THE SURVEY STUDY OF MATHEMATICS MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE (MMSLQ) FOR GRADE 10–12 TAIWANESE STUDENTS

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ABSTRACT
This study draws attention in understanding senior high and vocational school students' mathematics learning motivation and strategies. While Taiwan students have good mathematics performance in international competition but they have low confidence in learning mathematics well. Two questionnaires about motivation and learning strategies were developed based on Motivational Strategies for Learning Questionnaire (MSLQ), and were issued to 1,282 participants. The results show that the students have weak motivation and a less usage rate of learning strategies in learning mathematics. Besides, the result showed that the students went to cram school showed higher motivation for learning mathematics, and the students went to cram school also used learning strategies better than the students didn't go to cram school. Also, male students showed higher motivation for learning mathematics, and male students also used learning strategies better than female students.
Keywords: MSLQ, motivation, learning strategies, confirmatory factor analysis, adaptation of MSLQ

INTRODUCTION

According to the report of TIMSS program in 2003, at both the fourth and eighth grades, Taiwan had the fourth-highest average achievement in mathematics among the countries joining this program in 2003 (Mullis, Martin, Gonzalez, & Chrostowski, 2004). Moreover, in the report of TIMSS program in 2007, it showed that at the fourth grade, Taiwan had the third-highest average achievement in mathematics, and at the eighth grade, Taiwan had the highest average achievement in mathematics among all participating countries in 2007 (Mullis, Martin, & Foy, 2008). However, when talking about the affection and confidence of learning mathematics, the report of Timss 2003 indicated that most of Taiwan 8 graders' attitudes toward mathematics were negative. Moreover, seventy four percent of them reported they have no confidence in learning mathematics. These results are even worse than some countries whose mathematics grades were lower than Taiwan. The phenomenon of Taiwan students having good performance but low confidence and interest in learning mathematics, therefore, is worth paying close attention to and investigating. There are numerous factors which may affect students' learning performance such as teachers' instructional methods, learning environment, students' learning strategies, and motivation etc. Among all, it is always believed that the students' motivation and learning strategies play crucial roles in their learning (Schunk, 1990; O'Neil & Drillings, 1994; Pajares & Kranzler, 1995). Motivation and learning strategies, hence, are of particular interests to educational psychologist and researchers.

Because parents in Taiwan usually want their children to be better than others, common expectation from the parents is hoping their children getting good grades and enter a better school. In Taiwan, not only senior high school students have to attend the college entrance examination, but vocational school students have to face the Technological and Vocational Education joint college entrance examination. Therefore, in Taiwan, not only senior high school but also vocational school students have to endure the pressure from examination. The higher score they get the more chance to enter better schools they have. Besides, in the college entrance examination or the Technological and Vocational Education joint college entrance examination, mathematics is an important subject, and it makes the parents and the students pay much attention to this subject. In order to get good grades in mathematics, the parents and students attempt to find more other ways to improve mathematics skill. Because of the need of the parents and the students, cram schools showed up and developed. Contrary to school education, students may need to attend cram schools after regular school to master certain important courses. Cram schools prepare the students for the college entrance examination. In cram schools, the cram school staffs would not only help them review the content the students learn in schools, but also teach some new content in advance. In order to familiar the students with the college entrance examination, cram schools usually provide the students with lots of practice and teach the students different strategies to answer the questions in the examination. In cram schools, students have more chance to learn different strategies to solve similar questions in exams, but also have more channels to help them study the learning content. Going to cram school is a common phenomenon in Taiwan, and it seems that cram schools provide some different kind of learning support for students. In order to understand the effect of cram school on high school students' learning in mathematics, in this study, the effect of going to cram school on students' learning motivation and learning strategies in learning mathematics would be examined.

In Asian society, the gender stereotype in mathematics learning were affected the senior high school and vocational school students a lot. Boys usually were considered to study in science or engineering-related field, and girls would be suitable to study in liberal arts or related fields. Some studies found that the resource or assist for mathematics learning received from parents were different between boys and girls (Hektner, 1995). The attitude of learning peer also affected the mathematics learning attitude of girls and boys. Girls getting good grades in mathematics were not easy to be accepted in the peer groups; however, boys who get good grades in mathematics usually won recognition easily from peers. These kinds of stereotypes affect different aspect of mathematics learning of boys and girls. Boys would consider that they should learn mathematics well, and it is shameful if they don't learn mathematics well. Therefore, boys endure much pressure when learning mathematics. Contrarily, girls don't take getting good grades in mathematics too serious, and even take it for granted. It seems that boys and girls have different learning attitudes in mathematics. In order to understand the gender differences in motivation and learning strategies of mathematics, in this study, the differences of motivation and learning strategies in mathematics would be discussed.

Accordingly, the research questions will include:
1. What is the status of Taiwan senior high school and vocational school students' motivation toward mathematics learning?
2. What is the status of Taiwan senior high school and vocational school students' learning strategies used in mathematics learning?
3. How is the effect of going to cram schools on Taiwan senior high school and vocational school students' learning motivation and learning strategies in mathematics?
4. How is the effect of gender difference on Taiwan senior high school and vocational school students' learning motivation and learning strategies in mathematics?

