



Evaluation of Calculus Learning Outcomes Based on Basic Ability, Attitude, and Motivation, of Students of Faculty of Mathematics and Natural Science of Medan State University

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Abstract

This presented research intended to delve into a given effect between Mathematical Basic Ability, Attitude, and Motivation toward Calculus Learning Outcomes Though collected data extracted by giving mathematical psycho test and Calculus Learning Outcomes, and questionnaires presented to regain informations about Attitude and Motivation. The findings being analyzed through track technical analysis. The study exhibited that: (1) Basic Mathematical Competence directly influencing upon Calculus Learning Outcomes of 31.4% goes with Motivation of 61.5%. (2) Attitude contributed directly to Calculus Learning Outcomes of 30.9%, goes with Motivation of 65.9%. (3) Motivation contributed impact on Calculus Learning Outcomes of 51.4%. A combination of these three variables will be more enhancing Calculus Learning Outcomes.

Keywords: Basic Mathematical Ability; Attitude; Motivation; and Calculus Learning Outcomes.

1. Introduction

Calculus is one of Mathematical part which has a strategic role in developing technologies and other science within all lives aspects. Almost overall engineering sciences, medicals, and even social sciences enticed concept of Calculus in its sciences progress.

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In view of the importance of calculus role, whereby students are required paying special attention in learning concepts which the substances in it included. The facts revealed that generally the students of Faculty of Mathematics and Natural Science of Medan State University not meet the expectation yet. The low of Calculus Learning Outcomes explicitly viewed from Standard Test Outcomes which is always be assessed by Faculty Teamwork on the very year with students. The low of Calculus Learning Outcomes encountered by variety of students' competence as the author in [13] *"The difficulties encountered by students of differing abilities and experience, to obtain unbiased empirical evidence to build and test theories of learning to enable more fruitful learning experiences for students in the calculus."* If this manner let it go on, then undeniable that students always encounter difficulties to complete their education, because Calculus one of the requisite subject thenceforth, especially of the subjects that calculus regarded as a prerequisite for such equational differential, real analysis, vector, etc. That's why it's necessary to hold evaluation of Calculus Learning Outcomes in order to find out factors' cause. When the cause not unveiled, then will bring students' potentiality about not to grow up. As well the authors in [2] as stated *"Everyone has the ability to learn mathematics, although some children learn and make connections more quickly than others. Everyone has some mathematical ability, but some children have potential far beyond what most people are prepared to believe. Mathematical abilities in a child are often dormant and remain unnoticed both by the child and his or her teachers. This potential can be lost forever if it is not discovered and supported at the appropriate time."* The inferred evaluation is definable as resolution of any score encompasses activity done to set value and advantage from any program (or alternative programs) in improving some certain aspects of educational program. Evaluation defined as systematic investigation of value or advantage from an object. In case of this evaluation which will be worked it out is to collect and analyzed of data systematically to set value and advantage of a practice in education in order to design, to perfect and to examine implementation of an educational practice. Learning outcomes are individual activity series well in sense of knowledges, attitudes, and skills which can be tagged by acquire value through learning process.

The success of learning calculus its of course inextricable out of a variety of influenced factors. The factors may hatch from some factors which influencing learning achievement, which split off on internal factors and external factors. Internal factors embracing physical factor and psychological factors (intelligence, interest, aptitude, attention, motivation, maturity and readiness). External factors including social factor (family, school environment and community) and non-social factors.

These internal factors and external factors are linked to each other to predispose students learning calculus outcomes. One of them is basic ability that is an individual preowned potential which related with conceptual mastery, principles and mathematical abstraction that reflected in ability of arithmetics, algebra, geometry, and logic which is useful to comprehend a concept or in solving problem. Students basic mathematical ability is good, of course will conduce their good learning calculus outcomes. This basic ability escorting students are able to follow a study well and form students have positive attitude toward learning calculus. The authors in [5] said *"The fact that the basic skills mathematics score was consistent as a predictor of success even when controlling for course format and professor."*

The other internal factors that influencing too in learning calculus is attitude. The authors in [8] argued *"The*

conceptions, attitudes, and expectations of students regarding mathematics and mathematics teaching have been considered to be very significant factor underlying their school experience and achievement.” Attitudes as prone to behave determined actions of what will be acted, by positive attitude toward learning calculus will impel passion more fervent to attend lecture class and motivated to learn calculus. Some ideas such as delivered by the authors in [6] that: “There is also a common opinion for this field, where individuals with positive attitudes towards mathematics would be more successful than the individuals with negative attitude”. The research results of the authors in [3] also stated that “Students’ success in mathematics depends upon attitude towards mathematics”. The authors in [4] said attitude is a sensational propensity toward an object, situation, concept, others or self, other affect of learning process or experience signifying like/supportive (positive attitude) or dislike/unsupportive (negative attitude).

