CONSTRUCTION AND VALIDATION OF AN INSTRUMENT FOR MEASURING FACTORS INFLUENCING TO ALGEBRAIC LEARNING ACHIEVEMENT

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ABSTRACT
The objective of this research was the elaboration and validation of an instrument to the objective of this research was to elaborate and validate an instrument for measuring the factors influencing on algebraic learning achievement. With this purpose to verify the usefulness and validity of the instrument, the analysis of factors influencing on algebraic learning achievement was used in this research project. The designed instrument had 60 items that identified the perception of the students with respect to 7 variables: achievement emotions, engagement to learning, and student faith in teacher, achievement motivation, categorization skill, mathematical representation, and algebraic learning achievement. 160 surveys were applied randomly in different organizations during 2022. The results of the validation were as follows. The instrument had content validity through the Panel of Experts, and the reliability with Conbrach alpha. This showed that they were interval consistent. The results of Kendall coefficient of concordance of items of characteristic factor variables were also found. Each item of each factor variable had a concordance with the other items which were statistically significant. The validity of the construct was found with the test KMO and the sphericity of Bartlett. The contributions of this article were one questionnaire and one examination that could be applied to all demonstration schools, since it is regularly associated with algebraic learning achievement in the schools under the university sector. It could be concluded that the instrument met the optimal validity and could be used in the future school research studies.
Keywords: Construction of Instrument, Factor Influencing, Algebraic Learning Achievement

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INTRODUCTION

Algebra is a branch of mathematics related to structures, relations, and quantities. An algebraic statement or equation is a model for interpreting and drawing conclusions from information to make decisions. In addition, symbols and algebraic reasoning are fundamental of the design of computer systems. Mathematical reasoning is developed through algebra, and an understanding of algebra (Egodawatte, 2011: 1-2).

The learning model is divided into three parts: 1) Background consists of curriculum, teaching, basic characteristics of teachers and students, 2) Teaching-Learning Process consists of organizing teacher learning activities, and the pursuit of knowledge by students, and 3) Acquisition consists of student achievement (Wiley & Harnischfeger, 1976 as cited in Schreiber, 2000: 14-15). The model of factors influencing to learning achievement, is composed of achievement emotions, achievement motivation, Pictorial representation, and categorization skill or problem solving skill, etc. Research on the engagement to learning and student faith in teacher, shows effects on learning achievement. The researcher interested in studying dimensional factors related to the learning process especially the problem-solving process with its dimension that can be controlled by teachers and students. In order to study factors influencing to algebraic learning achievement, it is necessary to collect data using good quality measuring instruments.

A construction and validation of an instrument to measure factors influencing on algebraic learning achievement, contains complicated steps, procedures, and interrelationship of various ideas and latent variables. Subsequently, confirmation must follow guidelines to develop a firmly identified test with the expected outcomes (Hani; Talib; Zrekat; Nasir; Ahmad; & Wedian, 2021: 1527). Haladyna and Downing (2011 as cited in Hani, Talib, Zrekat, Nasir, Ahmad, & Wedian, 2021: 1527) said that the two most essential steps in test development are; 1) Item development, which includes content definition, preparation of test specifications, preparation of the item pool, content validation/experts judgment, pilot testing of the items, data analysis, and revision of test items. 2) Item validation through item analysis. These processes are carefully accomplished to ensure the instrument's validity and reliability developed and used to estimate items and a person's ability. In choosing appropriate scales two characteristics need to be aware of: reliability and validity (Pallant, 2011: 6).

For the reasons mentioned above, the researcher is interested in studying the construction and validation of an instrument to measure factors influencing on algebraic learning achievement. With the purpose to obtain the quality of measurements in terms of validity and reliability. The validity of a scale refers to the degree to which it measures what it is supposed to measure (Pallant, 2011: 7). It indicates that the measuring instrument can measure characteristics according to the defined definition or theory. The main types of validity are content validity and construct validity. The reliability of a scale indicates how free it is from random error. Two frequently used indicators of a scale's reliability are test-retest reliability (also referred to as 'temporal stability') and internal consistency (Pallant, 2011: 6). Therefore, the measuring instrument developed is an instrument that has a good quality. It is valid and reliable. It has a good difficulty level, and can distinguish the students' ability and learning achievement.

