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Achievement goals, emotions, and failure tolerance: Path model of students' mathematics motivation

Avelino G. Ignacio Jr.[1,*]

[1]**College of Education, Bulacan State University, Philippines**

Abstract

The purpose of this research paper is to decompose effect patterns comprising achievement goals, emotions, and academic failure tolerance in a single path model from a mathematics perspective. Teacher-education undergraduates from the College of Education of Bulacan State University, Philippines (N = 261) got via multistage sampling accomplished the self-report measures online: Achievement Goal Questionnaire, Achievement Emotions Questionnaire, and School Failure Tolerance Scale. Structural equation modeling was used to assess the research model. Results showed that the modified structural model indicators have good construct reliability, convergent validity, and discriminant validity, having an adequate fit, supporting several hypotheses. Findings showed that approach goals positively impact positive emotional pride, and negatively impact negative outcome emotions. Negative outcome emotions impact fear and discouragement after making errors on tasks they are trying to learn. Interpersonally defined avoidance goals yield low negative activity emotions. The path model offered a cleaner picture of the results.

Keywords: structural model, achievement goal, achievement emotion, academic failure tolerance, mathematics motivation

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1. Introduction

Learners usually give attention to tough topics at their own pace as long as they see themselves learning [1]. However, when context-specific academic-related drawbacks arise and are assumed to carry on through failure, complex developments may emerge [2, 3]–stirring achievement goals [4, 5], achievement emotions [6], and failure tolerance [7, 8] which when not addressed, may limit the ability to appraise necessary options for structuring desired outcomes [9, 10]. Upholding clear achievement goals orient students to focus on their progress rate, paying less weight to subjectively trivial ones [11, 12], which affects emotional inputs and academic preferences [13 – 15]. The amount of failure tolerance placed in schools powerfully predicts risk-taking on tasks that trigger self-enhancement goals [16 – 18], promoting mathematics efficiency [3]. That is, although the students may be extrinsically motivated by grades and by this means want to succeed in various mathematics-related activities and learning outcomes, they may still experience difficulties in pursuing their academic goals, motivational glitches concerning willingness and ability to remain focused, and on tasks in their mathematics studies. Consequently, teachers, in the pursuance of enhancing motivation towards mathematics learning, should be definite about how students' academic orientations, feelings, and failure tolerance vary and are linked to address the needs of students and eventually assist them in academic growth [19, 20]. Thus, the main goal of this research paper is to decompose effect patterns comprising achievement goals, emotions, and academic failure tolerance in a single path model. This research contributes to the achievement motivation research in mathematics.

2. Literature and Hypotheses

2.1 Achievement goals

Achievement goals (AGs) are mental images of intrapersonally or interpersonally stirred competence-based preference one seeks to attain [4, 21]. This preference can be chosen and later be valued according to definition and valence [4, 14]. In terms of definition, we have intrapersonal or interpersonal; in terms of valence, positive or negative [5, 22]. AGs theorized four types-mastery-approach (MAp), mastery-avoidance (MAv), performance-approach (PAp), and performance-avoidance (PAv) [4, 5]. MAp focuses on refining knowledge; MAv concentrates on avoiding misunderstanding; PAp centers on showing good relative performance; and PAv engages in preventing looking worse [21]. MAp and MAv are intrapersonal, while PAp and PAv are interpersonal. MAp and PAp are positive, while MAv and PAv are negative [22].

2.2 Achievement emotions

Achievement emotions (AEs) are formed when students assume subjectively valued outcomes and activities in or out of control [23 – 25]. AEs propose three-dimensional taxonomy: valence-activation-object focus [25]. The valence splits positive (e.g., pride and enjoyment) and negative (e.g., hopelessness, boredom, anxiety, shame, and anger) emotions. The activation splits activating (e.g., shame, anger, pride, anxiety, and enjoyment) and deactivating (e.g., boredom and hopelessness)