Next factor that could have impacted learning calculus outcomes is Motivation. In accordance with the author in [1] *Motivation is a complex part of human psychology and behavior that influences how individuals choose to invest their time, how much energy they exert in any given task, how they think and feel about the task, and how long they persist at the task.* Motivation is an important factor which is driving students to express their abilities to do something so bringing up a behavioral change to achieve a certain goal. According to the author in [10] *Interests and Motivations are the changes in oneself marked by reactive emergence “feeling” and preceded by responses of any goal.* The author in [9] that *learning motivation is a change within oneself reflected by arousing reaction to achieve goal. This change signaled by doing learning activity which is driven by eagerness to pursue good learning outcomes. In compliance with the author in [1] stated “Learning motivation of students in the education is important. Without learning motivation is not possible. So in education the role of motivation is effective on students learning. Due to motivation students do any task and achieve the goal. Motivation increase speed of work and a person is doing everything to achieve goal. Learning motivation is definable as a whole inner students’ locomotion which arousing learning activity and that providing direction of learning activity in order to required goal achieved. Motivation is a driving force or a will to behave, in this case it is clearly that attitude is close interrelated with motivation. The author in [11], said that motivation and learning could have affected each other. Students’ motivation could influence what and how they are learning, and then later on when they learn and considered themselves have more skilled, they are motivated to continue learning. The author in [14] said “According to the definition, students’ motivation may be manifested in cognition, emotion and/or behaviour. For example, a student’s motivation to get a good grade in mathematics may be manifested in happiness (emotion) if he or she scores high on a test.”* The importance of learning motivation also delivered by the author in [7] that *“Students’ perceptions of success in mathematics are highly influential in forming their motivational attitudes.”* From the ideas above is visible that motivation is an important thing. Therefore it is of course to influence students’ learning outcome itself.

When students are motivated in learning calculus then students will be inclined to discharge all their available abilities or potentials to achieve expected goal is learning calculus outcome. However from the study of the authors in [12] declared that *“The current study indicates changes in student attitudes about learning and mathematics over the course of a semester. More specifically, value, motivation and enjoyment decreased.”*

2. Research Method

The type of this study is quantitative research that is discoveries encompassing calculation or number or quantitative that intended to understand interrelationship between two or more variables. The relation is a contribution of one variable toward another variable or interrelated influence.

To get empirical data about observed variable, used instrument in a form of test and questionnaires. Instrument of Test is a variable of basic mathematical ability and calculus learning outcomes. Instrument of Questionnaires is a variable of attitude toward calculus and motivation of learning calculus. Instrumental evolution is going through with the following phases, (1) to review the theory of which is related to the observed variable, (2) to compile dimension and indicator of each variable observation; (3) to make up lattice instrument; (4) to create items of questions and set scale of measurement; (5) to do experiment; (6) to analyze each item of questions and validate observations.

The instrument of learning calculus outcomes is a phase mastery in a various scope of calculus which achieved by students after attending calculus study according to the set goal and classified into certain categories with cognitive sphere. The outcomes referred by score gained by test provided based on material of learning calculus that consisted of functional limit, derivative function, derivative application, definite integral, indefinite integral, integral application, and improper integral.

Basic ability is an individual preowned potential which related with conceptual mastery, principles and mathematical abstraction refelected in arithmatic ability, algebra, geometry, and logics useful to understand a concept or in solving problem. This is aquired from the students' score from a test on basic mathematical ability which comprised of mathematical concepts which they had learnt before.