This research aims to elaborate and validate an instrument for measuring the factors influencing on algebraic learning achievement

LITERATURE REVIEWS

Model of factors influencing to academic achievement

Over the past several decades, factors influencing on academic achievement and the relationship between them have been identified and investigated. Variables affecting the success of learning activities and learning achievement, have been studied by educators as follows: Taasoobshirazi and Carr (2009: 630-643), Bailey, Carr, and Taasoobshirazi (2014:

440-461). These studied found achievement emotions, achievement motivation, Pictorial representation, and categorization skill or problem solving skill affected learning achievement. Frontier (2007: 113-178), Gunuc (2014: 216-231), Dogra and Dutt (2016: 33-35) studied and found engagement to learning has a positive relationship with learning achievement. Battle (2007: 1-103), Moore Jr. (2009: 1-100), Bankole (2010: 1-82), Romero (2010: 1-127), Casper (2012: 1-80), Kennedy (2014: 1-92), Prickett (2016: 1-127) and Moses (2018: 1-186) studied and found student faith in teacher affecting learning achievement. Mathematical representation is an image formed in the mind of a person who uses images, graphs, tables, symbols or variables, letters, languages or other forms to describe mathematical relationships for a deep understanding of mathematical concepts, connect basic knowledge in mathematics and apply those understandings to communicate and solve problems or explain various phenomena (Brinker, 1997: 1-2; The National Council of Teachers of Mathematics (NCTM), 2000: 67-71; Goldin & Shteingold, 2001: 3-6; NCTM, 2014: 24-29) and Fashihah and Qohar (2020: 115-124). It was a tool and a way to communicate mathematical understanding, to solve problems and to explain mathematical and social phenomena as well (Ya-Amphan, 2022: 426). Wiley and Harnischfeger (1976 as cited in Schreiber, 2000: 14-15) studied the learning model and found the learning model divided into three parts: 1) Background consists of curriculum, teaching, basic characteristics of teachers and students. 2) Teaching-Learning Process consists of organizing teacher learning activities, and the pursuit of knowledge by students. And 3) Acquisition consists of student achievement.

From the integration of learning models, the model of factors influencing on learning achievement, includes the engagement to learning, and student faith in teacher, as mentioned above. In three causal variables: 1) the input aspect, which is the characteristic of the learners, consisting of achievement emotions, engagement to learning, student faith in teacher, and achievement motivation. 2) The process consists of categorization skill and mathematical representation. 3) The output is algebraic learning achievement.

Algebraic learning achievement

A student's ability to learn algebra is measured by the student's algebraic learning achievement. Algebraic learning achievement refers knowledge and understanding of algebraic learning about sets, symbolic logic, polynomial, and the ability to apply knowledge to solve problems. Which can be considered the scores on the algebraic achievement test, measuring according to the core learning indicators of the mathematics learning subject group (revised version 2017), the basic education core curriculum B.E.2551 (A.D. 2008) (Good, 1973: 7; Mehren, 1976: 73; Chirstmas; & Fey, 1999: 5-13; Lew, 2004: 88-95; Supadit, 2013: 7; Phiphitkul & Thipkong, 2010: 75; Office of the Basic Education Commission, Ministry of Education, 2017: 7-38).

The elaboration and validation of an instrument to measure

When reviewing possible scales to use, you should collect information on the reliability and validity of each of the scales. The reliability and the validity of measuring instruments are important to pilot-test with your intended sample. Both of these factors can influence on the quality of the data you obtain. The scale's reliability indicates it internal consistency (Pallant, 2011: 6). The most commonly used statistic is Cronbach's coefficient alpha (α) for measuring instruments with Likert-type scale and statistic KR-20 or KR-21 for examination. This statistic provides an indication of the average correlation among all of the items that make up the scale. Values range from 0 to 1, with higher values indicating greater reliability. The reliability of measuring instruments are different levels, depending on the nature and purpose of the scale (Pallant, 2011: 6). George and Mallery (2003), who are often cited, provide the following rules of thumb: $\alpha > .90$ (Excellent), $\alpha > .80$ (Good), $\alpha > .70$ (Acceptable), $\alpha > .60$ (Questionable), $\alpha > .50$ (Poor), and $\alpha < .50$ (Unacceptable). Pallant (2011: 6) have recommended a minimum level of .70.