RELATED RESEARCHES

Learning Mathematics

A wildly accepted consensual definition of learning proposed by Atkinson, Atkinson, Smith, and Hilgard is "a relatively permanent changes in behavior those results from practice" (Atkinson, Atkinson, Smith, & Bem, 1993). Although there are infinite subjects that may be learned and taught in the world, the knowledge that people acquire from learning may include facts, concepts, processes, procedures, and principles (Clark & Chopeta, 2004). Among these categories, learning mathematics involves the categories of concepts, procedures, and principles. However in Taiwan, senior high school students need to attend the university entrance examination and vocational school students have to face the technological and vocational education joint college entrance examination. The higher score the students get, the better university they can enter. Under pressure of the University Entrance Examination, right now in Taiwan most of the senior high and vocational high schools focus only on skills of correctly answering the questions. Consequently, the students can obtain high scores on test or international competitions, whereas their mathematics learning became a kind of rote learning.

Motivation

It is believed that motivation is an individual's internal status toward something. It has power to enhance the strength of the relationship between the input and the output of human behavior. Motivation refers to the reasons for directing behavior towards a particular goal, engaging in a certain activity, or increasing energy and effort to achieve the goal. The factors that will influence the extents of an individual's motivation include the types and intensity of needs and psychological process (Kleinginna & Kleinginna, 1981). Harmony with Kleinginna and Kleinginna, Geen (1995) indicated that motivation is a word used to refer to the direction, intensity, initiation and persistence of human behaviors.

Pintrich and De Groot (1990) proposed a motivation model named as social cognitive model of motivation. In this model, they asserted that the intensity of an individual's motivation will trigger him or her to execute good or bad learning strategies. Both motivation and learning strategies affect student's learning performance (Lee & Anderson, 1993; Lee & Brophy, 1996). The components of motivation in this model are value, expectancy, and affect (Pintrich & Schrauben, 1992; Pintrich, Smith, Garcia, & McKeachie, 1991). The researcher believed that issues of value will be influenced by intrinsic goal orientation, extrinsic goal orientation, and the task value; issues of expectancy will be affected by self-efficacy for learning and performance and control beliefs for learning. Finally, the issues of the affect will be impacted by test anxiety and the level of the learner's self-esteem.

Motivated Strategies for Learning Questionnaire (MSLQ)

Motivated Strategies for Learning Questionnaire (in short, MSLQ) was developed in 1991 (Pintrich, Smith, Garcia, & McKeachie, 1991) and validated in different countries (Karadeniz, Buyukozturk, Akgun, Cakmak, & Demirel, 2008). MSLQ scale contains two sub-scales: Motivation and learning strategies. Motivation scale composes 31 items that assess students' learning motivation. Motivation scales include three components: Value, expectancy, and affect. The component of value contains three elements: Intrinsic goal orientation (4 items), extrinsic goal orientation (4 items), and task value (6 items). Intrinsic goal orientation focuses on the inner reasons why students participate in a task, like: Curiosity, self-development, or satisfaction (ex. The most satisfying thing for me in the course is trying to understand the content as thoroughly as possible.). Extrinsic goal orientation concern about the outer reasons why students participate in a task, like: money, grades, or praises from others (ex. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.). Task value refers to the student's perception or the awareness about the material or task in terms of usefulness, importance, or applicability (ex. I think I will be able to use what I learn in this course in other courses.).

The component of expectancy contains two elements: Control beliefs (4 items), and self-efficacy for learning and performance (8 items). Control beliefs refer to the students' believe that their effort would lead to positive result (ex. If I study in a appropriate way, then I will be able to learn the material in this course). Self-efficacy for learning and performance refer to the judgment about one's ability to complete the task and the confidence in one's skills to accomplish the mission (ex. I believe I will receive an excellent grade in this course.). The component of Affective contains one element: Test anxiety (5 items). Test anxiety refers to the negative emotion related to taking exam (ex. I have an uneasy, upset feeling when I take an exam.). The Cronbach α of the six components in motivation scale ranged from .62 ~ .93, and it showed that the scale have good reliability. Confirmatory factor analysis was used to establish the construct validity of the motivation scale. The Lambda-ksi estimates of the 31 items in motivation scale ranged from .38 ~ .89. Due to the wide range of courses and domains, the result is acceptable, even though the Lambda-ksi estimates of 4 items were lower than .50.

Learning strategies scale consists of 50 items that assess students' learning strategies. Learning strategies include two components: Cognitive and meta-cognitive strategies, and resource management. The component of cognitive and meta-cognitive strategies contains five elements: Rehearsal (4 items), elaboration (6 items), organization (4 items), critical thinking (5 items), and meta-cognitive self-regulation (12 items). Rehearsal strategies involve reciting or naming the learning materials (ex. When I study for this class, I practice saying the material to myself over and over.). Elaboration strategies include summarizing, generative note-taking, or paraphrasing (ex. When reading for this class, I try to relate the material to what I already know.). Organization strategies include clustering, or outlining (ex. I make simple charts, diagrams, or tables to help me to organize course material.) Critical thinking refers to the strategies to make purposeful or reflective judgment or decisions by analyzing the information observed (ex. I try to play around with idea of my own related to what I am learning in this course.). Meta-cognitive self-regulation strategies contain planning, monitoring and regulating (ex. If course materials are difficult to understand, I change the way I read the material.)

