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From Modern Teaching to Mathematics Achievement: The Mediating Role of Mathematics Attitude, Achievement Motivation, and Self-Efficacy

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Abstract: A modern teaching method influences both direct and indirect learning achievement through the student's nonacademic factors. The researcher has an intention to examine the influences of new teaching methodology on mathematics achievement towards mathematics attitude, achievement motivation, and self-efficacy of students as mediating variables (n teacher = 117, n student = 2,205). The Multilevel Structural Equation Modeling revealed that attitude towards mathematics is the most important factor in explaining the academic achievement of individual students. It could be explained the variance with achievement motivation and perceived self-efficacy of students by 60.50%. As for the modern teaching method, there was a positive effect on achievement both directly and indirectly through all three factors with statistical significance and explained conjointly about the variance of student achievement in each classroom by 99.00%. This finding suggests the importance and direction of teaching design that covers the development of relevant factors as proposed in discussions and implementations.

Keywords: *Mathematics achievement, self-efficacy, mathematics attitude, achievement motivation, modern teaching, indirect effect.*

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Introduction

Learning achievement of students is a reflection of the teaching quality and the education system. When the learners have the skills to learn in the content and achieve the necessary performance, it inevitably results in answers to questions from the measurement process according to the learning objectives in the curriculum. Therefore, it enables many global countries to develop and formulate a standardized knowledge measure for determining the quality of educational management in each country based on national student assessment results (Kalaycioglu, 2015; Karakolidis, Pitsia, & Emvalotis, 2016; Lee, 2016), particularly mathematics which is a basic course in developing logic and reasoning for students.

Amidst keeping an eye on the results of the international student assessment annually, educators including researchers attempt to seek ways to improve the quality of learning management in various dimensions both in the development of learning materials (Gokalp & Kilic, 2013; Rosario, Nunez, Vallejo, Cunha, Nunes, Mourao, & Pinto, 2015; Rosario, Nunez, Vallejo, Nunes, Cunha, Fuentes, & Valle, 2018), application of technology for learning management (Balentyne, 2017; Pasztor, Molnar, & Csapo, 2015), the development of learners from the inside, such as emotional support, feedback, relationship of the person in the class as well as management of the environment that is conducive to learning (Nessipbayeva, 2012; Tosto, Asbury, Mazzocco, Petrill, & Kovas, 2016). Even if the development of various methods will differ in methods and guidelines, every guideline works under the same direction that is modern. It is expected to result in student outcomes different from the traditional teaching method and the students will have the readiness to survive in the 21st century society.

Not only modern teaching methods that affect the development of mathematics learning achievement, but there are also nonacademic factors within the students that are involved. The results of document synthesis showed that mathematics attitude, achievement motivation, and self-efficacy (e.g. Balentyne, 2017; Pitsia, Biggart, & Karakolidis, 2017; Sriphai, Damrongpanit, & Sakulku, 2012) received attention and were always used in research studies to predict

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the achievement of the learners which found that each factor has a close relationship with each other and has an influence on both direct effect and indirect effect on learning achievement both from the same level variables (Dickhauser, Dinger, Janke, Spinath, & Steinmayr, 2016; Lee, 2016) or the different level variables (Dinkelmann & Buff, 2016; Tambunan, 2018).

However, that mentioned conclusion depends on the linkage of separate research results and study different population, contexts and statistical methods. The conclusions thereupon could not yet be presented with clear results as follows: 1) when modern teaching methods have a focus on developing a wide variety of learners, academic achievement will still be clearly influenced by modern teaching methods and 2) how modern teaching leads to the development of academic achievement when considering the mutual influence, factors from the three sides as mediators.

Literature Reviews

Modern Teaching

The new trend of modern learning management has a connection with the development of learners to acquire learning skills of the 21st century (Boholano, 2017; Chineze, Leesi, & Fanny Chiemezie, 2016; Laal, Laal, & Kermanshahi, 2012) with a focus on preparing students to be ready for changes and become an important force in the new world with most complex technology, migration, changing markets and environmental and political changes (Tican & Deniz, 2019). As a result, teachers need to improve their skills to manage to learn with the consistency of the changes since it does not hold the focus on only one achievement.

In the past, educators and researchers defined the boundaries of modern teaching according to the skills of the 21st century summarized in 5 areas: (i) Plan and Preparation means teachers need to define the expectations of learners and the classes they require arising from teaching and learning (Almuntashiri, Davies, & McDonald, 2016; Sieberer-Negler, 2016; Zee, Koomen, & de Jong, 2018). The teachers have knowledge in the correct and clear content and curriculum, able to plan and implement strategies for learners to acquire the necessary knowledge and skills (Chineze et al., 2016) based on past student assessment results and the use of classroom potential to manage effective learning, is sensitive to the specific perception of specific abilities and needs for individual learning-capability (Gokalp & Kilic, 2013; Nessipbayeva, 2012) including awareness of the implementation of knowledge and skills from future studies (Almuntashiri et al., 2016), (ii) Environment and Relationships mean promoting the environment and learning resources that are conducive to learning depending on the engagement (Consalvo & David, 2016; Osborne, Simon, & Collins, 2003) provides classroom management skills to create effective communication for everyone, create mutual understanding for a mutual respect for the rules and regulations (Blazar, 2015; Lazarides & Buchholz, 2019; Sieberer-Negler, 2016) including to conserve the positive environment which affects the development of students continuously (Nessipbayeva, 2012), (iii) Teaching Strategy Implementation means applying skills to organize learning processes with various methods and resources. (Almuntashiri et al., 2016; Tican & Deniz, 2019), can reinforce learning through effective placement of tasks or homework (Gokalp & Kilic, 2013; Rosario et al., 2015; Rosarrio et al., 2018) with appropriate group and individual processes (Bardach, Yanagida, Schober, & Luftenegger, 2018) with the ability to create motivation and commitment to learners when encountering obstacles very well (Blazar, 2015; Keys, Conley, Duncan, & Domina, 2012; Schenke, Lam, Conley, & Karabenick, 2015; Sieberer-Negler, 2016), (iv) Media, Innovation, Technology, and Resources can be defined as creating, developing or applying innovative media and educational technology in a timely and global manner to stimulate interest and learners' learning (Faber, Luyten, & Visscher, 2017; Pasztor et al., 2015; Tican & Deniz, 2018; Turel & Sanal, 2018), and (v) Measurement and Evaluation Utilization refer to applying various measurement and evaluation techniques for learning to be consistent with the actual condition (Nessipbayeva, 2012), encourages motivation for students to be proud of inside themselves (Sieberer-Negler, 2016) with continuous feedback for self-improvement (Almuntashiri et al., 2016; Faber et al., 2017).