*Corresponding author; email: avelino.ignaciojr@bulsu.edu.ph

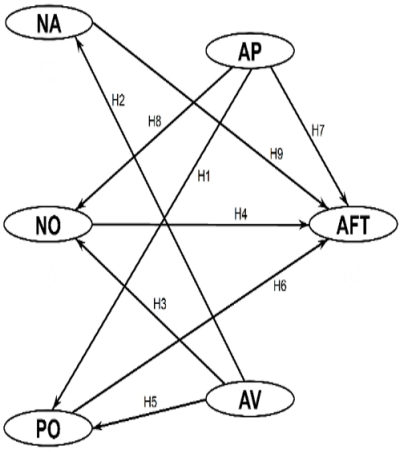

Figure 1: Research model
Notes: NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, and AFT academic failure tolerance

emotions. The 'object focus' separates activity (e.g., enjoyment, boredom, and anger) from outcome (e.g., retrospective outcome pride and shame; prospective outcome hopelessness and anxiety) emotions [26 – 30].

2.3 Academic failure tolerance

As Kim and Choi [8] defined: "Academic failure tolerance (AFT) is a characteristic that responds positively and constructively to failure in an academic situation." This indicates constructive resistance to current failures. From constructive failure theory, AFT varies depending on how the students respond to and are conscious of personal goals and available assessment and evaluation [3, 31]. With an amount of grit rising from clear responses to valued goals and available evaluation, students are assumed to increase effort after failure by using tougher constructive efforts on tasks that trigger self-enhancements [16, 32].

2.4 Research model

For the research model (see Figure 1), the latent variables are shown with an oval-NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, and AFT academic failure tolerance. The single-headed arrows specify the structural relationship between variables labeled by the research hypotheses.

Recent studies offer evidence as to the links of the key constructs. Approach goals are reported to have positive paths to enjoyment, pride, and hope; whereas avoidance goals, in general, posit significant paths to anger and boredom; while there are paths to hopelessness and shame when interpersonally stimulated; whereas shame has links to fear of failure [6, 15, 33 – 36].

H1: AP has a significant positive impact on PO.
H2: AV has a significant impact on NA.
H3: AV has a significant impact on NO.
H4: NO has a significant negative impact on AFT.

Interpersonally stirred avoidance goals are linked negatively to pride and hope [23]. When attached to challenge appraisals, approach-oriented hope and enjoyment lead to higher amounts of engagements [25, 35, 37], while approach goals are linked negatively to shame and hopelessness [23]. Low boredom, great pride, and enjoyment are more likely to incite better efforts after failure when academic control has been found [38, 39].

H5: AV has a significant negative impact on PO.
H6: PO has a significant positive impact on AFT.
H7: AP has a significant positive impact on AFT.
H8: AP has a significant negative impact on NO.
H9: NA has a significant negative impact on AFT.

3. Methods and Materials

3.1 Design and data collection

This study used structural equation modeling (SEM) [40]. SEM combines path analysis to develop a structural model with latent variables and factor analysis to test causal theories comprising multifaceted constructs measured with error. To determine the sample size, this research followed the recommendation of Hair *et al*. [40] involving an SEM study with seven or fewer constructs-a minimum sample size of 150, got via multistage sampling [41]. Voluntarily, the participants included undergraduate students of the Bulacan State University-College of Education (N = 261), located in Bulacan, Philippines, enrolled in the school year 2020 – 2021. Specifically, 177 Bachelor of Secondary Education (67.8%) and 84 Bachelor of Technical and Livelihood Education (32.2%) students were used, in which 61 (23.4%) and 200 (76.6%) were males and females, respectively.

The researcher asked for approval from the college dean to conduct the study and moved to the actual survey after getting approval. The survey was distributed via Google Forms. As to ethical considerations, informed consent, respect for confidentiality and anonymity, and voluntary participation were observed. The researcher clarified all essential matters about the study in the first section of the Google Forms survey and asked to confirm voluntary involvement using a consent form. Participants must have voluntarily filled out the consent form before answering the survey. The students were given ample time to reply. The data were transferred in a spreadsheet afterward.

Table 1. Goodness of fit and fit indices of the measurement model.

