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PROCEEDING

INTERNATIONAL CONFERENCE ON STATISTICS, MATHEMATICS, TEACHING, AND RESEARCH

ICSMTR 2015

Increasing Statistical and Mathematical Literacy through High Quality Teaching and Research

October 9-10, 2015

Makassar, South Sulawesi, Indonesia

STATISTICS DEPARTMENT AND MATHEMATICS DEPARTMENT
STATE UNIVERSITY OF MAKASSAR
INDONESIA

CONFERENCE PROCEEDING

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WELCOME SPEECH

Forewords from the Head of Committee

Bismillahirrahmanirrahim
Assalamu'alaikum Warahmatullahi Wabarakatuh

First, I want to give our welcome to all the delegates, speakers, and participants coming today. Welcome to the State University of Makassar, UNM.

This International Conference on Statistics, Mathematics, Teaching, and Research (ICSMTR) 2015 is primarily organized by Statistics Department and Mathematics Department, Faculty of Mathematics and Sciences, State University of Makassar. It is conducted in two days from 9th to 10th October 2015. It involves one keynote speaker, Governor of South Sulawesi, eight invited speakers, and approximately 80 parallel speakers. Besides, this conference also invites delegates from twelve LPTKs (Institute of Teacher Education) to conduct a scientific meeting reviewing KKNI for Mathematics Education curriculum in higher education.

Ladies and gentlemen, as I previously said, the conference proudly invites eight invited speakers coming from several countries. Therefore, on behalf of the committee members, I would like to express my sincere thanks to the invited speakers, specifically:

1. Professor Kerrie Mengersen (Queensland University of Technology, Australia)
2. Professor Shigehiko Kanaya (Nara Institute of Science and Technology, Japan)
3. Professor Ahmad A. Bahnassy (Faculty of Medicine, King Fahd Medical City, Saudi Arabia)
4. Professor I Gusti Ngurah Agung (State University of Makassar, Indonesia)
5. Professor Hamzah Upu (State University of Makassar, Indonesia)
6. Professor Muhammad Arif Tiro (State University of Makassar, Indonesia)
7. Professor Mohd. Salmi Md Noorani (Universiti Kebangsaan Malaysia, Malaysia)
8. Dr. Darfiana Nur (Flinders University, Australia)

Next, it is my privilege to thank all organizing committee members for their contributions to the success of this event. I would like also to apologize for all of you if there are some inconvenience during this conference.

Finally, I would like to thank to the speakers and participants. I wish you all have two fruitful days in Makassar.

Thank you very much for the attention.

Wassalamu'alaikum Warahmatullahi Wabarakatuh

Suwardi Annas, Ph.D.

Head of Committee

Forewords from the Dean of Mathematics and Sciences Faculty,

State University of Makassar

Bismillahirrahmanirrahim
Assalamu'alaikum Warahmatullahi Wabarakatuh

Alhamdulillah, all praises be to the Almighty God, Allah *subhanahu wata'ala*.

I would like to say that I welcome and highly appreciate any attempts of both the Statistics Department and Mathematics Department to organize this International Conference on Statistics, Mathematics, Teaching, and Research in the State University of Makassar. I do hope that this conference would be a great chance for you as researchers or scholars in enhancing your research quality within a framework of evolving sciences. May Allah *subhanahu wata'ala* opens our mind, widens our view, strengthens our soul, and blesses our conference that it will be useful as we are hoping.

At last, as the Dean of the Faculty of Mathematics and Natural Sciences, State University of Makassar (FMIPA UNM), I am sure that there are some weaknesses and mistakes in performing this conference. I therefore do apologize to you and may Allah *subhanahu wata'ala* forgive all of us.

Wassalamu'alaikum Warahmatullahi Wabarakatuh

Professor Abdul Rahman

Dean of Faculty of Mathematics and Sciences

State University of Makassar

Forewords from Rector of UNM

Bismillahirrahmanirrahim
Assalamu'alaikum Warahmatullahi Wabarakatuh

Your respectable, the high officials of State University of Makassar, the committee, the speakers, and the participants of conference.

It gives me great pleasure to extend to you all a very warm welcome, especially to our keynote speakers who have accepted our invitation to convene the conference. ICSMTR is one of our educational activities that covers a wide range of very interesting items relating to statistics, mathematics, teaching and research.

By taking participation of this conference, it is highly expected to all of us to share our research findings to society and continuously develop new ideas and knowledge. Those things are two significant steps in improving the quality of nations around the world, increasing our familiarity to each other, and even avoiding underdevelopment.

Furthermore, I would like to take this opportunity to express my heartfelt gratitude to all organizing committee especially for Statistics Department and Mathematics Department of Faculty Mathematics and Natural Sciences that primarily hosts this conference.

Finally, this is a great time for me to declare the official opening of the International Conference on Statistics, Mathematics, Teaching, and Research (ICSMTR) 2015.

I wish you a very enjoyable stay in Makassar
I warmly welcome you again, as in Makassar, we say "*salamakki battu ri mangkasara*"

Wassalamu'alaikum Warahmatullahi Wabarakatuh.

Prof. Dr. H. Arismunandar, M.Pd.