The three types of validity are content validity, criterion validity and construct validity. Content validity refers to the adequacy with which a measure or scale has sampled from the intended universe or domain of content. Criterion validity concerns the relationship between scale scores and some specified, measurable criterion. Construct validity involves testing a scale not against a single criterion but in terms of theoretically derived hypotheses concerning the nature of the underlying variable or construct. The construct validity is explored by investigating its relationship with other constructs, both related (convergent validity) and unrelated (discriminant validity) (Pallant, 2011: 7).

The difficulty level is a proportion of examinees answering items correctly. The test that can be used must have a difficulty level form .2-.8. The differentiation power of examination refers to the ability of a test item to distinguish those who have good scores out of those who do not have scores good. On tests with good differentiation power, test takers who answer the test correctly tend to score high, and test takers who fail the test, often get low scores. A good exam should have a value of differentiation power ≥ .20 (Iramaneeratana, 2009: 32-37).

RESEARCH METHODOLOGY

Participants

160 students studying in 10th grade in the demonstration school of a state university in the academic year 2022 were randomly applied to study the construction and validation of a measuring instrument with factors influencing algebraic learning achievement.

Instrument

Two measuring instrument were developed by researcher. They consisted of 1) a form to measure the factors influencing on the algebraic learning achievement, divided into 5 aspects: achievement emotions, engagement to learning, student faith in teacher, achievement motivation, were evaluated on a scale of 5 levels, namely, strongly agree, agree, neither agree nor disagree, disagree, strongly disagree and categorization skill is a subjective test. And 2) a form for measuring the algebraic learning achievement, consisting of the mathematical representations test, which is a conceptual representation of problem solving in multiple choice questions based the algebraic learning achievement test. The multiple choice questions were based on the algebraic learning achievement test.

Expert Panel

Five experts check content and construct validity of the two measuring instrument. Three experts were in the field of mathematics learning management, two experts were in the field of measurement and evaluation. They considered the consistency and the suitability of each question item with the operational definition (item-objective congruence: IOC) by whether it is appropriate or not appropriate including suggestions for improving the question. The selecting only questions had an IOC value of .50 or higher, along with improving the questions according to the experts suggestions before using them for testing.

RESEARCH RESULTS

The validity of the measuring factor instrument.

The validity of measuring factors instrument for the achievement emotions, the engagement to learning, the student faith in teacher, and the achievement motivation were calculated using the factors analysis. The results of the validity test of the measuring factors instrument were as follows:

Based on the results of Kendall coefficient of concordance of items of characteristic factor variables, it found out that the question items of achievement emotions of number 1-5 were negative, and the Kendall coefficient of concordance at .36**, -.61**, and items of number 6-10 were positive, have the Kendall coefficient of concordance at .23**, -.61**. The question items of Engagement to learning of number 1-10 were positive, and the Kendall coefficient of

concordance at .16*-.55**. The question items of Student faith in teacher of number 1-10 were positive, and the Kendall coefficient of concordance at 31**-.73**. The question items of achievement motivation of number 1-6 and 8-9 were positive, and the Kendall coefficient of concordance at .21**-.61**, items of number 7, 10 were negative, at the Kendall coefficient of concordance were .40**, items of number 7 is negatively concordance with items of number 1-5 and 8-9, and the Kendall coefficient of concordance were -.26**, -.40**, -.23**, -.35**, -.46**, -.30**, -.49** and -.29**, respectively. The question items of achievement motivation of number 10 was negatively concordance with items of number 1-5 and 8-9, and the Kendall coefficient of concordance were -.41**, -.40**, -.34**, -.29**, -.50**, -.28**, -.57** and -.50**, respectively. (** p < .01, *p < .05)

Table 1 Result of factor analysis for measuring instrument of the achievement emotions, the engagement to learning, the student faith in teacher, and the achievement motivation.