Model	m	χ^2	df	χ^2/df	CFI	TLI	RMSEA	Overall Model Fit
1	108	11421.58***	5655	2.02	.56	.55	.08	Inadequate
2	19	215.90***	137	1.58	.96	.95	.06	Adequate

Notes: ***$p < .001$; m number of measured variables. The threshold values are as follows: χ^2 ($p > .05$); χ^2/df (≤ 3); CFI ($\geq .95$); TLI ($\geq .95$); RMSEA ($\geq .08$). In case χ^2 is significant at $p < .001$, χ^2/df is referred [40].

Table 2. Convergent validity and construct reliability of the measurement model.

Latent Variables	Measured Variables	Convergent Validity		Construct Reliability	
		Loadings (≥.70)	AVE (≥.50)	CR (≥.70)	α (≥.70)
NO	Ho1	.800***	.651	.929	.928
	Ho3	.786***			
	Ho4	.830***			
	Ax10	.777***			
	Ax14	.823***			
	Sh6	.808***			
	Sh7	.822***			
NA	Br2	.766***	.655	.791	.787
	Ag4	.851***			
PO	Pr1	.901***	.839	.913	.912
	Pr2	.931***			
AFT	Af10	.756***	.619	.764	.762
	Af12	.816***			
AV	Pv1	.780***	.674	.861	.859
	Pv2	.852***			
	Pv3	.829***			
AP	Mp1	.758***	.626	.834	.833
	Pp1	.816***			
	Pp2	.799***			

Notes: ***$p < .001$; AVE average variance extracted; CR composite reliability; α alpha. Threshold values are placed below each indicator. Attributes of estimators for construct reliability and convergent validity were adapted from *Multivariate Data Analysis* by Hair *et al*. [40].

3.2 Measures

Achievement Goal Questionnaire (AGQ) [42], Achievement Emotions Questionnaire - Mathematics (AEQ-M) [30], and School Failure Tolerance Scale (SFT) [16] were used. AGQ has 12 items–three items reflecting each AG, evaluated on scales from 1 (not all true of me) towards 7 (very true of me). AEQ-M has 60 items–pride (6), enjoyment (10), boredom (6), anger (9), anxiety (15), hopelessness (6), and shame (8). Items are evaluated on scales from 1 (strongly disagree) to 5 (strongly agree). Lastly, SFT has 36 items, evaluated from 1 (strongly disagree) to 5 (strongly agree). Ignacio [29] offered evidence on the reliability of AGQ and AEQ-M, with $\alpha_{agq} \geq .76$ and $\alpha_{aeq} \geq .71$; while Clifford [16] stated SFT with $\alpha_{sft} \geq .80$. Reverse-coded SFT items are recoded, inferring high failure tolerance on a high score.

3.3 Data analysis

The researcher defined the latent variables specifying relevant scales. Secondly, unengaged responses were removed through standard deviation. Thirdly, confirmatory factor analysis (CFA) [40] was used to assess the models' fit, reliability, and validity and respecify the model. Fourthly, the structural model was modified using fit and modification indices, observing a priori knowledge for relevance. Lastly, after getting an adequate structural model, each path was tested. All significant paths were analyzed.

4. Results and Discussion

4.1 Model respecification

The overall fitness of the model was estimated based on the goodness of fit statistic and fit indices– χ^2 chi-squared statistic; χ^2/df normed chi-square; CFI comparative fit index; TLI Tucker-Lewis index; and RMSEA root mean square error of approximation (see Table 1) [40]. The respecified measurement model[2] (see Figure 2) fits the data adequately, in particular, $\chi^2(137) = 215.90$, $\chi^2/df = 1.58$, CFI = .96, TLI = .95, RMSEA = .06.

From Figure 2, all measured variables have standardized factor loadings greater than or equal to .76; all error variances are less than or equal to .43. More than half of the variation in an item is explained by their corresponding latent factor assessed

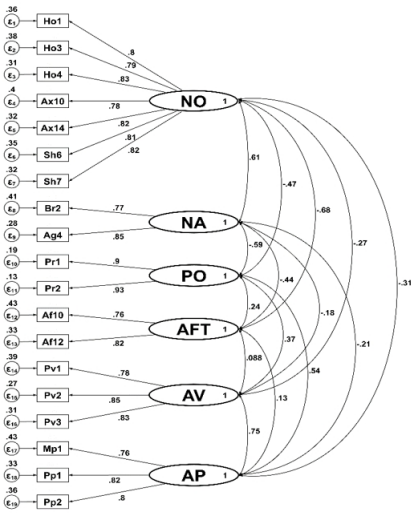

Figure 2: Measurement Model

Notes: NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, and AFT academic failure tolerance

Table 3. Discriminant validity of the measurement model.

