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Islamic Students' Achievement Emotions in Attending Algebra Class: Differences of Gender, Algebraic Content, Teaching Method, and Teacher Knowledge

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Abstract

Indonesian Islamic students' achievement emotions in conducting mathematics activities have relatively not been stable because their positive emotions decrease and their negative emotions increase (Suparman et al., 2021). The differences in students' achievement emotions in algebra class are predictively affected by natural and manipulated academic factors. This study describes Islamic students' achievement emotions in algebra class considering the differences in gender, teaching method, algebraic content, and teachers' technological, pedagogical, and content knowledge (TPACK). A survey study on three mathematics teachers and 90 tenth-, eleventh-, or twelfth-grade students at a public Islamic school in West Java, Indonesia was applied. A few questionnaires, such as TPACK and achievement emotions in mathematics were used to measure students' achievement emotions and teachers' TPACK. Particularly, the questionnaire of achievement emotions in mathematics was valid (r = 0.64) and reliable (α = 0.90). Additionally, the questionnaire of teacher's TPACK was also valid (r = 0.69) and reliable (α = 0.84). Independent samples-t test and one-way MANOVA test were applied to analyze the data. Results revealed that male students' shame was significantly lower than female students in algebra class. Additionally, there were significant differences in teaching methods and teachers' TPACK in students' enjoyment, anger, hopelessness, and boredom. Moreover, there were significant differences in algebraic contents in students' positive and negative emotions. Consequently, mathematics teachers in Islamic school institutions must pay attention to the differences in gender, teaching method, teachers' TPACK, and algebraic contents related to students' achievement emotions in doing mathematics activities.

INTRODUCTION

Every day students' academic life is signed by a variety of emotions which have an essential role in constructing students' experiences, perceptions, and behaviors in academic settings (Bieleke et al., 2023; Gur et al., 2023). Emotions in academic settings related to achievement activities (e.g., attending class, doing homework, or taking exams) and achievement outcomes (e.g., failure or success) are defined as achievement emotions (Pekrun & Linnenbrink-Garcia, 2012; Pekrun & Stephens, 2012). Further, Pekrun et al. (2007) stated that achievement emotions are categorized to be three dimensions, such as object focus,

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activation level, and valance. Particularly, by viewing its valance, achievement emotions are differentiated to be two categories, such as positive emotions and negative emotions. A few empirical studies revealed that positive emotions (e.g., enjoyment, hope, contentment, pride, and relaxation) are positively connected to academic achievement, motivation, performance, and interest (Bekker et al., 2022; Moustakas & Gonida, 2023). Negative emotions, however, are negatively connected to academic factors, such as performance, motivation, achievement, and learning interest (Broda et al., 2023; Raccanello et al., 2020). This indicates that achievement emotions become one of the crucial factors that have to be noticed in academic settings, specifically in mathematics education.

The existence of achievement emotions in conducting mathematics activities, such as attending math class, doing math homework, and taking math exams must be stable in promoting the enhancement of students' mathematics achievement, motivation, performance, and learning interest. In the literature, (S. Suparman et al., 2021) explained that the stability of students' achievement emotions in doing mathematics activities is characterized by the decrease of students' negative emotions and the increase of students' positive emotions. It means that students' stable mathematics achievement emotions are indicated by the higher positive emotions and the lower negative emotions. Some empirical studies, however, showed that students' achievement emotions are not relatively stable in doing mathematics activities whereby their negative emotions increase while their positive emotions decrease (Adigun et al., 2023; Gur et al., 2023; Rawlings et al., 2023). Specifically, a few empirical studies also revealed that Indonesian Islamic students' achievement emotions in conducting mathematics activities have relatively not been stable they often attended math class with anxious, bored, angry, shameless, and hopeless feelings (Ariati et al., 2022; Ilyas et al., 2020). Meanwhile, achievement emotions are positively or negatively related to students' mathematics achievement (Jenßen, 2023; Lichtenfeld et al., 2023; Mata et al., 2021; Putwain et al., 2021). This indicates that achievement emotions that are not stable in doing mathematics activities can hinder students' mathematics achievement. On the other hand, four relevant empirical studies have found that achievement emotions and mathematics achievement have significant positive relationship (Forsblom et al., 2022; Peixoto et al., 2016; Putwain et al., 2021; Van der Beek et al., 2017). Consequently, students must have stable achievement emotions in conducting mathematics activities.

There are no effective stimulants, such as educational games, learning environments, or interactive multimedia that can construct students' achievement emotions in doing mathematics activities to be unstable (Chen et al., 2023; Hanin & Gay, 2023; Hollenstein et al., 2023). Moreover, natural conditions, such as gender and learning content can differentiate students' achievement emotions in doing academic activities (Frenzel et al., 2007; Peklaj & Pečjak, 2011; Rodriguez et al., 2019). This indicates that natural factors, such as gender (e.g., male or female) and mathematics content (e.g., algebra, geometry, measurement, number & operations, or statistics & probability) are expected to differentiate students' achievement emotions in attending math class, especially algebra courses. Additionally, manipulated conditions, such as teaching method and teachers' TPACK level also can generate the difference in students' achievement emotions in taking exams, doing homework assignments, or attending class (Basarkod et al., 2023; Bieleke et al., 2021; Dettmers et al., 2011; Gildehaus & Jenßen, 2023; Goetz et al., 2012; Liverani et al., 2023). This also indicates that manipulated factors, such as teaching method (e.g., drill & practice, discussion, expository, question & answer, problem-solving, or inquiry) and teachers' TPACK level (e.g., high, moderate, or low) are predicted in making differences of students' achievement emotions in attending algebra class. Rationally, the differences in students' achievement emotions in doing mathematics activities indicate that there are unstable emotions describing the high positive emotions and the low negative emotions or vice versa.

