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Development of mathematical learning style test based on "MINDSET" theorem for senior high school students

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Abstract

The purpose of this research was to developing mathematical learning style test based on "MINDSET" theorem for senior high school students. The specific objective was shown the evidence of content validity by using the item objectives congruence (IOC), the evidence of construct validity by using the corrected item-total correlation (CITC) and using confirmatory factor analysis (CFA), and the evidence of the reliability by using Cronbach's alpha. The research samples were 254 Rachineeburana senior high school students in first semester of academic year 2016. The mathematical learning style test in this research comprised 20 items which aimed to assess the mathematical learning style in 2 areas: 1) growth mindset ability (GM) and 2) fixed mindset ability (FM).

The research results were as follows. 1) The IOC was 0.67 - 1.00. 2) The construct validity by using CITC was 0.24 - 0.56 for GM items and 0.36-0.66 for FM items. 3) Regarding the CFA with the mathematical learning style test in the aspect of GM found that, the model fit the empirical data, the Chi-square test was 17.05 ($p = 0.76$, $df = 22$), GFI = 0.99, AGFI = 0.97, RMSEA = 0.00, in the aspect of FM found that, the model fit the empirical data, the Chi-square test was 23.03 ($p = 0.15$, $df = 17$), GFI = 0.98, AGFI = 0.94, RMSEA = 0.04. 4) Regarding the reliability of the whole mathematical learning style test in general by using Cronbach's alpha was 0.76, when considering in the individual areas, it was found that the aspect of GM and FM were 0.72 and 0.83 respectively.

Keywords: mathematical learning style test, growth mindset, fixed mindset

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1. Introduction

Thai national education act year 1999 amendment (No. 2) 2002 and (No. 3) 2010 in the section 4 article 22 said that, the principle education must be based on that all students was able to learn and develop themselves and students was the most important. The education must encourage students to develop their potential and natural. The above showed that teachers who made learning well served in the learning process for students to achieve the objectives in curriculum. Consistent with his remarks about the education reforms of King Rama 9, Teachers loved children, and they loved teachers, not to compete with other students but to compete with themself, teachers organize activities for students to do together for the value of unity and the article 26 said that, the educational institutions assessed learners based on the development of the students, conducted, an observation study habits, activity and testing concurrently in the process of teaching follow by levels and forms of education. So, the development of provided students with generous and help to follow slow students. One way to develop student in this field was the development concept or mindset. Mindset was a development of motivation and students development of Carol S. Dweck [1] the students had motivated to learn and could set up the learning objective; they could develop their own learning. Dweck's research found that grade 7 students had growth mindset ability; having a learning achievement at grade 8 in second semesters more than students they had fixed mindset ability. Dweck told that students learned and understood the effort and the difficulty was to develop the capacity of their own. Consistent with the findings of John Hattie [2] about meta-analysis and visible learning; the students set a goal of learning and believed that they could develop their potential to be better than the original was a highly effective of education.

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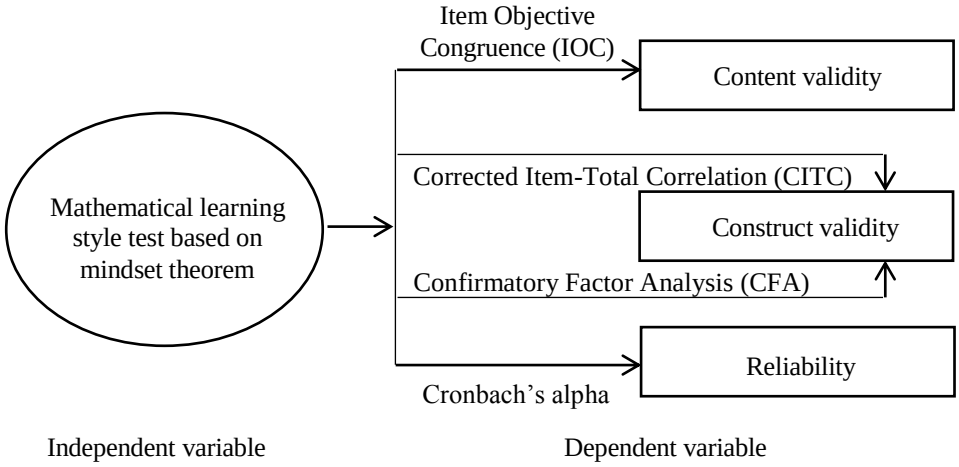