	Mean	SD	1	2	3	4	5	6
1. NO	3.22	1.21	.807					
2. NA	1.89	0.91	.608	.809				
3. PO	3.45	1.01	–.469	–.586	.916			
4. AFT	2.60	1.15	–.679	–.444	.239	.787		
5. AV	5.42	1.14	–.267	–.178	.366	.088	.821	
6. AP	5.39	1.16	–.307	–.208	.538	.130	.746	.791

Notes: SD standard deviation; diagonal elements (in bold) present the square root of AVE; off-diagonal entries show the latent correlations. Positive correlations move together, while negative correlations move inversely. The diagonal entries must be higher than the absolute value of any off-diagonal entries to establish discriminant validity. The Fornell-Larcker criterion was adapted from Fornell & Larcker [44].

using the variance extracted. The covariances between distinct latent variables are less than or equal to .75. While Hair *et al.* [40] suggested that latent constructs are to be specified by at least three measures, the conscientious use of at least two but best indicators is sufficient in SEM [43], allowing the use of two measured variables for the NA, PO, and AFT.

From Table 2, all factor loadings are greater than or equal to .76. The average variance extracted (AVE) on each latent construct is greater than or equal to .62. For CR and a, all values are greater than or equal to .76. Hence, the measured variables of each latent construct converge an acceptable amount of explained variance, thus, reliably and validly representing the same latent construct. Table 3 specifies the extent to which a latent construct is distinct from others via the Fornell-Larcker criterion [44]. The square root of the AVE is higher than any latent correlations, showing discriminant validity–each latent variable is distinct from the others. Accordingly, the model's indicators have been established (see Appendix).

4.2 Structural model modification

The overall fitness of the structural model was estimated based on the goodness of fit statistic and several fit indices (see Table 4). The same set of indicators defined earlier was used to test the fit of the structural model [40]. The modified structural model[2] fits the data adequately with $\chi^2(125) = 198.77$, $\chi^2/df = 1.59$, CFI = .96, TLI = .95, RMSEA = .06.

4.3 Path analysis and hypothesis testing

Table 5 specifies the paths supported and not supported by the modified structural model.

Significant Path AP→PO

The magnitude of determination the students place to thoroughly master the material presented in math class (Mp1) as well as to perform well in proportion to other students (Pp1, Pp2) meaningfully impacts the amount of positive emotion–pride (Pr1, Pr2). The more the students simultaneously aim to master the material (Mp1) and perform well interpersonally (Pp1, Pp2) in consequence of thinking deeply about competence as fulfilling and appealing [22], the more the students consciously form a sense of pride in their knowledge and contributions to the math class (Pr1, Pr2).

Significant Paths AP→NO and NO→AFT

The lesser attention the students place on improving their mathematical knowledge and understanding and demonstrating their ability to others induces negative-outcome emotions. Before taking a math test, the students feel down (Ho1), keep thinking that they do not understand the material (Ho3) and that they may never get good grades (Ho4), in addition to feeling

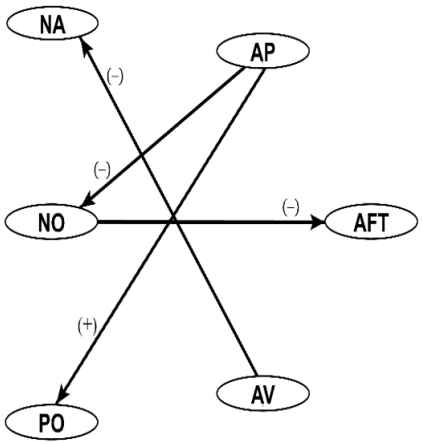

Figure 3: Final Path Model
Notes: NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, and AFT academic failure tolerance

Table 4. Goodness of fit and fit indices of the structural model.