Rector of State University of Makassar

TABLE OF CONTENTS

Welcome Speech iv

Table of Contents vii

Keynote Speakers

The Power and Promise of Immersive Virtual Environments: Extracting Expert Information to Support Rare or Unseen Spatial events 1
Kerrie Mengersen

Teaching Biostatistics for Health Care Professionals 2
Ahmed A. Bahnassy

Projective Lag Synchronization in Complex Dynamical Networks Via Hybrid Feedback Control 3
Mohd. Salmi Md Noorani, Ghada Al-Mahbashi

Experiences in Online Teaching of Statistics Topics 4
Darfiana Nur

Jamu Informatics: Strategy for Data Accumulation and Mining Concerning to Plane-Diseases Relations by KNApSAcK DB toward Big Data Science 5
Sony Hartono Wijaya, Shigehiko Kanaya

Misinterpretation of Some Selected Theoretical Concepts of Mathematical Statistics 6
I Gusti Ngurah Agung

Research on Teaching Statistics 7 – 16
Muh. Arif Tiro

Trend of Education Quality Improvement in Indonesia 17 – 26
Hamzah Upu

Parallel Speakers

Heterogeneous Regressions, Fixed Effects, or Random Effects Models. Is your Accounting Model Appropriately Presented? 27 – 55
I Gusti Ngurah Agung, Dodik Siswantoro

The Estimation of Generalized Seasonal Autoregressive Integrated Moving Average (GSARIMA) Models using Bayesian Approach for Forecasting the Number of Dengue Hemorrhagic Fever (DHF) Patients 56 – 65
Asrirawan, Suhartono

Bayesian Spatial Modeling and Mapping of Dengue Fever The Case of the City of Bandung, Indonesia 66 – 75
I Gede Nyoman Mindra Jaya, Henk Folmer, Budi Nurani Ruchjana

Bayesian Dengue Disease Mapping for Juvenile and Adult in Bandung, Indonesia 76 – 89
F. Kristiani , N.A. Samat, S.A. Ghani

Bayesian Estimation of Meta-Regression Model in Meta-Analysis Using a Linear Model Theorem 90 – 101
Junaidi, Darfiana Nur, Irene Hudson

Estimation of Loading Factor for Reflective and Formative Measurement Model SEM 102 - 115
Ruliana, I.N Budiantara, B. W Otok, W.Wibowo

Estimation Parameters and Testing Hypotheses for Geographically Weighted Negative Binomial Bivariate Regression 129 – 129
M. Ichsan Nawawi, I Nyoman Latra, Purhadi

Circular Descriptive Statistics for Describing Students' Sleeping Time 130 – 137
Cici Suhaeni, I Made Sumertajaya

Forecasting the Exchange Rate of U.S. Dollar against the Rupiah Using Model Threshold Autoregressive Conditional Heteroscedasticity (TARCH) 138 – 151
Hisyam Ihsan, Aswi, Ihram

Population Problem Indexes By *Kabupaten* in *Sulawesi Selatan*: A Study based on *SUSENAS* 2013 152 – 168
I Gusti Ngurah Agung, Muhammad Nusrang

Bias Comparison of Parameter Estimates In Cox Proportional Hazard and Logistic Regression (*Case Study in Student's Length of Study at Cokroaminoto University*) 169 – 181
Rahmat Hidayat

Spatial Analysis of the Spread of Tuberculosis using Local Indicator of Spatial Association (LISA) in Makassar, Indonesia 182 – 192
Aswi, Ahmad Zaki, Hijrayanti

The Worst ANCOVA Model among All Possible Models With The Same Set of Variables 193 – 210
I Gusti Ngurah Agung, Suwardi Annas

Algorithm of Spatial Outlier Detection *NbrAvg* And *AvgDiff* (Case Study on HDI in the province of South Sulawesi) 211 – 223
Muhammad Nusrang

Analysis of Susceptible, Infected, Recovered, Susceptible (SIRS) Model for Spread of the Acute Respiratory Tract Infections (ARI) Disease *Yulita Molliq Rangkuti, Syafruddin Side, Elvira Nanda Faramitri Harahap*	224 – 237
The Characteristics of Conicoid Based on Its Center *Sahlan Sidjara, Bahar*	238 – 245
Stability Analysis Susceptible, Exposed, Infected, Recovered (SEIR) Model for Spread of Dengue Fever in Medan *Syafruddin Side, Yulita Molliq Rangkuti, Dian Gerhana Pane, Marlina Setia Sinaga*	246 – 259
Some Remarks on Submodule Almost Prime of Multiplication Modules *Sahlan Sidjara*	260 – 263
Membership Function of Depth Hypnosis with Davis Husband Scale *Ja'faruddin, Muhammad Kasim Aidid, Sitti Indah Rahmadana Darwis*	264 – 272
The Application of Algebraic Methods in Balanced Incomplete Block Design. *Muhammad Abdy*	273 – 277
Modeling the Spread of Tuberculosis with Bayesian Car *Muhammad Kasim Aidid, Aswi, Ansari Saleh*	278 – 288
Application Rank Matrix to Determine the Type of Conics *Bahar, Fitriani*	289 – 399
The Odd Risks of Pregnancy Mothers with CED (Chronic Energy Deficiency) to the Baby with LBW (Low Birth Weight), and SBBL (Short Birth Body Length) in the Public Health Center of Pattingaloang Makassar *Muhammad Nadjib Bustan, Amaliyah Maulana Asis*	300 – 310
Using of C-Means Cluster Analysis in Object Grouping (Study of Poor Villages Grouping in Pangkep). *Irwan, Zulkifli, Firdaus*	311 – 318
Huffman Code to Transmit Messages in Data Communication *Sulaiman*	319 – 321
Genetic Algorithm in Solving Traveling Salesman Problem (TSP) *Sulaiman*	322 – 340
Inferential Statistical Reasoning of Preservice Teachers Based on Gender Differences in Solving Statistical Problem. *Rosidah*	341 – 349