The component of resource management includes four elements: Time and study environment (8 items), effort regulation (4 items), Peer learning (3 items), and help seeking (4 items). Time and study environment strategies include scheduling, planning and managing one's time (ex. I attend the class regularly.). Effort regulation reflects the commitment to completing one's goal (ex. Even when course materials are dull and uninteresting, I manage to keep working until I finish.). Peer learning refers to the strategies to cooperate with others to complete the task (ex. I try to work with other students from this class to complete the course assignment.). Help seeking refer to the strategies to manage and use the support from others (ex. I ask the instructors to clarify the concepts I don't understand well.). The Cronbach α of the nine components in motivation scale ranged from .52 ~ .80, and it showed that the scale have good reliability. Confirmatory factor analysis was used to establish the construct validity of the learning strategies scale. The Lambda-ksi estimates of the 50 items in learning strategies scale ranged from .17 ~ .90. Due to the wide range of courses and domains, the result is acceptable, even though the Lambda-ksi estimates of 9 items were lower than .50.

METHOD

The scale was developed based on the theoretical framework of social cognitive model of motivation (Pintrich & De Groot, 1990). In the social cognitive model of motivation, the researchers asserted that the intensity of an individual's motivation will trigger the learner to execute specific learning strategies. The motivation divided into three sub-scales: Value, expectancy, and affect. The learning strategies were classified into cognitive strategies, meta-cognitive strategies, non-informational resources management, and informational resources management. In this study, the MSLQ were adapted into the Mathematics Motivated Strategies for Learning

Questionnaire (in short, MMSLQ). Yet, because of the wildly spread of the use of informational technology (Chang & Lee, 2010; Işman & Celikli, 2009; Işman & Işbulan, 2010), the resource management strategies were divided into information related and non-information related sub-scales. Non-information related resource management strategies included two elements: Time and study environment and help-seeking. Information-related resource management strategies included two elements: Exploratory behaviour on internet and communication behaviour on internet.

Population

Participants of this study were 1,282 senior high and vocational school students in Miao-Li County of Taiwan. According the record of the Ministry of Education there were a total of 16 senior highs and vocational schools in Miao-Li County and 17,411 students not including the students in night schools which provided courses for on-job students in the night.

Sample

In this study, the authors first divided Miao-Li County into three strata based on the geographical location. Second, the stratified sampling method is used. The sample of 7.4% from the population of each stratum is then selected separately. Finally, a total 1,502 students were randomly selected and issued the questionnaire from 16 schools. However, after subtracting 220 invalid questionnaires from 1,502 questionnaires there were 1282 questionnaires retrieved. Among the participants, 582 were male, and 700 were female. It showed that in this study, the percentages of different genders were very close. The students ranged from grade 10 to grade 12, and the age of students ranged from 17 to 19 years old. Among the participants, 570 were grade 10 students, 384 were grade 11 students, 323 were grade 12 students, and there were 5 missing data. It showed that in this study, the percentage of grade 12 students was lowest. About the frequency of going to cram school, 996 students did not go to cram school, 162 students went to cram school one time a week, 90 students went to cram school two times a week, 15 students went to cram school three times a week, 10 students went to cram school more than three times a week, and there were 9 missing data. Among the participants, 727 were senior high school students, 554 were vocational school students, and there was 1 missing data. It showed that in this study, the percentages of senior high school students and vocational school students were very close.

Statistical Analysis

To study the senior high and vocational school student's motivation and learning strategies toward mathematics learning in Miao-Li County factor analysis was applied to analyze the construct validity of MMSLQ. Because there is no theoretical criterion for referencing, in this study, the average of 3 was set to be the criteria. Therefore, when interpreting the data, the practical mean and effect size were adopted to determine the rank between the factors. The t test was applied to analyze the differences between different student groups.

Measurement Instrument

Mathmatics Moitvation Scale: Selection of the Items. The items for the mathmatics moitvation scale were developed by both creating new items and adapting items from MSLQ. The items adapting from MSLQ were translated into Chinese by the authors with the supervision of two experts in English language. And then, the items, factors, design, and rating points of this scale were examined by three testing experts. According to these suggestions, the needed correction was made by the authors. Originally, there were three factors (value, expectancy, and affect) in mathematics motivation scale, and 36 items were included in this scale. The component of value could be divided into three elements: Intrinsic goal orientation (6 items), extrinsic goal orientation (6 items), and task value (6 items). The component of expectancy could be divided into two elements: Control beliefs for learning (6items) and self-efficacy (5 items). The component of affect only included one element: Test anxiety (7 items) (Table 1).

Table 1: Mathmatics Moitvation Scale

	Sub-scale	Factor	Item
Mathmatics motivation	Value	Intrinsic goal orientation	1, 7, 13, 18, 24, 30
		Extrinsic goal orientation	2, 8, 14, 19, 25, 31
		Task value	3, 9, 15, 20, 26, 32
	Expectancy	Control beliefs for learning	4, 10, 16, 21, 27, 33
		Self-efficacy	5, 11, 22, 28, 34
	Affect	Test anxiety	6, 12, 17, 23, 29, 35, 36

All the items in this scale adopt five-point Likert scale: strongly disagree (1), disagree (2), normal (3), agree (4), and strongly agree (5). Besides, the scores of all the negatively stated items in both sessions would be reversed before being calculated. The Mathematics Motivated Strategies for Learning Questionnaire with two sessions was then given to the sample of 310 students from senior high and vocational school for initial item analysis. After receiving 293 completed scales from the participants, the reliability and validity of the questionnaire would be examined. The 36 items listed in the pilot questionnaire were listed below.