Attitude toward calculus is a tendency to encounter positive reaction or negative in view of cognitive dimension, affective, and conative toward the object in calculus subject. This is referred by score obtained from students' answers of questions on a scale of attitude toward calculus that which what is trusted, what is sensed related to emotional gladness or inconvenience and tendency to behave according to attitude that the subject owned toward calculus.

Students' motivation on learning calculus is a power or enforcement derived within themselves, which including a impeling force to something which related to calculus, interest to deepen calculus material, persistent in learning calculus and fervent to learn.

The ability which students preowned relates to students' attitude toward calculus. The more basic intelligence better, the more positive attitude toward calculus. As well motivation as learning calculus influenced by basic intelligence and attitude toward calculus. Otherwise by basic ability and positive attitude will mostly motivate students to learn calculus to get better outcomes. Therefore, inferred that basic ability, attitude, and motivation will have immediate effect on learning calculus outcomes. As illustrated below:

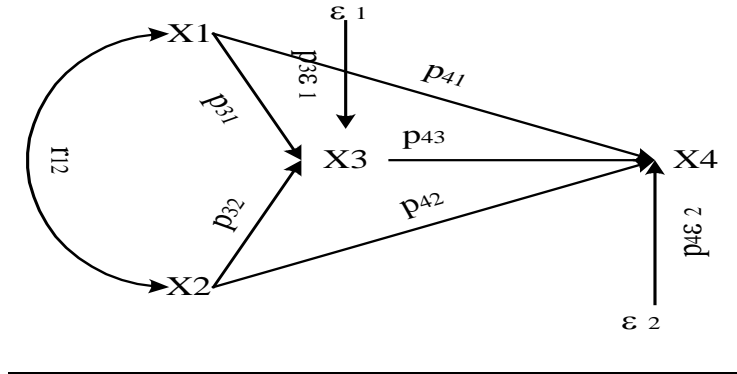


Figure 1: Casual Relation of X_1, X_2 , to X_3 and of X_1, X_2, X_3 to X_4

X_1 : Basic Ability on Mathematics

X_2 : Attitude toward Calculus

X_3 : Motivation on Learning Calculus

X_4 : Calculus Learning Outcomes

In order to analyze correlation between variables will elaborate Path Analysis which was developed by Sewal Wright as a method to study direct and indirect affect between independent variables and dependent variables. The goal of Path Analysis is to set direct dimension affect from a number of variables based on regressive coefficient beta (*coefficient path*). Path analysis is not a method to find out the causes. Therefore the method which is intended merely to examine the theorized causal truth. In elaborating path analysis, inferred about which one has a strong affect toward dependent variables.

3. The Results of Research And Discussion

Obtained data out of instruments upon variables of this research are examined with Path Analysis as diagram illustrated below and data tabulation with Program SPSS

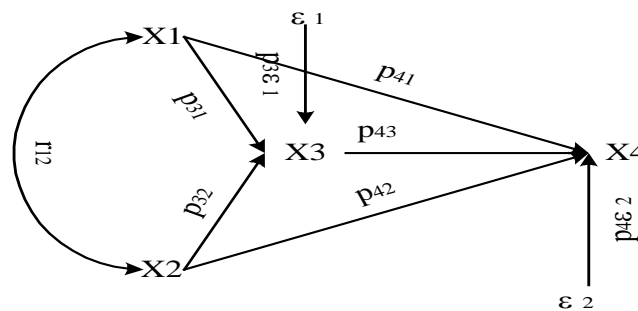


Figure 2: Path Analysis Diagram

Based on Path Analysis Diagram, hence acquired equational structure as follows:

$$X_3 = p_{31} X_1 + p_{32} X_2 + \epsilon_1$$

$$X_4 = p_{41} X_1 + p_{42} X_2 + p_{43} X_3 + \epsilon_2$$

From two equational structures, then each of equational structure elaborated by path analysis. By employing Program SPSS will have the outcomes as follows:

Table 1: R square For Equational Structure 1

| Model Summary | | | | |
|---------------|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | ,990 ^a | ,981 | ,977 | 2,23457 |

a. Predictors: (Constant), X2, X1

The large number R square (r^2) is 0.981. The number has significant that basic mathematical affect and attitude toward calculus are simultaneous toward motivation learning calculus is 98.1%. And the rest 1.9% affected by others factors. To perceive variable dimensional affect of ground mathematical ability and attitude toward calculus toward motivation learning calculus partially applied by examined t, while to detect dimensional affect applied Beta number and *Standard Coefficient* as follows:

