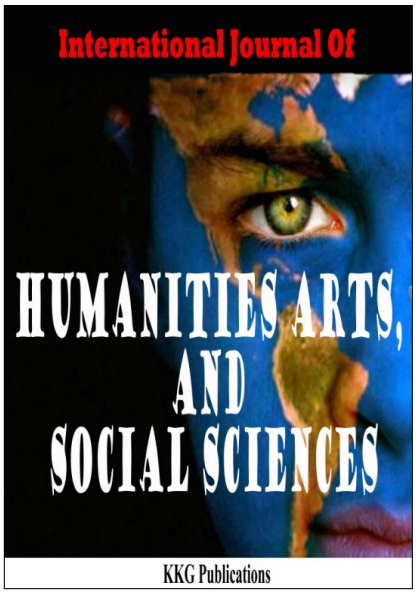

Key Knowledge Generation
Publication details, including instructions for author and subscription information:
http://kkgpublications.com/social-sciences/

Using Questioning Techniques to Enhance Students' Mathematics Achievement

PATIPAN PROMMARUK

Suan Sunandha Rajabhat University, Bangkok, Thailand

Published online: 13 December 2016

To cite this article: Prommaruk, P. (2016). Using questioning techniques to enhance students' mathematics achievement. *International Journal of Humanities, Arts and Social Sciences, 2*(6), 209-214.
DOI: https://dx.doi.org/10.20469/ijhss.2.20003-6

To link to this article: http://kkgpublications.com/wp-content/uploads/2016/2/Volume2/IJHSS-20003-6.pdf

International Journal of Humanities, Arts and Social Sciences
2016, 2(6), 209-214

IJHASS

USING QUESTIONING TECHNIQUES TO ENHANCE STUDENTS' MATHEMATICS ACHIEVEMENT

PATIPAN PROMMARUK *

Suan Sunandha Rajabhat University, Bangkok, Thailand

Keywords:
Questioning Techniques
Mathematics Achievement
Student Attitude

Received: 22 July 2016
Accepted: 28 September 2016
Published: 13 December 2016

Abstract. This action research aimed to enhance students mathematics achievement and to investigate students attitudes towards mathematics by using questioning techniques. The participants were 43 Grade 11 students at Satrinonthaburi School, Nonthaburi Province, Thailand. The mathematics content was Basic Statistics. The learning management plans lasted 12 periods with 50 minutes in each period. This action research was the integration of both quantitative and qualitative methods to complete answers to the posted research questions. The research instruments were learning management plans, an achievement test, and an attitude questionnaire. The pretest and posttest were used to determine the students' mathematics achievement. The attitude questionnaire with five-point Likert scale was used to evaluate the students attitudes (Brown, 2011). The data were statistically analyzed by using descriptive statistics. The E1/E2 criteria were used to evaluate learning process efficiency, and E.R. was used to evaluate students' mathematics achievement or effectiveness ratio. The research findings showed that the learning process had efficiency at 85.18/76.16 attaining above the 70/70 expected criteria. Students learning achievement after being instructed had the effectiveness ratio score of 0.9185 or 91.85%, which could be concluded that the questioning techniques can help to improve students' achievement. In addition, the students mean and standard deviation of the posttest score were 15.23 out of 20 and 2.86, respectively. For students' attitudes towards the instruction, the results showed that 44.38% of students tended to "agree" while 0.19% of students tended to "strongly disagree". In this research, more than half of students agreed that the questioning techniques help them to have efficiency and effectiveness of learning mathematics.

INTRODUCTION

Students who have problems in learning mathematics or fail to meet learning objectives usually get low mathematics achievement. These mathematics achievement problems are due to a combination of teaching strategies and student factors including mathematical skills, previous knowledge and habits of learning. Mathematical skills are abilities that students should acquire as they develop mathematics knowledge including the five mathematical processes: problem-solving, reasoning and proof, communication, and representation (The Ministry of Education, 2008).

However, the students have already prior knowledge before they meet new information which is the most important factor influencing learning and student achievement (Thompson & Zamboanga, 2003).

Also, students' habit of learning requires students to apply further mathematical reasoning, not just aiming at a correct solution, but comparing between different procedures by asking students to justify their answer involved in the thinking and reasoning (Seeley, 2015; Pengmanee, 2016). For enhancing students' mathematics achievement, teachers can apply the use of questioning to stimulate students' thinking at the beginning of the lesson for checking their prior knowledge or during the instruction to investigate the student habits of learning and mathematical skills or at the end of the lesson to evaluate the students' achievement (Latham, 1997).