Association between the Perception on Statistics and Statistical Thinking Ability of the Students in Integrated Social Science Education of Social Faculty in State University of Makassar 350 – 360
Misveria Villa Waru, Ilham Minggi, Suwardi Annas

A Cross-National Comparative Analysis of Statistics Problems in Indonesia and Australia Secondary School Mathematics Textbooks: What Might We Learn? 361 – 365
Bustang, Usman Mulbar

Description of Probability Literacy and Randomized Events Literacy for Statistics Student at FMIPA UNM 366 – 377
Sudarmin, Muhammad Arif Tiro, Irwan

Innovation in Statistics for Learning 378 – 386
Andi Arisyi Zulwaqar, Nurfadhila Fahmi Utami, Muhammad Nusrang

Preservice Teacher's Reflective Thinking process in Solving Mathematical Problem who has Field Independent Cognitive Style 387 – 398
Agustan S., Dwi Juniati, Tatag Y.E.S.

Development of Mathematics Learning Model Based on Student Character Involving Student Emotional Intelligence as a Prospective Teacher 399 – 411
Muhammad Ilyas

Developing Hypnoteaching Model in Mathematic Teaching (Hypnomatching) 412 – 421
Rusli, Ja'faruddin

Prospective Mathematics Teachers' Ability in Solving Contextual Problem Concerning Geometry 422 – 441
Syahrullah Asyari, Rahmat Kamaruddin, Sitti Busyrah Muchsin, Ikhbariaty Kautsar Qadry

Assessing Mathematics Skills through KONCAMA Learning 442 – 451
Asdar, Jeranah

The Development of Social Learning Model based on Metacognitive Strategies to Foster Mathematics Self-Efficacy of the Senior High School Students 452 – 468
Ramlan Mahmud, Alimuddin Mahmud, Suradi Tahmir

Adaptive Reasoning and Strategic Competence in Solving Mathematical Problems 469 – 478
Andi Syukriani

Effectiveness of Appropriation Motivation toward Students' Problem Solving Capability in Math Lessons 479 – 486
Khaerunnisa Syatir, Kartika Cahyaningrum, Amirah Aminanty, Ahmad Ridfah

Development Model of Authentic Assessment based Showcase Portfolio on Learning of Mathematical Problem Solving in Senior High School 487 – 499
Sukmawati, Faihatuz Zuhairoh

Students' Metacognition in Constructivism based Mathematics Learning 500 – 511
Usman Mulbar

Identification of Students' Misconceptions In Understanding the Concept of Simple Fractions Using CRI (Certainty of Response Index) 512 – 520
Darwan, Asdar, Nasrullah

Realistic Mathematics Education with the Sense of Madurese Culture 521 – 525
Sri Indriati Hasanah

The Model of Learning Instructional Design Evoking Cognitive Conflict and Intellectual Awareness: Study in the Topic of Combinatorics 526 – 536
Djadir, Dinar, Fajar Arwadi

Teacher Training and Recharging about Learning Models in Curriculum 2013 to Improve Teaching Quality of Math Teachers 537 – 545
Suradi Tahmir, Nasrullah

Mathematics Learning Software Development Involving Adversity Intelligence Approach Through the Submission of the Problem 546 – 564
Vivi Rosida, Bakhtiar

Relation among Attitude toward Mathematics, Mathematics Self-Efficacy, and Mathematics Achievement 565 – 576
Fajar Arwadi

A Profile of the Quality of Problem Posing Based Mathematics Learning Model in Improving Prospective Teachers' Creativity 575 – 590
Alimuddin, Syahrullah Asyari

The Development of Mathematical Communication based Worksheet with Character of Indonesian Culture 591 – 599
Izwita Dewi, Tiur Malasari Siregar, Nurhasanah Siregar

Pedagogical Content Knowledge (PCK): Type of Particular Knowledge for Teacher to Effective Learning (Case study of Mathematics Teacher at SMA) 600 – 611
Ma'rufi

Development of Learning Devices of Cybernetic Cooperative in Discussing the Simplex Method in Mathematics Education Students of FKIP UHO *Arvyaty, Ld. Ahmad Jazuli, Saleh, Latif Sahidin, Ikman, Kadir Tya, Yoo Ekayana Kansil, Hastuti Musa*	612 - 621
Design Research : Evoking Cognitive Conflict and Problem Simplification Strategy to Improve Students' Concept understanding in Problem Solving Skills in The Topic of Combinatorics *Nurdin Arsyad, Djadir, Fajar Arwadi*	622 - 634
The Model Development of Interprofessional Education (IPE) in the Faculty of Health Sciences (FIK) Islamic State University (UIN) Alauddin Makassar *Nur Hidayah, Saldi Yusuf*	635 – 643
Implementation of Learning Base-Guided Inquiry in the Lecture of Interaction between Physical Factors at Teacher Science Candidate *Muh. Tawil, Sitti Rahma Yunus*	644 – 649
Teaching Physics through Top Down Approach to Teach Critical Thinking Skills *Aisyah Azis, Muhammad Aqil Rusli, A Momang Yusuf*	650 – 656
Gasing Physics as Solution for Teaching Kinematics *Muhammad Aqil Rusli, A.Momang Yusuf, Aisyah Azis, Agus Purwanto, Jutri Taruna*	657 – 665
The Application of Student Worksheet based Local Wisdom in Physics Learning *M. Agus Martawijaya*	666 – 677
Implementation of Dynamic Problem Solving Strategies (DPSS) for Basic Electronics Subject, Physics Department, Makassar State University *Abdul Haris, Nurul Kusuma Wardani, Sirajuddin Jalil, Risnawati, Subaer*	678 – 682
The Effect of Teacher Competence toward Physics Achievement by Controlling Prior Knowledge *Salamang Salmiah Sari*	683 – 699
Utilizing ADDIE Model for Developing Brilian, Learning Application in Institute of Business and Informatics STIKOM Surabaya, Indonesia *Dewiyani, Bambang Hariadi*	700 – 712
Identification of Game Model for Health Education in Preschoolers *Arbianingsih, Yeni Rustina*	713 – 719
The Effect of Educational Level and Environmental Attitude toward the Hygienic and Healthy Life Behavior of Housewives at Bontoa District Maros Regency *Firdaus Daud, Muhammad Wiharto, Halifah Pagarra*	720 - 737