Value: Intrinsic Goal Orientation
M01. In math class, I would like to have some challenging materials and they will make me learn more.
M07. I would like to have curiosity-initials materials in math class even they are quite difficult.
M13. My biggest wish is to understand the content of the learning material used in the math class.
M18. In math class, I would like to have more projects and homework which will help me learn more, even though these will not improve my scores.
M24. Learning math can improve my thinking logics.
M30. To get better score in math, I will learn harder.

Value: Extrinsic Goal Orientation
M02. My most wanting is to get best grades in math class.
M08. To me, take math class can improve my overall academy score.
M14. I hope I can get higher grade in math than any other classmates.
M19. I want to get higher scores in math class, because I want to demonstrate my capability to my classmates.
M25. My best wish is to attend ideal university via learning math.
M31. I want to get other people's recognition so I want higher scores in math class.

Value: Task Value
M03. The skills I learn from the math class can be applied in other classes
M09. I am interested in the learning material in math class.
M15. I feel the leaning materials used in math class are useful.
M20. I like every topics and contents in math class.
M26. What I learn in the math class can be apply in my daily life.
M32. Mathematics contributes a lot to whole human beings.

Expectancy: Control Beliefs for Learning
M04. If I have correct learning pattern to learn math, I will learn better in the class.
M10. If I do not learn better in the math class, I believe it is my fault.
M16. If I study hard enough, I can understand the content of the learning materials used in math class.
M21. If I could not understand every topics in math class, that is because I did not work hard enough.
M27. If I pay full attention in math class, I can get better grades.
M33. If I have enough time to do practice in math, I will have better performance.

Expectancy: Self-efficacy
M05. I believe that I will have excellent math grades in math class.
M11. I believe that I can understand the most difficult part in the math materials by my own.
M22. I believe that I can master every topic in math class.
M28. As for math, I am competent to teach other my classmates.
M34. Math is not difficult to me.

Affect: Test Anxiety
M06. In taking math exam, I will have negative thought that I am inferior than other classmates
M12. In taking math exam, I will keep thinking of the questions that I can not answer in previous part.
M17. In taking math exam, I would think about the consequence of failing in the exam.
M23. In taking exam, I feel nervous and worry.
M29. In taking math exam, my hear beat faster.
M35. In taking math exam, I am totally blank and can not remember what I have learned before.
M36. Before taking math exam, I am too wary to take a good sleep.

Mathematics Moitvation Scale: Reliability. A Cronbach α analysis was calculated for each components of mathematics moitvation scale. The Cronbach α analysis could examine if the items were internally consistent, stable, and homogenous. In order to raise the reliability and lower the error, some unsuitable items would be deleted.

Reliability Analysis: Value. After the reliability analysis, item 8, item 18, item 30, and item 32 were deleted, and the value of Cronbach α raised to .884.

Reliability Analysis: Expectancy. After the reliability analysis, item 10, and item 21 were deleted, and the value of Cronbach α raised to .872.

Reliability Analysis: Affect. After the reliability analysis, item 12, was deleted, and the value of Cronbach α raised to .759.

Mathematics Moitvation Scale: Validity. A principle components factor analysis was performed on the 29 items in mathematics motivation scale with varimax rotation. After factor analysis, the item which loaded smaller than .399 on the relevant factor would be overlooked. Some of the items were suggested to move to the other factors by the analysis, and some factors were renamed. Before the factor analysis, in order to explain the correlation between items and suitability of sampling, the Bartlett's Test of Sphericity and the value of KMO (Kaiser-Mayer-Olkin of sampling) were calculated to make sure if the data were suitable for factor analysis.

Validity Analysis: Value. In this sub-scale, the Bartlett's Test of Sphericity reached significant level (1604.891, $p<.001$), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .888 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this sub-scale, no item was deleted, and two factors were extracted. The total variance explained of the first factor reached 39.896 %, and the total variance explained with the second factor reached 53.217 %. After examed the content of the items, the two fators were named: Intrinsic goal orientation and task value, and extrinsic goal orientation.

Validity Analysis: Expectancy. In this sub-scale, the Bartlett's Test of Sphericity reached significant level (1016.43, $p<.001$), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .883 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this sub-scale, no item was deleted, and two factors were extracted. The total variance explained of the first factor reached 48.914 %, and the total variance explained with the second factor reached 62.131 %. After examined the content of the items, the two factors were named: Self-efficacy, and control beliefs for learning.

Validity Analysis: Affect. In this sub-scale, the Bartlett's Test of Sphericity reached significant level (425.191, $p<.001$), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .733 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this dimension, no item was deleted, and two factors were extracted. The total variance explained of the first factor reached 45.536 %, and the total variance explained with the second factor reached 63.924 %. After examined the content of the items, the two factors were named: Phenomenon of anxiety, and causes of anxiety. After the reliability analysis and validity analysis, there are 29 items in the mathematics motivation scale.

Mathmatics Learning Strategies Scale: Selection of the Items. The items for the mathmatics learning strategies scale were developed by both creating new items and adapting items from MSLQ. The items adapted from MSLQ were translated into Chinese, and two experts in English language provide support on revision. Originally, there were four factors (cognitive strategies, meta-cognitive strategies, non-informational resources management, and informational resources management) in mathematics learning strategies scale, and 68 items were included in the scales. There are four factors in the mathematics learning strategies scale: Cognitive strategies (18 items), meta-cognitive strategies (12 items), non-informational resources management (25 items), and informational resources management (13 items). The component of cognitive strategies could be divided into three elements: Rehearsal (6 items), organization (6 items) and elaboration (6 items). The component of meta-cognitive strategies included two elements: Critical thinking (6 items) and self-regulation (6 items). The component of non-informational resources management could be divided into four elements: Effort regulation (5 items), time and study environment (8 items), peer-learning (6 items), and help-seeking (6 items). The component of informational resources management could be divided into two elements: Exploratory behaviour on internet (6 items) and communication behaviour on internet (7 items) (Table 2).

