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Development and Validation of a Mathematics Learning Motivation Questionnaire for Middle-Grade Elementary Students

Jin Xue[1]✉, Herdian[2]
[1]School of Art Management and Education, China Academy of Art, China
[2]School Of Psychology, Nanjing Normal University, China
[2]Psychology Faculty, Universitas Muhammadiyah Purwokerto, Indonesia

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ABSTRACT

This study aimed to develop and validate the "Mathematics Learning Motivation Questionnaire for Middle-Grade Elementary School Students," focusing on cognitive drive, self-enhancement drive, and affiliated drive, to measure the mathematics learning motivation among middle-grade elementary students. The study was conducted in two phases using a sample of students from third and fourth grades in Nanjing, Nantong, and Hefei. Initially, a pilot phase (Study 1) involved administering the questionnaire to 129 participants to perform item analysis and ensure item discrimination. In the formal testing phase (Study 2), the refined questionnaire was administered to a larger sample of 381 students to assess reliability and validity through item-total correlation. The questionnaire demonstrated significant discriminative capacity, with all items showing notable differences in motivation levels between high and low scorers. The reliability analysis yielded a Cronbach's Alpha of 0.949, indicating high reliability. However, items with low correlation coefficients in the pilot phase were removed to enhance the tool's focus and validity. The study's geographical limitation to specific regions might affect the generalizability of the findings. Additionally, the design of the questionnaire, while comprehensive, did not fully account for the discriminant validity due to the constrained development time. The "Mathematics Learning Motivation Questionnaire for Middle-Grade Elementary School Students" provides a reliable and valid tool for assessing student motivation in mathematics. Future research should expand the scope to include a more diverse geographic sample and employ longitudinal designs to explore motivational changes over time, enhancing the tool's applicability and effectiveness in diverse educational contexts.

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1. Introduction

The renowned American educator Jerome Bruner believed that "the best motivation for learning is interest in the subject matter itself." From the perspective of learning psychology, students' academic performance primarily depends on two factors: whether they know how to learn and whether they are willing to learn (Chen, 2000). The former pertains to learning measurement and methods, while the latter relates to learning motivation. With good learning motivation, students will naturally actively engage in various learning activities.

Mathematics, as a fundamental subject, is closely related to various fields. In the past, mechanics, physics, and astronomy have made extensive use of mathematics. In students' academic careers, mathematics plays a crucial role in entrance examinations. Thus, mathematics holds a significant position

[1] *Jin Xue. School of Art Management and Education, China Academy of Art, China
E-mail address: gin15385256777@gmail.com

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as a primary subject. Elementary school students' sensory and perceptual inadvertence and emotionality are pronounced, with poor perceptual persistence.

They are not adept at analyzing and synthesizing objects, particularly middle-grade students whose attention is still unstable and not easily sustained. They are in a stage of gradually transitioning from concrete image thinking to abstract logical thinking. Additionally, mathematics is abstract and logically rigorous. Therefore, in elementary school mathematics teaching, it is crucial to appropriately analyze students' learning motivation, discover its patterns, and targetedly cultivate students' mathematics learning motivation to improve the quality of mathematics teaching and learning.

Motivation is the driving force behind learning, significantly impacting whether students can effectively utilize all opportunities to learn. It is one of the most effective factors in predicting learning outcomes. Educational practice and educational psychology experiments have shown that learning motivation promotes learning activities, stimulates students' interest in learning, maintains a certain level of arousal, and directs specific learning activities. The relationship between learning motivation and learning is dialectical; learning can generate motivation, which in turn drives learning, and the two are interrelated. Motivation enhances learning; students with high motivation levels achieve high results, and conversely, high achievement levels can lead to high motivation levels.