The results of previous research have concluded that 1) Modern teaching has a direct effect on the development of mathematics achievement such as Rosario et al. (2018) and Skaalvik, Federici, and Klassen (2015), who found that the design and quality of homework together with team learning affects the intention of self-development from inside and can help primary and secondary learners to have higher mathematics learning results. Turel and Sanal (2018) have found that using an eBook can improve learning achievement and motivation in mathematics for undergraduates and can help to reduce mathematics anxiety, 2) Modern teaching has influenced mathematics achievement through moderators, some scholars (Blazar, 2015; Lazarides & Buchholz, 2019; Schenke et al., 2015; Skaalvik et al., 2015) have found that when teachers have the ability to manage and reinforce teacher emotional support, it will affect positively students' mastery goal orientation and self-efficacy, reducing anxiety in mathematics and finally leading to the development of mathematics achievement. Gokalp and Kilic (2013) and Tosto et al. (2016) have revealed that the classroom activity and the environment (in terms of caring for teachers, safety, orderliness of students in the class, and the ease of use as a learning facility) affects mathematics achievement through variables: self-efficacy, maths interest, and academic self-concept. Earlier researchers (Gokalp & Kilic, 2013; Sartawi, Alsawaie, Dodeen, Tibi, & Alghazo, 2012; Rosario et al., 2018) also have reported that the style and quality of the task and homework that were chosen by teachers strictly, interestingly consistent with teaching with classroom equipment, content and media/materials used in teaching and learning. All of this has an influence on the homework performance of students and bring about the development of mathematics achievement through homework effort both at the individual and classroom levels. Tambunan (2018) and Yurt (2015) and Zee et al. (2018) have indicated that teachers' expectation has an effect on mathematics achievement through motivation. Previous researchers (Almuntashiri et al., 2016; Faber et al., 2017; Rakoczy, Pinger, Hochweber, Klieme, Schutze, & Besser, 2019) have pointed out that the feedback of the teacher affects the mastery goal orientation and self-efficacy resulting in more achievement in mathematics. In addition, Tambunan (2018) and Turel and Sanal (2018) confirmed that the design of teaching that applies a variety of media and modern technologies such as e-book, social media (e.g. Snappet, FB, Slideshare, YouTube) affects the development of mathematics achievement through attitude, self-efficacy, and motivation. However, Pasztor et al. (2015) applied confirmatory factor analysis. It was found that the application of teaching technology for modern learning consists of 3 key elements: Fluency, Flexibility, and Originality.

Mathematics Self-efficacy

Self-efficacy is an important factor that is closely related to the student's ability to study, which means judging, recognizing and assessing their ability to manage various difficult tasks in order to be able to achieve the goals they set (Bandura, 1986: 39). When using in the mathematics course, the Mathematics Self-efficacy refers to students' perceptions of their ability to learn to succeed in learning Mathematics (Garcia, Rodriguez, Betts, Areces, & Gonzalez-Castro, 2016). Students with high self-efficacy tend to use effort and courage to stand up to high barriers to learning. They are not afraid of failure, stress, and low anxiety leading to the performance of duties that have already achieved success (Prast, de Weijer-Bergsma, Miocevic, Kroesbergen, & Van Luit, 2018; Zimmerman, 2000). It also reflects to indirectly affect to a positive self-concept (Karakolidis et al., 2016; Tosto et al., 2016) while the students with low self-efficacy have behavioral tendencies in avoiding math-related tasks (Berger & Karabenick, 2011).

The previous research results revealed that the development of learners to have self-efficacy has an effect on the development of Mathematics achievement. Karakolidis et al. (2016) Kalaycioglu (2015) found that mathematics self-efficacy is a variable that can be used to predict cognitive outcomes such as mathematics achievement or PISA scores in the mathematics of students. Mundia and Metussin (2019) showed that the students with self-efficacy will correlate with their own learning skills and have the ability to strategically study leading to the development of mathematical learning achievement. Rastegar, Jahromi, Haghighi, and Akbari (2010) also found that self-efficacy interacts with metacognition resulting in students having the ability to provide reasons, have good decisions, and have the opportunity to achieve high academic success. Earlier researchers (Guven & Cabakcor, 2013; Tosto et al., 2016) have pointed out that the classroom environment results in high school learners creating positive self-efficacy and then bring to develop the ability for mathematics problem solving and achievement.

Achievement Motivation

Motivation refers to the individual's personal interest in wanting to know, like, wanting to be close or related to the particular thing (Pitsia et al., 2017; Tambunan, 2018). It then reflects a person to be ambitious, indefatigable and to expect to be successful. Finally, he is going to find a way to get things done, especially with challenges (Elliot & Covington, 2001; McClelland, 1985). Students with high expectation of academic success will have a clear tendency to show positive behavior (Murayama, Pekrun, Lichtenfeld & Vom Hofe, 2013; Prast et al., 2018) because they would like to develop themselves or create self-esteem (called intrinsic motivation). It may derive from avoiding shame from others if they have a failure and receive praise from others (called extrinsic motivation) (Deci & Ryan, 1992; Steinmayr & Spinath, 2009).

In the past, many research results revealed that motivation has a relationship and is applied as a direct predictor of mathematics achievement while some argued that motivation interacts with other factors that affect mathematics achievement. Farmer (2018) found that motivation and self-efficacy are significant statistical related and also showed that the students who received the motivation supplement will have learned from teachers, both in terms of content, teaching ability including the relationship of the person in the class better than students without learning motivation. Dickhauser et al. (2016) and Yurt (2015) revealed that intrinsic motivation was an important factor used to predict mathematics achievement in both direct effect and indirect effect from student-level factors while some researchers (Sartawi et al., 2012; Schenke et al., 2015; Skaalvik et al., 2015) have found that the teaching like emotional support teachers implement the task in the appropriate class, design and assign homework with appropriate quality and quantity (no more than 3 hours) as well as provide positive feedback to students leading to motivation and to develop student achievement. Moreover, Kebritchi, Hirumi, and Bai (2010) indicated that the modern teaching of mathematics applied computer games affects the development of both the class motivation and mathematics achievement of students.

Mathematics Attitude

Attitude is a characteristic of emotions, feelings, and readiness of a person to respond to things (Moenikia & Zahad-Babelan, 2010; Lipnevich, Preckel, & Krumm, 2016). It occurs after a person has experiences, recognition, and evaluation of things which is found to be a self-sustaining belief (Eagly & Chaiken, 1993) that leads to the behavior of participating or escaping with things encountered. According to the theory of planned behavior (Ajzen, 1991), it identifies the role of attitude as one of the three key elements used to describe the trend of individual behavior (Attitude, Subjective Norm, Perceived Behavioral Control). It can be used to predict the outcomes of an individual's success or failure (Guimarest, 2005). While the Expectancy-value theory (Wigfield & Eccles, 2000) explains that people are involved in various things, it is the result of two components: intrinsic-value (How much people are interested in that) and the utility-value (How much the people acknowledge and believe in the benefits that are received from that).