Table 2: Mathematics Learning Strategies Scale

Sub-Scale	Factor	Item
Cognitive strategies	Rehearsal	3, 11, 22, 33, 44, 55
	Elaboration	4, 12, 23, 34, 45, 56
	Organizaton	5, 13, 24, 35, 46, 57
Meta-cognitive strategies	Critical thinking	6, 14, 25, 36, 47, 58
	Self-regulation	15, 26, 37, 48, 59, 65
Non-informational resources management	Effort regulation	17, 28, 39, 50, 61
	Time and study environment	16, 27, 38, 49, 60, 66, 67, 68
	Peer-learning	7, 18, 29, 40, 51, 62
	Help-seeking	8, 19, 30, 41, 52, 63
Informational resources management	Exploratory behavior on internet	1, 9, 20, 31, 42, 53
	Communication behavior on internet	2, 10, 21, 32, 43, 54, 64

All the items in this scale adapted five-point Likert scale: strongly disagree (1), disagree (2), normal (3), agree (4), and strongly agree (5). Besides, the scores of all the negatively stated items in both sessions would be reversed before being calculated. The mathematics learning strategies scale was then given to the sample of 310 students from senior high and vocational school for initial item analysis. After receiving 293 completed scales from the participants, the reliability and validity of the scale would be examined. The 68 items listed in the pilot scale were listed below:

Cognitive Strategies: Rehearsal
S03. In studying math class materials, I will analyze again and again.
S11. In studying math, I will study the class notes and textbook again and again.
S22. I memorize the important and key math formula to remind me the important part of my math class
S33. I memorize the important and key math formula to remind me the important part of my math class
S44. In studying math, I will repeatedly practice similar question types.
S55. In studying math, I will repeatedly practice similar question types.

Cognitive Strategies: Elaboration
S04. I will do my best to link relative portions of math and other subjects.
S12. In reviewing my math materials, I will reorganize the subtraction from class notes and textbook.
S23. I will link the class notes to textbook examples to improve my understanding.
S34. In studying math, I will combine my own known knowledge with the learning materials.
S45. In studying math, I will find out any sample in daily life to link with math materials.
S56. I will ask questions to myself to make sure that I understand the math materials content.

Cognitive Strategies: Organizaton
S05. In studying math class materials, I will mark-up the important lines for concepts organization.
S13. In reviewing my math materials, I will read through the class notes and textbook and find out the most important parts.
S24. I will make simple charts and tables to help me in organizing my math class materials.
S35. In studying math, I will read through the class notes and mark up the important parts.
S46. In studying math, I will go over the formula and important concepts by myself.
S57. I will categorize the easy-hard type questions of every exam.

Metacognitive Strategies: Critical Thinking
S06. I usually question what I heard or what I earn in math class, and judge if these information is persuasive.
S14. I will make the math class materials as a start point and try to self-develop my own viewpoint to the topics.
S25. I will combine my own idea into the math class learning.
S36. In math class, I will try to find out other efficient way to solve problem when I hear some idea or some solution.
S47. I will use real example to verify the math theory conclusion.
S58. In studying math, I will compare the difference between the teacher’s explanation and textbook content.

Metacognitive Strategies: Self-regulation
S15. If I feel confused about the math class materials, I will go over to find out where the problem is.
S26. In studying math, I will set up my own target and follow the agenda I make.
S37. I will reorganize and clarify the confused points after class.
S48. I will check my answer again after I finish the question.

S59. In solving math questions, I will list related formula first.
S65. When I make wrong math answers, I will clarify whether this conceptual mistake or miscalculation.

Non-informational Resources Management: Effort Management
S17. Even I do not like math, I still will study hard.
S28. If the materials and content are difficult, I will choice to give up.
S39. If the class material is difficult, I will pick up the easy part to study.
S50. Even the math class is boring; I will still finish the homework.
S61. Even I do not have good math score, I still pay good attention in class.

Non-informational Resources Management: Time and Study Environment
S16. I can make good use of the time to study math.
S27. I have a regular study place.
S38. I will follow the every week schedule to study math materials.
S49. I make it a hobby to study math at the fixed time.
S60. I will use segmented and fragile time to study math.
S66. I can strictly control my math studying time.
S67. In math studying, I can always go to class on time.
S68. Before I study, I have a hobby to clean up the desk for study concentration.

Non-informational Resources Management: Peer-learning
S07. In studying math materials, I will explain the content to my friends or classmates.
S18. I do my math homework or assignment with my classmates.
S29. I will actively invite my classmate to review the materials together.
S40. In studying math, I will discuss with the classmates who have better score than me.
S51. I will have a math study schedule to study and review with my classmates.
S62. I will compete with my classmates and even compete with math scores.

Non-informational Resources Management: Help-seeking
S08. In studying math, even the most difficult part, I intend to solve the problem by myself and will not ask for help from other people.
S19. I will ask the teacher for help to clarify the confused parts in my math class.
S30. If I do not understand the studying materials, I will ask my classmates for help.
S41. I tried to find out the classmates who can help me in math class.
S52. If I do not understand the math study materials, I will go and find solution on the math related websites.
S63. I will ask teacher the confused part immediately in the class.