The differences in students' achievement emotions in attending algebra class are predictively affected by natural academic factors (e.g., gender and algebra content) and manipulated academic factors (e.g., teaching method and teachers' TPACK level). Consequently, these academic factors are really important to investigate in mathematics education, mainly regarding how significantly those differentiate and affect students' achievement emotions in attending algebra class. To date, many empirical studies comprehensively investigate students' achievement emotions in doing mathematics activities, such as attending math courses, doing math homework, and solving math problems (Dettmers et al., 2011; Frenzel et al., 2007; Gur et al., 2023; Holm et al., 2020; Karamarkovich & Rutherford, 2021; Merrick & Fyfe, 2023; Raccanello et al., 2018; Sakaki et al., 2024). Additionally, a lot of empirical studies particularly investigate students' achievement emotions in mathematics related to achievement, motivation, cognitive appraisals, self-concept, learning outcomes, teaching quality, self-efficacy, self-regulated learning, and gender (Ahmed et al., 2013; Clem et al., 2021; Forsblom et al., 2022; Haciomeroglu, 2019; Hanin & Gay, 2023; Lazarides & Buchholz, 2019; Moustakas & Gonida, 2023; Niculescu et al., 2015; Peklaj & Pečjak, 2011; Putwain et al., 2021; Schukajlow et al., 2017; St Omer & Chen, 2023; Van der Beek et al., 2017). The present study, however, particularly investigates Islamic students' achievement emotions when attending algebra class while considering the difference in gender, algebraic content, teaching method, and teachers' TPACK.

This study aims to describe Islamic students' achievement emotions in attending algebra class by viewing differences of gender, algebraic content, teaching method, and teachers' TPACK. Algebra is one of the fundamental mathematics contents contributing most to students' mathematics achievement (Ariani, 2024). As a consequence, the higher positive emotions and the lower negative emotions in attending algebra class have a pivotal role in promoting students' achievement in algebra. The present study is expected to describe Islamic students' achievement emotions in following algebra lessons viewed by some academic factors, such as gender, teaching method, algebraic content, and teachers' TPACK.

Literature Review

Achievement Emotions and Mathematics Activities

Emotions exist in academic settings everywhere and extremely affect students' academic performance. In contemporary research, emotions are defined as multifaceted phenomena involving a series of coordinated psychological processes, including affective, cognitive, physiological, motive, and expressive components (Pekrun & Linnenbrink-Garcia, 2012). Generally, Pekrun & Stephens (2012) stated that academic emotions consist of achievement emotions, epistemic emotions, topic emotions, and social emotions. Moreover, Pekrun and Stephens particularly explained that achievement emotions are related to achievement activities and achievement outcomes. In detail, activity emotions encompass continuing emotions experienced by students when involved in achievement activities, such as attending classes, doing homework assignments, and taking exams. Meanwhile, outcome emotions cover prospective emotions related to success or failure in the future, and retrospective emotions related to success or failure in the past (Pekrun et al., 2007; Pekrun & Stephens, 2012). This explains that achievement emotions emerge from learning activities and learning outcomes.

In the literature, Pekrun & Linnenbrink-Garcia (2012) explained that achievement emotions are categorized to be two dimensions, such as valance and activation. From the dimension of the valance, achievement emotions are differentiated by positive emotions (e.g., enjoyment, hope, pride, gratitude, relaxation, contentment, and relief) and negative emotions (e.g., anger, anxiety, shame, boredom, sadness, hopelessness, and disappointment). Additionally, of the dimension of activation, achievement emotions are categorized to be activating emotions (e.g., enjoyment, hope, pride, gratitude, anger, anxiety, and shame) and

deactivating emotions (e.g., relaxation, contentment, relief, boredom, sadness, hopelessness, and disappointment). Moreover, the present study involves two types of positive emotions, such as enjoyment and pride, and five types of negative emotions, such as anger, anxiety, shame, boredom, and hopelessness to measure the stability of students' achievement emotions in doing mathematics activities. Mathematics activity in the present study is specified in students' activities in attending algebra class.

Gender

Gender refers to the social and cultural characteristics and expectations associated with being male or female (Kreiser & White, 2014). In the context of achievement emotions, gender influences how individuals interpret and respond to success and failure in academic settings. Studies have consistently found that there are gender differences in the experience and expression of achievement emotions, such as pride, shame, and anxiety (Holm et al., 2020; Kogler et al., 2015). Gender plays a significant role in shaping individuals' experiences of achievement emotions, particularly in academic settings like mathematics. Research has shown that gender differences exist in the way individuals perceive and express achievement emotions, influencing their overall academic achievement (Fierro-Suero et al., 2023; Reilly & Sánchez-Rosas, 2021). Understanding how gender intersects with achievement emotions is crucial for educators and policymakers to create an inclusive and supportive learning environment for all students.