Development of Teaching Material for Geography in SMA/MA on Grade X with Dick and Carey Model 738 – 752
Maddatuang

Mapping Protected and Cultivation Zone in North Luwu, South Sulawesi, Indonesia 753 – 760
Rosmini Maru, Muh. Rais Abidin, Amal, Ibrahim Abbas, Suprapta

The Development of Investigation-Based Chemistry Learning Tools for Senior High School and Its Effect toward Student's Critical Thinking Skill and Concept Mastery 761 – 772
Muhammad Danial, Pince Salempa, Anis Muliati, Husnaeni

The Influence of Using Instructional Media Lectora Inspire to Student's Learning Outcomes of Class X at Material of Invertebrate at SMA Negeri 9 Bulukumba 773 – 783
Andi Asmawati Aziz, Nurhayati B, Andi Irma Mutmainnahtul Adawiyah

Contextual Teaching Learning Approach in Economy Improving Learning Outcomes in SMA Negeri 1 Maros 784 – 803
Muhammad Azis

A PROFILE OF THE QUALITY OF PROBLEM POSING BASED–MATHEMATICS LEARNING MODEL IN IMPROVING PROSPECTIVE TEACHERS' CREATIVITY

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ABSTRACT

This research is Research and Development (R & D). The principal target to reach is the availability of a learning model along with the supporting package towards mathematics learning model that can be applied for enhancing prospective teachers' understanding to the mathematics content taught and evolving their creativity. To attain the target, it will be utilized R & D method by Plomp consisting of five phases, namely: (1) preliminary study, (2) designing, (3) realizing or constructing, (4) testing, evaluating and revising, and (5) implementing. The long term goal of this research is to obtain a problem posing–based–mathematics learning model to improve prospective teachers' creativity (PMP2MK Model). It is expected that through implementing this model, prospective teachers would have dual purpose, that is: (1) understanding and mastering mathematics content, and 2) improving their creativity. To assess the quality of the PMP2MK model, it is used criteria by Nieveen, that is, satisfying validity, practicality, and effectiveness. The research results within the first year indicate that: (1) the average score for the content validity of the book of PMP2MK Model is 3.9. This validity is in very high category with the reliability is 0.95, whereas the average for the construct validity is 4.2. This validity is in very high category with the reliability is 0.99; and (2) concerning the supporting package for the PMP2MK model, that is: (a) the average score for the validity of the lesson plan is 3.89 and this validity is in very high category with the reliability is 0.97; (b) the average score for the validity of students' worksheet is 3.9 and this validity is in very high category with the reliability is 0.98; (c) the average score for the validity of the instrument for assessing creative thinking is 4.2 and this validity is in very high category with the reliability is 0,98; (d) the average score for the validity of lecturer' guide book is 4.1 and this validity is in very high category with the reliability is 0.98; (e) the average score for the validity of students' learning material is 4.2 and this validity is in very high category with the reliability is 0.97; and (3) the average score for the practicality of the PMP2MK Model according to experts is 4.1 and this is in practicable category.

Keywords: Creative thinking, problem posing, learning model

1. INTRODUCTION

Human is created by God and equipped with mind in order to be able to think about. World development nowadays, particularly in the field of information technology is the outcome of human thought. Thinking enables human to model world, and through thinking, human can tackle problems effectively in accord with their goal, plan, and desire (http://en.wikipedia.org/ wiki/Portal:Thinking). One of higher order thinking types that is

currently attractive to consider in the circle of cognitive psychologists and being the educational objective in each country are creative thinking or creativity (Simonton, 2003).

The importance of creative thinking ability is stated by many scholars. Some of them are Sternberg (1999a; 1999b); Mumford & Gustafson (1988); Runco (2004); Oldham & Cummings (1996); Goldenberg & Mazursky (1999); Goldenberg, Mazursky & Salomo (1999) stating that individual having highly creative thinking ability can create vocations for people, solve problems effectively, overcome any changes, benefit existing chances, get the upper hand in technology, adapt with change, succeed in life, excel in work, or change the world face.

Craft (2005), Shaheen (2010), Fisher (1990), Kitano (1986), Craft (2001), de Bono (2007), and Feldman & Benjamin (2006) argue that: 1) ability to think creatively is very significant for individual to have; 2) all individuals possess potential to be creative; and 3) ability to think creatively can be evolved through training continuously. On the basis of the three things, then curriculum reform has been conducted and creativity is already inserted into educational policy in the western countries like US, UK, France, Germany, Sweden and Australia (Feldman & Benjamin, 2006; Craft, 2005; Shaheen, 2010). Asian countries also provide with responses to this trend. For instance, exhortation of educational reform in China to make potential students creative, since the phenomena of students with high achievement in mathematics in international events are noted for having low achievement in imagination and creativity (Jun, Wu, & Al-Banese, 2010). In Hong Kong, creativity is admitted as one of three generic skills to be developed in education, and some general principles to advance creativity are already incorporated into curriculum (Cheng, 2010). In the other countries like Japan, South Korea, Taiwan, and Singapore have also reformed curriculum with the emphasis on developing creativity (Choe, 2006; Shaheen, 2010). That is undertaken in a way of top-down (Cheng, 2010; Lin, 2009).

