..... 462-469

P. 3. Andi Nurul Aeni Daud, Aswar Syafnur, Harjumi, Indah Nurul Mutiah. Soil Density and Moisture Measurement Using Electrical Density Gauge (EDG) In ‘S’ Area
..... 470-474

P.4. Nurul Muhlisah, Sernita Domapa, Muhammad Taufiq Rafie, Andi Tenri Awali Wildana. Determination of Lithology and RQD (Rock Quality Designation) Value Using Well Logging and Full Coring In ‘T’ Area
..... 475-481

B. POSTER PRESENTATION

Po.1. Nur Haedar, Asadi Abdullah, Ruslan Umar, Ambeng. Production of Poly-B-HydroxyButyrate (PHB) by Isolates Bacteria from Sugar Factory Waste on Some Substrate Molasses Concentrations
..... 482-487

Po.2. Elis Tambaru. The Comparative Characteristics Cell of Leaves Anatomy of Motor Vehicles Location and Less Polluted in Makassar City Indonesia



- 488-492
- Po.3. Ismail Marzuki.** Isolation and Identification on Degradator Bacterium of Petroleum waste which Symbions with Sponge from Melawai Beach
..... 493-503
- Po.4. Nirmalasari Idha Wijaya, Triyanto.** The Influence of Eye Stalk Ablation to Gonadal Maturity of Mud Crab *Scylla Serrata* That Cultivated on Battery Cell Cage
..... 504-509
- Po.5. Juhriah, A. Masniawati, Mir Alam .**Genetic Diversity of 1st Generation Selfing Local Corn of Selayar Regency South Sulawesi And Corn From Cimmyt Based on Simple Sequence Repeat (Ssr) Molecular Marker
.....510-517
- Po.6. Zaraswati Dwyana, Nurul Muthmainnah.** Production and Optimization Anti diarrheal Agent from Potency of *Lactobacillus acidophilus* at the Variation pH and Temperature
..... 518-523
- Po.7. Rosana Agus.** Characterization Of Recombinant Protein Esat-6 Mycobacterium Tuberculosis As Immunodiagnostic Latent Tuberculosis
..... 524-529
- Po.8. Nur Aliah Rusman, Magdalena Litaay, Zaraswati Dwyana, Nur Haedar, Elmi Zainuddin, Kurniati Umrah Nur.** Bioactivity of Sponge *Clatria sp* Symbiotic Bacteria against *Staphylococcus aureus* and *Salmonella typhi*.
..... 530-536
- Po.9. Waode Nur Rahmaniah, Alfian Noor, Muhammad Zakir, Maming.** Utilization of diethanolamin as CO₂ absorbent for measurement of Carbon-14 in Coral Sample from Langkai Island
.....537-543
- Po.10. Andi Asdiana Irma Sari Yusuf, Maming, Muhammad Zakir, Alfian Noor.** Utilization of Ethanolamine as Carbon Dioxide Absorber for Estimating of Coral Age from Langkai Island via LSC (Liquid Scintillation Counting) Method
..... 544-551
- Po.11. Febby Kurniaty, Maming, Muhammad Zakir, Alfian Noor.** Utilization of Sodium Hydroxide as Absorber for ¹⁴C Analysis of Coral Ages Estimation in Langkai Island Using LSC (Liquid Scintillation Counting) Method
..... 552-559
- Po.12. Agnes Rantesalu, Nursiah La Nafie, Syarifuddin Liong.** Synthesis of Silver Nanoparticles using *langsat* peel Extract *Lansium domesticum*
..... 560-567



Po.13. Tuti Suprianti, Indah Raya, Hasnah Natsir. Effectiveness Extract of Fatty Acids of Microalga *Chlorella Vulgaris* as a Cream to Repair The Face Skin Texture

..... 568-572

STUDENTS' DIFFICULTIES IN MATHEMATICS PROOFS

Sabri¹ and Ilham Minggu²

^{1,2}Mathematics Department, Faculty of Mathematics and Science, State University of Makassar
Jurusan Matematika FMIPA UNM Jl. Daeng Tata Raya Mallengkeri Makassar 90224
email: ibesabri@yahoo.com,

