ANALYSIS OF SELF-DIRECTED LEARNING UPON STUDENT OF MATHEMATICS EDUCATION STUDY PROGRAM

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Abstract
Various studies have rendered self-directed learning disposition to be significant in the learning of mathematics, however several previous studies have pointed the level of self-directed learning disposition to be at a low point. This research is aimed to enhance self-directed learning through implementing a metacognitive strategy in learning mathematical statistics. This research incorporates both methods of quantitative and qualitative ones while employing a sequential explanatory strategy. Research design takes a pretest-posttest control group design (Creswell, 2009). The subjects of the research are students of Mathematics Education Study Program of the University of Kupang, East Nusa Tenggara Province currently taking Mathematical Statistics course. Research sample is filtered from two class levels of mathematical statistics course Research instruments include the Likert scale to measure self-directed learning disposition. Results point an increment of self-directed learning disposition of students who were being taught through either a Metacognitive Strategy Approach (MSA) or Conventional Approach (CA). The Self-directed learning disposition of students based on the MSA approach was found to be better than those of the CA approach. The lowest average increase of the CA class was based on the identification of the goals indicator. Furthermore, the lowest average increase of the MSA class was based on the evaluation of the advantages and the disadvantages of learning. The highest average increase for either MSA or CA classes was observed because of the presence of learning initiatives. The average increase of the presence of learning initiatives indicator for the MSA class was higher than those of the CA class.
Keywords: Self-directed learning, metacognitive strategy

1. Introduction

The study of mathematics incorporates a relatively abstract object of study which requires perseverance, tenacity, and discipline in learning. This is due to the fact that mathematics is not solely about counting, but also about selecting and employing the precise, accurate and efficient information necessary in problem solving. These are necessary tools in formulating and interpreting alternative solutions for a better comprehension and eventually solution. This is found to be parallel to the utterance of Johnsons and Rising (1972) who stated that solving a mathematical problem is a complex mental process which requires visualization, imagination, analysis, abstraction, and cohesion of ideas.

Throughout the previous years, learning mathematics involves material presentation from teachers or lecturers. Teachers identify learning goals and evaluate student learning comprehension. This approach does not allow students to criticize what has been learned thus they remain unable to comprehend and assess their own cognitive abilities. Students do not possess initiatives to learn what they want and to identify their own goals in learning. Students are significantly dependent on their teachers.

This statement indeed contradicts the position of Van Briesen (2010) who argues that in order to succeed, a student should be able to self-evaluate and comprehend his own cognitive abilities. This utterance suggests that a student who has the ability to evaluate what has been learned, has the opportunity to identify what is correct and accurate. Further, the student, in the process, would be able to correct any identified mistakes.

Comprehension towards self-cognitive ability renders the potential to actually self-identify one's learning goals. A self-understanding renders someone to be more comfortable and content to undertake any sort of activities. Anything that someone is to undertake must experience a level of comforting terms that guarantees the work an optimum result.

In the University level, there are still a handful of cases in which a passive student only receives information in a traditional learning setting. The truth is that in such a study level, a student is required to be able to not only receive information but also to be able to sort, select, assimilate and synthesize such information. Such setting would require students to self-learn. Wilcox (McCauley and McClelland, 2004) states that a university should involve students in a self-directed learning process not only for the sake of learning in university, but also to prepare students to learn for life.

Students are expected to initiate their own learning process. Initiating self-learning, scheduling learning time, identifying learning necessities, formulating learning goals, identifying resources and materials for learning, selecting and employing appropriate learning strategy, and evaluating learning outcomes, are important aspects in learning mathematics. Students will put in their utmost effort since they are the ones who designed their own learning, thus optimum resources would be employed in achieving their learning goals. Students are rendered to be responsible for what they have set and will employ all what is necessary in order to succeed. Through the learning process, students will be free to navigate different information essential for achieving their goals.

Further, through designing, monitoring, and evaluating, students employ new knowledge and extract knowledge they already have into solving various problems. This learning process involves such activities of monitoring and evaluation. Monitoring and evaluation of the thinking process render awareness on what is being thought upon. This enables students to question themselves in regards to their actions on creating conducive learning atmosphere, and by this eventually present effective questions. Effective questions contribute to problem solving, stimulate thinking process and triggers imagination. This would be achieved not through outside force but from what is in the students themselves. Attitudes in learning mathematics as described above are the essentials to a self-directed learning disposition.