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	Overall Model Fit
1	385.42***	143	2.70	.87	.85	.10	Inadequate
2	198.77***	125	1.59	.96	.95	.06	Adequate

Note: $***p < .001$

sick to their stomach, suggesting feeling troubled and worried (Ax14). While taking a math test, students worry they might get a bad grade (Ax10). It can be observed that the future outcome of any effort to gain academic control before and while taking a math test can be subjectively thought of as uncertain, either favorable or unfavorable [25]. After taking a math test, students feel ashamed (Sh7). Likewise, they avoid eye contact when discussing the homework assignments with their classmates (Sh6). Here, the negative-outcome emotion can be attributed to their personal interpretation of the possible causes of past outcomes [45]. The inadequacy of grit [32] to completely master the material and to perform well compared to others (Mp1, Pp1, Pp2) [21] impacts negative-outcome emotions (hopelessness and anxiety due to uncertainty of future outcomes and shame due to the subjective interpretation of the possible causes of past outcomes, either caused by the self, other people, or external circumstances) [25, 45].

The negative-outcome emotion is specified as having a significant negative effect on academic failure tolerance. Items Af10 and Af12 are reverse items and were recoded during the data analysis. Thus, the more the students hold negative-outcome emotions, the more discouraged they get after committing errors on tasks they are trying to learn (Af10) and feel terrible after giving wrong answers to a teacher's question (Af12). It must be pointed out that the indirect path AP→NO→AFT is not significant. NO does not meaningfully influence variations in AP→AFT, although AP→NO and NO→AFT are significant.

Significant Path AV→NA

The extent of prevention the students put to avoid looking slow, performing worse, and doing poorly in proportion to other students (Pv1, Pv2, Pv3) influences the extent of negative-activity emotion-boredom and anger (Br2, Ag4) in a sufficiently meaningful way. As the students attempt to avoid doing worse than the others entirely (Pv1, Pv2, Pv3), they become more focused, so much that their boredom (Br2) and irritation during math class (Ag4) diminishes. While this path is significant, this result contradicts one of Linnenbrink-Garcia & Barger's [23] findings. The result of the present study involving undergraduate education students confirmed that the performance-avoidance goal (Pv1, Pv2, Pv3) relates negatively to negative-activity emotion (Br2, Ag4). As stated by Pekrun *et al.* [45]: "... boredom is induced when the activity lacks any incentive value" (p. 38). Inversely, anger is induced when the subjective value of achievement-related activities is high [25] (p. 320). It can be stated that the central focus is on action for boredom and anger, not on outcomes [25] (p. 319). Therefore, strong performance-avoidance goals that satisfy students' actions and engagements in math class (Pv1, Pv2, Pv3) meaningfully yield low boredom (Br2) and low anger (Ag4).

5. Conclusion

The present research findings attest to the reliability and validity of the respecified measurement model (see Figure 2). The findings show that the indicators (see Appendix) are good and are well-suited for their purpose. The modified structural model[2] (see Table 4) utilized fit and modification indices and a priori knowledge in refining its overall fit. Findings show that the students who simultaneously aim to master the material presented in math class and do well relative to others consciously feel pride for their knowledge and contributions to the math class, or else negative-outcome emotions may occur. When future outcomes are seen as uncertain or by any means are associated with subjective causes of their past outcomes, students who are making an effort to learn some materials presented in the math class, if faced with academic-related drawbacks,

Table 5. Hypothesis testing.

Hypothesis	Hypothesized Path	Loadings	*p*-value	Decision
H1	AP→PO	.459	.000	Supported
H2	AV→NA	–.183	.039	Supported
H3	AV→NO	–.128	.190	Not Supported
H4	NO→AFT	–.797	.000	Supported
H5	AV→PO	.101	.296	Not Supported
H6	PO→AFT	–.058	.656	Not Supported
H7	AP→AFT	–.053	.617	Not Supported
H8	AP→NO	–.251	.006	Supported
H9	NA→AFT	.169	.264	Not Supported

Notes: NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, and AFT academic failure tolerance

both discouragement and fear of committing errors preoccupy their minds. Strong performance-avoidance goals that satisfy students' actions in the math class produce low boredom and low anger. The final path model (see Figure 3) utilizing the achievement goals, emotions, and failure tolerance constructs presented a more straightforward and cleaner picture of the findings, bearing in mind the indicators of the modified structural model.