Abstract

This qualitative research aimed at investigating difficulties experienced by students in Mathematics Department, State University of Makassar. This study was conducted in Mathematics Education Study Program at Mathematics Department, Faculty of Mathematics and Science, State University of Makassar in academic year 2013/2014. The subjects involved in the research were students of Mathematics Education Study Program in the subjects of Calculus, Trigonometry, and School Mathematics. The subjects were administered in tests concerning mathematics proof. Further, the students' answers were then categorized into several aspects of difficulties in proving. The research findings showed that there were four categories of difficulties experienced by the students in proving statements in mathematics. The four categories were: (1) the use of symbols which was inappropriate; (2) the lack of students' understanding about mathematics proof; (3) the difficulties in selecting strategies for mathematics proof; and (4) the lack of understanding of concepts and principles in mathematics.

Key Words: *Mathematics proof, difficulties, students.*

1. INTRODUCTION

In mathematical courses at universities, students strive to solve problems requiring them to prove, verify, justify, or show. Essentially, all these instructions ask them to prove mathematical statements. Proof is the most important tool in mathematics [6]. Proving is one of the main activities when someone is learning mathematics. However, difficulties in proving mathematical statements are encountered by most of the students. In the last few years of our teaching, we found that students showed symptoms of problems in proving mathematical statements. It is evident that some of them just take one or two examples or cases and verifying the truth of the statements on the cases carelessly lead them to conclude that the statements are true or already proven. It seems that they do not understand what constitutes a mathematics proof [16]. Besides, a conditional sentence confuse students and they cannot figure out where to start its proof and where it ends. Above all, they do not comprehend what attributes are assigned to a valid mathematics proof. In this research, the problem under investigation is what and how are the difficulties experienced by the students in proving mathematical statements. The findings will be beneficial for lecturers to further identify appropriate strategies to help the students succeed in proving mathematical statements.

2. PROVING AND PROOF IN LEARNING MATHEMATICS

2.1 Proving and Proof

Everyone learning mathematics, especially in higher level, must know what constitutes a proof, why proof is needed, and how to construct proof. All these are to lead the learners to comprehend the structure of mathematics. Proving is a challenging activity in learning (doing) mathematics. Constructing proof is not considered as a branch of mathematical activities. It is actually the essence of mathematics, and someone cannot be considered as learning mathematics unless they learn the 'what' and the 'how' of mathematics proof [2]. With a very close relationship to reasoning, both proof and reasoning are not merely an occasional activity done within a special time or a special topic in mathematics, but they should be a natural, ongoing component of learning activities [12]. Within the community of mathematics, there is no strict consensus about the meaning of proof, its role, and the way it is constructed, verified, and accepted [8].

Although students have been exposed to proofs in their school mathematics, they first meet the formal proof concept as accepted in the community of mathematicians at university level. Much of the proving process is a sequence of mental and physical actions, such writing or thinking of a statement in a proof, drawing or visualizing an illustration on the results of previous actions, or trying to remember an example [15]. It is useful to consider a whole range of roles proofs play in mathematical practices [6]. Some of them are verification, explanation, systematization, discovery/invention, communication, exploration, construction, and incorporation (see [13]). Learning and teaching are expected to reflect all the roles. It is argued that while in mathematical practice the main function of proof is verification and justification, its main role in mathematics education actually is explanation [5]. Accordingly, the need for understanding and the need for validity seem to be recognized as being the characteristics of the theoretical discussion about the nature and the function of proofs [10]. Some of the roles seem to be indistinguishable and overlap to one another [9]. Also, some of them exist in a close relationship to other functions such as: incorporation and systematization, or discovery and exploration.