The researcher as a student teacher took practicum course in teaching mathematics for Grade 11 students at Satrinonthaburi School. During two semesters of practicing in teaching, the researcher was interested in using the questioning techniques to motivate the students to develop mathematical thinking in mathematics class and enhance students' mathematics achievement on the topic "Basic Statistics".

The questioning techniques were applied three types of interaction: student-content interaction (exercises, homework, and assignment), student-teacher interaction (verbally), or student-student interaction (verbally).

Conceptual foundations of "Basic Statistics" in this research include "Measures of Central Tendency" and "Positional Measure". The questioning techniques were used to engage the students interact with the text to construct meaning of concepts and monitor the students' comprehension in those topics.

In addition, questions from teacher during instruction can guide

*Corresponding author: Patipan Prommaruk
†Email: Plamm_napan@hotmail.com

student thought or check student recall of content previously covered and questions from students help them to develop skills of probing questions that lead to meaningful inquiry for problem solving.

LITERATURE REVIEW

This section was divided into two related topics, questioning techniques and learning basic statistics.

Questioning Techniques

Classroom questioning is one type of classroom interaction for helping students understand the contents and enable teachers to gauge what students know and learn. It can enhance students develop critical thinking skills (Chidongo, 2013; Edwards & Bowman, 1996; Caram & Davis, 2005).

Students employ different preferred styles of learning and habits of learning. Wong (2012) studied about the use of student mathematics questioning with Grade 4 and 7 students in Singapore. He found that students asking their own question can promote active learning and metacognition with four key aspects of mathematical learning: Meaning, Method, Reasoning, and Application.

Small (2008, p.11) suggested that "In a constructivist classroom, students are recognized as the ones who are actively creating their own knowledge. The teacher's skillful questioning plays a vital role in this context, helping students to identify thinking processes, to see the connections between ideas and to build new understanding as they work their way to solution that makes sense to them". Questioning is an important component of student-centered teaching and learning and is useful to guide learning activities to meet lesson objectives (Chin, 2007; Yildiz & Kayili, 2015).

Wilen and Clegg Jr (as cited in Gegen, 2006) has provided seven suggestions for effective questioning. These are summarized as follows: plan key questions, phrase questions clearly, adapt questions to students' abilities, ask questions sequentially, ask questions at a variety of levels, follow-up on responses, and allow for think time. In addition to planning effective questions, teachers have to make decision about what questions to ask during student activities (Ontario Ministry of Education, 2006). The purpose of the questions before the first part of the lesson is to get the students' previous knowledge. During studies, both teachers and students use questions to develop and clarify their mathematical thinking. After studies, teachers and students ask questions that help to summarize the mathematical ideas (Ontario Ministry of Education, 2011).

Learning Basic Statistics

Neumann, Neumann and Hood (2010) recommended that the use of real life data set can be used to illustrate concepts in learning of statistics and to increase students' interest. In addition to the use of both outside and inside classroom questions can encourage the student to link to learning goals (Bruce, Flynn & McPherson, 2009). In this action research, the researcher planned to use the questioning techniques in teaching "Basic Statistics" 12 lesson plans. In each lesson plan the researcher used questioning techniques with real data both inside and outside classroom questions composed of three steps:

Step 1 Questioning for Engagement,

Step 2 Questioning for Concept Constructing, and

Step 3 Questioning for Conclusion and Feedback. Action research for this study based on Kemmis and McTaggart (Dick, 2000) is as follows: Plan $\rightarrow$ Act $\rightarrow$ Observe $\rightarrow$ Reflect (and then $\rightarrow$ Plan etc.)

METHODOLOGY

Participants

The participants in this classroom action research were 43 Grade 11 students studying in the second semester of the academic year 2015 at Satrinonthaburi School, Nonthaburi province, Thailand.

Research Instruments

The instruments used in this research were divided into three types as follows:

Lesson Plans

Research instruments were 12 lesson plans on "Basic Statistics" by using questioning techniques. Details of lesson plan were shown in Table 1.

Table 1 showed contents and time to spend in each lesson plan with three steps in teaching.

Step 1 Questioning for Engagement,

Step 2 Questioning for Concept Constructing and

Step 3 Questioning for Conclusion and Feedback.

After that, the researcher reflected students' behaviors and results for improvement in the next period. In implementing each lesson plan, the researcher employed questioning techniques and investigated students' mathematics achievement from the results of pretest and posttest.