6. Recommendation

The researcher initially tried to assess the fit, reliability, and validity of each construct existing in the literature but was unsuccessful due to low construct and discriminant validity and thus ended up with six constructs through item parceling. The study included teacher education students. In connection to this, the researcher recommends using a more diverse set of samples to acquire more information comprising indirect effects and not ending up with item parceling.

References

[1] M. H. Cho, M. L. Heron, Self-regulated learning: The role of motivation, emotion, and use of learning strategies in students' learning experiences in a self-paced online mathematics course, Distance Education, 36(1) (2015) 80 – 99.

[2] R. P. Perry, S. Hladkyj, R. H. Pekrun, R. A. Clifton, J. G. Chipperfield, Perceived academic control and failure in college students: A three-year study of scholastic attainment, Research in Higher Education, 46(5) (2005) 535 – 569.

[3] J. E. Rowlett, Constructive failure in mathematics classes, Principal Leadership, 11(8) (2011) 36 – 39.

[4] A. J. Elliot, A conceptual history of the achievement goal construct, In A. J. Elliot & C. S. Dweck (Eds.), Handbook of Competence and Motivation, 52 – 72, New York: The Guilford Press, 2005a.

[5] A. J. Elliot, Competence and motivation: Competence as the core of achievement motivation, In A. J. Elliot & C. S. Dweck (Eds.), Handbook of Competence and Motivation, 3 – 12, New York: The Guilford Press, 2005b.

[6] T. Goetz, F. Sticca, R. Pekrun, K. Murayama, A. J. Elliot, Intraindividual relations between achievement goals and discrete achievement emotions: An experience sampling approach, Learning and Instruction, 41 (2016) 115 – 125.

[7] S. J. Chae, M. Kim, K. H. Chang, Longitudinal analysis of the effect of academic failure tolerance on academic achievement fluctuation in medical school students, Korean Journal of Medical Education, 28(1) (2016) 25 – 28.

[8] S. Kim, N. Choi, The relationships between children's ego function and fear of negative evaluation affecting academic failure tolerance in early school age: Analysis by grade level considering sustainability of academic motivation, Sustainability, 12 (2020) 1888. https://doi.org/10.3390/su12051888

[9] I. Brdar, M. Rijavec, D. Loncaric, Goal orientations, coping with school failure and school achievement, European Journal of Psychology of Education, 21(1) (2006) 53 – 70. https://doi.org/10.1007/bf03173569

[10] S. L. Gable, Approach and avoidance social motives and goals, Journal of Personality, 74(1) (2006) 175 – 222. https://doi.org/10.1111/j.1467-6494.2005.00373.x

[11] P. A. Gable, E. Harmon-Jones, Attentional consequences of pregoal and postgoal positive affects. Emotion, 11(6) (2011) 1358 – 1367. https://doi.org/10.1037/a0025611

[12] L. J. Levine, R. S. Edelstein, Emotion and memory narrowing: A review and goal-relevance approach, Cognition and Emotion, 23(5) (2009) 833 – 875. https://doi.org/10.1080/02699930902738863

[13] A.G. Ignacio, Students' viewpoints on mathematics courses in engineering: A basis for improvement, Asia Pacific Journal of Multidisciplinary Research, 4(3) (2016) 111 – 118.

[14] A.G. Ignacio, J. D. Reyes, Exploring mathematics achievement goals using Kolb's learning style model, Asia Pacific Journal of Multidisciplinary Research, 5(1) (2017) 19 – 24.

