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Some Researches Related to Effect in Mathematics Education since 1980s in Japan

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Abstract: Some researchers in Japan began to try to investigate students' attitudes toward mathematics in 1980s. They translated some instruments developed by foreign researcher to Japanese and analyzed the validity and the reliability. Some of them tried to develop the original instruments in order to investigate students' attitudes towards mathematics in Japan. Some researchers investigated to relationships between attitude toward mathematics and mathematics achievement and between attitude toward mathematics and other variables. Recently some researchers tried to analyzed various aspect of affect, for example consciousness on mathematics problem solving and belief on mathematics learning.

Key words: mathematics education, effect in mathematics learning, attitudes toward mathematics

1. Introduction

McLeod D. B. (1989) described affect in the terms of beliefs, attitudes, and emotion. The discussion of these three topics indicates the broad impact of affective factors in mathematics learning and teaching.

Some researchers began to try to investigated variables related to affective domain in mathematics learning and teaching as research of attitudes toward mathematics in 1980s mainly.

I want to introduce some researches related to effect in 1980s, 1990s and 2000s in Japan.

2. Researches in 1980s

Minato S. (1983) developed a semantic differential, simply referred to as the MSD, for measuring attitudes toward school mathematics. The development and the results of examinations of the instrument MSD will be reported. He reported some attitudinal data on eight grade students of a lower secondary school from administration of the MSD, which is the only SD type mathematical attitudinal instrument developed in Japan. The data reported are the results of item analysis, reliability coefficients, factor analytic results, correlation between attitudes and achievement, and some sex-related difference statistics. He conducted the results based on following purposes. For the first purpose, the results of item analysis of the MSD were described. The results showed that subjects of the study discriminated all the items of the MSD. For the second purpose, some reliability coefficients were described. These coefficients were correlation coefficients of the DAS and ASD with the MSD, correlation coefficient between the MSD score and the teachers' estimate of subject's attitudes, and test-related

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correlation coefficient. For the third purpose, factor analytic results were described, and three predicted factors: the evaluation, potency and beauty factor, and one unpredicted clarity factor were obtained. For the fourth purpose, correlations between attitudes and achievement, and some sex-related difference statistics were described. Higher correlations than those usually obtained in the United States between attitudes and achievement were obtained, and a result of female superiority on the MSD was obtained.

Minato S. (1983) reported that a factor analysis of the MSD indicates that there are three factors: Evaluation, Potency, and Clarity. Validation of the analysis is supported by the result of fuzzy clustering. Other data for the MSD and prospective elementary school teachers, such as SD-profiles of the good and poor subjects are obtained by further treatment. The administration of the MSD to groups of eight grade students attending to one of four junior high schools A, B, C and D, sample size of each group is A:263, B:175, C: 193, D:151, reveals that coefficient of correlation between scale value of the MSD and achievement test score on school mathematics of each group is distributed from 0.4430 to 0.6610.

Minato S. & Yanase S. (1984) reported about the relationship between students attitudes towards school mathematics and their levels of intelligence. The study was conducted to clarify the fact that the effect of attitudes towards school mathematics on mathematical achievement in the effect of students towards school mathematics on mathematical achievement in the classrooms was larger in a group of low intelligence students than in a group of high intelligence students, using the technique of the analysis of covariance. In this study they interpreted the effect as the coefficient of regression of summative test scores on attitudinal scores. This study involved eighth grade students attending three junior high schools in Japan. For the three schools, they obtained the expected inequalities: the regression coefficient of the low intelligence group (> that of the middle intelligence group) > that of the high intelligence group, almost all of which were statistically significant.

Imai T. (1985) intended to investigate relation to mathematics achievement as internal variable in six sides of students' attitudes toward mathematics. Moreover Imai intended to investigate the variables of mathematics teachers as related to students' attitudes toward mathematics and mathematics achievement as external variables, because there were almost few investigations in Japan. In the first place Imai developed the instrument measuring students' perception of mathematics teacher as the results of testing validity and reliability. This scale was consisted of 14 sub-categories constructed with seven sides of students' perception of mathematics teacher, that were teachers' character, favor toward mathematics teacher, teacher's attitude toward mathematics, teacher's instruction, device of motivation, and teaching how to think and solve problems. Aiken Mathematics Attitude Scale: enjoyment, motivation, important, and freedom from fear, Fennema-Sharman self-confidence scale in mathematics learning, Holy, etc. self-concept scale in mathematics , and the Imai's scale of students' perception of mathematics teacher were administered to lower secondary school students. Results of analysis of variance showed that students' appreciation of importance of mathematics didn't relate to mathematics achievement or intelligence. There were significantly positive correlations between students' perception of mathematics teacher's instruction and many sides of students' attitude toward mathematics. Especially the correlation between the degree of case to understand teacher's instruction and all sides of attitudes toward mathematics were comparatively high. This finding suggested that students' appreciation of the degree of ease to understand teacher's instruction was one of importance variables of mathematics teaching related to students' toward mathematics.