Table 2: Path Coefficient For Equational Substructure 1

| Coefficients ^a | | | | | | |
|---------------------------|------------|-----------------------------|------------|---------------------------|--------|------|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | | Sig. |
| | | B | Std. Error | Beta | t | |
| 1 | (Constant) | 51,434 | 2,199 | | 23,389 | ,000 |
| | X1 | 1,476 | ,112 | ,585 | 13,140 | ,000 |
| | X2 | ,687 | ,045 | ,682 | 15,305 | ,000 |

a. Dependent Variable: X3

3.1 Equational Structure

$$X_3 = 0,585 X_1 + 0,682 X_2 + \epsilon_1$$

This Model is significant because p-value = 0.000 less than β .

3.2 Path Coefficient

- $p_{31} = 0.585$, because p-value = 0.000 less than β , this path coefficient significant
- $p_{32} = 0.682$, because p-value = 0.000 less than β , this path coefficient significant
- $p_{X_3\varepsilon} = \sqrt{1 - R^2} = \sqrt{1 - 0,981} = 0,138$.

This means that:

Direct influence of basic mathematical ability toward learning Motivation is 58.5%, whilst attitude affect toward learning motivation is 68.2% and disguised influence is 13.8%.

The thing is going paralle with the study of the authors in [15] who denoted that *research into student attitudes toward traditional and online methods of delivery is important in order to determine whether the increased usage of technology in the curriculum has been beneficial to their learning. This paper investigates the student perceptions of these two methods of delivery in a first-year introductory accounting unit in a number of key areas. These include their perceptions of learning effectiveness, motivation and impact on assessment outcomes.*

Table 3: R Square For Equational Substructur 2

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1 | .997 ^a | .994 | .992 | 1.38903 |

^a. Predictors: (Constant), X2, X1, X3

Dimensional number R square (r^2) is 0.994. The number has a significant means that the influence of basic mathematical ability, attitude toward calculus and learning motivation of calculus simultaneously toward learning calculus is 99.4%. The rest of 0.6% influenced by other factors. To perceive variable dimensional influence of basic mathematical ability, attitude toward calculus, and learning motivation of calculus toward learning calculus outcomes partially applied by examined t, while dimensional influence applied Beta number and *Standard Coefficient* as follows:

Table 4: Path Coefficient For Equational Substructure 2

Coefficients^a

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------|------------|-----------------------------|------------|---------------------------|-------|------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 22,248 | 10,202 | | 2,181 | ,057 |
| | X3 | ,541 | ,197 | ,514 | 2,750 | ,022 |
| | X1 | ,831 | ,298 | ,314 | 2,785 | ,021 |
| | X2 | ,327 | ,138 | ,309 | 2,372 | ,042 |

a. Dependent Variable: X4

3.3 Equational Structure

$$X_4 = 0.314 X_1 + 0.309X_2 + 0.514X_3 + \varepsilon_2$$

This Model is significant because p-value = 0.000 less than dari β

3.4 Path Coefficient

- $P_{41} = 0.314$, because p-value = 0,021 less than β , this path coefficient is significant
- $P_{42} = 0.309$, because p-value = 0,042 less than β , this path coefficient is significant
- $P_{43} = 0.514$, because p-value = 0,022 less than β , this path coefficient is significant
- $P_{4\varepsilon} = \sqrt{1 - R^2} = \sqrt{1 - 0,994} = 0,077$.

This case explained that direct influence of basic mathematical ability toward calculus learning outcomes of 42.4%, influential attitude toward learning calculus outcomes of 30.9% at the mean time motivation influence on learning calculus outcomes of 51.4%. while disguised influence of 7.7%