Figure 1 Research framework
(Source: Ranabut and Pinyoarnantapong) [4]

Mindset ability was concept of faith in students learning into 2 causes for behavioral learning comprising of 1) growth mindset; believes that human could develop, capacity building through learning, perceived problem and barriers as opportunities to learn and develop. If students had growth mindset ability they was eager to learn, like to learn from problems, enjoy the time with a difficult problem, and attempt to find a solution to the problem and 2) fixed mindset, believe that human intelligence can't be changed, not be able to improve their skills, focus on image or qualification. If students have fixed mindset ability they do not like learning because they think that can't change their own ingenuity, no effort, avoid the challenging tasks, when they encounter an obstacle that was a failure. But so difficult to determine mindset ability of students. Because of mindset ability was a difficult psychological factor to measure. The measurement of mindset requires quality and standardly tools can separate student mindset. For this reason, it should be developed to mathematical learning style test based on mindset theorem for senior high school students. To achieve quality measurement tools and standards consist of national education act and develop student mindset in the future.

This research objective was developing mathematical learning style test that based on "MINDSET" theorem for senior high school students. The specific objective was shown the evidence of content validity by using the Item Objectives Congruence (IOC), the evidence of construct validity by using the Corrected Item-Total Correlation (CITC) and using Confirmatory Factor Analysis (CFA), and the evidence of the reliability by using Cronbach's alpha.

2. Methods

2.1 Populations and samples

The research populations were 1,475 senior high school students in the first semester of academic year 2016 of Rachineeburana School and comprising of 480, 516, and 479 students in grades 10, 11 and 12 respectively. The research samples were 254 senior high school students comprising of 82, 88, and 84 students in grades 10, 11 and 12 respectively, choosing by the quota sampling [3].

2.2 Research definitions

1) Mathematical learning style test based on mindset theorem was a psychological tool on learning mathematics for separate students' mindset in 2 areas such that; 1) growth mindset and 2) fixed mindset.

2) Growth mindset was special ability of students about learning mathematics; they believes that human can develop, capacity building through learning, perceived problem and barriers as opportunities to learn and develop.

3) Fixed mindset was special ability of students about learning mathematics; believe that human intelligence can't be changed, not be able to improve their skills, focus on image or qualification.

2.3 Research framework

See Figure 1.

Table 1 Set of question in mathematical learning style test based on mindset theorem

Item	Code	Question
1	G1	You think; you can learn all the time and always start.
2	F1	One month ago, for learning mathematics you focus on answers or results rather than processes or mathematical thinking.
3	G2	Before doing any work, you set goals and envision outcomes or quality of work that will come out.
4	G3	You think that mathematics problem is challenging.
5	F2	When you do a difficulty math problem, you often wait for an answer from your friend or teacher.
6	G4	You believe that you have the ability and potential to learn mathematics and understand it.
7	F3	You're angry when someone blames your actions or your works.
8	F4	If you not satisfy with score of math test, you think that's because of the difficult exam.
9	G5	You believe that if you tried, you can learn mathematics.
10	F5	You believe that you try it but you can't learn mathematics.
11	G6	If you did not satisfy of score math test, you asked yourselves. "I do not /did not understand anything".
12	G7	You think that the hardworking was a cause of different abilities.
13	G8	When you do a difficulty math problem, you will be dedicated and efforts.
14	F6	You think that you can learn in the classroom only. If you do not understand, you won't understand in anyway.
15	F7	You think the talent is a cause of different abilities.
16	G9	One month ago, for learning mathematics you focus on processes or mathematical thinking rather than answers or results.
17	F8	You think that the difficult mathematics problem was appropriate with smart students.
18	F9	You believe that you don't have the ability and potential to learn mathematics.
19	G10	You accept and take the advice of others to improve your work.
20	F10	Before doing any work, you won't regard in the outcome or quality to come out.

2.4 The development of mathematical learning style test

Mathematical learning style test was questionnaire with four scaling. Establish and develop in 2 steps thus;

The first step: construct and develop mathematical learning style test.