Generally speaking, motivation is not directly involved in the interaction process of cognition nor does it function through assimilation mechanisms. Instead, it affects the interaction process of cognition by intensifying effort, concentrating attention, and immediately preparing for learning. Many psychologists believe that a moderate level of motivation arousal or evocation has the best effect on learning. Too weak motivation cannot stimulate learning enthusiasm, reaching a peak. Beyond this point, an increase in motivation intensity will reduce learning efficiency. The optimal level of motivation varies depending on the nature of the task. In relatively easy tasks, work efficiency increases with rising motivation; as task difficulty increases, the optimal level of motivation gradually declines. Excessively strong or weak motivation is detrimental not only to learning but also to retention. Furthermore, the intensity of motivation affects problem-solving efficiency in tasks of varying difficulty.

2. Literature Review

2.1. Definition of Learning Motivation

Learning motivation (motivation to learn) refers to the psychological process that initiates, sustains, and directs learning activities towards goals set by teachers. Learning motivation is the motivational tendency that inspires and maintains students' learning behavior towards a certain goal (Fan, 2005). Learning motivation is closely related to students' interest in learning, learning needs, personal values, attitudes, ambition levels, external encouragement, learning consequences (such as degrees, remuneration, and social status), and the requirements of the objective realistic environment (such as examinations, competitions, and enrollments). Students' learning motivation gradually forms under the influence of social living conditions and education. Different societies and education have different requirements for students' learning, so the learning motivation reflected in students' minds is complex and diverse (Zhou, 2011).

Mathematics learning motivation refers to the psychological factor that arises from certain needs related to mathematics, which converts the desire for mathematics learning into mathematics learning behavior. It stimulates, maintains, and directs mathematics learning behavior, serving as the internal driving force that directly motivates individuals to engage in mathematics learning activities to achieve certain goals. It originates from certain needs for mathematics learning.

2.2. Theories Related to Learning Motivation

Due to the diversity of learning motivation, there are various explanations for its role, leading to the derivation of multiple different motivation theories, each emphasizing different aspects. This study primarily summarizes the following classic learning motivation theories. David Ausubel's classic achievement motivation theory posits that achievement motivation in school situations should include at least three types of drives: cognitive drive, ego-enhancement drive, and affiliative drive. Cognitive drive refers to a student's desire to understand and comprehend, acquire knowledge, and systematically articulate and solve problems (Cheng Hong, Liu; Ching Yuan, Chang; Ting Yen, Hsu; Chiu, 2005). Generally, this drive stems from curiosity. In meaningful learning, cognitive drive is the most important and stable motivation. Ego-enhancement drive is the individual's desire to win a corresponding status through their competence and achievements.

Unlike cognitive drive, ego-enhancement drive does not directly point to learning tasks themselves. Ego-enhancement drive views achievement as the source of winning status and self-esteem; it is clearly an external motivation. Affiliative drive is the need for students to work hard to maintain approval or recognition from parents, teachers, and other authorities. It is also an external motivation. In early childhood, affiliative drive is most prominent. Modern S-R psychologists use reinforcement to explain not

only the occurrence of operant learning but also the arousal of motivation. This theory suggests that human behavior can only generate motivation after being continuously stimulated and reinforced by external stimuli(Shengqi Chen; Jinlei Li, 2017). Reinforcement can be positive or negative. When teachers use praise or rewards to administer positive reinforcement during the learning process, students' learning motivation increases; otherwise, it weakens. "Reward" is positive reinforcement, while "punishment" is negative reinforcement. This learning motivation theory ignores or even denies the consciousness and initiative of human learning behavior, thus having certain limitations.

Maslow's hierarchy of needs theory states that all human behaviors are meaningful and have specific goals derived from our needs. As an organic whole, humans have multiple motivations and needs, and motivation is the process of satisfying needs at different levels. Maslow divided human needs into seven categories: physiological needs, safety needs, belonging and love needs, esteem needs, cognitive and understanding needs, aesthetic needs, and self-actualization needs. He defined the first four needs as deficiency needs and the last three as growth needs. At least some of the lower-level needs must be satisfied before the pursuit of higher-level needs can emerge. Generally speaking, the most important deficiency needs in school are love and self-esteem.