2.2 Difficulties of Proving

In their school mathematics experiences, in general students struggle mostly with the computational aspect of mathematics and see mathematics as a list of facts, rules, and procedures. Therefore when they move to a university, they have difficulties in understanding the abstract and axiomatic structure of mathematics based on concepts, relations between concepts, definitions, theorems, and proofs. There have been seven major sources of student difficulties in proving [11], that is, inability to state the definition; lack of intuitive concept understanding; inadequate concept images of proving; inability to generate examples; inability to understand and use mathematical language and symbols; inability to utilize definitions to structure proofs; and inability to start proving.

The occurrence of student difficulties in proving are associated with factors, such as, the understanding of the rules and nature of proof; conceptual understanding supporting the proof; proving techniques and strategies; and cognitive load [4]. Reasoning errors and misconceptions also contribute to the difficulties in proving [14] including misconception in

categorizing definitions and misunderstanding about the mathematical language [3]. Further, the difficulties are caused by the imprecision in writing mathematics and lack of understanding about how to construct proofs by appropriately applying rules of logic [1]. There are two general issues concerning the students' difficulties in doing proof [10]. These issues correspond to two main questions, that is, what are the kinds of difficulties and which might be the origin of such difficulties. This research only covers the former question.

3. METHODOLOGY

This research is an explorative qualitative study aiming at exploring and describing the difficulties experienced by students in mathematics proof. It was conducted at Mathematics Education Study Program, Mathematics Department, State University of Makassar, Indonesia during the second semester of academic year 2013/2014. The research subjects were 121 students enrolled in three different units, that is, Calculus 2 (37 students), Trigonometry (31 students), and School Mathematics 1 (53 students). The instruments used in this study were written essay tests. The tests were administered both at the mid and the end of the semester. The students sit in the mid semester test in two units, that is, Calculus 2 and Trigonometry, and they sit in the final semester test in three units, that is, Calculus 2, Trigonometry, and School Mathematics 1. The students' answer sheets were then examined and an inductive analysis was employed focusing on the difficulties encountered by them in solving problems of mathematical proving. The difficulties were grouped based upon categories provided in the theoretical review. Besides, additional categories were made in order to cover the kinds of difficulties left uncovered in the initial categories. Further, the students' difficulties were described in the form of simple profiles accompanied by illustrations exemplifying students' difficulties which were quoted from mistakes performed in their answer sheets.

4. RESULTS AND DISCUSSION

4.1. Results

Based upon the inductive analysis, it was found that there were four categories of students' difficulties in mathematical proof.

4.1.1. Mathematical Symbols

Some students could not understand the meaning of mathematical symbols. Further, they did not use them appropriately. This caused the proof they constructed to be meaningless. The meaning of symbols in mathematics is very specific and unique, so their use

$$\text{Buktikan bahwa } \arcsin \frac{x}{\sqrt{x^2+1}} + \arccos \frac{2x}{1-x^2} = \arctan \frac{1}{x}$$

$$\text{Jawab! } \arcsin a + \arccos b = \arctan \frac{1}{x} \text{ (Buktikan)}$$

$$\arcsin \frac{x}{\sqrt{x^2+1}} + \arccos \frac{2x}{1-x^2} = \arctan \frac{1}{x}$$

$$\arcsin a + \arccos b = \arctan \frac{1}{x}$$

$$= \arcsin a + \arccos b$$

$$= \arcsin a + \arccos b \Rightarrow \arcsin a + \arccos b + \arccos b$$

$$\Rightarrow \arcsin a + \arccos b \Rightarrow \arcsin a + \frac{1}{\arccos b}$$

$$\Rightarrow \frac{\arcsin a \cdot \arccos b + 1}{\arccos b} \Rightarrow \frac{(\arcsin a)(\arccos b) + 1}{\arccos b}$$

$$\Rightarrow \frac{\arcsin a \cdot \arccos b + 1}{\arccos b} \Rightarrow \frac{\arcsin a \cdot \arccos b + \arccos b}{\arccos b}$$

$$\Rightarrow \frac{\arcsin a \cdot \arccos b + \arccos b}{\arccos b} \Rightarrow \frac{\arcsin a \cdot \arccos b + \arccos b}{\arccos b}$$

$$= \frac{(\arcsin a \cdot \arccos b + \arccos b) \arccos b}{\arccos b} = \frac{\arcsin a \cdot \arccos b + \arccos b}{\arccos b}$$