Reasoning to the description above, it could be sensed that self-directed learning is a form of disposition required for students in learning mathematics. However, several research findings indicate that students' self-directed learning to be low. McCauley and McClelland (2004) suggest that the majority of Physics students possess an average or low level of self-directed learning. Further studies coducted by Kleden (2013) indicates that self-directed learning of Mathematics students are found to be low. In general, students possess a low level of initiatives on determining learning goals, creating conducive learning environment, and evaluating learning outcomes.

In order to overcome a low level of self-directed learning, a learning strategy is required which could enhance such disposition. One mathematics learning strategy rendered appropriate would be a metacognitive strategy.

A metacognitive strategy is a sequential process used to control cognitive activities and to ensure that these cognitive goals are achieved. This particular process entails designing and monitoring cognitive activities, and evaluating outcomes of these activities. The sequence of designing involves setting learning goals and job analysis in actualizing relevant knowledge. This is to assist and to ease organization and to comprehend further the available learning materials. Further, the way students actuate their cognitive abilities, monitor their thinking process and employ appropriate strategy in forming a new thinking process set to be efficient and effective in solving problems, are essential aspects of metacognitive learning.

Within a metacognitive strategy frame, students are required to possess their own initiatives to learn. This entails initiatives in determining learning goals, selecting learning resources and learning strategies, and evaluating and monitoring thinking and employed strategies. These aspects are incorporated into self-directed learning.

In regards to the introductory above, a problem statement is formulated as: (1) Are there enhancements to self-directed learning following the learning of metacognitive strategy? (2) Is the self-directed learning class employing metacognitive strategy doing better than those of a conventional class? (3) What aspects of self-directed learning are found to be the highest among students? (4) What aspects of self-directed learning are found to be the lowest among students?

In relevance to the problem statement, this research is aimed to analyze several factors related to students' self-directed learning subsequent to learning metacognitive strategies, and to analyze the highest and the lowest aspects of self-directed learning among students.

2. Theoretical Framework

2.1 Self-Directed Learning Disposition

Van Briesen (2010) defines self-directed learning as an individual attitude which incorporates initiatives and responsibility to learn, select, manage, and assess self-learning activity, motivation and interest, freedom in setting goals and determination of appropriate learning objects. Grow (McCauley and McClelland, 2004), suggests self-directed, difficult to define, as a sole concept as it incorporates a variety of elements such as attitude, perception, thought, experience, and communication. Knowles (in Hoban & Hoban, 2004), defines self-directed learning as a process in which an individual undertakes initiatives to identify learning needs, construct learning goals, identify learning resources, select and employ learning strategies and evaluate learning outcomes. Hoban & Hoban (2004) argue that there are primary and secondary dimensions in defining self-directed learning.

Primary dimension includes motivation, metacognition, and self-regulation. Meanwhile, the secondary dimension includes selection, competency, control, and self-confidence.

All arguments above emphasize the existence of a particular initiative within students to manage their learning process. In this case, desire to study does not depend on other people. The self-directed learning requires initiative of students to determine learning goals, select relevant learning resources, schedule learning time and to be consistent to this schedule, select most effective learning strategy, and self-evaluate learning outcomes. If students were to incorporate all of these elements into their learning process, it would be rendered that these students actually possess a high level of self-directed learning. Within this frame, the role of the teachers is to provide some kind of scaffolding which is monitor and to supervise.

Indicators to assess self-directed learning within this research include: (1) Creating productive learning environment; (2) Creating learning schedule; (3) Determining learning goals; (4) Possessing initiatives in order to learn; (5) Overcoming constraints (tenacious); (6) Searching and utilizing learning resources; (7) Monitoring and evaluating learning advantages and disadvantages.