TABLE 1
Lesson Plans on Basic Statistics

Lesson Plan No.	Contents	Period (50 minutes)
	Pretest	1
1	Quartile for ungrouped data	1
2	Decile for ungrouped data	1
3	Percentiles for ungrouped data	1
4	Arithmetic mean for ungrouped data, Weight arithmetic mean and combined arithmetic mean	2
5	Median and mode for ungrouped data	1
6	Remark and rules in using the central tendency	1
7	Quartile for grouped data	1
8	Decile for grouped data	1
9	Percentiles for grouped data	1
10	Arithmetic mean for grouped data	1
11	Median for grouped data	1
12	Mode for grouped data	1
	Posttest	1
	Total	13

Pretest and Posttest

Pretest and posttest were designed to use in this study in order to determine students' mathematics achievement. The test comprised 20 items focused on the students' general knowledge of Basic Statistics.

The items in the test were presented in a multiple-choice format and each item had four alternatives with one correct answer. The content and objectives of the test were checked, improved, verified and strengthened by three professional mathematics teachers through IOC (Index of Item Objective Congruence). A value of approximately at least 0.50 was used as accepted value.

Questionnaire

A questionnaire adapted from Measuring Student Attitude in Mathematics Classrooms (Brookstein, Hegedus, Dalton, Moniz & Tapper, 2011) was used to measure students' attitudes towards mathematics with application of the questioning techniques.

The researcher divided the questionnaire into three types, cognitive attitude, affective attitude and behavioral attitude. For each statement, respondents specified their level of agreement or disagreement on five-point Likert scale.

Data Collection

This research was conducted following the lesson plans in Table 1 displayed in the previous section. There were 12 lesson plans on Basic Statistics.

This research was conducted and data were collected by the following steps:

1. A pretest was given at the beginning of the lesson.
2. The researcher taught in the specified topic as mentioned in Table 1 by using questioning techniques with real data both inside and outside the classroom. The assignments of each topic during learning activities were evaluated and reflected for learning efficiency.
3. After finishing learning activities, a posttest was administered to measure the achievement of students and a questionnaire was used to measure students' attitude towards mathematics.
4. The researcher collected data from pretest, posttest, assignments, and a questionnaire to determine students' achievement and attitude towards mathematics after they had been instructed by using questioning techniques.

Data Analysis

The data of this research were analyzed following these steps:

Analysis of Research Instruments' Quality

The researcher evaluated the quality of research instruments by using index of item objective congruence (IOC) Rovinelli and Hambleton, as cited in (Turner & Carlson, 2003) based on the average of three experts' opinions. The computed value of the index would be at least 0.50 that means at least 50 percent of the content specialists gave a perfect rating to the items of tests, assignments, and lesson plans.

Data Analysis of Research Objectives

The researcher analyzed the data to meet the expectations of research objectives. Data analysis comprised of the scores on

assignment, pretest, posttest and responses to the questionnaire. The researcher analyzed students' achievement and attitude towards mathematics by using statistics as follows:

1. Learning efficiency (E1/E2) (Brahmwong, 2013).
2. Effectiveness ratio (E.R.) (Issel, 2014).

In addition, the students' mean and standard deviation of the posttest score were computed to determine the central tendency of students' enhancement.

RESULTS

The results of this study were reported as follows:

Results of Quantitative Data

Learning efficiency

In Table 2, the efficiency of using questioning techniques was 85.18/76.16 attaining above the 70/70 criteria.

TABLE 2
Efficiency of Using Questioning Techniques

	Scores	n	$\overline{X}$	Percentage
E1	84	43	71.55	85.18
E2	20	43	15.23	76.16

Effectiveness ratio

In Table 3, the effectiveness ratio of using questioning techniques was 91.85% attaining above the 80% criteria.

Means and Standard Deviation

Results of the mean and standard deviation of students' pretest and posttest scores were shown in Table 4.

TABLE 3
Effectiveness Ratio of Using Questioning Techniques

Sum of Pretest	Sum of Posttest	Sum of Target Scores	E.R.
283	655	688 (16*43)	91.85%

TABLE 4
Results of Pretest and Posttest Scores

Types of Test	n	Overall scores (20 points)	
		$\overline{X}$	S.D.
Pretest	43	6.58	2.56
Posttest	43	15.23	2.86

In Table 4, the results of the mean and standard deviation of students' pretest scores were 6.58 and 2.56 respectively and posttest scores were 15.23 and 2.86 respectively.