Student's Inappropriate Use of Mathematical Symbols

will very much influence the meaning of sentences. The use of implication and bi-implication in the proof as illustrated in the picture ruins the meaning of the sentence. The relationship between the components of the sentence, indeed, is equal ($=$), as they talk about real values; they are not equivalent sentences with their truth values. It was also found that the students were confused by the power of -1 where they considered $\cot^{-1}x$ as the reciprocal of $\cot x$, that is, $\tan x$.

4.1.2. Comprehension of Mathematics Proofs

Students' seemed to experience difficulties in understanding what a mathematics proof is. Although a heuristic proof assisted by computer software could be accepted nowadays, logic involving a deductive axiomatic system still dominates the discussion about proving in mathematics. Some students still considered it enough just to give or show one example or case satisfying the statement to prove. In proving a trigonometry identity, some students tried to substitute certain real value into variable x . An understanding that verifying a case constitutes a proof sometimes leads students to a very clear correct statement. This fact turns to ensure him that the expected proof has been completed, while he forgets that the statement to prove applies for infinite number of cases. Students' understanding of proving an equity in mathematics was still problematic because they did not realize that proving an equity was about proving the value, not the form or appearance. The integrands can be different in appearance but the final results are equal to each other.

4) Jika a dan b bilangan riil positif - buktikan bahwa

$$\int_0^1 x^a (1-x)^b dx = \int_0^1 x^b (1-x)^a dx$$

Jawaban: a dan b adalah bilangan riil positif
 Misalkan $a = 2$ $a \neq b$
 $b = 3$

atau ditunjukkan

$$\int_0^1 x^a (1-x)^b dx = \int_0^1 x^b (1-x)^a dx$$

$\Rightarrow \int_0^1 x^2 (1-x)^3 dx = \int_0^1 x^3 (1-x)^2 dx$

$\Rightarrow \int_0^1 x^2 (1 - 3x + 3x^2 - x^3) dx = \int_0^1 x^3 (1 - 2x + x^2) dx$

$\Rightarrow \int_0^1 x^2 - 3x^3 + 3x^4 - x^5 dx = \int_0^1 x^3 - 2x^4 + x^5 dx$

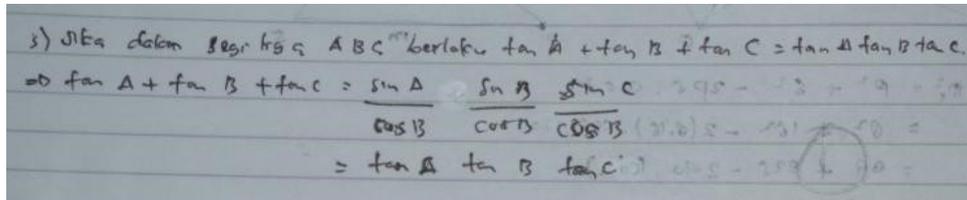
Karena integral dari ruas kiri dan ruas kanan tidak sama, maka

$$\int_0^1 x^a (1-x)^b dx \neq \int_0^1 x^b (1-x)^a dx$$

Student's Problem of What Constitutes a Mathematical Proof

The students also found it difficult to understand what was expected by the sentence to prove. They failed to comprehend a conditional sentence, its essence and how to prove it. It seems difficult for them to utilize the sufficient condition in the statement and to proceed through several steps to achieve the necessary condition or the conclusion of the statement.