Component of factor variables	**N of Items**	**Factor loading**
Achievement emotions	10	
1) Boredom in learning	5	.42-.96
2) Enjoyment in learning	5	.41-.66
the test KMO = .812, the sphericity of Bartlett = 791.543, df = 45, p-value = .000		
Engagement to learning	10	
1) Power to learning	3	.64-.84
2) Dedication to learning	3	.45-.74
3) A sense of unity with learning	4	.42-.51
the test KMO = .886, the sphericity of Bartlett = 612.188, df = 45, p-value = .000		
Student faith in teacher	10	
1) Faith in benevolence	3	.65-.76
2) Faith in competence	3	.63-.64
3) Faith in integrity	4	.57-.73
the test KMO = .917, the sphericity of Bartlett = 1101.630, df = 45, p-value = .000		
Achievement motivation	10	
1) Commitment	3	.53-.61
2) Satisfaction to learning activities	3	.54-.72
3) Awareness level of self-learning ability	4	.60-.74
the test KMO = .804, the sphericity of Bartlett = 538.574, df = 45, p-value = .000		

In table 1 it can be seen the validity of the construct with the test KMO were .80-.92 and the sphericity of Bartlett were 538.57-1101.63 (df = 45, p = .00), with overall significance of the correlation matrix. The achievement emotions had two components and the factor loading value were .41-.96. The engagement to learning had three components and the factor loading value were .42-.84. The student faith in teacher had three components and the factor loading value were .57-.76. The achievement motivation had three components and the factor loading value were .53-.74. In each item of each factor variable, it had a concordance with the other items, and it was statistically significant, indicating that the item-level validation was satisfied.

The reliability of the measuring instrument.

The reliability of the measuring factors instrument was calculated using the Cronbach Alpha formula. The results of the reliability test of the measuring instrument were as follows:

Table 2 Reliability test of an instrument for measuring factors influencing to the algebraic learning achievement

Measuring instrument for	N of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
Achievement emotions	10	.71	.71
Engagement to learning	10	.91	.91
Student faith in teacher	10	.92	.93
Achievement motivation	10	.81	.81
Categorization skill	10	.75	.75
Mathematical representation	10	.90	.90

In table 2 it can be seen the value of Cronbach's Alpha Based on Standardized Items were .71-.93. The value of Cronbach's Alpha were .71-.92, greater than .70. It showed that overall the measuring instrument developed was reliable (Pallant, 2011: 6). This resulted in explaining that every item of the measuring factors instruments could measure factors influencing to the algebraic learning achievement.

The reliability of the measuring instrument for algebraic learning achievement was calculated using the KR-20 formula. The value of KR-20 was .76 > 0.70, which showed that the test instrument developed was reliable (Pallant, 2011: 6). This resulted in explaining that this instruments could measure the algebraic learning achievement.

Difficulty level and differentiation power of the test instrument

A good examination was also determined by the level of difficulty and differentiation of each item. The difficulty level of the each item was a property of an exam that indicated whether a particular item had more or less correct answers. The different power of the each item was a property of an exam that could classify learners according to individual differences as good, average, weak, knowledgeable-not knowledgeable, based on the principle that smart people must answer that question correctly and incompetent person will answer incorrectly. The test result of difficulty level and differentiation power was presented in Table 3.

Table 3 The test result of difficulty level and differentiation power of an measuring instrument for categorization skill, mathematical representation, and algebraic learning achievement.

Measuring instrument for	N of Items	Difficulty level	Differentiation power	Conclusion
Categorization skill	10	.42-.79	.42-.81	Used
Mathematical representation	10	.44-.60	.40-.88	Used
Algebraic learning achievement	10	.56-.80	.21-.44	Used

In table 3 it can be seen the value of the difficulty level of every test instrument were within the criteria (.20-.80). The value of the different power of every test instrument were greater than .20. It showed that it could be used to measure achievement, and distinguish students.