When gender comes to mathematics, a subject often stereotyped as being more challenging for females, gender differences in achievement emotions become particularly pronounced. For example, research has shown that boys tend to experience more pride and less shame compared to girls when they succeed in mathematical tasks. On the other hand, girls may experience higher levels of anxiety and self-doubt, especially in competitive math environments where they are in the minority (Reilly & Sánchez-Rosas, 2021). These gender differences in achievement emotions can affect students' motivation, engagement, and performance in mathematics (Hwang & Lew, 2018; Rodriguez et al., 2019). Boys' higher levels of pride and lower levels of shame may contribute to their increased confidence and persistence in mathematical tasks, leading to better academic outcomes. In contrast, girls' higher levels of anxiety and self-criticism may hinder their performance and lead to a decrease in their interest and participation in math-related activities (Frenzel et al., 2007; Pelch, 2018). Educators and policymakers play a crucial role in addressing the gender disparities in achievement emotions. By fostering a supportive and inclusive classroom environment that promotes a growth mindset and emphasizes effort over innate ability, educators can help all students, regardless of gender, develop a positive relationship with mathematics. Encouraging girls to challenge stereotypes and promoting collaborative learning experiences can also help mitigate the negative impact of gender on achievement emotions.

Technological, Pedagogical, and Content Knowledge

TPACK refers to a framework to understand and describe the kinds of knowledge required for teachers to generate pedagogical and content practice effectively by integrating technology into the learning environment (Hulya & Ay en, 2015; Koehler et al., 2011; Koehler et al., 2014). The basic concept of TPACK points out the relationship between learning content, pedagogics, and technology whereby the interactions among components have interesting power to cultivate active learning focusing on students. In the TPACK scheme, there are relationships among components that are commonly intersected between content, pedagogics, and technology (See Figure 1).

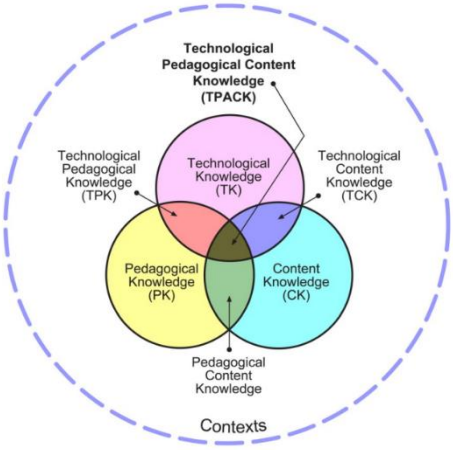

Figure 1. The TPACK Framework and Its Knowledge Components

From Figure 1, it can be known that there are seven knowledge components, such as content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical and content knowledge (TPACK). This current study, however, only uses four knowledge components, such as TPACK, PCK, PK, and CK to measure teachers' TPACK levels which is the instrument to measure those referred to Smith & Zelkowski (2022). TPACK framework is very essential for mathematics teachers to teach algebraic content to secondary students.

Algebraic Content

Mathematics is a vast field that deals with numbers, quantities, structures, and space. It plays a crucial role in various aspects of our lives, from basic everyday tasks to complex scientific research. Mathematics encompasses a wide range of topics, including arithmetic, geometry, calculus, and statistics (Suparman Suparman et al., 2021). At its core, mathematics provides a systematic way to understand and analyze the relationships between quantities and shapes. It helps in solving real-world problems, making predictions, and developing new technologies (Hodaňová & Nocar, 2016). By using logical reasoning and precise calculations, mathematics allows us to make sense of the world around us. Furthermore, algebra is a branch of mathematics that deals with symbols and the rules for manipulating these symbols to solve equations and represent relationships between quantities (Planas, 2020). One of the core concepts in algebra is solving equations. This involves isolating the variable on one side of the equation to determine its value. By applying mathematical operations such as addition, subtraction, multiplication, and division, algebra allows us to find solutions to equations and make predictions about the behavior of mathematical relationships. In algebra, variables are used to represent unknown quantities, and algebraic expressions are used to represent mathematical relationships (Lee et al., 2020).

In algebra class, the present study involves some algebraic contents, such as arithmetic sequence and series, geometric sequence and series, matrix determinant, and compound interest. An arithmetic sequence is a sequence of numbers that has the same difference between adjacent terms. This difference can be called differently, the symbol is b. Meanwhile, an arithmetic series is the sum of the first n terms in an arithmetic sequence (Sari et al., 2020). Moreover, a geometric sequence is a pattern that has a fixed multiplier or ratio for every 2 adjacent terms. The ratio in a regular geometric series is symbolized by r. If this sequence is written in additive form, its name is a geometric series (Lee et al., 2021). Additionally, the determinant can be thought of as a scaling factor of the transformation described by the matrix.

The determinant of matrix A is written with a sign, namely: det(A), det A, or |A| (Raghu et al., 2019). On the other hand, compound interest is interest determined based on initial savings plus additional interest in previous periods (Song, 2019). This means that in the first period, the interest calculation is the same as single interest. However, in the second period, the interest calculation refers to the total savings in the first period. In the third period, the interest calculation refers to the total savings for the second period. This will continue as long as the savings are still active.