Indonesia as a developing country realizes that for being a developed country and being parallel to other developed nations, it is needed creative human resources. Therefore, creative thinking ability is inserted into national education goal. This is contained in Ministry Regulation No. 22 Year 2006:

> *Pendidikan nasional yang berdasarkan Pancasila dan Undang-Undang Dasar Negara Republik Indonesia Tahun 1945 berfungsi mengembangkan kemampuan dan membentuk watak serta peradaban*

> *bangsa yang bermartabat dalam rangka mencerdaskan kehidupan bangsa, bertujuan untuk mengembangkan potensi peserta didik agar menjadi manusia yang beriman dan bertakwa kepada Tuhan Yang Maha Esa, berakhlak mulia, sehat, berilmu, cakap,* ***kreatif****, mandiri, dan menjadi warga negara yang demokratis, serta bertanggung jawab.*

In the Ministry of National Education's vision 2025, it is stated that:

> *Dalam rangka mewujudkan cita-cita mencerdaskan kehidupan bangsa dan sejalan dengan visi pendidikan nasional, Kemendiknas mempunyai visi 2025 untuk menghasilkan insan Indonesia Cerdas dan Kompetitif (Insan Kamil/Insan Paripurna). Insan Indonesia cerdas adalah insan yang cerdas komprehensif, yaitu cerdas emosional, cerdas sosial, cerdas intelektual, dan cerdas kinestetis. Cerdas intelektual adalah aktualisasi insan intelektual yang kritis, kreatif, inovatif dan imajinatif.*

Seriousness of the government of Indonesia in posturing for the importance of creativity is indicated with the outward of curriculum 2013 promoting the existence of human with creativity, character and no yielding up. The impact of this policy is that teacher is demanded to develop a character–based–learning package. One of indicators of the nation's cultural character is creativity.

A variety of attempts have been taken to establish creative human, particularly, in the school and college spheres. But, the reality shows that creative ability of teachers and learners in school and college is still low. The research results of TIMSS *(Trends in International Mathematics and Science Study)* with sample as private or public SMP/MTs students show that the average of their scores in mathematics and science particularly in higher order thinking ability (both critical and creative thinking) of Indonesia students in 1999 was in the-32nd of 38 countries; in 2003, it was in the-37th of 46 countries; and in 2007, it was in the-35th of 49 countries (TIMSS, 2011). This indicates that creative and critical thinking ability of students in Indonesia in international level is still in highly apprehension. *Association of American Colleges and Universities* (2005) reports that only 6% of senior students in college can think creatively and critically in solving problems encountered (Ku, 2009).

Slameto (2003) in his research reveals that:

> *Rendahnya kreativitas ini tidak hanya pada guru-guru lulusan SPG saja, tetapi juga pada mahasiswa-mahasiswa di perguruan tinggi. Hal ini diakui kebenarannya oleh guru besar UGM, M.S.A. Sastroamidjojo, dalam keprihatinannya akan menurunnya kreativitas manusia.*

The finding above is then strengthened our own research to teachers and learners in school and college showing that their creativity is still low.

Now, the question is, "what attempt that academics can take to crystallize the government's program?"

Fryer (2003) retains that creative skill can be taught through certain strategy. For example, training in creatively problem solving can activate people to be skillful in finding the best solution quickly. Esquivel (1995) also emphasizes on the great role of educator in improving creative potential of each student. Menawhile Cheng (2004), Wu (2004), Simonton (2003) state that teacher and traditional practice become obstacle in improving creativity in the classroom. On the other side, there is bit of responses from teachers at school to promote the improvement of creativity through education. Therefore, comprehensively learning framework must be developed to tackle this problem. Quality and capacity of creativity in our daily life can be kept and showed in every subject in school or in each aspect of life (Lucas, 2001). Keeping creativity through education is aimed at supporting individuals to develop creative quality in facing daily problems, underpinning their need in self-actualization, as well as improving their capacity to be success in the future.

The aforementioned scholars indicate that teacher is expected to participate actively in evolving students' creativity by developing learning model, strategy, approach, as well as method coming in useful for evolving their creativity.

The outline above intimates that to make students creative, it is required creative teacher. The State University of Makassar as one of universities mandated by government to produce teachers has a great moral responsibility to yield creative teachers. This can only be realized, if teaching and learning process is aimed at developing the creative thinking of learners as prospective teachers. For that purpose, it is needed a learning model, strategy, approach, and method that enable to evolve their creative thinking.

One learning approach promoting students' creative thinking in mathematics is problem posing. This is in line with Pehkonen (1997) stating that teaching matematics is able to:

(1) develop cognitive skill in general, (2) promote creativity, (3) apply mathematics, and (4) motivate students to learn mathematics.

Tasks of mathematics problem posing are widely varied. There is an open-ended task requiring students to write arbitrary problems they are thinking without boundary of content or context in mathematics. For instance, Ellerton (in Leung, 1997) had Australian students write a complex problem and Winograd got American students to make a word problem. Another task is *semi-open* and related to learners' perception to a mathematical problem or structure. Regarding the problem *Billiard Ball mathematics* (*BBM*) created by Silver & Cai (1996) is that a ball shot in the left corner of billiard (rectangular) table or field and rebound. Silver finds that learners pay attention to problems concerned with billiard game.