1) Study the theoretical of mindset from document, research article, and academic article to determinate terminology for mathematical learning style test. In this research applied a set of questionnaire from Emily Diehi [5].

2) Constructing mathematical learning style test and designed 4 scaling, level 4 means of strongly agree, level 3 means of agree, level 2 means of disagree, and level 1 means of strongly disagree. Total by 20 items comprising of a set of positive or growth mindset question (10 items) include item 1, 3, 4, 6, 9, 11, 12, 13, 16 and 19 and a set of negative or fixed mindset question (10 items) include item 2, 5, 7, 8, 10, 14, 15, 17, 18, and 20 by randomly. For any question of mathematical learning style test showed at Table 1. Defined a criteria based on 60 total score, described below.

45 - 60 points meaning of strongly growth mindset

34 - 44 points meaning of growth mindset with some fixed ideas

21 - 33 points meaning of fixed mindset with some growth ideas

0 - 20 points meaning of strongly fixed mindset

For a set of positive question if answer were 4, 3, 2, 1 then given 3, 2, 1, 0 score respectively and a set of negative question. On the other hand, if answer were 4, 3, 2, 1 then given 0, 1, 2, 3 score respectively.

The second step: a quality inspection of mathematical learning style test.

1) Quality inspection on validity aspect of content validity evidence by Item Objective Congruence (IOC). Considering for each items by 3 experts and compute score by the Rowinelli and Hambleton' formula [6].

2) Using a mathematical learning style test with 254 senior high school students, who were a research samples.

Table 2 Result of analyzes CITC of mathematical learning style test

Item	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Alpha if item deleted	Item	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Alpha if item deleted
Growth mindset model					**Fixed mindset model**				
G1	29.11	9.26	0.24	0.71	F1	20.54	21.30	0.36	0.83
G2	29.73	8.71	0.27	0.71	F2	20.61	18.88	0.61	0.80
G3	29.84	7.84	0.30	0.72	F3	21.04	20.58	0.34	0.83
G4	29.89	8.47	0.44	0.69	F4	20.48	20.12	0.46	0.82
G5	29.35	8.17	0.54	0.67	F5	21.48	18.76	0.60	0.80
G6	29.71	8.34	0.35	0.70	F6	21.68	18.84	0.66	0.80
G7	29.45	8.11	0.43	0.69	F7	20.58	21.16	0.27	0.84
G8	29.97	8.28	0.41	0.69	F8	20.96	18.18	0.67	0.80
G9	29.76	7.68	0.56	0.66	F9	21.19	18.28	0.60	0.80
G10	29.61	8.32	0.32	0.71	F10	20.63	19.13	0.59	0.80

3) Analyzes data from mathematical learning style test (collected) to show the evidence of construct validity by using the Corrected Item-Total Correlation (CITC) and using the first order of confirmatory factor analysis (CFA).

4) Findings a quality of mathematical learning style test aspect of reliability on internal consistent principle by using the formula of Cronbach's alpha [7].

2.5 Data analysis

1) Analyzes the content validity by using Item Objective Congruence (IOC), considered by 3 experts. The criterion was IOC of any items since 0.50 to except that mathematical learning style test has a content validity [8].

2) Analyzes the construct validity by using the Corrected Item-Total Correlation (CITC) to show the value of discrimination index of item by using the correlation between item score and total score of mathematical learning style test. The criterion was for each item had discrimination index since .20 to except that mathematical learning style test has construct validity [8].

3) Analyzes the construct validity by using confirmatory factor analysis (CFA). The criterion was Chi-square test no significant ($p > 0.05$). Goodness of fit index (GFI) and adjust goodness of fit index (AGFI) more than 0.90 and Root Mean Square Error of Approximation (RMSEA) lees than 0.05 [9] to except that mathematical learning style test has construct validity.

4) Analyzes the reliability using by Cronbach's alpha. The criterion was Cronbach's alpha more than 0.70 to except that mathematical learning style test has a good reliability [10].

3. Results

The section 1 the aspect of content validity, the analysis the content validity by using Item Objective Congruence (IOC), considered by 3 experts found that the IOC was 0.67-1.00.