Mathematics Attitude or Attitude toward Mathematics (Moenikia & Zahad-Babelan, 2010) is one of the important elements to explain mathematical learning. Students with high mathematics attitude tend to be more successful in learning mathematics than those with low attitude (Ma & Krishor, 1997). Based on previous research (Burrus & Moore, 2016; Laal et al., 2012; Papanastasiou, 2000; Sartawi et al., 2012) have found that the 21st century teaching (such as STEM or Task-based) results in students' developing mathematics achievement, mathematics attitude, analytical thinking as well as students' mathematical process skills. Sriphai et al. (2012) indicated that attitude has a relationship with motivation and self-efficacy, leading to the predictability of mathematics learning ability. Furthermore, Guven and Cabakcor (2013) found that attitude is a mediator from applying the classroom activities to examine students' mathematics problem-solving.

The Present Study

The result of document synthesis helped the researcher to be able to link that 1) modern learning management has a connection with the 21st teaching covering five important elements: planning and preparation of teaching and learning, classroom management, organizing learning activities, media, technology, innovation, and learning resources, and measurement and evaluation of learning contribute to the development of mathematics achievement, 2) Mathematics Achievement has been proven through many types of research that there is the difference as hierarchical structures, and 3) mathematics attitude, achievement motivation, and mathematics self-efficacy is not only factors that have a direct effect on mathematics achievement, but also as a mediator from other factors as well. Therefore, after linking the above reasons, it became a hypothesis model [Figure 1] describing the relationship structure between variables in the multilevel structural equation model which defines the research hypothesis that this model can be used to describe existing relationships from empirical data. From hypothesis model, the researcher expect that this model should fit with the empirical data.