2.2 Metacognitive Strategy

AeU (2011) suggests that there are several metacognitive strategies which can be employed in the learning process,. They are as follows: Self-Questioning, KWL (Know, What, Learn), PQ4R (Preview, Question, Read, Reflect, Recite and Review), and IDEAL (Identify, Define, Explore, Act, Look). This research employs the PQ4R (Preview, Question, Read, Reflect, Recite and Review)startegy.

PQ4R strategy assists students to process a lot of information within a short period of time. This would help students direct their perspectives to the tasks prior to completion of material reading. This is the description of the PQ4R strategy (AeU, 2011): Preview: preview the material in order to extract ideas in general, identify the main topics and the subtopics. Title and figures preview to identify what will be learned and be assigned to. Question: construct questions related to materials learned. Questions (what, how, why) are in regards to learning goals and materials being learned. Read: study on materials related with tasks and answering questions out of self-constructed questions. Reflect: reflect on materials which had just been learned, and attempting to reason on learned materials by: (1) Bridging what has just been learned with an already-known knowledge, (2) Connecting subtopic and main topic, (3) Attempting a do-over work by contradiction, (4) Attempting to employ learned materials to solve simultaneous problems. Recite: practice on retrieving and conveying information and ideas obtained. Review: review on materials learned, focus on self-constructed questions, recreate questions and review materials if unsure on answer, and constructing a summary.

In general, the PQ4R strategy emphasizes on how the students are conditioned to express what they are thinking by means of questions in which they construct themselves, which is in regards to activities in monitoring and evaluation. This metacognitive strategy actually incorporates similarity in various aspects such as planning, monitoring, and reflecting on mathematical ideas which is expressed in their work, and reviewing. This is found to be parallel to AeU (2011),which argues that an effective metacognitive strategy for learning includes three basic pillars, which are: Planning, Monitoring, and Reflection, as well as Awareness. In particular, several key aspects which are to be considered in each pillar namely: (1) Planning: (a) Identifying learning goals. (b) Selecting appropriate learning resources. (c) Forecasting time required to solve problems in tasks. (d) Planning a learning time fitted in a schedule and determining priority scales. (e) Constructing a list on resources (f) Managing learning materials. (g) Identifying steps necessary for learning by utilization of techniques such as outlines, diagrams, etc. (2) Monitoring and Reflection: (a) Reflection on learning process by recording what has been and has not yet been learned. (b) Monitoring work by questions of which by self-constructed in regards to self-verification (c)Providing feedback. (3) Awareness: (a) Identifying what has been learned. (b) Examining task requirements. (c) Evaluating work on completion. (d) Identifying difficulties/constraints. (e) Identifying solutions towards constraints founded. Metacognitive strategy employed in this research is PQR4 (Preview, Question, Read, Reflect, Recite and Review), in which sequential details are among and a combination of the strategies described above.

3. Method

This research is a combination of both quantitative and qualitative methods (mixed method) by a sequential explanatory substance. Research design undertakes a pretest-post-test control group design (Creswell, 2009). An experimental batch is presented with a metacognitive strategy, and a control batch is presented with conventional learning.

Research population (subjects of study?) is accounted for as all students of the odd semester of 2014/2015 which undertakes Mathematical Statistics course in a Mathematics Education Study Program of Teaching and Education Faculty in a particular University in Kupang City. Research sample is filtered as students of the Mathematics Education Study Program which counts as 65 students divided into two batches: batch A which consists of 33 students, and batch B of 32 students. Outset competency on mathematics of these two batches is relatively homogenous.

This research employs a Likert scale in regards to the self-directed learning disposition model. Prior to the execution of the scale, a validation test was undertaken where research instrument was presented upon five (5) validators. These validators presented similar considerations towards each item of the scales of the self-directed learning disposition. Subsequent to validation, the scales were executed.

Analysis on quantitative data was conducted through description and by estimating N-gain value for both pretests and post-tests. N-gain (<*gain*>) formula was adapted from Hake. Assumption test was conducted in regards to data normalization and group data homogeneity. Research hypothesis testing undertook parametric statistic analysis.

4. Result and Discussion

Table 1 presents statistical data on self-directed learning disposition for each batch of study. Data below includes pretest, posttest, and normalized gain value. Normalized gain value (g) renders increment level of self-directed learning disposition subsequent to learning.