Teaching Method

In the mathematics learning context, teaching method refers to teachers' techniques and ways to teach and present mathematics content to students in the classroom individually or in groups, so it can be understood well by students (Große & Renkl, 2006; Lessani et al., 2017). Moreover, Lessani et al. (2017) mentioned that some teaching methods can be suitable for mathematics learning, especially in algebra instruction, such as drill & practice, discussion, expository, question and answer, problem-solving, and inquiry. This recent study observes that there were two main teaching methods used in the process of algebra learning and teaching, such as drilling & practice and discussion & question-answer. In the literature, Hendrickson (2017) explained that drilling and practice refer to a way to enhance students' competencies in some domains, such as cognition, affection, and psychomotor which usually it is given after they learn mathematics content or teachers explain those, moreover it is extremely important to internalize algebra concepts in students thinking. Meanwhile, discussion and question-answer refer to the ways used by teachers to motivate students to develop their knowledge to deal with mathematics problems and state their ideas regarding those problems. Thus, the teaching methods (e.g., drilling & practice and discussion & question-answer) were used to teach algebraic contents, such as arithmetic and geometric sequence, matrix determinant, and compound interest.

METHODS

Research Design and Approach

To describe students' achievement emotions in attending algebra class viewed by differences of gender, algebraic content, teaching method, and teachers' TPACK level, a survey study using a quantitative approach was carried out. Algebra was selected as one of the mathematical contents in this descriptive study because some empirical studies found that students' algebra achievement had not been optimal (Das & Ali, 2023; Lee & Mao, 2020; Leite et al., 2022). Moreover, a few empirical studies showed that some students still had low achievement in algebra learning (Dougherty et al., 2015; Ezeugwu et al., 2016). Consequently, students' obstacles in algebra class were possible to be analyzed from the perspective of their achievement emotions. Achievement emotions and mathematics achievement had a significant positive relationship (Forsblom et al., 2022; Peixoto et al., 2016; Putwain et al., 2021; Van der Beek et al., 2017). Additionally, the algebraic contents (e.g., arithmetic sequence and series, geometric sequence and series, matrix determinant, and compound interest) were selected because those were adjusted to mathematics teachers' schedules and the regulation of school institutions in permitting us to investigate students' achievement emotions in attending algebra class.

Participant

The present study involved 90 Islamic students at a public Islamic school in West Java, Indonesia consisting of 27 tenth-grade students (18 males and 9 females), 34 eleventh-grade students (13 males and 21 females), and 29 twelfth-grade students (11 males and 18 females). Additionally, this study also involved three different female mathematics teachers that were

Mrs. T.H who had ten years of mathematics teaching experience and taught the topic of arithmetic sequence & series and geometric sequence & series, followed by Mrs. W.S who had eight years of mathematics teaching experiences and taught the topic of matrix determinant, and Mrs. A.D who had six years of mathematics teaching experiences and taught the topic of compound interest. Particularly, they contributed as research assistants in teaching algebraic contents in recent study. Students and teachers were selected using purposive sampling with reasons, such as teachers' schedules and the regulation of Islamic school institutions.

Instrument

Achievement Emotions Questionnaire-Mathematics (AEQ-M) developed by Bieleke et al. (2023) was adapted to measure students' achievement emotions in attending algebra class. The questionnaire contained seven types of emotions consisting of two positive emotions (e.g., enjoyment and pride) and five negative emotions (e.g., anxiety, hopelessness, boredom, shame, and anger). Each statement in AEQ-M used a 5-point Likert scale (1=strongly disagree; 2=disagree; 3 = quite agree; 4=agree; 5=strongly agree). Additionally, the questionnaire was valid and reliable whereby the value of validity and reliability for each emotional type was such as enjoyment ($r = 0.64$; $\alpha = 0.90$), pride ($r = 0.67$; $\alpha = 0.87$), anger ($r = 0.62$; $\alpha = 0.88$), anxiety ($r = 0.61$; $\alpha = 0.91$), shame ($r = 0.57$; $\alpha = 0.84$), hopelessness ($r = 0.70$; $\alpha = 0.89$), and boredom ($r = 0.72$; $\alpha = 0.89$). Additionally, this study also adopted a valid and reliable questionnaire to measure the teachers' TPACK level developed by Smith & Zelkowski (2022), but there were only four main knowledge components used for this measurement, such as TPACK, PCK, PK, and CK. In detail, the TPACK questionnaire consisted of three statements in TPACK, one statement in PCK, six statements in PK, and three statements in CK. Every statement in TPACK questionnaire used a 5-point Likert scale (1 = not true at all; 2 = hardly true; 3 = somewhat true; 4 = largely true; 5 = exactly true). The value of validity and reliability for every part of this questionnaire was such as CK ($r = 0.71$; $\alpha = 0.85$), PK ($r = 0.69$; $\alpha = 0.81$), PCK ($r = 0.75$; $\alpha = 0.87$), and TPACK ($r = 0.61$; $\alpha = 0.84$).

Procedure

To do this study, firstly we adapted and re-arranged the AEQ-M and TPACK questionnaire. Secondly, we requested permission from the head of Islamic school institutions by using the formal cover letter from our higher educational institution. Thirdly, we observed the process of algebra learning and teaching of three different mathematics teachers in a public Islamic school to get the data regarding the teaching method applied and algebraic contents in algebra class. Fourthly, we administered the AEQ-M to students and the TPACK questionnaire to teachers to collect data regarding students' achievement emotions and teachers' TPACK. Fifthly, we analyzed the data using descriptive and inferential statistics.