3.5 Complete Path Diagram

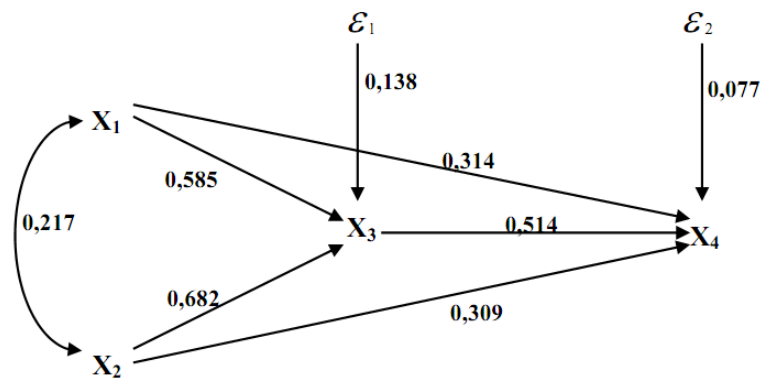


Figure 3: Direct and Indirect Effect Path Analysis

Interpretation:

The effect from X_1 to X_4

Direct effect = 0.314 or 31.4%

Indirect effect through $X_3 = 0.585 \times 0.514 = 0.301$

Total effect = $0.314 + 0.301 = 0.615$ or the effect of basic mathematical ability with learning motivation toward learning calculus outcome is 61.5%.

The effect from X_2 to X

Direct effect = 0.309 or 30.9%

Indirect effect through $X_3 = 0.682 \times 0.514 = 0.350$

Total effect = $0.309 + 0.350 = 0.659$ or the effect of attitude and learning motivation toward learning calculus outcome is 65.9%.

The effect from X_3 to X_4

Direct effect = 0.514 or learning motivation is 51.4%.

4. The Effect of Basic Mathematical Ability toward Learning Motivation and Learning Calculus Outcome

Basic Mathematical Ability has a prominent role in bringing up students' motivation. By good basic mathematical ability will ease students to attend calculus class to more motivated to learn calculus. This thing is discovered that from this observation has an effect of 58.5%. Direct effect of basic mathematical ability toward learning calculus outcome in only 31.4%, but simultaneously the basic mathematical ability with learning calculus motivation rendering effect of 61.5%. This effect of course its enough to set how the successful learning calculus is, because the more basic mathematical ability better, the more its motivation growing up to set success in learning calculus.

5. The Effect of Attitude toward Learning Motivation and Learning Calculus Outcome

Attitude as a tendency to behave while motivation is a driving or will to behave in manner of closely related to motivation. In this research discovered the effect of attitude toward learning motivation is 68.2%. Direct effect of attitude toward learning calculus outcome is only 30.9%. This effect is regarded is big enough to set the successful learning calculus.

6. The Effect of Learning Motivation toward Learning Calculus Outcome

Learning Motivation is an urgent factor to set learning calculus outcome because motivation is a locomotion to achieve the goal. This manner is viewed from the observation result that learning motivation rendering effect of 51.4%. The effect of basic ability toward motivation is 58.5%, while the effect of attitude toward motivation is 68.2%. Though direct effect of basic ability toward learning calculus outcome is 30.9%. Nevertheless if attitude and motivation combined its rendering effect toward learning calculus outcome of 65.9% more than the effect of basic ability with motivation of 61.5%. Inferred the effect of attitude is greater than basic ability toward motivation.

7. The effect of Basic Mathematical Ability, Attitude, and Motivation toward Learning Calculus Outcome

Based on this research defined factor of successful learning calculus is learning Motivation, Attitude and basic mathematic ability. This individual variable rendering direct effect toward successful learning calculus, whereas motivation rendering effect greater followed by basic mathematical ability and attitude toward calculus. However common attitude with motivation rendering greater effect from basic Ability along with motivation toward learning calculus outcome. Simultaneously basic ability, attitude, and motivation rendering effect greater toward students' success in learning calculus, because basic ability through motivation rendering effect of 61.5%, attitude through motivation rendering effect of 65.9%, and motivation itself rendering effect of 51.4%. Therefore the combination of this three variables will render effect greater toward learning calculus outcome.

8. Conclusion

Based on descriptions upon the outcomes and discussion above, then presented the conclusion of observation outcomes as follows:

- The effect of basic Ability toward students' learning motivation of 58.5%
- The effect attitude toward learning motivation of 68.2%
- The effect learning motivation toward learning outcomes of 51.4%

If it is come to view the combination of three variables that is the effect of basic ability, attitude through motivation toward student's learning outcomes found out that:

- Basic ability through motivation rendering effect of 61.5%
- Attitude through motivation rendering effect of 65.9%
- Motivation itself rendering effect of 51.4%

Therefore the combination of this three variables inferrable that basic ability and attitude through motivation rendering effect greater toward learning calculus outcomes.