The section 2 the aspect of construct validity

1) The analysis of construct validity by using CITC found that discrimination index of positive or growth mindset question was 0.24-0.56 and negative or fixed mindset question was 0.36-0.66. Showed as Table 2

2) The analysis of construct validity by using CFA found that the assessment model in both not consistent with empirical data. So, researcher adjust this assessment model and after adjusted found that, 1) the growth mindset model was consistent with empirical data. Compute Chi-square test = 17.05 ($p = 0.76$, $df = 22$), GFI = 0.99, AGFI = 0.97, and RMSEA = 0.00 and 2) the fixed mindset model was consistent with empirical data. Compute Chi-square test = 23.03 ($p = 0.15$, $df = 17$), GFI = 0.98, AGFI = 0.94, and RMSEA = 0.04. Detail of analyzes was shown as Figure 2 and Table 3.

As a Table 3 found that; growth mindset model were 3 most important weight item comprising of item G10 (You accept and take the advice of others to improve your work.), item G8 (When you do a difficulty math problem, you will be dedicated and efforts.), item G5 (You believe that if you tried, you can learn mathematics.), and item G7 (You think that the hardworking was a cause of different abilities.) by 0.43, 0.35, 0.32, and 0.32 of respectively factors loading (b). For fixed mindset model were 3 most important weight item comprising of item F8 (You think

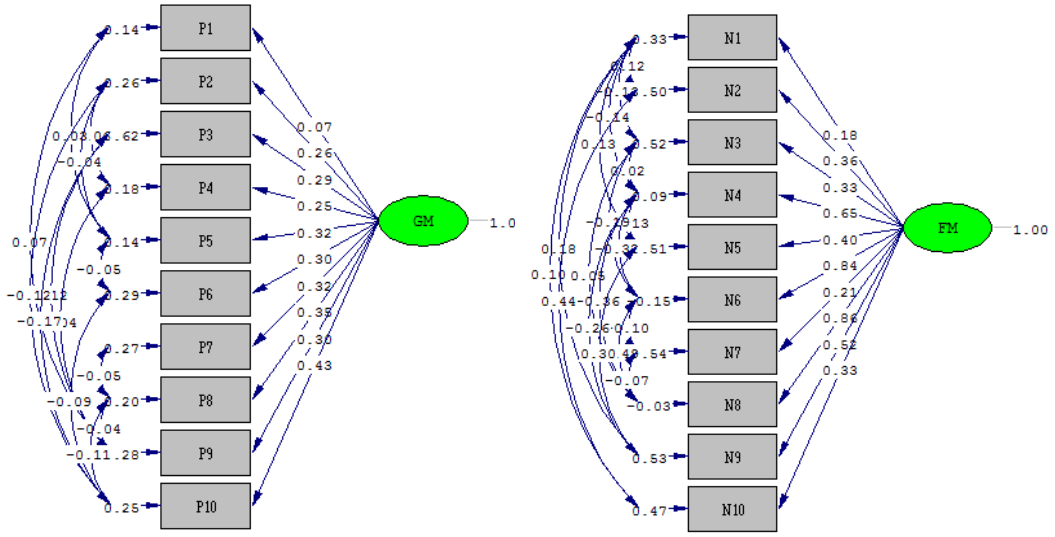

Figure 2 The result of analyzes construct validity by using CFA
(Left-hand: growth mindset model, right-hand: fixed mindset model)