Data Analysis

The profile of students' achievement emotions in attending algebra class was described using the framework proposed by Azwar (2012) as such: $x \leq Mi - Si$ (low), $Mi - Si < x \leq Mi + Si$ (moderate), and $x > Mi + Si$ (high). Moreover, an independent sampled-t test was applied to examine the differences in students' achievement emotions in attending algebra class viewed by gender (e.g., male and female), teaching method (e.g., drill & practice and discussion & question-answer), and teachers' TPACK level (e.g., moderate and high) (Bakker & Wicherts, 2014). Meanwhile, one way of multiple analysis of variance (MANOVA) was applied to examine the difference in students' achievement emotions in attending algebra class viewed by algebraic content (e.g., arithmetic sequence & series, geometric sequence & series, matrix determinant, and compound interest) (Rutherford, 2011). All of the calculations in this study were promoted by a few software (e.g., SPSS ver. 26 and Ms. Excel).

RESULTS AND DISCUSSION

Results

Students' achievement emotions in attending algebra class consist of positive emotions (e.g., enjoyment and pride) and negative emotions (e.g., anxiety, anger, shame, hopelessness, and boredom). The achievement emotions were categorized into three categories, such as low, moderate, and high. The profile of students' achievement emotions in attending algebra class is shown in Table 1.

From Table 1, it can be stated that overall, when attending algebra class, students had moderate enjoyment, followed by moderate pride, low anger, moderate anxiety, moderate shame, moderate hopelessness, and low boredom. Moreover, of the positive emotions, the level of students' enjoyment was equal to the level of students' pride. Additionally, of the negative emotions, the level of students' anger and boredom was lower than the level of students' anxiety, shame, and hopelessness. This indicates that the difficulties of algebra content taught (e.g., arithmetic and geometric sequence, matrix determinant, and compound interest) stimulate a few of students' negative emotions to be moderate level. As a consequence, students' anxiety, shame, and hopelessness in attending algebra class are required to be paid attention by mathematics teachers in algebra learning using strategies that can ease difficulties of the algebra content. Students' achievement emotions in attending algebra class analyzed by gender differences (e.g., male students and female students) are shown in Table 2.

From Table 2, it can be stated that descriptively, there was no difference in some achievement emotions, such as enjoyment, pride, anxiety, shame, hopelessness, and boredom in attending algebra class between male students and female students. Meanwhile, there was a difference between male students' anger and female students' anger. Female students were more angry than male students in attending algebra class. To examine the differences of gender in students' achievement emotions in attending algebra class, the independent samples-t test was applied (See Table 3).

Table 1. Students' Achievement Emotions in Attending Algebra Class

Achievement Emotions	Mean	Deviation Standard	Sample Size	Category
Enjoyment	15.73	3.81	90	Moderate
Pride	6.28	2.03	90	Moderate
Anger	7.70	3.04	90	Low
Anxiety	13.06	3.98	90	Moderate
Shame	10.87	3.89	90	Moderate
Hopelessness	4.91	2.04	90	Moderate
Boredom	8.74	4.06	90	Low

Table 2. Gender Differences in Students' Achievement Emotions

Gender	Achievement Emotions	M	SD	Sample Size	Category
Male	Enjoyment	16.10	4.19	42	Moderate
	Pride	6.45	2.13	42	Moderate
	Anger	7.55	2.72	42	Moderate
	Anxiety	12.36	4.19	42	Moderate
	Shame	9.64	3.54	42	Moderate
	Hopelessness	4.71	1.89	42	Moderate
	Boredom	9.26	4.22	42	Low
Female	Enjoyment	15.42	3.45	48	Moderate
	Pride	6.13	1.95	48	Moderate
	Anger	7.83	3.32	48	Low
	Anxiety	13.67	3.74	48	Moderate
	Shame	11.94	3.90	48	Moderate
	Hopelessness	5.08	2.17	48	Moderate
	Boredom	8.29	3.92	48	Low

Table 3. The Results of Independent Samples-t Test for Gender Differences

Achievement Emotions	t-value	Degree of Freedom	Significance value	Conclusion
Enjoyment	0.842	88	0.402	No Significant
Pride	0.760	88	0.449	No Significant
Anger	-0.443	88	0.659	No Significant
Anxiety	-1.567	88	0.121	No Significant
Shame	-2.904	88	0.005*	Significant
Hopelessness	-0.854	88	0.396	No Significant
Boredom	1.130	88	0.261	No Significant

Note: * < 0.05

This study has proved that male students' shame in attending algebra class was significantly different from female students' shame whereby in attending algebra class, the level of male students' shame was lower than the level of female students' shame. Students' achievement emotions in attending algebra class analyzed by the differences in teaching method (e.g., drill & practice and discussion & question-answer) are shown in Table 4.

From Table 4, it can be stated that descriptively, there was no difference in some achievement emotions, such as enjoyment, pride, anger, anxiety, and shame between students who studied algebra using the drill and practice method and students who studied algebra using discussion and question & answer method. Meanwhile, there was a difference in a few achievement emotions, such as hopelessness and boredom between students who studied algebra using drill and practice methods and students who studied algebra using discussion and question-and-answer methods. Particularly, the level of students' hopelessness and boredom who studied using the drill and practice method was lower than the level of students' hopelessness and boredom who studied using the discussion and question & answer method.