[15] L. Y. Jang, W. C. Liu, 2 × 2 Achievement goals and achievement emotions: A cluster analysis of students' motivation, European Journal of Psychology of Education, 27(1) (2011) 59 – 76. https://doi.org/10.1007/s10212-011-0066-5

[16] M. M. Clifford, Failure tolerance and academic risk-taking in ten- to twelve-year-old students, British Journal of Educational Psychology, 58(1) (1988) 15 – 27. https://doi.org/10.1111/j.2044-8279.1988.tb00875.x

[17] M. M. Clifford, F. C. Chou, K. N. Mao, W. Yun Lan, S. Y. Kuo, Academic risk-taking, development, and external constraint, The Journal of Experimental Education, 59(1) (1990) 45 – 64. https://doi.org/10.1080/00220973.1990.10806550

[18] M. M. Clifford, W. Y. Lan, F. C. Chou, Y. Qi, Academic risk-taking: Developmental and cross-cultural observations, The Journal of Experimental Education, 57(4) (1989) 321 – 338. https://doi.org/10.1080/00220973.1989.10806514

[19] S. Guha, J. Leonard, Motivation in elementary mathematics: How students and teachers benefit from computers, TechTrends, 46(1) (2002) 40 – 43. https://doi.org/10.1007/BF02772036

[20] A. G. Ignacio, M. L. Santos, Assessment of student learning 1 (2nd ed.) Philippines: St. Andrew Publishing House, 2019.

[21] A. Elliot, Approach and avoidance motivation and achievement goals, Educational Psychologist, 34(3) (1999) 169 – 189.

[22] A. J. Elliot, & H. A. McGregor, A 2 × 2 achievement goal framework, Journal of Personality and Social Psychology, 80(3) (2001) 501 – 519. https://doi.org/10.1037//0022-3514.80.3.501

[23] L. Linnenbrink-Garcia, M. M. Barger, Achievement goals and emotions, In R. Pekrun & L. Linnenbrink-Garcia (Eds.), International Handbook of Emotions in Education, 142 – 161, Routledge/Taylor & Francis Group, 2014.

[24] R. Pekrun, A social-cognitive, control-value theory of achievement emotions, In J. Heckhausen (Ed.), Advances in psychology, 131.

Motivational psychology of human development: Developing motivation and motivating development, 143 – 163, Elsevier Science, 2000. https://doi.org/10.1016/S0166-4115(00)80010-2

[25] R. Pekrun, The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice, Educational Psychology Review, 18(4) (2006) 315 – 341. https://doi.org/10.1007/s10648-006-9029-9

[26] H. Anttila, K. Pyhältö, T. Soini, J. Pietarinen, From anxiety to enthusiasm: emotional patterns among student teachers, European Journal of Teacher Education, 40(4) (2017) 447 – 464. https://doi.org/10.1080/02619768.2017.1349095

[27] A. R. Artino, E. S. Holmboe, Durning, S. J. Control-value theory: Using achievement emotions to improve understanding of motivation, learning, and performance in medical education: AMEE Guide No. 64. Medical Teacher, 34(3) (2012) 148 – 160.

[28] A. C. Frenzel, T. M. Thrash, R. Pekrun, T. Goetz, Achievement emotions in Germany and China, Journal of Cross-Cultural Psychology, 38(3) (2007) 302 – 309. https://doi.org/10.1177/0022022107300276

[29] A. G. Ignacio, Explanatory cross-sectional analysis on achievement emotions in mathematics using achievement goal and Kolb's learning style frameworks, International Review of Social Sciences, 7(2) (2019) 100 – 111.

[30] R. Pekrun, T. Goetz, A. C. Frenzel, Achievement emotions questionnaire - mathematics (AEQ-M). User's manual, Department of Psychology, University of Munich, Germany, 2005.

[31] M. M. Clifford, Thoughts on a theory of constructive failure. Educational Psychologist, 19(2) (1984) 108 – 120.

[32] A. L. Duckworth, P. D. Quinn, Development and validation of the short grit scale (Grit-S), Journal of Personality Assessment, 91(2) (2009) 166 – 174. https://doi.org/10.1080/00223890802634290

[33] R. Pahljina-Reinic, S. Kolic-Vehovec, Average personal goal pursuit profile and contextual achievement goals: Effects on students' motivation, achievement emotions, and achievement, Learning and Individual Differences, 56 (2017) 167 – 174.

[34] R. Pekrun, A. J. Elliot, M. A. Maier, Achievement goals and achievement emotions: Testing a model of their joint relations with academic performance, Journal of Educational Psychology, 101(1) (2009) 115 – 135. https://doi.org/10.1037/a0013383

[35] R. Puente-Díaz, Achievement goals and emotions, The Journal of Psychology, 147(3) (2013) 245 – 259.