Table1: Student Self-Directed Learning Disposition (SDLD)

Learning Approach	SDLD value	*n*	Average	Stdev
MSA	Pretest	33	95.758	14.645
	Posttest	33	119.238	14.753
	N-Gain	33	0.280	0.125
CA	Pretest	32	104.280	9.983
	Posttest	32	118.371	12.930
	N-Gain	32	0.188	0.122

As presented in Table 1, average increment of self-directed learning disposition of the MSA batch is .28, whilst that of batch CA is .188. Therefore, it concludes that average increment of self-directed learning disposition of students who are being taught through a metacognitive strategy approach (MSA) is found to be higher than those of a conventional approach (CA). However, based on Hake's classification, increment of self-directed learning disposition is to be categorized within a low level.

Data distribution normality and data group homogeneity tests undertook Shapiro-Wilk test (Z-test) and Levene test (F-test), respectively. Test results point that data was normally distributed and had similar variances. Hypothesis of testing increment of self-directed learning disposition was as follows: H_0: There is no increment difference of SDL disposition between students of different learning approaches and H_1: There is increment difference of SDL disposition between students of different learning approaches.

Increment significance test results of SDLD in both batches from a sole t-test are presented in Table 2.

Table 2: Increment Significance Test of Students of SDLC in Both Batches

Approach	*N*	Average	t	df	*Sig.*	Information
MSA	33	0.275	12.924	32	0.000	H_0 rejected
CA	32	0.188	8.695	31	0.000	H_0 rejected

Table 2 displays test results and points that H_0 is rejected. This suggests that there are significant increments of SDLD upon students either in the MSA bacth or in the CA batch.

Hypothesis test regarding differences of SDLD increment between students of the MSA batch and the CA batch were as: H_0: There is no increment difference of SDL disposition between students of different learning approaches vs.H_1: There is increment difference of SDL disposition between students of different learning approaches. Significant difference test by means of the t-test is presented in Table 3.

Table 3: Difference Test of Students of SDLD in Both Batches

Approach	*N*	Average	Avg. Dif.	t	df	*Sig.*	Information
MSA	33	0.275	0.087	2.847	62	0.006	H_0 rejected
CA	32	0.188					

H_0 is rejected due to probability value (*sig.*) being smaller than α = 0.05. This concludes that mathematical statistics students undertaking learning process through the MSA approach is found to be higher in SDL disposition level than those students undertaking learning process through the CA approach.

In general, inferential analysis results regarding self-directed learning disposition suggest that there are average increments of self-directed learning disposition for all students in both batches (MSA and CA). Average increment of self-directed learning upon students of the MSA approach is found to be higher than those of the CA approach. Table 4 displays average increment of self-directed learning disposition based on learning approach.

Table 4 presents an increment in all indicators of self-directed learning of students in both class of treatments (MSA and CA). Of the MSA class, lowest increment occurred for the indicator of evaluating learning advantages and disadvantages. Interview results illustrate lack of time for students to review their mistakes on previous completed work since subsequent assignments awaits them for the next meeting. Students often prefer to prepare themselves for next meeting's tasks in order to not be left behind by their peers in the coming class discussions. However, there are a small handful of students who attempt to evaluate previous meeting's work yet to be rendered not optimum reasoning to time shortage.

Table 4: Average Increment of Each Indicator of SDL Disposition

Self-Directed Learning Indicator	SMI	Learning Approach					
		MSA			CA		
		$\bar{X}$ Pretest	$\bar{X}$ Posttest	N-gain	$\bar{X}$ Pretest	$\bar{X}$ Posttest	N-gain
Creating productive learning environment	25	13.939	16.862	0.210	14.830	16.669	0.155
Creating learning schedule	30	14.388	19.271	0.298	17.074	19.084	0.120
Determining learning goals	15	8.304	9.805	0.177	8.850	10.164	0.081
Possessing initiatives to learn	20	13.457	16.143	0.378	14.832	16.815	0.321
Searching and utilizing learning resources	30	15.366	20.568	0.352	16.940	19.823	0.187
Overcoming constraints to learn (tenacious)	30	16.020	19.939	0.259	17.848	19.958	0.162
Evaluating learning advantages and disadvantages.	30	14.284	16.650	0.137	13.906	15.859	0.116