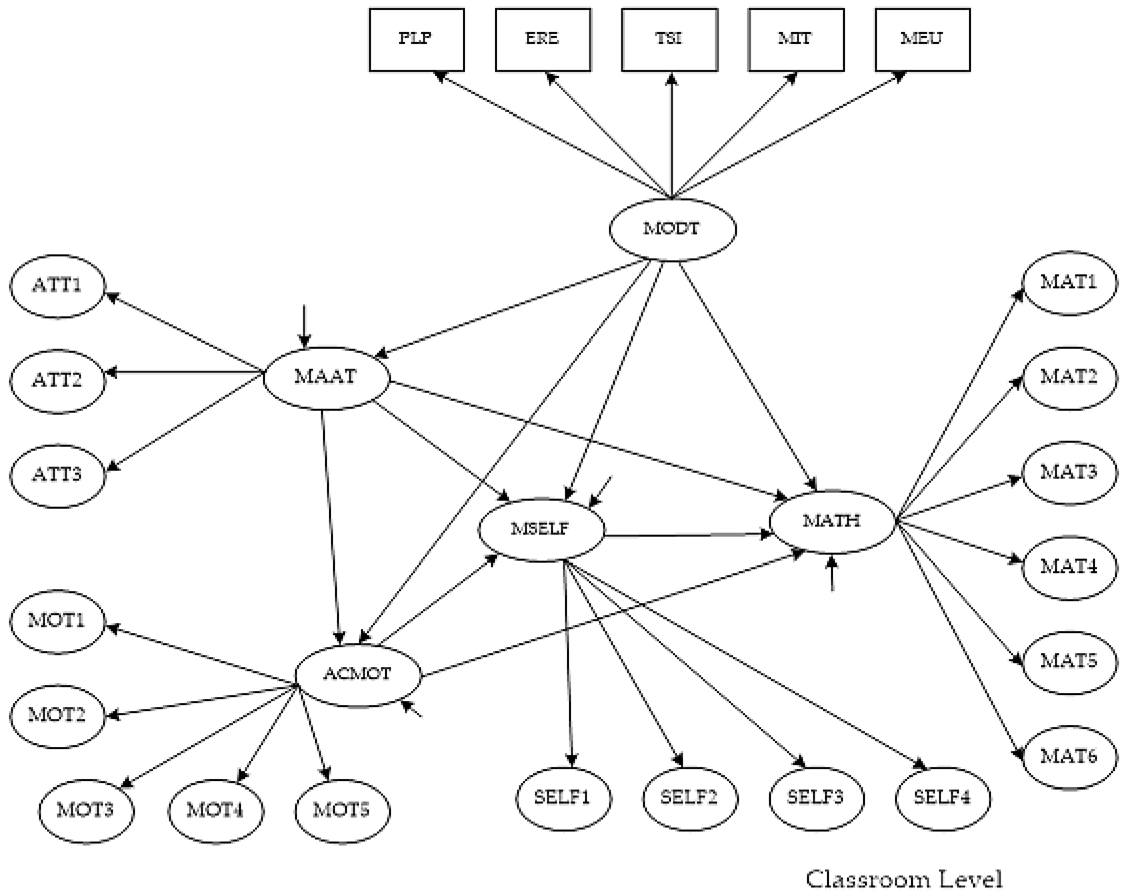

Figure 1a. Hypothesis model

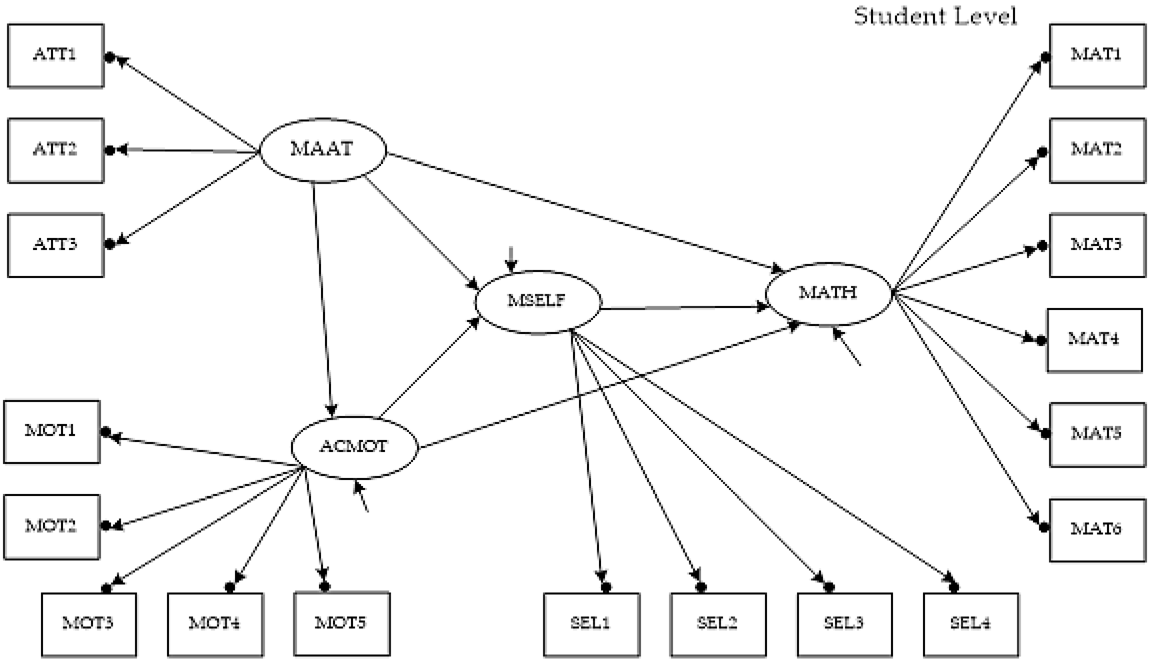

Figure 1b. Hypothesis model

Materials and Methods

Participants

The participants included 1) 2,205 of 9th-grade students: 745 male students and 1,460 female students, and 2) 117 teachers; 54 males and 63 females. This number sufficient for the multilevel analysis in term of considering group level variance (more than 100) (Afshartous, 1995). Most of teachers were between 30- 39 years (43.600%) had the highest education in a bachelor's degree (54.700%). Both informants were in small schools, 47 schools (45.631%), 42 medium schools (40.777%), 6 large schools (5.825%) and 8 extra-large schools (7.767%). The number of students per class was between 11-31 people selected by stratified random sampling of a population of 26,225 people from 192 schools in the northern part of the country. All were under the Office of the Basic Education Commission, Ministry of Education, Thailand.

Research Instruments

Modern teaching (MODT) is measured by 5 level rating questions (1 = showing the least or no behavior at all, 5 = showing that behavior very often, or every time the course is taught). 5 aspects of the measurement (from synthesis and summary of definitions in the literature reviews) are 1) Plan and Preparation (PLP), 18 items (for example, I take the course evaluation results to improve and develop the curriculum continuously, I set goals study Know on the basis of differences and learning nature of each student), 2) 14 items of Environment and Relationship Enhancement (ERE) (for example, I pay attention to the equality of everyone in the classroom, I give students the opportunity to participate in the agreement), 3) Teaching Strategy Implementation (TSI) with 17 items (e.g. I choose to use activities that students can learn from direct experience, I design activities for students to work and collaborate as a team). 4) Media, Innovation, Technology, and Resources for Learning (MIT) with 10 items (e.g. I choose various media innovations and technologies in teaching and learning management, I create a learning network for students in conjunction with homes, communities, and entrepreneurs in the community), and 5) Measurement and Evaluation Utilization (MEU): there are 11 items (for example, I designed and used many evaluation tools depending on the purposes and things that need to be evaluated, giving feedback by me is useful for improving the learning of each student). The try-out results showed that item discrimination based on item-total correlation (r_{xy}) methods had a value between 0.441-0.665. The reliability value according to Cronbach's Alpha (α) method in each element measurement was 0.877, 0.661, 0.760, 0.856 and 0.696 respectively.

Mathematics Attitude (MAAT) is measured by 5 rating scale questionnaire (1 = Disagreeing / Less or Not performing at all, 5 = Most agree / Very often or every time). The total number is 15 items and consists of three areas of measurement (Guimarraest, 2005): 1) knowledge (ATT1) means belief about the role, importance and benefits of mathematics in self-improvement and daily life in 5 items (e.g. I think the math helps develop reasonably and carefully), 2) The feeling towards mathematics (ATT2) refers to the desire to know mathematics, want to use mathematics to develop logical thinking and daily life in 5 items (e.g. I like and have fun when learning mathematics) and 3) mathematical behavior (ATT3) means an expression of learning mathematics and in daily life in 5 items (e.g. I am willing to participate in mathematical activities both inside and outside the schools as far as possible). The try-out results had the discrimination index (r_{xy}) between 0.397 to 0.685 and reliability (α) of each element between was 0.785, 0.790, and 0.470, respectively.

Achievement Motivation (ACMOT) looks like a 5 rating scale questionnaire (1 = disagreeing / less performing or not performing at all, 5 = most agreeing / performing very often or every time), a total of 15 items. There are 5 aspects of measure: 1) Risk (MOT1) means practice / decide on the situation of modern learning, has difficulty and requires the ability to achieve successes in 3 items (for example, I like to solve difficult and challenging math problems), 2) Enthusiasm (MOT2) means lively feeling, having motivation to learn and doing activities in 3 items (e.g. I did my homework and math's work every time). 3) Responsibility (MOT3) means having a sense of responsibility as assigned with 3 items (e.g. I can solve problems in learning mathematics by themselves), 4) Estimation of results (MOT4) means the expectation of the results of the decision and practice activities with 3 items (e.g. I try to search the content resources in various channels in order to understand more things learned), and 5) the Impact of Actions (MOT5) means readiness and can face the consequences of decisions and take action to use as information for improvement, correct for an achievement (for example, when trying to learn maths hard enough, the results are satisfactory). The try-out results had the discrimination index as 0.377-0.736 and validity value in each element was between 0.702, 0.834, 0.700, 0.822, and 0.775, respectively.

Mathematics Self-efficacy (MSELF) is a 5 rating scale questionnaire (1 = Disagree / Less or Not perform at all, 5 = Most agree / Perform more or more frequently). The total items are 12 with 4 aspects areas of measurement: 1) Maths learning ability (SEF1) refers to the recognition of their ability to study mathematics, having 3 items (for example, I can learn all about mathematics when I am interested in), 2) The Opinion on Mathematics learning (SEF2) refers to the viewpoint of benefits and values from learning mathematics, having 3 items, such as mathematics is as a basis for learning other subject content), 3) Expectation from Mathematics learning (SEF3) refers to the intention and predictability of the benefits derived from learning mathematics, having 3 items (for example, I can apply mathematical knowledge in daily life), and 4) the Effort in Learning (SEF4) means using perseverance, self-reliance, self-improvement in mathematics), having 3 items (for example, I tried to study the lesson in order to understand the content before the teacher taught). The discrimination index was between 0.582-0.817 and the reliability value of each element was between 0.854, 0.780, 0.768, and 0.833, respectively.

Mathematics Achievement (MATH) looks like a norm reference test, with 4 choices, 40 items, 1 correct answer, 0 points for wrong answer. Eight content which are surface area, Graph, linear equation with two variables, linear inequality with one variable, probability, Statistics, similarity, and mathematical skill and processes to measure the cognitive domain structure in 6 areas of mathematics consisting of 1) Remembering (MAT1) with 5 items, 2) Understanding (MAT2) with 9 items, 3) applying (MAT3) with 9 items, 4) Analyzing (MAT4) with 9 items, 5) Evaluating (MAT5) with 6 items , and 6) Creating (MAT5) with 2 items. Try-out results with 120 students found that the exam had item difficulty (p) between 0.220-0.680. The item discrimination (r) was 0.210-0.820 and reliability (KR20) was 0.900.

Data Collection

The researcher arranged 3 copies to collect data with students and teachers.