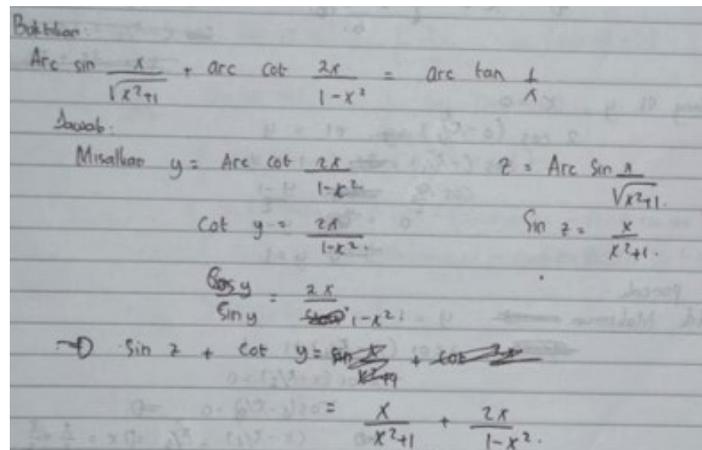
In illustration above, the student was just busy with the laws of tangent without capitalizing on the hypothesis that the angles under investigation were of a triangle.



Student's Misunderstanding of the Statement to be Proved

4.1.3. Strategies for Mathematical Proving

Students experienced problems in constructing the proof of a statement. They found it difficult to determine which strategy was appropriate to employ. For example, when they came to prove an equality. In the illustration, the first step was actually on the right track, namely, simplifying the problem by symbolizing, which should help the student work on the left-hand side of the equality and modify it to be the right-hand side. Further, as the results of the lack of proving strategies, the student faced difficulties to complete the proof. He should take the sum of the angles, instead of taking the sum of the trigonometric values of the angles.



Student's Strategy of Proving a Trigonometric Identity

In this picture, the student failed to prove an equality because his first strategy to work on both side simultaneously had turned into changing the equality to be a difference of the two sides in the previous line, while unfortunately, he did not equalize the difference to zero.

Buktikan bahwa $\sin(\cot^{-1} x + \frac{\pi}{2}) = \tan(\cos^{-1} \frac{\sqrt{x^2+1}}{2x^2+1})$

$$\Rightarrow \sin(\cot^{-1} x + \frac{\pi}{2}) = \tan\left(\frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}}\right)$$

$$= \sin \cot^{-1} x + \frac{\pi}{2} = \frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}} + \frac{\sqrt{x^2+1}}{2x^2+1}$$

$$= \sin \cot^{-1} x + \frac{\pi}{2} - \frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}} + \frac{\sqrt{x^2+1}}{2x^2+1}$$

$$= \sin \cot^{-1} x + \frac{\pi}{2} - \frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}} + \frac{\sqrt{x^2+1}}{2x^2+1}$$

$$= \sin \cot^{-1} x + \sin 90^\circ - \frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}} + \frac{\sqrt{x^2+1}}{2x^2+1}$$

$$= \sin(\cot^{-1} x + 90^\circ) - \frac{\sin^{-1} \frac{\sqrt{x^2+1}}{2x^2+1}}{\frac{\sqrt{x^2+1}}{2x^2+1}} + \frac{\sqrt{x^2+1}}{2x^2+1}$$

Student's Inappropriate Strategy of Proving

$$\int_0^1 x^a (1-x)^b dx = \int_0^1 x^b (1-x)^a dx$$

$$\int_0^1 x^a (1^b - b \times 1^{b-1} x + \dots - x^b) dx = \int_0^1 x^b (1^a - a \times 1^{a-1} x + \dots - x^a) dx$$

$$\int_0^1 x^{a+b} - b x^{a+b-1} - x^{a+b} dx = \int_0^1 x^{a+b} - a x^{a+b-1} - x^{a+b} dx$$