To examine the differences in teaching methods in students' achievement emotions in attending algebra class, an independent samples-t test was applied (See Table 5). This study has

Table 4. The Differences of Teaching Method in Students' Achievement Emotions

Teaching Method	Achievement Emotions	M	SD	Sample Size	Category
Drill and Practice	Enjoyment	16.25	3.92	63	Moderate
	Pride	6.41	1.99	63	Moderate
	Anger	7.11	2.44	63	Low
	Anxiety	12.73	3.61	63	Moderate
	Shame	10.49	3.69	63	Moderate
	Hopelessness	4.63	2.08	63	Low
	Boredom	7.76	3.61	63	Low
Discussion and Question-Answer	Enjoyment	14.52	3.29	27	Moderate
	Pride	5.96	2.12	27	Moderate
	Anger	9.07	3.83	27	Low
	Anxiety	13.81	4.73	27	Moderate
	Shame	11.74	4.26	27	Moderate
	Hopelessness	5.56	1.83	27	Moderate
	Boredom	11.04	4.21	27	Moderate

Table 5. The Results of Independent Samples-t Test for Teaching Method Differences

Achievement Emotions	t-value	Degree of Freedom	Significance value	Conclusion
Enjoyment	2.014	88	0.047*	Significant
Pride	0.961	88	0.339	No Significant
Anger	-2.923	88	0.004*	Significant
Anxiety	-1.185	88	0.239	No Significant
Shame	-1.402	88	0.164	No Significant
Hopelessness	-1.992	88	0.049*	Significant
Boredom	-3.747	88	0.000**	Significant

Note: * < 0.05; ** < 0.01

Table 6. The Teachers' TPACK in Algebra Class

TPACK Component	Teachers		
	Mrs. T. H	Mrs. W. S	Mrs. A. D
CK	10 (Moderate)	12 (High)	12 (High)
PK	22 (Moderate)	23 (Moderate)	21 (Moderate)
PCK	4 (High)	4 (High)	4 (High)
TPACK	10 (Moderate)	10 (Moderate)	11 (Moderate)
Overall	46 (Moderate)	49 (High)	48 (High)

Table 7. The Differences of Teachers' TPACK Level in Students' Achievement Emotions

Teachers' TPACK Level	Achievement Emotions	Mean	Deviation Standard	Sample Size	Category
Moderate Level	Enjoyment	14.52	3.28	27	Moderate
	Pride	5.96	2.12	27	Moderate
	Anger	9.07	3.83	27	Low
	Anxiety	13.81	4.73	27	Moderate
	Shame	11.74	4.26	27	Moderate
	Hopelessness	5.56	1.83	27	Moderate
	Boredom	11.04	4.21	27	Moderate
High Level	Enjoyment	16.25	3.92	63	Moderate
	Pride	6.41	1.99	63	Moderate
	Anger	7.11	2.44	63	Low
	Anxiety	12.73	3.61	63	Moderate
	Shame	10.49	3.69	63	Moderate
	Hopelessness	4.63	2.08	63	Low
	Boredom	7.76	3.61	63	Low

proved that students' enjoyment who studied algebra content using the drill and practice method was significantly higher than students' enjoyment who studied algebra content using the discussion and question-answer method. Additionally, students' negative emotions, such as anger, hopelessness, and boredom who studied algebra contents using drill and practice methods were significantly lower than students' negative emotions, such as anger, hopelessness, and boredom who studied algebra contents using discussion and question-answer methods.

Each statement in the TPACK questionnaire has a 5-point Likert Scales (1 = not true at all, 2 = hardly true, 3 = somewhat true, 4 = largely true, 5 = exactly true). The acquisition of teachers' TPACK in algebra class for each case topic of arithmetic and geometric sequence & series, matrix determinant, and compound interest is shown in Table 6.

From Table 6, it can be stated that the teacher who taught the topic of arithmetic and geometric sequence & series had moderate TPACK levels. Meanwhile, the teachers who taught the topic of matrix determinants and compound interest had high TPACK levels. This means that the teacher TPACK level who taught the topic of arithmetic and geometric sequence is lower than the teacher TPACK level who taught matrix determinant or compound interest. Students' achievement emotions in attending algebra class analyzed by the differences in teachers' TPACK level (e.g., moderate level and high level) are shown in Table 7.

From Table 7, it can be stated that descriptively, there was no difference in some achievement emotions of students in attending algebra class, such as enjoyment, pride, anger, anxiety, and shame between those who were taught by mathematics teacher who had moderate TPACK and mathematics teacher who had high TPACK. Meanwhile, there was a difference in a few achievement emotions of students in attending algebra class, such as hopelessness and boredom between those who were taught by mathematics teachers who had moderate TPACK and mathematics teachers who had high TPACK. Particularly, the level of students' hopelessness and boredom who were taught by mathematics teachers who had moderate TPACK was higher than the level of students' hopelessness and boredom who were taught by mathematics teachers who had high TPACK.

Table 8. The Differences of Algebraic Content in Students' Achievement Emotions

Algebraic Content	Achievement Emotions	Mean	Deviation Standard	Sample Size	Category
Matrix Determinant	Enjoyment	18.26	3.38	34	Moderate
	Pride	6.97	1.58	34	Moderate
	Anger	5.85	1.71	34	Low
	Anxiety	11.50	3.76	34	Low
	Shame	9.35	3.70	34	Moderate
	Hopelessness	4.09	2.14	34	Low
	Boredom	7.74	4.38	34	Low
Arithmetic Sequence & Series and Geometric Sequence & Series	Enjoyment	14.52	3.28	27	Moderate
	Pride	5.96	2.12	27	Moderate
	Anger	9.07	3.83	27	Low
	Anxiety	13.81	4.73	27	Moderate
	Shame	11.74	4.25	27	Moderate
	Hopelessness	5.56	1.83	27	Moderate
	Boredom	11.04	4.21	27	Moderate
Compound Interest	Enjoyment	13.90	3.15	29	Moderate
	Pride	5.76	2.24	29	Moderate
	Anger	8.59	2.35	29	Low
	Anxiety	14.17	2.88	29	Moderate
	Shame	11.83	3.27	29	Moderate
	Hopelessness	5.28	1.85	29	Moderate
	Boredom	7.79	2.49	29	Low