Table 3 Result of analyzes construct validity by using CFA

Growth mindset ability						**Fixed mindset ability**					
Item	**b**	**SE**	**t**	**R^2**	**% b**	**Item**	**b**	**SE**	**t**	**R^2**	**% b**
G1	0.07	0.02	2.76**	0.03	2.42	F1	0.18	0.03	5.47**	0.09	3.85
G2	0.26	0.04	6.34**	0.21	9.00	F2	0.36	0.05	7.39**	0.21	7.69
G3	0.29	0.06	5.05**	0.12	10.03	F3	0.33	0.07	4.72**	0.18	7.05
G4	0.25	0.03	8.06**	0.25	8.65	F4	0.65	0.09	7.23**	0.82	13.89
G5	0.32	0.03	10.32**	0.42	11.07	F5	0.40	0.05	8.18**	0.24	8.55
G6	0.30	0.04	7.07**	0.24	10.38	F6	0.84	0.06	13.25**	0.17	17.95
G7	0.32	0.04	8.31**	0.27	11.07	F7	0.21	0.05	4.33**	0.08	4.49
G8	0.35	0.04	9.16**	0.39	12.11	F8	0.86	0.07	11.97**	0.24	18.38
G9	0.30	0.04	7.68**	0.24	10.38	F9	0.52	0.06	9.06**	0.34	11.11
G10	0.43	0.05	9.36**	0.42	14.88	F10	0.33	0.05	7.24**	0.19	7.05
Chi-square = 17.05, p = 0.76, df = 22, GFI = 0.99, AGFI = 0.97, RMSEA = 0.00						Chi-square = 23.03, p = 0.15, df = 17, GFI = 0.98, AGFI = 0.94, RMSEA = 0.04					

** $p < 0.01$ ($t_{(.01,\ 254)} = 2.33$) [1], b = factors loading, SE = Standard error, t = t-test, R^2 = reliability

that the difficult mathematics problem was appropriate with smart students.), item F6 (You think that you can learn in the classroom only. If you do not understand, you won't understand in anyway.), and item F4 (If you not satisfy with score of math test, you think that's because of the difficult exam.) by 0.86, 0.84, and 0.65 of respectively factors loading (b).

The section 3 the aspect of reliability, the analysis the reliability by using Cronbach's alpha found that, for the positive or growth mindset question was 0.72 of Cronbach's alpha and the negative or fixed mindset question was 0.83 of Cronbach's alpha. When consider all question was 0.76 of Cronbach's alpha.

4. Discussion

The research result had an important issue to be discussed below.

4.1 A mathematical learning style test based on mindset theorem had a content validity with IOC since 0.67 to 1.00 may be to determine the questions; researcher had prudently study in mindset theorem according to clear definition of mathematical learning style test. In addition, researcher constructing criteria to evaluate learning style consistently. So, the result of this testing founded a mathematical learning style test was a content validity and consistent by Saiyot [11] and Neangchalearm [8] they told that IOC must

more than or equal to 0.50. This result showed that mathematical learning style test can measure to definition of mindset theorem.

4.2 Mathematical learning style test based on mindset theorem that develops in this research had construct validity. The result of calculating discrimination index for each item by correlation coefficient between for each score item and total score of aspect of a test or corrected item-total correlation (CITC) more than 0.20 in 20-item, between 0.24 to 0.66 was consistent by Saiyot [11], they told that in the general we can use only the item that it was discriminant index more than or equal to 0.20 and if the item was a discriminant index approach +1, then it showed that this item can separate a high quality responder from low quality responder. Consistent by Neangchalearm [8] they told that we must be used the item had 0.20 to 0.80 for discriminant index. In addition; the result of confirmatory factor analysis (CFA) founded in the both model comprising of growth mindset model and fixed mindset model were not consistent with empirical data in this causes researcher adjusting the both model. Finally; both models (growth mindset model and fixed mindset model) were consistent with empirical data. In this evidence showed that mathematical learning style test based on mindset theorem was a constantly for a measurement and all item were measuring in unity factor. Consistent by Pinyoarnantapong [12] his said that construct validity was ability of testing that can able to measure the psychological structure and the developing construct validity of tool a researcher must analyze the factor of the ability. A tool construct validity can showed that the psychology difference each personal to make the score obtained by measuring the variation to the terms and consistent by Ritjaroon [7] and Anastasi [13] said that the construct validity was the features of tool that can be measured in concept, theory of the structure of ability which needs to be measured. Hence; if create a tool was consistent and relate with a small capacity as defined in the structure, then we told that this tool was a construct validity.

4.3 Mathematical learning style test based on mindset theorem had develop in this research was a reliability by using Cronbach's alpha for the positive or growth mindset question was 0.72 and the negative or fixed mindset question was 0.83. When consider all questions were 0.76 of Cronbach's alpha. Be consistent by Gable [14] Pinyoarnantapong [12] and Saiyot [11] said that a tool should have a reliability at least 0.70. This evidence showed that mathematical learning style test had features to stably measurement. Be consistent by Phengsawad [15] said that reliability was a stability of score from measurement.