Silver (1997) provides indicators to assess students' creative thinking ability (fluency, flexibility and originality) using problem posing and problem solving. The relationship may be described in the following table.

Table 1.
Relationship between Problem Solving and Problem Posing with Creativity Component

Creativity Component	Problem Posing
Fluency	Students make many solvable questions or problems. Students share problems they pose each other
Flexibility	Students pose questions or problems with a variety of solutions. They use "what-if-not?" strategy to pose question.
Originality	Students check some problems that they pose, and then posing different problem

This research are to: 1) develop a problem posing based mathematics learning model that is valid, practical and effective to improve creative thinking ability of students as prospective teachers (PMP2MK model), 2) develop package or devices supporting the mathematics learning model comprising: Lesson Plan (RPP), Students Worksheet (LKM), Students Book (BM), Lecturer Guide Book (BPD).

2. RESEARCH METHOD

Research Type and Design

This is developmental research. The research design concerns with the developmental research objective constituting adaptation of *developmental design* by Plomp (1997) as described below.

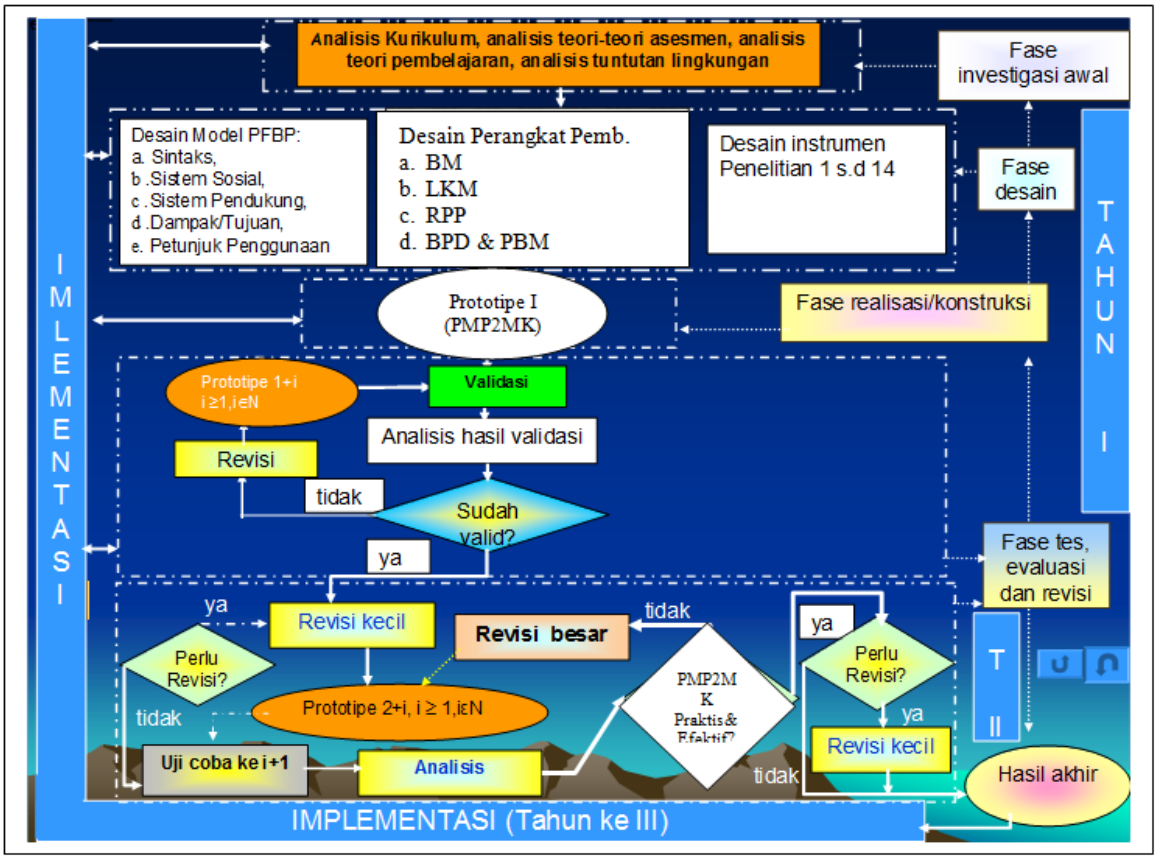

Figure 1. Developmental Research Design by Plomp

Note:

▭	Activity	→	Main Plot
◇	Result	↔	Mutual Activity Direction
⬚	Development	- · - ▸	Cyclical Activity
⬭	Activity Result		

Research Subject

The research subject was mathematics department students. The research was conducted for the fifth semester students of academic year 2012-2013 as Try Out I, academic year 2013-2014 as Try Out II, and academic year 2014-2015 as for implementing PMP2MK model.

Implementing Research

There are three components that will be developed within this research, that is, (a) problem posing-based-mathematics learning model to improve creative thinking ability of students as prospective teachers (PMP2MK model); (b) learning package for supporting PMP2MK model; and (c) research instruments that will be used to assess the quality of PMP2MK model.

DEVELOPING PMP2MK MODEL

Learning model that will be developed within this stage is problem posing-based-mathematics learning model to improve creative thinking ability of students as prospective teachers. The components incorporated in the model refer to those in the model proposed by Joyce, Weil, & Shower (1992), that is: (a) syntax, (b) social system, (c) reaction principle, (d) supporting system, and (e) instructional and nurturing effects.