Table 9. The Results of One-Way MANOVA for Algebra Content Differences

Achievement Emotions	F-value	Degree of Freedom	Significance value	Conclusion
Enjoyment	16.523	2	0.000**	Significant
Pride	3.418	2	0.037*	Significant
Anger	13.037	2	0.000**	Significant
Anxiety	4.552	2	0.013*	Significant
Shame	4.457	2	0.014*	Significant
Hopelessness	4.973	2	0.009*	Significant
Boredom	6.944	2	0.002*	Significant

Note: * < 0.05; ** < 0.01

To examine the differences in teachers' TPACK level in students' achievement emotions in attending algebra class, an independent samples-t test was applied (See Table 8). This study has proved that in algebra class, students' enjoyment taught by mathematics teachers' high TPACK was significantly higher than students' enjoyment taught by mathematics teachers' moderate TPACK. Meanwhile, students' negative emotions, such as anger, hopelessness, and boredom taught by mathematics teachers' high TPACK were significantly lower than students' negative emotions, such as anger, hopelessness, and boredom taught by mathematics teachers' moderate TPACK.

Students' achievement emotions in attending algebra class analyzed by the differences in algebraic contents (e.g., arithmetic sequence & series, geometric sequence & series, matrix determinant, and compound interest) are shown in Table 8. From Table 8, it can be stated that descriptively, there was no difference in some achievement emotions, such as enjoyment, pride, anger, and shame between students who studied matrix determinant, arithmetic & geometric sequence and series, and compound interest. Meanwhile, there was a difference in a few achievement emotions, such as anxiety, hopelessness, and boredom between students who studied matrix determinants, arithmetic & geometric sequence and series, and compound interest. Particularly, the level of students' anxiety and hopelessness who studied matrix determinants was lower than the level of students' anxiety and hopelessness who studied compound interest and arithmetic & geometric sequence and series. Additionally, the level of

students' boredom who studied arithmetic and geometric sequence and series was higher than the level of students' boredom who studied matrix determinants and compound interest.

To examine the differences in algebraic content in students' achievement emotions in attending algebra class, one-way MANOVA was applied (See Table 9). This study has proved that students' positive emotions who studied matrix determinants were significantly higher than students' positive emotions who studied arithmetic and geometric sequences & series, and compound interest. Meanwhile, students' negative emotions who studied matrix determinants were significantly lower than students' negative emotions who studied arithmetic and geometric sequences & series, and compound interest.

Discussion

This study reveals that students' boredom and anger were low when attending algebra class while students' enjoyment was moderate level. This interprets that the algebra lesson implemented by mathematics teachers is interesting and motivates students to learn algebraic content. Moreover, this situation indicates that students' achievement emotions in attending algebra class were adequately stable in which students' positive emotions were high but students' negative emotions were low. Pekrun & Stephens (2012) explained that an interesting learning environment can stimulate students' achievement emotions to be stable. Additionally, Forsblom et al. (2022) in an empirical study stated that the stability of students' achievement emotions in academic settings was represented by the high positive emotions of students and the low negative emotions of students. Thus, mathematics teachers in academic settings have to pay attention to students' stable achievement emotions whereby they stimulate students to encounter high positive emotions and low negative emotions.

Male students' shame in attending algebra class was significantly different from female students' shame whereby in attending algebra class, the level of male students' shame was lower than the level of female students' shame. A few empirical studies have consistently found that there are gender differences in the experience and expression of achievement emotions in academic settings, such as pride, shame, and anxiety (Holm et al., 2020; Kogler et al., 2015). Moreover, particularly the level of female students' shame in academic settings was higher than the level of male students' shame. This interprets that the algebraic competencies of female students in algebra classes are lower than the algebraic competencies of male students. Female students can't answer well some questions from mathematics teachers regarding arithmetic sequence and series, geometric sequence and series, matrix determinant, and compound interest. Consequently, female students have red faces when they convey ideas in algebra class.

Students' enjoyment who studied algebra content using the drill and practice method was significantly higher than students' enjoyment who studied algebra content using the discussion and question-answer method. Additionally, students' negative emotions, such as anger, hopelessness, and boredom who studied algebra contents using drill and practice methods were significantly lower than students' negative emotions, such as anger, hopelessness, and boredom who studied algebra contents using discussion and question-answer methods. In the literature, Hendrickson (2017) explained that drilling and practice refer to the ways to enhance students' competencies and affective and cognitive domains which usually it is given after they learn mathematics content or teachers explain those, moreover it is extremely important to internalize algebra concepts in students thinking. Therefore, students wait for algebra class using the drill and practice method because this class is interesting and helps students in understanding algebraic contents. Consequently, they smiled at the mathematics teachers in algebra class.