Imai T. (1986) translated "The Mathematics Attitudes Inventory (MAI)" by Sandman R. S. to Japanese. I analyzed the responses of Japanese junior high students about MAI. I tried to check the validity and reliability of MAI (math teacher, anxiety, value, self-concept, enjoyment, motivation).

Kamata T. (1988) developed the Likert-type instrument measuring mathematics anxiety of Japanese junior high school students. The purpose of this study was to develop an instrument for measuring anxiety toward junior high school mathematics, and to investigate the followings: (1) existence of school, grade, and sex-related differences of mathematics anxiety, and (2) relationships between mathematics anxiety and mathematics achievement, and among mathematics anxiety and some affective variables, one of which is attitude toward mathematics. Scores for investigating the above (1) and (2) were gathered from students of four junior high schools which were in the north, central, and south parts of the Akita Prefecture, Japan. The instrument developed with validity and reliability is a five-point Likert-type one, and consists of 24 items, each of which represents mathematics anxiety. Main findings obtained from using the instrument were as follows: Although school and grade differences of mathematics anxiety were not be able to be found significantly, sex-related differences were in existence. Coefficients of correlation between mathematics anxiety and mathematics achievement in the four schools were distributed from 0.34 to 0.56, Mathematics anxiety and each of the affective variables draft within the study were closely related

3. Researches in 1990s

Imai T. (1990) tried to investigated the causal relationships between students attitudes toward mathematics and related variables. The purpose of this study was to cause and effect relationships between students attitudes toward mathematics and their related variables. I found some path diagrams of causal and effect relationships among students' attitudes toward mathematics, students feeling levels of difficulty toward mathematics and students feelings levels of difficulty toward mathematics and students perceptions of mathematics teacher on three groups of students based on levels of mathematics achievement. The results of this study revealed that there were more significant cause and effect relationships on junior high school students than on senior high school students, and that there were more significant cause and effect relationship on high level class students than on low level class students. I was able to get the results that "attitude→achievement" relation was stronger than "achievement →attitude" relation, and that teacher variables and students feeling levels of difficulty toward mathematics influenced students attitudes toward mathematics strongly.

Isoda M. & Abe H. (1994) reported that mathematics teacher tried to observe students' working about mathematics problem solving. The purpose of this study was to consider possibility about assessing students' belief of mathematics problem-solving by method of observing students' expression. He insisted that it was difficult to know students' belief of mathematics problem solving by teacher's observing students' expressions. They considered that it was possible to know consciousness of social cognition (for example, discussion about mathematics problem solving).

Ito T. (1995) reported the development, the validation and application of the Shimane Affective characteristics Test toward School Mathematics (Shimane-ACTM) developed by Ito's investigations on the affective domain in mathematics learning for 16 years. Main evidences that suggest the following have been presented: (1) The ACTM obtained a high discrimination validity by the item analysis. (2) Cronbach's α coefficient was 0.832, and the ACTM obtained a moderately high reliability. (3) A principal components solution using the principal axis method with varimax rotation resulted four Mathematics anxiety, and Attitudes toward mathematics. (4) The cluster analysis resulted four clusters as well as the results of the factor analysis. It was concluded that ACTM could be used for evaluating the affective characteristics toward school mathematics.

Minato S. & Kamata T. (1996) considered the results of research studies on causal predominance between achievement and attitude in junior high school mathematics of Japan. They insisted that there were two main approaches for revealing the relationship between achievement and attitude in mathematics education: one was the estimation of achievement using plausible variables, for example, parential and peer attitudes as well as student attitudes; the other was research such as that of Minato & Yanase (1984), who assume that there might be some attitudinal effects on achievement from differential levels of students' intelligence. Next they insisted that A common and essential aim of both approaches was to obtain the causal relationship between achievement and attitude in school mathematics. There may be some reciprocal or cyclical effects of achievement and attitude. Therefore, even thought determination of exact causality may not be possible, it is important to attempt to determine which is predominant, achievement effects, or attitude effects on achievement.

Minato S. & Kamata T. (1997) investigated predominant causal relationship, which was a probabilistic version of causal relation, between achievement of and attitude toward mathematics of junior high school students of Japan was dealt with. They perform it using so-called Cross-Lagged Panel Correlation analysis. Formally causal relationship between variables X(cause) and Y(result) should be satisfied the following conditions: (1) X is antecedent to Y, (2) there is a functional relation Y = f(X), (3) the relation is not spurious, and if the functional relation in the second condition is psychological in nature, is permitted, then (4) the relation seems vital. If the functional relation in the second condition is slightly altered to a probabilistic relation, with the others still maintained, the conception of predominant causal relationship between X and Y can be obtained. Cross-Lagged Panel Correlation analysis is a quasi-experimental design appropriate for such a setting as the study, and the most effective method dealing with the predominant causal relationship between achievement and attitudes measured at two points in time. The subjects of this study were the students entered in one of four public junior high schools located at Akita, the north east area of Japan in the beginning of the 1991 school year. The number of the original subjects were 965. In Japan the school year begins in April and ends in March of the next year. It consists of three parts: first term(April-July), second term(August-December), and third term (January-March), and subjects in this study had three vacation: four weeks of summer vacation in July and August, three weeks of winter vacation in December and January of the next year, and a week of Spring vacation in March. Achievement test, which is 3×45 minutes long in time in each time point and developed by one of the researchers of this study were administered by teachers of each school for measuring total cognitive ability on mathematics. Attitude was measured by a Likert-type instrument named FA, consisted of 12 scale with five points from positive to negative by degree, an SD type instrument named MSD which consists of 17 bipolar adjective pairs, and MSD(E), the factor of the MSD. They analyzed causal relationships and interpreted these results. Their interpretation was as follows: when students entered in junior high school, and for several months after this, they might endeavor to get exclusively their cognitive ability, whether they have positive attitudes or not.