DISCUSSION & CONCLUSION

This study presented the key aspects of methodological rigor required for the construction, validation and consistency determination of an instrument to measure factors influencing on algebraic learning achievement. Based on the research results outlined above they can be analyzed as follows: The process of the development of measuring instruments began with creating a measuring instrument design. The measuring instruments on this research were designed by the indicators of achievement emotions, engagement to learning, student faith in teacher, achievement motivation, categorization skill, ability of mathematical representation, and algebraic learning achievement. The basic test preparation was the result of reviewing the

factor variables and drafting a measuring instrument. Therefore, in theory, the measuring instrument developed could be determined to be valid to fulfill the validity of content validity and construct validity. Content validity of a measuring instrument referred to the adequacy with which a measure or scale has sampled from the intended universe or domain of content. The construct validity was explored by investigating its relationship with other constructs, both related (convergent validity) and unrelated (discriminant validity) (Pallant, 2011: 7).

The process of content validation of measuring instruments was assessed by five experts. Three experts were in the field of mathematics learning management, and two experts were in the field of measurement and evaluation. The expert assessment results showed that all question items developed were valid. Therefore, in theory, the measuring instruments developed was valid by experts and could be used to assess or measure the factors influencing to algebraic learning achievement. The process of construct validation of measuring instruments assessed by a confirmatory factor analysis. Each item of each factor variable had a concordance with the other items statistical significantly, and factor loading values were in acceptable criteria. The results of the construct validity test showed that the item-level validation was satisfied.

The results of calculation of the reliability of an instrument to measure factor variables by Cronbach's Alpha, and an algebraic learning achievement by the KR-20 formula, showed that they were greater than .70. This showed that overall the measuring instrument developed was reliable and internal consistency (George and Mallery, 2003; Pallant, 2011: 6). In addition, the quality of the instrument to measure categorization skill, the ability of mathematical representation, and the algebraic learning achievement were also determined by the difficulty level and differentiation power of each item. Based on the test results, this showed that all items have difficulty levels within the criteria, and the value of the different power of every test instrument was greater than .20. Therefore, the test instruments developed could be used to measure the categorization skill, the ability of mathematical representation, and the algebraic learning achievement, and to distinguish students with more or less achievement (Iramaneeratana, 2009: 32-37).

In conclusion, the developed measuring instruments had acceptable quality. The contributions of this article were one questionnaire and one examination that could be applied to all demonstration schools, since it is regularly associated with algebraic learning achievement in the school, under university sector. It could be concluded that the instrument met the optimal validity and could be used in the future school research studies.

REFERENCES

Bailey, M., Carr, M., & Taasoobshirazi, G. (2014). A Multivariate Model of Achievement in Geometry. *The Journal of Educational Research, 107*, 440-461.

Bankole, R. A. (2010). *Student Faith in Teachers and Its Relationship to Student Identification with School, Student Perceptions of Academic Press, and Achievement*. Degree of Doctor of Philosophy in Education, The Faculty of the School of Education, The College of William and Mary in Virginia.

Battle, A. R. (2007). *Faith and Leadership*. Degree of Doctor of Education, The Graduate Faculty, Education, Arizona State University.

Brinker, L. (1997). *Using Structured Representations to Solve Fraction Problems: A Discussion of Seven Students' Strategies*. University of South Carolina, the National Science Foundation.

Casper, D. C. (2012). *The Relationship Between Collective Student Faith and Student Achievement*. Degree of Doctor of Education, The Graduate Faculty, University of Oklahoma.

Chrismas, T. Paul., & Fey, T. James. (1999). Communicating the Importance of Algebra to Students. In Barbara Moses. *Algebraic Thinking Grades K-12: Reading from NCTM's*

School-Based Journals and Other Publications (pp. 5-13). Reston, VA: The National Council of Teachers of Mathematics.

Dogra, A. & Dutt, S. (2016, September). The association between students' learning engagement and their achievement in psychology. *International Journal of Multidisciplinary Education and Research, 1*(7), 33-35.

Egodawatte, G. (2011). *Secondary School Students' Misconceptions in Algebra*. Doctoral dissertation, University of Toronto, Canada.

Fashihah & Qohar, A. (2020, September). Analysis of Mathematical Representation Process Standard in Learning Mathematics on Relation Concept. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 10*(2), 115-124.

Frontier, A. C. (2007). *What is the Relationship between Student Engagement and Student Achievement? A Quantitative Analysis of Middle School Students' Perceptions of Their Emotional, Behavioral, and Cognitive Engagement as Related to Their Performance on Local and State Measures of Achievement*. Doctor of Philosophy Degree, Leadership for the Advancement of Learning and Service College of Education & Leadership, Cardinal Stritch University.