Student's Wrong Binomial Expansion

4.1.4. COMPREHENSION OF MATHEMATICAL CONCEPTS AND PRINCIPLES

The most disturbing difficulty the students face in mathematics proving was their lack of understanding of concepts and principles. They experienced problems in determining the appropriate contexts to employ the principles; therefore falling into an overgeneralization phenomenon. The students showed peculiar thought leading to a strange result. Some students used the expansion of $(a - b)^2$ as the general form for $(a - b)^n$, where it should be expanded using the binomial expansion formula: $(a + b)^n = \sum_{i=0}^n C_i^n a^{n-i} b^i$. The trigonometric ratios $\tan A$ and $\cos A$ were derived based on the generalization of other trigonometric ratios. They failed to understand simple relationships, such as, in trigonometry. For example, in a triangle, they made a false identity, such as $\tan(180 - (A + B)) = \tan(A + B)$, where it should be $\tan(180 - (A + B)) = -\tan(A + B)$.

$$\cos A = \frac{a}{c}$$

$$\cos B = \frac{c}{a}$$

$$\cos C = \frac{a}{b}$$

$$\tan A = \frac{a}{c}$$

$$\tan B = \frac{b}{c}$$

$$\tan C = \frac{c}{b}$$

$$A + B + C = 180^\circ$$

$$A = 180 - (B + C)$$

$$\tan(180 - (B + C)) + \tan B + \tan C$$

$$\tan(B + C) + \tan B + \tan C$$

Also, students were confused about the equality and considered $\sin \frac{a}{b}$ as the same as $\frac{\sin a}{b}$, as portrayed in the illustrations.

Buktikan bahwa $\sin^{-1} x + \cot^{-1} 2x = \tan^{-1} \frac{1}{x}$

Jawab:

$$\Rightarrow \sin^{-1} \frac{x}{\sqrt{x^2+1}} + \cot^{-1} \frac{2x}{1-x^2}$$

$$\Rightarrow \frac{\sin^{-1} x (1-x^2) + \cot^{-1} 2x (\sqrt{x^2+1})}{(\sqrt{x^2+1})(1-x^2)}$$

$$\Rightarrow \frac{\sin^{-1} x (1-x^2)}{(\sqrt{x^2+1})(1-x^2)} + \frac{\cot^{-1} 2x (\sqrt{x^2+1})}{(\sqrt{x^2+1})(1-x^2)}$$

Student's Confusion about Inverse Trigonometric Function

4.2. DISCUSSION

Students' difficulties in proving seem to root in their lack of understanding of what mathematics proof is and how to construct it. As a discipline built on the deductive-axiomatic system, the students who tend to employ an inductive strategy will experience problems. The domain where the statement applies is sometimes not considered thoughtfully and entirely. Therefore, taking one or two cases is claimed to be enough to show the truth of a statement applying for infinite number of cases. Actually, showing that the statement is correct in several cases can sometimes inspire the students to construct a general deductive proof. This finding is in line with that of Weber's study where verifying a general theorem in one or several cases is considered as an accepted proof [16].

The students still have problems in understanding and using mathematical symbols. The notation difficulty [15] causes them to carelessly use notations or symbols in their sentences; therefore resulting in meaningless expressions. Mathematics is full with symbols and it requires precision in writing or expressing the ideas with symbols. Further, the understanding of symbols will influence the ability to comprehend definitions, propositions, or theorems. Misunderstanding or misconception is another cause of students' difficulty in constructing mathematics proof. As a consequence, the students fail to apply the concepts of principles appropriately [7]. Knowing facts or theorems does not guarantee the correct application of them [16]. Some mistakes performed by the students in the last category found in this present research supports this statement.

By and large, the statements to prove in mathematics are mostly expressed a conditional sentence—an implication. Therefore, for those having weak logical thinking, the proof of a logical statement will be a challenging endeavour. It is found that students encounter significant problems in structuring the proof they construct using logic. In essence, they also show the lack of proving strategies. In solving complex problems, including proving propositions, theorems, or other mathematical statements, someone frequently has several alternative actions, steps, or strategies to employ. However, it should

be realized that only few of them effective in solving the problems. This phenomenon is clearly taking place in the course of proving mathematical statements [16], where one could possess some inferences derived as a strategy for constructing a proof, but most of them are not applicable in the problems encountered. An effective problem solver sometimes has strategic knowledge [16], namely, a heuristic guide to be used to recall actions which are possibly useful to solve a problem or to select appropriate abilities to respond to a challenge. In terms of proving mathematical statements, this quality will be reached by the students if they have been exposed to rich experience of successful proving of mathematical statements.