Data collection from students utilized 2 issues: 1) student questionnaire using to collect variables of Mathematics Attitude, Achievement Motivation, and Mathematics Self-efficacy, total length of 42 items with free response time and 2) Mathematics achievement test with 40 items, 90 minutes of exam time, information provided verbally and with clarification about instrument tools and response characteristics before collecting data including clarifying the right to terminate the information at any time if the students are not willing or feeling tired. Both scales were used to collect data with each student to complete within one week after using the first issue. The results of data collection showed that the researcher, distributed questionnaires and examined 2,450 sets and they returned 2,322 sets (90.69%). The 17 set of questionnaires were incomplete due to the incomplete answer. Therefore, the remaining data of students were able to import into the analysis of 2,205 sets. The analysis was done totally for 2 months (February to March 2018).

Data collection for teachers utilized one scale that was 70 items without time limit for answers. The researcher clarified how to respond and rights of the respondents as well as providing student information. The results revealed that the data was returned from the teacher completely. Most respondents spent about 40 minutes. All 117 set of teacher questionnaires were completed and qualified for the next step.

Data Analysis

The analysis of research data used a multilevel structural equation model which is suitable for predicting the value of the variable, followed by independent variables that consider the grouping of data providers as non-independent subgroups. Each student was in the same classroom in the same school, but staying in a different classroom with other students in other schools (Heck & Thomas, 2015) resulting in differences in the characteristics and factors in predicting the variables in each group of individuals. It is also an analytical method that allows the standard error (SE) to be lower than it should be (Steele, 2008).

The researcher designed the model and analysis into 2 levels: "Student Level", consisting of 4 latent variables (MATH, ACMOT, MSELF, and MAAT), measured from 18 observed variables with 2,205 units of analysis. "Classroom Level" consists of 5 latent variables, classified as a class-level latent variable according to the measurement definition "MODT" which is measured from 5 observed variables and each student's latent variable derived from the aggregation of observed variables at the student level in order to study the MODT influencing on mathematics learning achievement through the latent variables of students aggregated by each of the variables. Each measured from the existing student-level observed variables. As a result, there were 117 units of analysis at the classroom level and the average classroom size was 18.846 students. After checking the completeness of the questionnaire received, the researcher conducted the data code and calculated the average question value according to the observed variable at the student level of 18 variables and at the classroom level of 5 variables. Moreover, there was a study of data distribution of all 23 observed variables, it showed skewness and kurtosis not over than -2 to +2 which indicated that the data is likely to be distributed as normal curves (Boomsma & Hoogland, 2001; Muthen & Kaplan, 1985). Then, the data was taken into the multilevel analysis by considering the important statistics: 1) intra-class correlation (ICC) indicates the similarity of students in the same classroom rather than students in the different classroom (Goldstein, 2011; Cohen, Manion, & Morrison, 2011). It calculated from the proportion of variances of variables between groups divided by the total variance from the variable according to the values between 0 and 1 (Heck & Thomas, 2015). In case of more than 12 students in the group size, ICC value for consideration was 0.10 or higher (Muthen, 1997), 2) The goodness of fit indices showed the consistency between, the correlation matrix of the relationship structure between the variables in the hypothesized model and the correlation matrix of the relationship structure between variables from empirical data. It consisted of a group of statistical values and criteria for determining as the Relative Chi-square or the ratio between the statistics, Chi-square ($\chi2$) per degree of freedom (df) should be not exceeded 5 (because the model is complex) (Joreskog, 1969). Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) should be greater than 0.90 (if greater than 0.95 is preferably). Root Mean Square Error of Approximation (RMSEA) should be less than 0.06, and the Standardized Root Mean Square (SRMR) should be lower than 0.08 (Hair, Anderson, Babin & Black , 2010; Hu & Bentler, 1999). For studying mediated effect, it is considered from indirect effect (Kline, 2011: 105; Geiser, 2013: 63) with across level latent variables by writing data analysis commands and using the estimation method with Maximum Likelihood Estimation with Robust Standard Error (MLR), which is the robust to non-normality and non-independence of observations with Mplus 7.4 program.

Findings

The results of the initial data analysis showed that the observed variable had an average of between 0.43 (MAT5) - 4.12 (TSI), standard deviation between 0.23 (MAT5)-0.90 (MOT4) for the distribution of skewness between -0.62 (ERE) to 0.39 (SEL1) and Kurtosis values between -0.86 (MAT2) to 0.16 (ERE) indicating that the trend of data distribution had normality. Moreover, the KMO Measure of Sampling Adequacy = 0.806 and Bartlett's Test of Sphericity = 127932.890, df = 253, p = .000 reject null hypothesis, hence it showed that the observed variables had the relationship and the correlation matrix of such variables was not identity matrix. The overall relationship between the variables at the same level had a positive to moderate level to high level while the overall picture of the relationship between the different levels of variables was very positive at a very low level (Details shown in Appendix).

The result of multilevel structural equation model found that the ICC values of all 18 observable variables at the student level were between 0.20 (SEL2)-0.50 (MOT2) indicating that the variance of each variable among the 117 students was very valuable for studying the causal relationship with multilevel analysis. As for the observed variable of the modern teaching method, it was a variable in the classroom level and therefore did not appear to calculate the ICC value (details are shown in the Appendix). Additionally, the model presented the Model fit information such as $\chi2$ = 1472.572 (358), $\chi2$ / df = 4.113, CFI = 0.973, TLI = 0.969, RMSEA = 0.038, SRMRw = 0.026, and SRMRb = 0.230, which conformed to the conformity assessment criteria of the model and empirical data. It excepted that the SRMRb value exceeding the threshold and indicated that the overall overview of the hypothesis model is likely to be consistent with the empirical data

When considering the parameters in Student Level, the factor loadings of each latent variable were positive and were significantly different from zero at the significant level of .01, indicating that all observed variables can be used to measure the latent variables clearly by standardized factor loadings of MAAT = 0.773-0.896, ACMOT = 0.745-0.930, MSELF = 0.622-0.894, and MATH = 0.543-0.820 as detailed in Figure 2.

When we have considered the standardized path coefficient of each factor, it has been found that the totals was positive effect and the total effect of the MAAT→MATH value was the highest (β = 0.768**), which indirect total effect (total IE = 0.425**) were a slightly greater than direct total effect influence (DE = 0.343**). ACMOT and MSELF had the close total effect to MATH (TE = 0.391** and 0.363** respectively). However, there were differences that ACMOT had an indirect effect. (IE = 0.311**) rather than direct effect (DE = 0.080**) while MSELF had the only direct effect (DE = 0.363**). Nevertheless, factors and the relationship structure between these three aspects could explain the variance MATH for each student as 60.50%.