Of the CA class, lowest average increment occurred for the determining goals indicator which resulted as .0081. Observation and interview shows that several students suggest that during learning process in class, they are yet to have specific targets upon their study, either to that which has already been learned or to materials which are to be learned. This argument is made clear by incomplete/unfinished work which was assigned to the students. Several students did not even start on their assignments. The highest level of increment for both batches (MSA and CA) occurs for possessing initiatives to learn indicator. Of the MSA batch, increment amounts up to .378, whilst those of the CA batch amounts up to .321. Increment of possessing initiatives to learn indicator for students of the MSA batch is therefore higher than those of the CA batch. Students of both batches possess relatively similar learning initiatives, however students of the MSA batch are found to be more diligent in working on their assignments as opposed to those of the CA batch.

Based on interview sketches, it is perceived that students of the MSA class were seen to be more challenged to work on their assignments compared to the CA class, primarily due to the fact that students of the

MSA class are required to be active in group discussions and presentations in class and therefore are required a certain level of adequate comprehension regarding study materials. Throughout the discussion process, students are assigned to self-constructed questions and self-answering. This particular aspect actually motivates students to diligently work on their assignments regardless any constraints/difficulties presented to them. This statement is proven by the average increment in overcoming constraints to learn indicator (tenacious) upon students of the MSA class as .259, which is higher than those of the CA class which is .162. Overall, there are increments in all aspects of self-direct learning disposition for all students of all batches.

5. Conclusions

Several conclusions are drawn based on the results of the research presented above, which are as follows: After treatment, there are increments of student self-directed learning disposition for both batches of the MSA approach and the CA approach. Self-directed learning disposition of students of the MSA treatment are found to outperform those of the CA treatment. Of the CA class, lowest average increment occurred for the determining learning goals indicator. Of the MSA class, lowest average increment occurred for the evaluating learning advantages and disadvantages indicator. Moreover, highest average increment occurred for the possessing learning initiatives indicator in all groups (students of MSA and CA classes). However, average increment of the possessing learning initiatives indicator of the MSA class was higher than those of the CA class.

REFERENCES

AsiaeUniversity (AeU). (2011). *Course Overview*. [Online]. http//www.learningdomain. com. [5 Oktober 2013].

Creswell, J. W. (2009). Educational Research: Planning, Conducting, and Evaluating Qualitative & Quantitative Research. Pearson Education, Inc., Upper Saddle River, Nwe Jersey.Pearson Prentice Hall.

Hoban, S. and Hoban, G. (2004).*Self-Esteem, Self-Efficacy, and Self-Directed Learning: Separate, but Interrelated*.International Journal of Self-Directed Learning, Volume 1, Number 2, Fall-2004.

Johnson & Rising. 1972. *Guidelines for Teaching Mathematics*, Wadsworth Publishing Company, California.

Kleden, Maria A. (2013). Kemampuan Komunikasi Matematis dan *Self- Directed Learning* Mahasiswa, *Jurnal Delta-Pi, Vol. 2, No. 2*, Oktober 2013, ISSN: 2089-855X.

McCauley, V. and McClelland, G. (2004).Further Studies in Self-Directed Learning in Physics at the University of Limerick, Ireland.*International Journal of Self-Directed Learning, Volume 1, Number 2, Fall 2004*. [online]. http : //www. sdlglobal. com /IJSDL/ IJSDL1.2-2004. pdf. [2 September 2013].

Miller, B. A. (1999). *The Mutigrade Classroom: A Resource Handbook for Small, Rural School. Book 6: Self-Directed Learning*. Northwest Regional Educational Laboratory 101 S.W. Main Street, Suite 500 Portland, Oregon 97204.[online]. *http://educationnorthwest. org/webfm_send/1155*. [16 Oktober 2013].

Pratiwi, A. C. (2012). Makalah *Strategi Metakognitif*, Fakultas Matematika dan Ilmu Pengetahuan Alam. [online]. http://www.scribd.com /doc/100366479/Makalah-Strategi-Metakognitif. [1 Maret 2013].

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