In algebra class, students' enjoyment taught by mathematics teachers' high TPACK was significantly higher than students' enjoyment taught by mathematics teachers' moderate TPACK. Meanwhile, students' negative emotions, such as anger, hopelessness, and boredom taught by mathematics teachers' high TPACK were significantly lower than students' negative

emotions, such as anger, hopelessness, and boredom taught by mathematics teachers' moderate TPACK. This study interprets that mathematics teachers who have high TPACK can promote students' positive emotions to be high and students' negative emotions to be low in algebra class. A few literatures also revealed that mathematics teachers' TPACK is one of the essential predictors of the stability of students' achievement emotions (Bieleke et al., 2021; Gur et al., 2023). As a consequence, mathematics teachers must have high TPACK to construct interesting and motivating algebra classes such that it can stimulate students' achievement emotions to be stable in attending algebra class.

Students' positive emotions who studied matrix determinants were significantly higher than students' positive emotions who studied arithmetic and geometric sequences & series, and compound interest. Meanwhile, students' negative emotions who studied matrix determinants were significantly lower than students' negative emotions who studied arithmetic and geometric sequences & series, and compound interest. This interprets that the topic of matrix determinants is more interesting and motivating students to study the algebra than other algebraic contents, such as arithmetic and geometric sequences and series, and compound interest. Consequently, they have high positive emotions and low negative emotions in attending algebra class. Three empirical relevant studies also found that the interesting and motivating topics of a learning can stimulate students' positive emotions to be high and students' negative emotions to be low (Hascher et al., 2024; Schukajlow et al., 2017; Sydänmaanlakka et al., 2024). Theoretically, algebraic contents, such as compound interest and arithmetic and geometric sequences & series are more complex than matrix determinants. The determinant can be thought of as a scaling factor of the transformation described by the matrix (Raghu et al., 2019). This implies that the complexity of algebraic contents influences students' understanding in algebra class. Moreover, they feel more joyful and proud in attending algebra class regarding matrix determinants than other algebraic contents. Therefore, the complexity of algebra content must be seriously considered by mathematics teachers such that it does not stimulate students' positive emotions to be low and students' negative emotions to be high.

Implications to the Mathematics Education

The significant gender difference in Islamic students' shame in attending algebra class implies that mathematics teachers in Islamic school institutions must have more consent on the algebra competencies of female students than male students. Such that female students can answer well the teachers' questions regarding matrix determinants, compound interest, and arithmetic and geometric sequences and series. Additionally, the significant differences in teaching method and teachers' TPACK level of students' enjoyment, anger, hopelessness, and boredom in attending algebra class implies that mathematics teachers can apply the drill and practice method in algebra class to construct students' stable achievement emotions in which students have high enjoyment and low anger, hopelessness, and boredom. Moreover, they also must have high TPACK to construct an interesting and motivating algebra class such that students' achievement emotion in attending algebra class is stable. Subsequently, the significant differences in algebraic content of students' positive and negative emotions in attending algebra class implies that mathematics teachers must pay attention to the complexity of algebraic contents delivered to students such that they can understand the contents well. When students have understood algebraic contents, such as matrix determinant, compound interest, and arithmetic and geometric sequences & series, their positive emotions will be high and their negative emotions will be low in attending algebra class.

Limitations and Suggestions

The present study involves two types of positive emotions (e.g., enjoyment and pride) and five types of negative emotions (e.g., anger, anxiety, shame, hopelessness, and boredom).

This condition shows that there is no equilibrium between positive emotions and negative emotions. Consequently, future relevant studies should include other positive emotions, such as hope, contentment, and relaxation to make the equal frequency between positive emotions and negative emotions. Additionally, this study only takes the data of students' achievement emotions after the algebra class has been implemented. To describe the increase of students' positive emotions and the decrease of students' negative emotions in mathematics activities, such as attending algebra class and taking algebra exams, the future relevant studies have to take pre-emotions and post-emotions before and after mathematics activities have been carried out.

CONCLUSIONS

The present study reveals that Islamic students have moderate enjoyment, followed by moderate pride, low anger, moderate anxiety, moderate shame, moderate hopelessness, and low boredom when attending algebra class. Additionally, there are significant gender differences in Islamic students' shame whereby male students' shame is lower than female students' shame. Moreover, there are significant differences in teaching methods and teachers' TPACK in students' enjoyment, anger, hopelessness, and boredom in algebra class. Students' enjoyment who studies the algebraic contents using drill and practice method and taught by teachers' high TPACK is higher than students' enjoyment who study the algebraic contents using discussion and question-answer method and taught by teachers' moderate TPACK. Meanwhile, Students' anger, hopelessness, and boredom who study the algebraic contents using drill and practice method and taught by teachers' high TPACK are lower than students' anger, hopelessness, and boredom who study the algebraic contents using discussion and question-answer method and taught by teachers' moderate TPACK. In addition, there are significant differences in algebraic contents in students' positive and negative emotions. Specifically, students' positive emotions, such as enjoyment and pride who study matrix determinants are higher than students' positive emotions who study compound interest and arithmetic and geometric sequences and series. Meanwhile, students' negative emotions, such as anger, anxiety, shame, hopelessness, and boredom who study matrix determinants are lower than students' negative emotions who study compound interest and arithmetic and geometric sequences and series.

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AUTHOR CONTRIBUTION STATEMENT

All authors contributed to this survey study. Suparman: conceptualizing the idea, adopting and re-arranging instruments (AEQ-M and TPACK), observing and surveying students' achievement emotions in algebra class, analyzing the data & interpreting it, and writing the original manuscript; Dadang Juandi: validating and supervising survey study; Turmudi: reviewing and editing the manuscript.

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