After examining the analysis results in classroom level, it was found that each factor loadings were positive and were significantly different from zero at .01 significant level. It indicated that the observed variables were both from aggregation at the Student Level and the observable variables based on the teaching quality of each classroom have the appropriateness to represent latent variables by standardized factor loadings of MAAT = 0.579-0.979, ACMOT = 0.787-0.992, MSELF = 0.709-0.963, MATH = 0.819-0.953, MODT = 0.460-0.606 as detailed in Figure 2.

The results of comparing the effect as the standard scores between the variable structure of MAAT, ACMOT, MSELF and MATH ,between the student level and classroom level model, it was found that the total effect of the MAAT→MATH in the classroom level was about 1 time lower than the Student Level (TEclassroom = 0.311**, TEstudent = 0.768**). In particular, the direct effect had the difference of effect size clearly which corresponds to the total effect of the MSELF→MATH which had the total effect in the Classroom Level lower than the Student Level (TEclassroom = 0.266**, TEstudent = 0.363**). This amount had only ACMOT→MATH which had a direct effect on the classroom level rather than the direct effect on the student level (DE = 0.210**). Nevertheless, although it had the differences in effect size between two levels of analysis, all the effect values in the model also showed significant positive direction at the level of .01. Both direct and indirect effects showed that the factor effect and factor structures could describe each student with, different from the structural factors described in each class.

When considering the effect of MODT on all latent variables in the classroom level, it was found that the factor with the highest total effect per MATH (TE = 0.976**) was the indirect effect which was a slightly more direct effect (total IE = 0.527**, DE = 0.449**). In addition, the indirect effect also showed that MAAT, ACMOT, and MSELF were the mediator variable between MODT and MATH with statistical significance in all directions. The path that had the most mediated effect were MODT→ACMOT→MATH (IE = 0.114**), followed by MODT→MSELF→MATH (IE = 0.104**) and MODT→MAAT→ACMOT→MATH (IE = 0.084**) respectively. Both factors and structures of the four factors were important and explained the variance of MATH of each class as 99.00%. The details are described in Table 1 and Figure 2.

Table 1. Standardized path coefficients for multilevel structural equation modeling

Path Directions	Student Level			Teacher Level		
	DE	IE	TE	DE	IE	TE
MAAT→MATH	0.343**	0.425**	0.768**	0.092**	0.220**	0.311**
MAAT →MSELF→MATH		0.051**			0.130**	
MAAT →ACMOT→MATH		0.076**			0.067**	
MAAT →ACMOT→MSELF→MATH		0.297**			0.050**	
ACMOT→MATH	0.080**	0.311**	0.391**	0.210**	0.102**	0.312**
ACMOT→MSELF→MATH		0.311**			0.102**	
MSELF→MATH	0.363**		0.363**	0.266**		0.266**
MODT→MATH				0.449**	0.527**	0.976**
MODT →ACMOT→MATH					0.114**	
MODT →MSELF→MATH					0.104**	
MODT → MAAT →MATH					0.074**	
MODT → MAAT →ACMOT→MATH					0.084**	
MODT →ACMOT→MSELF→MATH					0.055**	
MODT → MAAT →MSELF→MATH					0.055**	
MODT → MAAT →ACMOT→MSELF→MATH					0.041**	

Note: 1) **p<0.01, 2) DE=direct effect, IE=indirect effect, TE=total effect

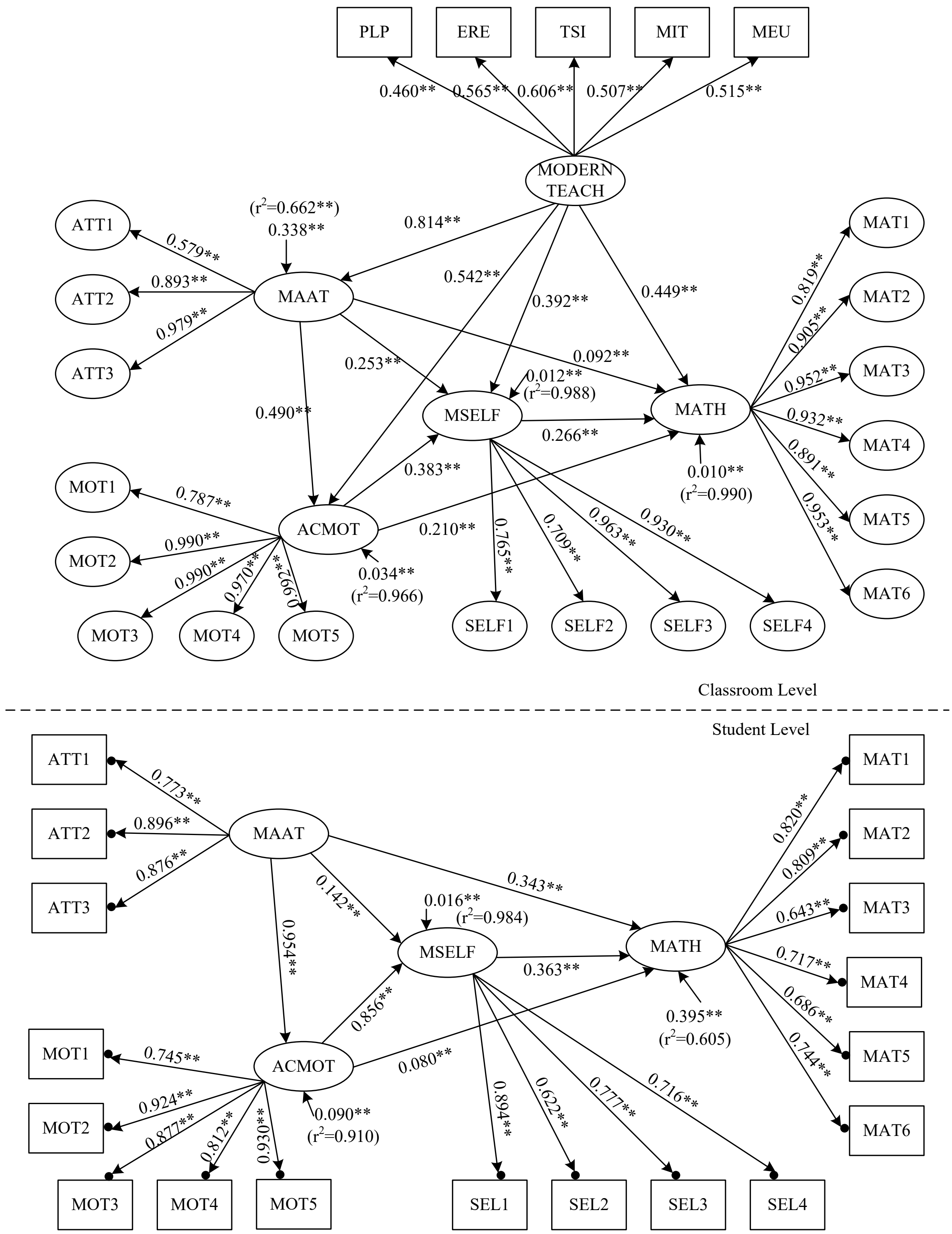

Figure 2. Standardized path coefficients for the multilevel structural equation model.