9. Recommendation

Based on observation outcomes, discussions, and conclusion the writer deliver some recomendation in connection with : Elevating Basic Mathematical Ability, Elevating Attitude and Motivation to enhance Learning Calculus Outcome as follows:

1. To Elevate Basic Math Ability

- a. To Elevate Basic Mathematics Ability for students who are accepted already standing as students in Faculty Mathematics and Natural Science of Medan State University through *crash program*, provision of reference library.
- b. Organazing matriculation to those students who attend Faculty Mathematics and Natural Science of Medan State University so that students can prepare themselves in learning strategies and apply them in

learning-teaching activities.

- c. To Provide complete Mathematical Text Books.

2. To Elevate Attitude toward Calculus

Endeavors to elevate attitude toward calculus is of course not only an easy thing as flipping off hand, encouragement needed which enable to motivate students to enhance attitude toward calculus to expound deeply and to expand about technic to grow up attitude toward calculus.

3. To Elevate Students' Learning Motivation

To elevate students' learning motivation toward calculus might be applied by proposing motivation through presenting application sample of calculus toward various segment in lives and how calculus roles buttress another successful study in particularly to become calculus as prerequisite subject.

References

- [1] Bakar, Ramli. 2014. The Effect of Learning Motivation on Student's Productive Competencies In Vocational High School, West Sumatra. *international Journal of Asian Social Science*. 4(6): 722-732
- [2] Borovic and Tony.2006.Mathematical Abilities and Mathematical Skills .World Federation of National Mathematics Competitions Conference 2006 Cambridge, England. <http://www.wpr3.co.uk/wfnmc>
- [3] Farooq, M. S. and Shah, S. Z. U.. (2008). Students' Attitude Towards Mathematics. *Pakistan Economic and Social Review* Volume 46, No. 1 (Summer 2008), pp. 75-83
- [4] Lestari, K.E dan Mokhammad R.Y.2015. *Penelitian Pendidikan Mtematika*.Bandung: Refika ADITAMA.
- [5] Lunsford and Philip.2011. Basic Mathematics Skills and Success in Introductory Statistics.*Journal of Statistics Education*, Volume 19, Number 1 (2011).
- [6] Memnum and Recia .2012.Pre-Service Teachers' Attitudes towards Mathematics in Turkey.*International Journal of Humanities and Social Science* Vol. 2 No. 9; May 2012
- [7] Middleton and Photini.1999.Motivation for Achievement in Mathematics: Findings, Generalizations, and Criticisms of the Research. *Journal for Research in Mathematics Education* 1999, Vol. 30, No. 1, 65-88.
- [8] Mohd, N. and Farah, T. 2011. The effects of Attitude Towards Problem Solving in Mathematics Achievements. *Australian Journal of Basic and Applied Sciences*, 5(12): 1857-1862.
- [9] Nashar, 2004. *Peranan Motivasi dan Kemampuan awal dalam kegiatan pembelajaran*. Jakarta: Delia

Press.

- [10] Sardiman, 2007. *Interaksi dan motivasi belajar*. Jakarta: Raja Grasindo Persada.
- [11] Schunck, D.H. 2012. *Learning Theories an Educational Perspective*. Jakarta : Pustaka Pelajar.
- [12] Sundre dkk.2012. *Motivation for Achievement and Attitudes toward Mathematics Instruction in a Required Calculus Course at the Norwegian University of Science and Technology*. Numeracy: Vol. 5 : Iss. 1 , Article 4.
- [13] Tall, D. 1993. *Students' Difficulties in Calculus*. Published in *Proceedings of Working Group 3 on Students' Difficulties in Calculus, ICME-7 1992, Québec, Canada*. ISBN 2 920916 23 8.
- [14] Waege, K. 2009. *Motivation For Learning Mathematics In Terms Of Needs And Goals*. *Proceedings of CERME 6, January 28th-February 1st 2009*.
- [15] Wong, Lili and Michelle Fong, 2014. *Student Attitudes to Traditional and Online Methods of Delivery*. *Journal of Information Technology Education: Research*. Vol 13, 1 - 13