Informational Resources Management: Exploratory Behavior on Internet
S01. I like to surf and find latest math related websites.
S09. I will visit the new math related websites if I know there is one.
S20. I open key-in the math related keyword and surf the found websites.
S31. I like to find the latest math related information on the websites.
S42. I will do some on-line math test.
S53. I will download the math questions to practice from the websites.

Informational Resources Management: Communication Behavior on Internet
S02. I will share my math learning experience with my friends and classmates via email.
S10. I will ask math questions for help to my friends or classmates via email.
S21. I will email to my teacher for math questions.
S32. I will use BBS to share my math learning experience with my friends and classmates.
S43. I will use MSN to discuss math class experience with classmates and friends.
S54. I will ask math questions on Yahoo knowledge webpage.
S64. I will leave message for asking math questions on some teaching websites.

Mathematics Learning Strategies Scale: Reliability. A Cronbach α analysis was calculated for each components of this scale. The Cronbach α analysis could examine if the items were internally consistent, stable, and homogenous. In order to raise the reliability and lower the error, some unsuitable items would be deleted.

Reliability Analysis: Cognitive strategies. After the reliability analysis, item 57 was deleted, and the value of Cronbach α raised to .921.

Reliability Analysis: Metacognitive strategies. After the reliability analysis, no item was deleted, and the value of Cronbach α was .890.

Reliability Analysis: Non-informational Resources Management. After the reliability analysis, item 39 and item 68 were deleted, and the value of Cronbach α raised to .874.

Reliability Analysis: Informational Resources Management. After the reliability analysis, no item was deleted, and the value of Cronbach α was .932.

Mathematics Learning Strategies Scale: Validity. A principle components factor analysis was performed on the 65 items in mathematics learning strategies scale with varimax rotation. After factor analysis, the item which loaded smaller than .399 on the relevant factor would be overlooked. Some of the items were suggested to move to the other factors by the analysis, and some factors were renamed. Before the factor analysis, in order to explain the correlation between items and suitability of sampling, the Bartlett's Test of Sphericity and the value of KMO (Kaiser-Mayer-Olkin of sampling) were calculated to make sure if the data were suitable for factor analysis.

Validity: Cognitive Strategies. In this sub-scale, the Bartlett's Test of Sphericity reached significant level (941.167, p<.001), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .846 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this dimension, item 3, 4, 5, 22, 23, 33, 34, 35, and 56 were deleted, and two factors were extracted. The total variance explained of the first factor reached 49.183 %, and the total variance explained with the second factor reached 63.553 %. After examining the content of the items, the two factors were named: Rehearsal and organization, and practice and Deduce.

Validity: Metacognitive Strategies. In this dimension, the Bartlett's Test of Sphericity reached significant level (602.816, p<.001), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .842 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this sub-scale, item 15, 37, 47, 48, 65 were deleted, and two factors were extracted. The total variance explained of the first factor reached 48.258 %, and the total variance explained with the second factor reached 62.824 %. After examining the content of the items, the two factors were named: Critical thinking, and self-regulation.

Validity: Non-informational Resources Management. In this sub-scale, the Bartlett's Test of Sphericity reached significant level (1115.052, p<.001), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .841 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this sub-scale, item 7, 17, 19, 27, 28, 50, 51, 52, 61, 62, 63, and 67 were deleted, and two factors were extracted. The total variance explained of the first factor reached 36.279 %, and the total variance explained with the second factor reached 55.920 %. After examining the content of the items, the two factors were named: Time and study environment, and help-seeking.

Validity: Informational Resources Management. In this factor, the Bartlett's Test of Sphericity reached significant level (2096.933, p<.001), and it meant that some degree of correlation between items was shown. Besides, the value of KMO was .910 that meant the data was suitable for factor analysis. A principle components factor analysis was performed on the items with varimax rotation. After factor analysis, the item which factor loading was smaller than .399 on the relevant factor would be overlooked. In this factor, item 10, and 42 were deleted, and two factors were extracted. The total variance explained of the first factor reached 57.532 %, and the total variance explained with the second factor reached 68.811 %. After examining the content of the items, the two factors were named: Exploratory behaviour on internet, and communication behaviour on internet. After the reliability analysis and validity analysis, there are 37 items in the mathematics learning strategies scale.

Administration and Scoring

The final scale was developed with two sub-scales. There were total 66 items in form of five-point Likert scale: Strongly disagree (1), disagree (2), normal (3), agree (4), and strongly agree (5) listed in this questionnaire. This formal questionnaire can be administered and completed in 20 minutes. When the questionnaire was issue to the participants, a succinct introduction was provided to tell the participants that this scale was designed and administered only for survey their learning motivation and strategies not for testing. Besides, the personal data would not be leaked to anyone not in the research team, and those data were used only for research purpose. By doing so, the researcher would more possible to get the real status of participants' motivation and learning strategies of mathematics in use.

By allocating a numerical value to each response: Strongly disagree (1), disagree (2), normal (3), agree (4), and strongly agree (5), the scores can be obtained. The researchers can sum up and average the scores in its belonging factor. When the average score in that factor was greater than 3, the median, it means that the motivation and learning strategies of mathematics in use which the participants posses in this factor were positive or more used. However, when the obtained score was smaller than 3, it means that their motivation and learning strategies were more negative or less used.