Note: 1) ** p <.01, 2) Black dot = average of variables in each classroom, 3) r² = Coefficient of determination

Discussions and Implementations

According to the above research results, the researcher has the following important discussions:

Analytical results of the multilevel structural equation model showed the overview that the hypothesized model is in harmony with empirical data as expected due to the screening of important variables and having the foundation based on research that confirmed the causal relationship with mathematics achievement both directly and indirectly (e.g. Lee, 2016; Prast et al., 2018; Sartawi et al., 2012; Skaalvik et al., 2015). Then, it results in the statistical significance of all positive effect values in both the relationship structure at the Student Level and the Classroom Level. Moreover, in terms of design, data collection, the researcher determined the sample size was sufficient to estimate the parameters and applied a multilevel analysis technique that is suitable for a hierarchical level structure based on the recommendations of various scholars (Burrus & Moore, 2016; Karakolidis et al., 2016; Pipere & Mierina, 2017; Pitsia et al., 2017; Sriphai et al., 2012). However, even though the model overview has achieved the expected results, there is a notice from the SRMRb value that still has over value.

The researchers predicted that there are two important reasons: 1) The relationship structure between MAAT, ACMOT, MSELF affecting MATH is similar in both levels and it may be accurate in explaining the MATH at the Student Level rather than explaining at the classroom level and 2) in the relationship structure of the classroom level factors is a structure that aims to study the mediator effect of MODT towards MATH through all student variables. It can be considered that MODT is truly the classroom level factor based on specific definitions that appear in the Classroom Level model. It did not require to study the structure of all classroom and teacher variables according to the theory, thus bringing the value of SRMRb exceeds the threshold as shown. Therefore, according to the researcher's viewpoint, such results are acceptable since the research objectives do not focus on combining classroom variables and many other teachers to participate in the conceptual framework which may affect the model to be more complicated than necessary (Kline, 2011).

According to the structure of the student level model, MAAT, ACMOT, and MSELF are still important factors to explain MATH variance as well as much previous research with the finding that each factor has a direct and indirect effect on MATH with statistical significance in all directions. It can be also said that each factor is related to each other for explaining the ability of each student to study mathematics and cannot separate since co- explaining the variance of MATH for up to 60%. In this amount, MAAT is considered the most prominent factor because it has a very high effect to compare with other factors, including direct effect and an indirect effect through both factors. The results of this research also confirm the conclusion from previous research findings that an important variable in the development of mathematics achievement was the mathematics attitude (e.g. Lee, 2016; Lipnevich et al., 2016; Sriphai et al., 2012). Since there was an effect both on learning results and other factors at the same time, it showed that in developing learners to have mathematics achievement cannot only focus on promoting each students' content understanding, but it should also encourage students to have a good attitude towards mathematics, realize the benefits of applying mathematical content in various situations, practice applying mathematics in various situations (Wigfield & Eccles, 2000) because it helps students to understand the content learned and also helps students reach achievement motivation.

It has obviously seen that for the classroom level, MODT is an important role for both academic and non-academic learners. When teachers design the teaching with quality, it not only helps students to develop learning achievement, but also helps to develop the factors of MAAT, ACMOT, and MSELF which will eventually lead to the development of the achievement. Significantly, the most obvious change is in the ACMOT factor which plays a greater role in students while is in the Student Level structure. The researcher is hardly ever surprised at the answers obtained from this analysis for MODT has defined and measured in five key elements, especially classroom management and building relationships among effective class people, organizing cooperative teaching activities, using emotional support, using homework and assigning effective tasks, teaching students to deal with problems and obstacles to develop themselves, using modern technology and learning resources, assessing learning assessments in various ways and reflecting positive learning results for continuous defect correction. These will clearly lead to the development of learners in both academic and nonacademic factors like the past research results (Farmer, 2018; Key et al., 2012; Schenke et al., 2015; Yurt, 2015).

The researcher had the observations about the factor loadings of MODT that were found to be between 0.460-0.606 which is lower than the factor loadings of other variables in the overall picture. The expected cause might be that the MODT measurement framework used in this research. This framework has the specific characteristics developed from the synthesis of documents and research reports both domestically and abroad. Therefore, it has the MODT measurement framework in general. In fact, each country has a different context or readiness to develop teaching and learning (Kalaycioglu, 2015). As in Thailand, with the context of developing national education management, which differs from foreign countries, even though Thailand is a country with a relatively small area compared to countries around the world, there are more than thirty-three thousand schools that open for the high school level nationwide There are many types of teacher production systems from various departments. However, the problem of educational inequality is found, according to the location and affiliations and then it causes the delayed development of modern teaching and learning management based on teaching in the 21st century still, especially in the development of curriculum/teaching activities that emphasize the development of advanced thinking processes (Damrongpanit, 2018) and the application of media and technology to learn from online society. For research sample teachers who have started working for less than 15 years, about half of those with bachelor's degree education and educational applications are still problems that all concerned parties are trying to push to the present. This reason reflects that the component weight of MODT is not very high. However, the researcher foresees that this particular value is still at a moderate level close to the high and does not affect the conclusion about the causal relationship of variables in the model.

In conclusion, the development of mathematics achievement cannot be done only by teaching the content in detail in the classroom anymore due to some part of success is derived from the nonacademic factor of the learners themselves. Consequently, the teaching adjustment that takes into account the development of learning results together with the development of nonacademic factors is a direct development of learners with effectiveness and sustainability. Furthermore, good teaching quality will only affect the quality of learners' learning. It also prepares students to be able to apply the knowledge to a new world that is full of a variety of language groups, advanced technology, and knowledge. Therefore, preparing logic for mathematical reasoning for young people is one of the important foundations that should start from the teaching penetrated teaching.

Referring to the research results, the researcher suggested the application of research results in two important areas: 1) the development of individual student mathematics, the teachers should focus on the affective domain that covers both attitudes toward mathematics, mathematics achievement motivation, and self-efficacy of students, respectively. It may be considered more stimulating through new learning management because there is a much more flexible and versatile process, such as using Blended Learning Online (Balentyne, 2017) Online Application (Boholano, 2017). Applying design strategies and assignments (Sartawi et al., 2012) can utilize various and modern resources to stimulate attitude toward mathematics. The development of mathematics achievement motivation can be developed using a variety of learning activities (Tambunan, 2018), promoting participation in teaching and learning (Putwain, Symes, Nicholson, & Becker, 2018), using emotional support for students (Skaalvik et al., 2015), learning and working as a team with the creation of a good relationship with students (Nessipbayeva, 2012) including encouraging learners to use the strengths based on learning styles for learning (Sriphai et al., 2012). As the promotion of self-efficacy has guidelines such as providing emotional support for students to feel warm in using their personal ability to learn and solve problems (Dinkelmann & Buff, 2016; Guven & Cabakcor, 2013; Skaalvik et al., 2015), promoting learners' meta-cognition (Altun & Erden, 2013; Mundia & Metussin, 2019; Rastegar et al., 2010) through work and homework with reflection processes (Almuntashiri et al., 2016; Rosarrio et al., 2015), etc.