5. CONCLUSION

It has been found that there were four categories of difficulties experienced by the students in proving statements in mathematics. The four categories were:(1) the use of symbols which was inappropriate; (2) the lack of students' conceptual understanding about mathematics proof; (3) the difficulties in selecting strategies for mathematics proof; and (4) the lack of understanding of concepts and principles in mathematics. It seems that the students in this research need to improve their comprehension of what constitutes a mathematics proof and how to construct a mathematics proof. They might need to be exposed to an activity enriched with various strategies of proving.

6. BIBLIOGRAPHY

- [1] Baker, D and Campbell, C (2004) Fostering the development of mathematical thinking: Observations from a proofs course. *Primus* 14(4): 345–353.
- [2] Balacheff, N (2010) Bridging knowing and proving in mathematics: A didactical perspective. In: Hanna, G, Jahnke, HN, and Pulte, H [eds.], *Explanation and proof in mathematics: Philosophical and educational perspectives*. New York, NY: Springer Science + Business Media, LLC, pp. 115-135 DOI 10.1007/978-1-4419-0576-5_9
- [3] Edwards, BS & Ward, MB (2004) Surprises from mathematics education research: Student (mis)use of mathematical definitions. *The American Mathematical Monthly* 111: 411–424.
- [4] Gibson, D (1998) Students' use of diagrams to develop proofs in an introductory analysis course. Students' proof schemes. In: Dubinsky, E, Schoenfeld, A, and Kaput, J [eds.], *Research on Collegiate Mathematics Education III*: 284–307.
- [5] Hanna, G (1995) Challenge to the importance of Proof. *For the learning of mathematics* 15(3): 42-49.
- [6] Hanna, G (2000) A critical examination of three factors in the decline of proof. *Interchange* 31(1): 21-33.
- [7] Harel, G (1999) Students' understanding of proofs: a historical analysis and implications for the teaching of geometry and linear algebra. *Linear algebra and its applications* 302-303: 601-613.
- [8] Harel, G and Sowder, L (2007) Toward comprehensive perspectives on learning and teaching proof. In: Lester, F [ed.], *Handbook of research on teaching and learning mathematics* (second edition). Greenwich, CT: Information Age Publishing, pp. 805-842.

- [9] Knuth, E. (2002) Teachers' conceptions of proof in the context of secondary school mathematics. *Journal of mathematics teacher education* 5: 61-88.
- [10] Mariotti, MA (2006) Proof and proving in mathematics education. In: Gutierrez, A and Boero, P [eds.], *Handbook of research on the psychology of mathematics education: Past, present and future*. Rotterdam: Sense Publishers, pp. 173–204.
- [11] Moore, RC (1994) Making the transition to formal proof. *Educational Studies in Mathematics* 27: 249-266.
- [12] National Council of Teachers of Mathematics (NCTM) (2000) *Principles and standards for school mathematics*. Reston, USA: NCTM.
- [13] Sabri (2012) Contextualising mathematical proof within constructivism. *Jurnal Sainsmat* 1(2): 132-146.
- [14] Selden, A and Selden, J (2003) Errors and misconceptions in college level theorem proving. Tennessee Technological University Department of Mathematics Tech Report No. 2003-3. Accessed on September 18, 2014 from http://math.tntech.edu/techreports/TR_2003_3.pdf.
- [15] Selden, A and Selden J (2011) Mathematical and non-mathematical university students' proving difficulties. In: Wiest, LR and Lamberg, T [eds.], *Proceedings of the 33rd Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Reno, NV: University of Nevada, Reno, pp. 675-683.
- [16] Weber, K (2001) Student difficulty in constructing proofs: The need for strategic knowledge. *Educational studies in mathematics* 48: 101–119.