Results of Qualitative Data

Attitude towards questioning techniques

The attitude results of Grade 11 students towards "Questioning Techniques" were shown in Table 5 with Likert scale: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree.

TABLE 5
Students' Attitude in Using Questioning Techniques

Categories of Students' Attitude	Statement	Percent				
		1	2	3	4	5
Affective attitude (feelings or emotions)	1. Using question in classroom motivates my attention in learning mathematics.	32.56	46.51	20.93	0.00	0.00
	2. Mathematics teacher encourages me to answer questions in a mathematics lesson.	14.00	30.95	46.51	6.98	2.33
	3. Mathematics teacher gives me enough time to answer mathematics questions.	18.6	48.84	30.23	2.33	0.00
Behavioral attitude (tendency or disposition to act)	4. I have more confidence in learning mathematics.	26.00	30.23	44.19	0.00	0.00
	5. When I do not understand some mathematics lessons in class, I ask the teacher or other students.	41.9	48.84	9.30	0.00	0.00
	6. When the teacher asks mathematics problems, I try to figure out the solutions.	27.91	58.14	9.30	4.65	0.00
	7. When I make mistakes in solving mathematics problems, I will try to solve them until they are correct.	23.26	53.49	23.26	0.00	0.00
Cognitive attitude (thought, beliefs, ideas)	8. I found that the questions promote me to do well in mathematics.	20.93	58.14	13.95	6.98	0.00
	9. I listen to others explaining solutions in class then I have more knowledge.	32.56	51.16	16.00	0.00	0.00
	10. I am interested in learning new things in mathematics.	26.00	44.19	30.23	0.00	0.00
	11. In mathematics I try to link new ideas to my previous knowledge.	20.93	34.88	44.19	0.00	0.00
	12. Mathematics is a very worthwhile and necessary subject.	46.51	27.91	23.26	2.33	0.00

Table 5, Category 1 Affective Attitude showed the highest percentage, 48.84% (agree) in "Mathematics teacher gives me enough time to answer mathematics questions". Category 2 Behavioral Attitude showed the highest percentage, 58.14%

(agree) in "When the teacher asks a question in class, I try to figure out the answer". Category 3 Cognitive Attitude showed the highest percentage, 58.14% (agree) in "I found that the questions promote me to do well in mathematics".

CONCLUSION AND DISCUSSION

This action research using questioning techniques was performed under the selected topic on "Basic Statistics". The researcher developed the research instruments composed of 12 lesson plans which had three steps of learning activities: Step 1 Questioning for Engagement, Step 2 Questioning for Concept Constructing and Step 3 Questioning for Conclusion and Feedback, pretest, posttest, and assignments for each lesson plan. The research instruments were determined with content validity by using index of Item Objective Congruence (IOC) from three experts' evaluation. The lesson plans were applied to 43 Grade 11 students with four cycles of action research: Plan, Act, Observe, and Reflect.

The results of enhancing students' mathematics achievement using questioning techniques were determined by the efficiency index (E1/E2) and Effectiveness Ratio (E.R.). Students' learning achievement after being instructed was shown an efficiency index score of 85.18/76.16 attaining above the 70/70 criteria and effectiveness ratio score of 91.85% attaining above the 80% criteria. The results of students' attitude towards the instruction demonstrated that most students responded agree or strongly agree that the questions promote them to do well in mathematics (cognitive attitude), mathematics teacher gives them enough time to answer mathematics questions (affective attitude), and they try to figure out the answer when the teacher asks a question in class (behavioral attitude).

The findings of this study showed that applying questioning techniques enhanced students' mathematics achievement and engaged students' progress (Caram & Davis, 2005). Furthermore, the use of questioning techniques in teaching "Basic Statistics" with real data both inside and outside classroom motivated students' positive attitude in learning mathematics. Finally, students strongly agreed that using the questioning techniques motivates their attention in learning mathematics. Besides, they can ask the teacher or other students when they do not understand some mathematics lessons in class.

For teaching recommendation, focusing on basic statistics concepts is important not only in order to let students learn statistical content but to guide students to understand the characteristics and role of statistical thinking in realistic problem situation including data collection, data processing and decision making (Xu, Fang & You, 2010).