RESULTS

The Status of Students' Mathematics Motivation

The five of six dimensions have medium effect size whereas their effect size greater than .3 and lower than .8 in absolute value. Those five dimensions in the questionnaire are the control belief for learning (M=3.40, SD=.85, ES=+0.47), cause of anxiety (M=2.63, SD=.91, ES=-0.41), intrinsic motivation and task value (M=2.65, SD=0.79, ES=-0.44), phenomenon of anxiety (M=2.57, SD=0.91, ES=-0.47), and self-efficacy (M=2.45, SD=.92, ES=-0.41). The dimension which effect size lower than .3 is extrinsic goal orientation (M=2.93, SD=.86, ES=-0.08). Accordingly, the senior high and vocational school students have most motivation in control beliefs for learning factor and least motivation in the factor of self-efficacy.

The Status of Students' Mathematics Learning Strategies

Seven dimensions including self-regulation (M=2.66, SD=.84, ES=-0.40), rehearsal and organization (M=2.61, SD=.81, ES=-0.48), critical thinking (M=2.58, SD=.85, ES=-0.49), practice and deduce (M=2.53, SD=.80, ES=-0.59), time and study environment (M=2.14, SD=.74, ES=-1.16), exploratory behavior on the internet (M=1.63, SD=.67, ES=-2.04), and communication behavior on the internet (M=1.51, SD=.61, ES=-2.44) have medium to high effect size greater than .3 and even greater than .8 in absolute value. The dimension which effect size lower than .3 is help-seeking (M=2.99, SD=.69, ES=-0.01). Among all, the highest average comes from the factor of help-seeking while the lowest one comes from the factor of communication behavior on the internet.

Difference in Mathematics Motivation and Mathematics Learning Strategies between Students Who Went to and Who Didn't Go to Cram School

Mathematics Motivation. In order to compare the learning motivation between students who went to cram school and students who didn't went to cram school, the t test was used in this study. The result showed that the mean of the motivation of students who didn't go to cram school is 2.726 (SD=.548) and the mean of the motivation of students who went to cram school is 2.974 (SD=.464). The motivation between the students who didn't go to cram school and the students who went to cram school reached significant difference (t = -7.208, p<.001). It showed that students who went to cram school had higher motivation on learning mathematics than students who didn't go to cram school. The possible reason is that the cram school provided more support to the students, and these supports can help students to solve the problems students faced in math class.

In order to realize the difference more clearly, the t test was used to exam the difference in the six factors. In the factors of intrinsic goal orientation and task value (t = -5.066, p<.001), extrinsic goal orientation (t = -7.120, p<.001), control beliefs for learning (t = -5.543, p<.001), self-regulation (t = -6.477, p<.001), and phenomenon of anxiety (t = -3.359, p<.001), the motivation between the students who didn't go to cram school and the students who went to cram school reached significant difference. After comparing the means between the two group students in the six factors, the result showed that students who went to cram school had higher intrinsic motivation, extrinsic motivation, control beliefs, self-regulation, and anxiety on learning mathematics than students who didn't go to cram school. However, in the factor of cause of anxiety, the motivation between the students who didn't go to cram school and the students who went to cram school didn't reach significant difference (t = .980, p>.05). It showed that the cause of anxiety between students who went to cram school and students who didn't go to cram school was no significant difference in this study.

Mathematics Learning Strategies. In order to compare the learning strategies between students who went to cram school and students who didn't went to cram school, the t test was used in this study. The result showed that the mean of the learning strategies of students who didn't go to cram school is 2.279 (SD=.597) and the mean of the leaning strategies of students who went to cram school is 2.531 (SD=.503). The learning strategies between students who didn't go to cram school and the learning strategies of students who went to cram school reached significant difference ($t = -6.746$, $p<.001$). It showed that students who went to cram school used more learning strategies for learning mathematics than students who didn't go to cram school.

In order to realize the difference more clearly, the t test was used to examine the difference in the eight factors. In the factors of rehearsal and organization ($t = -6.324$, $p<.001$), practice and deduce ($t = -5.602$, $p<.001$), critical thinking ($t = -6.536$, $p<.001$), self-regulation ($t = -6.872$, $p<.001$), time and study environment ($t = -6.612$, $p<.001$), help-seeking ($t = -4.206$, $p<.001$), and exploratory behavior on internet ($t = -3.173$, $p<.001$), the learning strategies between the students who didn't go to cram school and the students who went to cram school reached significant difference. After comparing the means between the two group students in the seven factors, the result showed that students who went to cram school used the learning strategies, rehearsal and organization, practice and deduce, critical thinking, self-regulation, help-seeking, exploratory behavior on internet better than students who didn't go to cram school. Besides, students who went to cram school managed their time and study environment better than students who didn't go to cram school. However, in the factor of communication behavior on internet, the learning strategies between the students who didn't go to cram school and the students who went to cram school didn't reach significant difference ($t = -1.732$, $p>.05$). It showed that the communication behavior on internet between students who went to cram school and students who didn't go to cram school was almost the same.

Difference in Mathematics Motivation and Mathematics Learning Strategies between Students in Different Genders

Mathematics Motivation. In order to compare the learning motivation between different genders, the t test was used in this study. The result showed that the mean of the motivation of male is 2.866 (SD=.558) and the mean of the motivation of female is 2.707 (SD=.515). The motivation between male and female reached significant difference ($t = 5.041$, $p<.001$). It showed that male students had higher motivation on learning mathematics than female students.