The stages of developing this PMP2MK model refer to those stated by Plomp (1997:6-15) consisting of 4 stages, they are: **1) preliminary study**. The activities conducted in this stage are: studying learning models theoretically, studying creative thinking theories and posing problems in terms of mathematics, and studying the curriculum of the study program of mathematics education particularly Algebra Course, **2) design**. The main activities undertaken in this stage are: designing outlines of components of PMP2MK model, arranging outlines of supporting theories for the model, and arranging draft of protocol or guide of the administration of PMP2MK model, **3) realization (construction)**. Within this stage, it is arranged Prototype I of PMP2MK model by referring to the components of mathematics learning model. Prototype I of this PMP2MK model is arranged into 4 (four) parts comprising: rationality of PMP2MK model, supporting theories

for the model, components of the model, and the protocol or guide for the administration of the model. Here is the Prototype I which will then continuously be developed in the next development stages, and **4) test, evaluate, and revise.** The activities conducted in this stage are: validating Prototype I by experts, revising it based on expert consideration to get Prototype II, conducting first try out of Prototype II, analyzing data of the try out outcomes of Prototype II, revising prototype II get Prototype III, administering the second try out for Prototype III. The outcomes of the second try out result in PMP2MK model which is valid, effective and practical.

DEVELOPING PACKAGES

The stage of developing learning package supporting PMP2MK model refer to mengacu *Plomp's* Model, that is: **1) preliminary study.** In this stage, it is conducted a study about: the format for the package to develop, syntax of the PMP2MK model as a reference for developing course hand out, LKM, students' worksheet/lecturer, creative thinking theories, and problem posing, particularly, the components of the research objectives and the curriculum of the study program of mathematics education, i.e. linear algebra course; **2) design.** The main activity undertaken in this stage is designing the learning package supporting the PMP2MK mode, that is designing: students' book and lecturer book, hand-out/lesson plan, students' worksheet (LKM), **3) realization/ construction.** Within this stage, it is arranged Prototype I of the package comprising: (a) students book and lecturer book, (b) students' worksheet (LKM), and (c) hand-out/lesson plan, 4) **test, evaluate, and revise**. The activities conducted in this stage are: validating Prototype I of the learning package supporting the PMP2MK model by experts, revising Prototype I based on experts consideration to produce Prototype II; administering first try out for Prototype II. If its result shows that the Prototype II of the supporting learning package of the PMP2MK model is good enough (standard), then it will be revised to get Prototype III, undertaking the second try out for Prototype III. If its result shows that Prototype III is good enough (standard), then it will again be revised. And so forth. Activities like testing, evaluating, and revising are conducted cyclically until getting the prototype of the supporting learning package of the PMP2MK model is good (standard) [the final prototype of the supporting learning package of the PMP2MK model].

DEVELOPING INSTRUMENTS

Developing validated instruments aims at assessing the quality of the PMP2MK model and its supporting packages. The instruments developed here are: 1) Assessment Sheet on PMP2MK Model (LPM), 2) Observation Sheet of the Practicality of the Model, 3) Observation Sheet of The Learning Management, 4) Observation Sheet of Lecturer Activity (LPAD), 5) Questionnaire of Lecturer's Response (ARD) concerning the Implementation of the Model, 6) Observation Sheet of Student's Activity (LPAM) in Mathematics Learning with the Model, 7) Questionnaire of Student's Response (ARM) concerning the Implementation of the Model, 8) Assessment Sheet of Student Book (LPBM), 9) Assessment Sheet of Lecturer Book (LPBD), 10) Lecturer' Response to the Lecturer's Guide Book (RDBD), 11) Lecturer's Response to Student Book (RDMM), 12) Students' Response to Student Book (RMBM), 13) Lecturer's Response to LKM (RDLKM), 14) Students' Response to Students' Worksheet (RMLKM), 15) Test on Students' Creative Thinking Ability (TKBM).

The stages of developing instruments are: arranging instrument drafts, validating them by experts, revising the validation results, trying them out, analyzing the try out results to see the level of reliability using the formula proposed by Grinnell (1988) as follows:

$$PA = \frac{A}{A+D} \text{ x } 100\ \%$$

PA = Percentage of Agreement (PA denotes the level of reliability R).

A = Agreement, i.e. two observers have the same views on the same aspects.

D = Disagreement, i.e. two observers have different views on the same aspects.

The reliability criteria used is that stated by Borich (1994), that is, if R ≥ 75%, then the instrument is reliable.

Techniques of Data Analysis and Interpretation of the Research Results

The quality criteria of the PMP2MK model developed is referring to that stated by Nieveen (1999), they are validity, practicality, and effectiveness. The model is then said to be valid, if it satisfies criteria: at least four of six experts (validator) argue that the model is based on strong theoretical foundation, at least four of six experts (validator) state that the components of the model are interrelated consistently, validity criteria is in high category. Qualification of quality criteria is obtained by referring to the *methods of grading in Summative Evaluation* by Bloom, Madaus & Hasting (1981) (in Utomo, Dwi Priyo) administering the following stages: 1) recapitulating all validator statements into table

comprising of: Aspect (Ai), Sub-Aspect (ki), the Result of Validator Assessment (Vji), 2) finding the average of the validation result of all validators for each sub-aspect using formula: $ki = \frac{\sum_{j=1}^{n} V_{ji}}{n}$, where k_i = the average of sub-aspect *i*-nth, V_{ji} = the assessment result score of validator j-nth to sub-aspect *i*-nth, and *n* is the number of validator, 3) finding the average of each aspect using the formula: $A_i = \frac{\sum_{j=1}^{n} k_{ij}}{n}$, A_i = the average of aspect i-nth, k_{ij} = the average of aspect i-nth to sub-aspect j-nth, *n* = the number of sub-aspects in aspect i-nth, 4) finding the total average (VR) using the formula: $VR = \frac{\sum_{j=1}^{n} A_i}{n}$ where VR is total average, *Ai* is the average of aspect i-nth, and *n* is the number of aspects, 5) finding the validity category by fitting the total average with that established by Bloom, Madaus & Hasting (1981) (in Utomo, Dwi Priyo, 2007) as follows.