Saito N. (1999) reported to the development of the attitude scale of creativity in mathematics education. He called this attitude scale as CAS (Creative Attitude Scale). He analyzed factors on the creativity which are known so far. The attitude scale was composed of 7 factors consisting 27 items. On composing the scale, He investigated the degree of discrimination for each item, the reliability of all the items, the correlation coefficient between each item and the correlation coefficient between CAS and the scales which were proposed by Torrance E. P. and Munzert A. W..

The results of experiments performed on 753 students of elementary school (grade 6) and junior high school (grades 1–3) are as follows: (1) The degree of discrimination for each item is very high. (2) The value of

coefficient α of reliability of all the items is 0.97. (3) The value of correlation coefficient between each item ranges from 0.40 to 0.75. Torrance E. P. and Munzert A. W., range from 0.88 to 0.92. These results show a higher discrimination and larger reliability of CAS. Also, I classified the values of the measurement by CAS in five steps and interpreted the creativity for each step.

4. Researches in 2000s

Sasa H. (2000) tried to find Students' consciousness toward mathematics. He analyzed the difference in consciousness between junior high school students and high school students. This research was based on a series of studies entitled "Research on Students' Belief, Goal and Attitudes on Mathematics" that was carried out in Fukuyama junior and senior high school attached to Hiroshima University from 1995 to 1997. As a result of the research, the following differences in consciousness concerning creativity and communication with other students between junior and senior high school students became clear. (1) Though high school students think that "Mathematics is free and it has possibilities", junior high school students think that "Mathematics is a set of problems to be solved." (2) Though junior high school students think that mathematics ability improves by solving many problems, high school students think that it improves by creative learning.

Imai T. (2000) investigated the influence of affect of overcoming fixation in mathematical problem-solving towards divergent thinking in open-ended mathematics problem on Japanese junior high school students. Students who overcame fixation in Problem (A) scored significantly higher in divergent thinking (1), divergent thinking (2), and divergent thinking (3) in Problem (B). The score of divergent thinking (1) is the number of statements which students wrote. This score reveals how students find many divergent ideas in a short time. So this score shows the aspect of thinking related to both flexibility and fluency in this research. The score of divergent thinking (2) shows flexibility. And the score of divergent thinking (3) shows originality. The conclusion of this investigation was as follows. Those students who have affect of overcome fixation in mathematics can make varied and original ideas in open-ended situations in mathematics. It is important for junior high school students to have affect of overcome fixation in mathematics in order to do this. Affect of overcoming fixation influences divergent thinking related to flexibility and originality.

Imai T. (2004) investigated attitudes of prospective elementary school teachers toward school mathematics. The purpose of this research were to investigate "like-dislike" toward arithmetic, junior high school mathematics, high school mathematics and to investigate belief for self, especially the cause of not getting good marks in mathematics (lack of ability, difficulty of problem, lack of effort, lack of luck by Weiner). The results were follows. Many of non-scientific course students responded that they became to dislike high school mathematics. Lack of effort was the selected as the cause of not getting good marks in mathematics among lack of ability, difficulty of problem, lack of effort, and lack of luck. It is important for high school math teachers to develop good teaching methods related to non-scientific courses. Many students responded that they liked arithmetic when they were elementary school students. Therefore it is important for them to remember liking arithmetic after they have studied relations between theory and practice in arithmetic education using a teaching method.

Imai T. (2010) investigated the effects of monitoring about overcoming fixation in mathematics problem-solving on college students of prospective elementary school teachers in Japan. The conclusions of this research were follows. It is effective to experience overcoming fixation in order to overcome fixation in mathematics problem-solving. It is important for affect of overcoming fixation to monitor how to overcome

fixation in similar problems. Monitoring of overcoming fixation in mathematical problem-solving is one of the emotion about mathematical problem-solving.

5. Conclusions

Some researchers in 1980s began to try to investigate students' attitudes toward mathematics. They translated some instruments, especially semantic differential, developed in USA. They investigated the relationships between students' attitudes toward mathematics and other variables.

Several researches in 1990s tried to develop the mathematics attitudes instruments, especially Likert type scale and investigated to find the causal relationships among affective variables, mathematics achievement and other variables.

Some researchers in 2000s were interested in the results of international investigations, especially TIMMSS by IEA. They considered the Japanese students' results related to affect in school mathematics.

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