[36] J. Ranellucci, N. C. Hall, T. Goetz, Achievement goals, emotions, learning, and performance: A process model, Motivation Science, 1(2) (2015) 98 – 120. https://doi.org/10.1037/mot0000014

[37] A. R. Nicholls, J. L. Perry, L. Calmeiro, Precompetitive achievement goals, stress appraisals, emotions, and coping among athletes, Journal of Sport and Exercise Psychology, 36(5) (2014) 433 – 445. https://doi.org/10.1123/jsep.2013-0266

[38] J. Kurman, The role of perceived specificity level of failure events in self-enhancement and in constructive self-criticism, Personality and Social Psychology Bulletin, 29(2) (2003) 285 – 294. https://doi.org/10.1177/0146167202239053

[39] J. C. Ruthig, R. P. Perry, S. Hladkyj, N. C. Hall, R. Pekrun, J. G. Chipperfield, Perceived control and emotions: Interactive effects on performance in achievement settings, Social Psychology of Education, 11(2) (2007) 161 – 180.

[40] J. F. Hair, W. C. Black, B. J. Babin, R. E. Anderson, Multivariate Data Analysis, United States: Pearson Prentice Hall, 2010.

[41] A.G. Bluman, Elementary statistics: A step by step approach, New York: McGraw-Hill Companies, Inc., 2009.

[42] A. J. Elliot, K. Murayama, On the measurement of achievement goals: Critique, illustration and application, Journal of Educational Psychology, 100(3) (2008) 613 – 628.

[43] L. Hayduk, L. Littvay, Should researchers use single indicators, best indicators, or multiple indicators in structural equation models? BMC Medical Research Methodology, 12(159) (2012) 1 – 17. https://doi.org/10.1186/1471-2288-12-159

[44] C. Fornell, D. F. Larcker, Evaluating structural equation models with unobservable variables and measurement error, Journal of Marketing Research, 18(1) (1981) 39 – 50. https://doi.org/10,2307/3151312

[45] R. Pekrun, T. Goetz, A. C. Frenzel, P. Barchfeld, R. P. Perry, Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ), Contemporary Educational Psychology, 36 (2011) 36 – 48.

Appendix. Indicators of the modified measurement model

LV	MV	Indicators
NO	Ho1	I feel down.^{**b}
	Ho3	I keep thinking that I don't understand the material.^{**b}
	Ho4	I keep thinking that I will never get good grades in mathematics.^{**b}
	Ax10	When taking the math test, I worry I will get a bad grade.^{**d}
	Ax14	When I have an upcoming math test, I get sick to my stomach.^{**b}
	Sh6	When I discuss the homework assignments with my classmates, I avoid eye contact.^{*d}
	Sh7	After taking a test in mathematics, I feel ashamed.^{**a}
NA	Br2	I can't concentrate because I am so bored.^{***d}
	Ag4	I get irritated by my math class.^{***d}
PO	Pr1	I think I can be proud of my knowledge in mathematics.^{***a}
	Pr2	I am proud of my contributions to the math class.^{***a}
AFT	Af10	I get very discouraged if I make errors on a task I am trying to learn.****
	Af12	If I give a wrong answer to a teacher's question, I feel terrible.****
AV	Pv1	My aim is to avoid doing worse than other students.
	Pv2	I am striving to avoid performing worse than others.
	Pv3	My goal is to avoid performing poorly compared to others.
AP	Mp1	My aim is to completely master the material presented in this class.
	Pp1	My aim is to perform well relative to other students.
	Pp2	I am striving to do well compare to other students.

Notes: LV latent variables; MV measured variables; NO negative-outcome emotion, NA negative-activity emotion, PO positive emotion, AP approach goal, AV avoidance goal, AFT academic failure tolerance; ^{**b} emotion experienced before taking a math test; ^{**d} emotion experienced while taking a math test; ^{**a} emotion experienced after taking a math test; ^{*d} emotion experienced while studying or doing homework in math; ^{***d} emotion experienced while being in math class; ^{***a} emotion experienced after being in math class; ****reverse coded item.