5. Conclusions

The result of this research found that mathematical learning style test had a quality and was standardly tool, had a content validity by using IOC was 0.67 - 1.00, had the construct validity by using 1) CITC was 0.24 - 0.56 for GM items and 0.36 - 0.66 for FM items 2) CFA; the aspect of GM the model fit the empirical data compute Chi-square test was 17.05 ($p = 0.76$, $df = 22$), GFI = 0.99, AGFI = 0.97, RMSEA = 0.00 and the aspect of FM the model fit the empirical data compute Chi-square test was 23.03 ($p = 0.15$, $df = 17$), GFI = 0.98, AGFI = 0.94, RMSEA = 0.04 , and had the reliability by using Cronbach's alpha was 0.76.

6. Suggestions

6.1 The suggestions for further utilization and application

The research results on the development of mathematical learning style test based on mindset theorem for senior high school students can be utilized extensively as follows:

1) Result of research given a mathematical learning style test. Hence; there should be use it to measure student' learning style based on mindset theorem and applied the result of measurement to develop learning management to improve student mindset in the further.

2) Although this test created by mindset theorem, which is divided into two types of learning styles comprising growth mindset and fixed mindset but the interpretation of learning styles was classified as a four-type; strongly growth mindset, growth mindset with some fixed ideas, fixed mindset with some growth ideas, and strongly fixed mindset. For users knew about direction of learning style of respondents. If students' learning style was fixed mindset with some growth ideas or strongly fixed mindset, teacher will be enhancing students' mindset immediately. Hence; for using this test user will be careful interpretation of learning characterized.

6.2 The suggestions for further study

Students or teachers who are interested in doing researches on mathematical learning style test based on mindset theorem may consider the following issues:

1) For this research, the development of a learning style test that is a measure of four levels of 20 items which are appropriate and easy to collect from high

school students. It should create a more measured manner such as situation test or observation form which can collect more information related respondent's learning style. In addition; may create more questions for those students in higher levels.

2) You should check the criterion related validity of mathematical learning style test by studying the relationship between scores in this test with score from other standard test which can measure learning style in mathematics based on mindset theorem.

References

[1] Dweck CS. **Self-theories: Their role in motivation, personality and development**. Philadelphia: Taylor and Francis/Psychology Press; 1999.

[2] Hattie J. **Visible-learning [internet]**. 2011. [cited 30 July 2015]. Available from: http://visible-learning.org/2013/02/infographic-john-hattie-visible-learning/

[3] Nilpan M. **Methodology of educational research**. Nakhon Pathom: Silpakorn University Press; 2011.

[4] Ranabut S, Pinyoarnantapong S. The construction of measure the student engagement in early childhood education program bachelor degree. **Journal of education**. 2014; **15** (2).

[5] Diehi E. **Motivating students with mindset coaching and how brains work [internet]**. 2008. [cited 16 July 2015]. Available from: http://www.classroom20.com

[6] Saiyot L, Saiyot A. **Technique of educational research**. Bangkok: Chomromdek; 1995.

[7] Ritjaroon P. **Principle of educational measurement**. Bangkok: House of Kermit; 2009.

[8] Neangchalearm P. **Educational research**. Bangkok: Chulalongkorn University Press; 2013.

[9] Gaiyawan Y. **Multivariate statistical analysis for research**. Bangkok: Chulalongkorn University Press; 2013.

[10] Wongrattana C. **Technique of using statistics for research**. Nonthaburi: Trinearamitgit Interprogressive; 2009.

[11] Saiyot L, Saiyot A. **Technique of learning measurement**. Bangkok: Chomromdek; 2000.

[12] Pinyoarnantapong B. **Measurement of education**. Bangkok: Faculty of Education, Srinakharinwirot University; 1976.

[13] Anastasi A. **Psychological testing**. U.S.A.: Macmillan Publishing Company; 1982.

[14] Gable, RK. **Instrument in the affective domain**. Boston: Klnwer-Nijhoff; 1986.

[15] Phengsawad W. **Classroom action research**. Bangkok: Chomromdek; 2009.