Acknowledgments

The author would like to thank International College, Suan Sunandha Rajabhat University (SSRUIC), Thailand, for providing me with the program of Mathematics Education and conducting this research. I would like to express my appreciation to students who participated in the research practicum school, Satrinonthaburi School, Nonthaburi Province, Thailand. At last I also offer my sincere appreciation to Assoc. Prof. Chaweewan Kaewsaiha, Asst. Prof. Dr. Supotch Chaiyasang, and Dr. Kanokrat Kunasaraphan from Mathematics Education Program (SSRUIC) for their invaluable comments to review this research report.

REFERENCES

Brahmwong, C. (2013). Performance tests, media or teaching. *Silpakorn Educational Research Journal, 5*(1), 7-20.

Brookstein, A., Hegedus, S., Dalton, S., Moniz, R., & Tapper, J. (2011). *Measuring student attitude in mathematics classrooms.* Kaput Center for Research and Innovation in STEM Education. Retrieved from https://goo.gl/LCZjBC

Brown, J. D. (2011). Likert items and scales of measurement. J*ALT Testing & Evaluation SIG Newsletter. 15*(1). 10-14.

Bruce, C. D., Ross, J., Flynn, T., & McPherson, R. (2009). *Lesson study and demonstration classrooms: Examining the effects of two models of teacher professional development.* Ministry of Education, Ontario, Canada.

Caram, C. A., & Davis, P. B. (2005). Inviting student engagement with questioning. *Kappa Delta Pi Record, 42*(1), 19-23.

Chidongo, M. (2013). Teachers' questioning techniques in mathematics at grade 11 level: The case of four selected secondary schools in petauke district (Master's thesis). University of Zambia, Lusaka, Zambia.

Chin, C. (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. *Journal of Research in Science Teaching, 44*(6), 815-843.

Dick, B. (2000). *A beginner's guide to action research.* Retrieved from http://www.aral.com.au/resources/guide.html

Edwards, S., & Bowman, M. A. (1996). Promoting student learning through questioning: A study of classroom questions. *Journal on Excellence in College Teaching, 7*(2), 3-24.

Gegen, S. R. (2006). The effect of higher-level questioning in a high school mathematics classroom (Master's thesis). Wichita State University, Wichita, KS.

Issel, M. L. (2009). *Health program planning and evaluation: A practical, systematic approach for community health.* Boston, MA: Jones and Bartlett.

Latham, A. (1997). Asking students, the right questions. *Educational Leadership, 54*(6), 84-85.

Neumann, D. L., Neumann, M. M., & Hood, M. (2010). The development and evaluation of a survey that makes use of student data to teach statistics. *Journal of Statistics Education, 18*(1), 1-19.

Ontario Ministry of Education. (2006). *A guide to effective instruction in mathematics: Kindergarten to grade 6.* Ontario Ministry of Education, Ontario, Canada.

Ontario Ministry of Education. (2011). *Asking effective questions.* Ontario Ministry of Education, Ontario, Canada.

Pengmanee, S. (2016). Developing students' mathematical reasoning ability based on constructivist approach. *Journal of Advances in Humanities and Social Sciences, 2*(4), 221-231.

Seeley, C. L. (2014). *Smarter than we think: More messages about math, teaching, and learning in the 21st century.* Sausalito, CA: Math Solutions.

Small, M. (2012). *Making math meaningful to Canadian students, K-8. Ontario.* Canada: Nelson Education.

The Ministry of Education (MoE) (2008). *The basic education core curriculum B.E. 2551* (A.D. 2008). The Ministry of Education, Thailand.

Thompson, R. A., & Zamboanga, B. L. (2003). Prior knowledge and its relevance to student achievement in introduction to psychology. *Teaching of Psychology, 30*(2), 96-101.

Turner, R. C., & Carlson, L. (2003). Indexes of item-objective congruence for multidimensional items. *International Journal of Testing, 3*(2), 163-171.

Wilen, W. W., & Clegg Jr, A. A. (1986). Effective questions and questioning: A research review. *Theory & Research in Social Education, 14*(2), 153-161.

Wong, K. Y. (2015). Use of student mathematics questioning to promote active learning and metacognition. In *Selected Regular Lectures from the 12th International Congress on Mathematical Education* (pp. 877-895). New York, NY: Springer International Publishing.

Xu, W., Fang, Y., & You, X. (2010). The investigation of statistics teaching about new mathematics curriculum of senior high school in China. *Journal of Mathematics Education, 3*(2), 67-76.

Yildiz, F. U., & Kayili, G. (2015). Examining the effects of computer-assisted preschool educational activities on children's intuitive mathematical ability. *Journal of Advances in Humanities and Social Sciences, 1*(1), 1-8.

— This article does not have any appendix. —