The researchers with the interest of studying causal relationships between various factors that affects mathematics achievement, the researcher foresees that factor structure at the Student Level has a clear and comprehensive research result. Some factors do not lead to this research framework, such as self-confidence (Karakolidis et al., 2016; Pipere & Mierina, 2017; Pitsia et al., 2017; Tosto et al., 2016) and learning Styles (Mundia & Metussin, 2019; Sriphai et al., 2012) since the need to develop models, it necessarily uses the variables as necessary and as an economical model.

In sequence, the student factors that appeared in the model have been synthesized and there is evidence confirming the importance of the direct effect. In contrast to the structural factors of the class or school that still lack sufficient clear conclusions due to the area of the variable that may be effective, student learning is extensive, contextual differences, including conclusions from past research results that give priority to the structure of the cascading structure of each factor, rather limited. It may have the synthesis of results from research about the classroom factors inaccurate. In addition, with the changing trend of new and more flexible teaching and learning management perspectives. It is appropriate that researchers should conduct additional studies to get further conclusions.

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Appendix

Table 2. Descriptive statistics and correlation matrix of observed variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. MAT1	1.00																						
2. MAT2	0.58*	1.00																					
3. MAT3	0.53*	0.50*	1.00																				
4. MAT4	0.55*	0.65*	0.49*	1.00																			
5. MAT5	0.50*	0.47*	0.45*	0.51*	1.00																		
6. MAT6	0.52*	0.56*	0.54*	0.52*	0.46*	1.00																	
7. ATT1	0.62*	0.61*	0.55*	0.57*	0.52*	0.57*	1.00																
8. ATT2	0.69*	0.68*	0.61*	0.66*	0.62*	0.65*	0.79*	1.00															
9. ATT3	0.72*	0.69*	0.68*	0.69*	0.61*	0.65*	0.74*	0.80*	1.00														
10. MOT1	0.60*	0.61*	0.54*	0.58*	0.53*	0.58*	0.80*	0.82*	0.70*	1.00													
11. MOT2	0.77*	0.77*	0.72*	0.76*	0.68*	0.73*	0.75*	0.85*	0.87*	0.76*	1.00												
12. MOT3	0.71*	0.70*	0.65*	0.67*	0.60*	0.65*	0.72*	0.82*	0.82*	0.75*	0.88*	1.00											
13. MOT4	0.67*	0.65*	0.64*	0.64*	0.59*	0.63*	0.77*	0.79*	0.73*	0.69*	0.84*	0.79*	1.00										
14. MOT5	0.73*	0.72*	0.67*	0.68*	0.63*	0.67*	0.71*	0.83*	0.86*	0.74*	0.90*	0.89*	0.80*	1.00									
15. SEL1	0.72*	0.71*	0.69*	0.71*	0.64*	0.69*	0.70*	0.84*	0.85*	0.74*	0.90*	0.89*	0.82*	0.90*	1.00								
16. SEL2	0.53*	0.50*	0.43*	0.48*	0.41*	0.47	0.75*	0.65*	0.69*	0.67*	0.63*	0.70*	0.56*	0.62*	0.62*	1.00							
17. SEL3	0.69*	0.65*	0.58*	0.63*	0.54*	0.62*	0.68*	0.76*	0.74*	0.71*	0.83*	0.83*	0.70*	0.80*	0.80*	0.57*	1.00						
18. SEL4	0.56*	0.56*	0.49*	0.55*	0.51*	0.52*	0.63*	0.73*	0.71*	0.64*	0.69*	0.71*	0.60*	0.73*	0.71*	0.68*	0.64*	1.00					
19. PLP	0.02	0.02	-0.01	0.02	-0.03	0.02	0.00	-0.01	-0.02	0.00	0.02	0.01	0.01	0.01	0.01	0.02	0.00	-0.01	1.00				
20. ERE	0.12*	0.13*	0.08*	0.10*	0.01	0.08*	0.06*	0.06*	0.07*	0.05*	0.10*	0.10*	0.08*	0.10*	0.10*	0.06*	0.09*	0.07*	0.61*	1.00			
21. TSI	0.16*	0.16*	0.15*	0.16*	0.07*	0.14*	0.10*	0.13*	0.14*	0.13*	0.17*	0.15*	0.15*	0.17*	0.17*	0.11*	0.13*	0.11*	0.56*	0.72*	1.00		
22. MIT	0.21*	0.22*	0.21*	0.23*	0.15*	0.22*	0.16*	0.19*	0.24*	0.17*	0.26*	0.22*	0.21*	0.24*	0.24*	0.15*	0.20*	0.16*	0.31*	0.54*	0.59*	1.00	
23. MEU	0.16*	0.15*	0.15*	0.18*	0.11*	0.11*	0.12*	0.12*	0.16*	0.12*	0.17*	0.15*	0.14*	0.15*	0.17*	0.13*	0.12*	0.12*	0.55*	0.57*	0.55*	0.44	1.00
Mean	0.56	0.60	0.45	0.49	0.43	0.54	3.35	3.38	2.83	3.20	2.94	3.00	3.18	2.98	2.92	3.09	2.98	3.08	4.09	4.09	4.12	3.49	3.90
SD	0.25	0.25	0.24	0.26	0.23	0.24	0.82	0.71	0.83	0.73	0.77	0.79	0.90	0.80	0.84	0.71	0.79	0.75	0.42	0.36	0.42	0.66	0.51
Skewness	-0.09	-0.14	0.24	0.18	0.10	0.06	-0.51	-0.36	0.33	-0.24	0.28	0.00	0.03	0.19	0.39	0.00	-0.02	0.10	-0.20	-0.62	-0.31	0.14	0.03
Kurtosis	-0.75	-0.86	-0.57	-0.76	-0.76	-0.67	-0.18	0.04	-0.58	0.00	-0.72	-0.53	-0.59	-0.25	-0.25	-0.22	-0.27	-0.36	-0.62	0.16	-0.35	-0.77	-0.63
ICC	0.41	0.39	0.363	0.44	0.30	0.33	0.27	0.37	0.41	0.28	0.50	0.40	0.37	0.456	0.47	0.20	0.34	0.24	n.a.	n.a.	n.a.	n.a.	n.a.

Note: 1) n.a. = not calculate for ICC value because it used as the variables for the Classroom Level, 2) KMO Measure of Sampling Adequacy=0.806, 3) Bartlett's Test of Spherity=127932.890, df=253,p=.000, 4) * p<.05