In order to realize the difference more clearly, the t test was used to exam the difference in the six factors. In the factors of intrinsic goal orientation and task value ($t = 8.883$, $p<.001$), extrinsic goal orientation ($t = 5.217$, $p<.001$), control beliefs for learning ($t = 3.440$, $p<.01$), self-regulation ($t = 8.397$, $p<.001$), cause of anxiety ($t = -2.467$, $p<.05$), and phenomenon of anxiety ($t = -4.143$, $p<.05$), the motivation between male students and female students reached significant difference. After comparing the means between the two group students in the six factors, the result showed that male students had higher intrinsic motivation, extrinsic motivation, control beliefs, self-regulation on learning mathematics than female students. Moreover, female students had more cause of anxiety and phenomenon of anxiety on learning mathematics than male students.

Mathematics Learning Strategies. In order to compare the learning strategies between different genders, the t test was used in this study. The result showed that the mean of the learning strategies of male is 2.405 (SD=.626) and the mean of the learning strategies of female is 2.268 (SD=.545). The learning strategies between male and female reached significant difference ($t = 3.990$, $p<.001$). It showed that male students had better learning strategies for learning mathematics than female students.

In order to realize the difference more clearly, the t test was used to examine the difference in the eight factors. In the factors of rehearsal and organization ($t = 1.153$, $p>.05$), practice and deduce ($t = 4.422$, $p<.001$), critical thinking ($t = 8.844$, $p<.001$), self-regulation ($t = 2.471$, $p<.05$), time and study environment ($t = 3.756$, $p<.001$), help-seeking ($t = -3.755$, $p<.001$), exploratory behavior on internet ($t = 4.771$, $p<.001$), and communication behavior on internet($t = 3.550$, $p<.001$), the learning strategies between male students and female students reached significant difference. After comparing the means between the two group students in the eight factors, the result showed that male students used the learning strategies, rehearsal and organization, practice and deduce, critical thinking, self-regulation, exploratory behavior on internet, and communication behavior on internet better than female students. However, in the factor of help-seeking, female students used the learning strategies, help-seeking, better than male students.

DISCUSSION

The scales to measure students' mathematics motivation and learning strategies studying in senior high and vocational schools were developed under the theoretical framework and the MSLQ (Pintrich et al., 1991). Besides, the scales were with high internal consistency, reliability and validity. It is hoped that the educators and researchers will use this scale in their class. The scale could be used before the teaching in order to understand the current status of the students' mathematics motivation and the learning strategies they used, or used after instruction to acknowledge whether they uptrend their motivation and improve their learning strategies.

Taiwan's students usually have good performance in international mathematics competitions; however, their good performance did not enhance their confidence or interest in learning mathematics as a matter of course. Therefore, this study focused on senior high and vocational school students' real condition of learning mathematics from the aspect of motivation and learning strategies and find out that senior high and vocational school student slanted to have almost negative perceptions toward both their motivation and learning strategies. The participants gave the lowest score to self-efficacy which could be translated into low confidence. Besides, the analysis result of motivation scale shows that the senior high and vocational school students consider mathematics as a difficult subject for them. Although the students viewed mathematics as a difficult subject, they also believe only if they study harder, pay more attention in class, spend more time on practicing, and use appropriate learning approaches, they will have good performance in mathematics. Moreover, they think they are the only ones who have to be responsible to the learning results.

The most and the least frequent use learning strategies among eight categories are help- seeking and communication behaviour on the internet respectively. The order from the most to the least are seeking help, self-regulation, rehearsal and organization, critical thinking, practice and deducing, time and study environment, exploratory behaviour on the internet, and finally communication behaviour on the internet.

An interest issue of ambivalence revealed that although the students believe they can learn mathematics well with spending more time on learning, the learning strategies of time and study environment was not frequently used when they study. Therefore, a suggestion is proposed that the teachers and parents should teach students how to arrange and use their time and study environment well. Furthermore, even though the students consider math as a difficult subject and possess less motivation, they did not give up learning mathematics because they still kept seeking others help to improve their performance. Therefore, it is suggested that the teachers should actively care about the students' study and provide their encouragement to the students. Finally, with the development of internet and informational technology, people can learn a lot of knowledge about mathematics on the internet (Crawford & Brown, 2003). However, from this study it shows the students rarely improve their learning with the aids of the internet. Hence, the suggestion that the teachers have to teach their students how to find resources from internet and get assistance are proposed to make the students learning a continual process.

In this study, effect of gender difference and the effect of the experience of going to cram school were discussed. The result showed that students who went to cram school had higher motivation and used leaning strategies better than students who didn't go to cram school. This showed that the cram school did provide some useful supports students needed. The instructors should consider how to provide this kind of support in school.

Besides, the differences of motivation and learning strategies between different genders were found. In general, male students showed higher motivation on learning mathematics, and male students also used learning strategies better than female students. The instructors should provide more support to help female students to solve the problems they faced, and improved their motivation for learning mathematics. Furthermore, the instructors should also teach the female students how to use the learning strategies to learn mathematics better.

For future study, it is suggested that the researcher could focus on the influence of the students' background on their mathematics learning. Especially, in Taiwan going to cram schools where provide courses for students after school are a popular way to make up for bad performance could be an interesting phenomenon to discuss concerning its impact on the learning of mathematics and even other subjects.

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