Table 2. Criteria for Categorizing the Validity of PMP2MK Model

Score Interval	Validity Category
$4 \leq VR \leq 5$	Very High
$3 \leq VR < 4$	High
$2 \leq VR < 3$	Low
$1 \leq VR < 2$	Very Low

Note:

VR is the average of the assessment results of experts, practitioners, and observers to the components of the book of PMP2MK Model and that of the supporting learning package of the PMP2MK model.

Criteria state that the PMP2MK Model has a good validity degree, if the minimum validity level attained is valid. If the level of validity attainment is not valid, then it is necessary to revise it based on the suggestion (correction) of validator. Further, it is then re-validated,

and so forth until obtained the PMP2MK Model which is ideal according to construct and content validities.

Furthermore, the level of reliability is computed using the formula proposed by Grinnell (1988), that is: percentage of agreements formula which is modified to be the following reliability formula:

$$R = \frac{\overline{d(A)}}{\overline{d(A)}+\overline{d(D)}} x100\%$$

Note:

R is reliability coefficient

$\overline{d(A)}$ is the average of the agreement degree of the assessor.

$\overline{d(D)}$ is the average of the disagreement degree of the assessor.

The instruments are said to be reliable, if the value (R) ≥ 75%. (Borich, G.D (1994: 385). The agreement rules for the combination of scores is (4,5), (5,4); and that for disagreements is the combination of scores: (1,1), (1,2), (2,2), (4,1), (1,3), (2,3), (2,4) and conversely.

3. RESEARCH FINDINGS

The research results show that problem posing–based–learning model developed satisfies the valid, practical, and effective criteria. This indicates that the product of this model is able to be used by anyone mathematics lecturer and anywhere universities in the Linear Algebra course. PMP2MK Model can also evolve the creative thinking ability of students as prospective teachers. This is in accord with the finding of Pehkonen (1997) stating that teaching problem is able to: (1) develop cognitive skill in general, (2) promote creativity, (3) apply mathematics, and (4) motivate students to learn mathematics. Meanwhile Silver & Cai (1996) and English (1997) explain that problem posing approach enables to help students in developing belief and pleasure to mathematics, since students' mathematical ideas are tried out in order to understand the problem they are carrying out. Problem posing is also as the mathematics

communication tool of students. The research result is in line with the theory by Nasoetion (1991) stating that problem posing constitutes a task leading students to critical and creative attitudes, because within this, they are to make questions of the information given. Asking question is the starting point of all creations. Those who have creating ability are then said to be possessing creative attitude. In addition, through problem posing, students are given chances to be active mentally, physically and socially as well as provided with opportunities to investigate and make divergent answers. Further, Leung (1997) studies the relationship between general verbal creativity and arithmetic problem posing. It is found that subjects with verbal creativity ability have high fluency and they tend to also be more fluent in problem posing, whereas those with high flexibility in verbal creativity are not necessarily flexible in problem posing. In the study, problem posing task is considered as a creative thinking test, like Balka (in Leung, 1997), assessing and scoring problem posing task on the basis of fluency, flexibility and originality.

Silver (1997) outlines the relationship between creativity product (creative thinking product) and problem posing as well as problem solving as follows.

> *As these observations suggest, the connection to creativity lies not so much in problem posing itself, but rather than in interplay between problem posing and problem solving …. Both the process and the product of this activity can be evaluated in order to determine the extent to which creativity is evident.*

This quotation shows that creativity, problem solving and problem solving are interrelated. Both process and product of that activity can determine the extent of creativity obviously. Once carrying out the problem given, students are to pose new questions such modification of goal or condition of the previous question to create a new one. This problem posing type is post solution posing, as in Silver & Cai (1996). Silver (1997) provides indicator for assessing students' ability to think creatively (fluency, flexibility and originality) when using problem posing and problem solving.

In terms of Curriculum 2013, this problem posing method is extremely in line with the problem-based-learning model as well as project-based-learning model, notably scientific approach. In the problem-based-learning, learners are provided with situation, and then they are to pose mathematical questions related to the situation given. Within this stage, it is required ability to observe sharp situation to generate quality questions. Before posing questions, they explore and synthesize their knowledge to draw a conclusion on the relevant questions to pose. Thus, exploration, confirmation, reasoning

and experiment crystallized by trying some relations of knowledge simultaneously becoming learner's learning experience. If this learning is taken collaboratively, then the process of communicating ideas in group members internally and inter-groups will be running well. In relation to the authentic assessment, then problem posing learning will measure competencies such as: students' cognition, attitude and skill, particularly their creative thinking and problem solving skills.

4. RECOMMENDATIONS

To follow the research findings up, it is then recommended several policy options as the following.

1. University and College

Facilitating the making of learning material or learning module based on problem posing. Some steps required are: 1) taking policy for all lecturers in order to stage by stage revise or make learning module based on problem posing, 2) providing fund, and 3) activating research related to the implication of problem posing-based-learning.

2. Ministry of Education and Culture

Habituating problem posing-based-learning in schools for all educational levels; the steps enabling to take are: 1) taking policy literally in terms of this learning type, 2) improving teachers' capability related to problem posing-based-learning through workshop or training, 3) providing handbook for teachers as well as students containing problem posing.

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