George, D. & Mallery, P. (2003). *SPSS for Windows step by step: A Simple Guide and Reference*. 11.0 Update. Boston: Allyn & Bacon.

Goldin, G. & Shteingold, N. (2001). *Systems of Representations and the Development of Mathematical Concepts. In The Roles of Representation in School Mathematics*. The United States of America: The National Council of Teachers of Mathematics.

Good, C. V. (1973). *Dictionary of Education*. 3rd ed. New York: McGraw-Hill,

Gunuc, S. (2014, October). The Relationships between Student Engagement and Their Academic Achievement. *International Journal on New Trends in Education and Their Implications, 5*(4), 216-231.

Hani, A. B., Talib, R., Zrekat, M., Nasir, M. A., Ahmad, A. A., and Wedian, N. (2021). Development and Validation of the Mathematics Test for Tenth Grade Jordanian Students, According to the Partial Credit Model. *Turkish Journal of Computer and Mathematics Education, 12*(6), 1527-1536.

Iramaneeratana, C. (2009, January-April). Multiple choice test analysis. *Siriraj Medical Bulletin, 2*(1), 32-37.

Kennedy, L. T. (2014). *An Exam Ination of Eighth Grade Students' Faith Levels of Their Principal and Its' Impact on Academic Achievement in A Selected School District in Northeast South Carolina*. Degree of Doctor of Education, The Graduate Faculty, South Carolina State University.

Lew, H. C. (2004). Developing Algebraic Thinking in Early Grades: Case Study of Korean Elementary School Mathematics. *The Mathematics Educator, 8*(1), 1-5.

Mehren, W. (1976). *Measurement and Evaluation in Education and Psychology*. New York: Holt, Rinehart and Winston, Inc.

Moore Jr., D. M. (2009). *Student and Faculty Perceptions of Faith and Their Relationships to School Success Measures in an Urban School District*. Degree of Doctor of Education, The Faculty of the School of Education, The College of William and Mary in Virginia.

Moses, L. D. (2018). *A Case Study of the Dynamics of Faith in a Reconstituted Urban Middle School*. Degree of Doctor of Education, The Faculty of the School of Education, The College of William & Mary.

Office of the Basic Education Commission, Ministry of Education. (2017). *indicators and core learning content Mathematics learning group (revised edition 2017) according to the basic education core curriculum B.E. 2551 (A.D. 2008)*. 1st ed. Agricultural cooperative printing demonstrations of Thai Co., Ltd.

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using SPSS*. 4th ed. Maidenhead: Open University Press.

Phiphitkul, Y. & Thipkong, S. (2010). *Mathematics Dictionary*. 3rd ed. Bangkok: Pajera Publishing Co., Ltd.

Prickett, T. P. (2016). *A Study of Relationships between Teacher Leadership, Student Faith, and Student Commitment to Ethical Goodness*. Degree of Doctor of Education, The Graduate Faculty, Liberty University.

Romero, L. (2010). Student Faith: Impacting High School Outcomes. (the Degree of Doctor of Philosophy in Education). University of California, Graduate Program in Education.

Schreiber, J. B. (2000). *Advanced Mathematics Achievement: A Hierarchical Linear Model*. Doctor of Philosophy, The Faculty of the University Graduate School, Indiana University.

Supadit, T. (2013). *Factors Affecting Master's Degree Achievement of the National Institute of Development Administration, academic year 2011*. (Research report). Bangkok: National Institute of Development Administration.

Taasoobshirazi, G. & Carr, M. (2009). A Structural Equation Model of Expertise in College Physics. *Journal of Educational Psychology, 101*(3), 630-643.

The National Council of Teachers of Mathematics (NCTM). (2000). *Principles Standards And for School Mathematics*. The United States of America.

The National Council of Teachers of Mathematics (NCTM). (2014). *Principles to Actions Ensuring Mathematical Success for All*. The United States of America.

Ya-Amphan, D. (2022, July-September). Representation Model for Designing Mathematics Instruction. *Dhammathas Academic Journal, Khon Kaen University, 22*(3), 425-428.

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