Atkinson believed that initial high achievement motivation originates from a child's family or cultural group, especially the intentions of education and training during early childhood. In other words, achievement motivation involves the emotional conflict between the desire for success and the fear of failure. He believed that achievement motivation is determined by three factors: the need for achievement (the motive for success); the likelihood of success in the task; and the incentive value of success (Zhang, 2012). The level of achievement motivation is closely related to the quality and quantity of academic task completion. High achievers can maintain good performance without external control and demonstrate stronger perseverance in tasks when experiencing failure. Moreover, achievers have strong self-confidence, high achievement motivation levels, and internal attribution.

2.3. Research on Learning Motivation

Foreign research on learning motivation started earlier and has a diverse range of perspectives. Various motivation or learning motivation theories have been involved, and scholars have developed learning motivation assessment tools from different angles based on their research objects and content. Biggs developed two Learning Process Questionnaires in 1987: the Learning Process Questionnaire (LPQ, with 36 items) and the Study Process Questionnaire (SPQ, with 42 items). These two questionnaires have similar dimensions and can measure three learning methods of students: surface approach, deep approach, and achieving approach, each consisting of motivation and strategy. In 2001, Biggs proposed a simplified revised version of the Study Process Questionnaire, R-SPQ-2F, with a total of 20 items, selecting only four factors from the original questionnaire: surface motivation, deep motivation, surface strategy, and deep strategy, with certain items modified and supplemented.

Another widely used tool is the Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich et al. in 1991. This self-report scale is used to assess students' autonomous learning abilities and has versions for university and high school students, both using a 7-point scoring method. The university version includes 81 items, divided into six motivation subscales and three learning strategy subscales; the high school version includes 44 items, divided into motivational beliefs (self-efficacy, intrinsic value, test anxiety) and autonomous learning strategies (cognitive learning strategies, self-regulation). Other researchers have also developed learning motivation assessment tools based on their own criteria. Nagy's 1996 Motivation to Learn Questionnaire includes four parts: parental motivation, school motivation (teachers' and classmates' motivation), intrinsic motivation, and academic self-concept (Zsolnai, 2002). The Collaborative Inquiry-based Project Questionnaire, developed by Chow and Law in 2005, consists of 40 items, primarily measuring learning self-efficacy, learning purposes, class activities, and group project activities.

In China, Most learning motivation assessment tools for students are obtained through translation and revision of foreign scales. Liu Yuexiong and Fang Ping(2006) developed a middle school students' learning motivation questionnaire based on social cognitive motivation theory, using achievement goals, academic self-efficacy, academic success or failure attribution, and achievement motivation as measurement indicators of learning motivation. Li Xiaowen (2018) divided mathematics learning motivation into internal and external motivation and further classified it into six dimensions: cognitive drive, self-efficacy, willpower, ego-enhancement drive, affiliative drive, and objective pressure, combining achievement motivation theory and self-efficacy theory. Duan Chunjuan (2019) combined Ausubel's theory with Bandura's self-efficacy theory to compile a questionnaire from five aspects: cognitive drive, ego-enhancement drive, affiliative drive, self-efficacy, and willpower, studying the mathematics learning motivation of high school students in rural areas.

Lin Wei et al. (2020)modified Anthony R. Artino Jr.'s Motivated Strategies for Learning Questionnaire (MSLQ), resulting in 31 items across six dimensions: extrinsic motivation, intrinsic motivation, task value, learning beliefs, self-efficacy, and test anxiety. They found that enhancing students' learning beliefs and self-efficacy, as well as strengthening intrinsic and extrinsic motivation, can improve students' academic performance. Some researchers have also summarized literature and theories, selected appropriate dimensions based on the actual situation of Chinese students, and self-compiled questionnaires. Li Guang (2011)preliminarily compiled an elementary school students' learning motivation test based on classic measurement theory, using both self-report and "semi-projection" tests. Each test is divided into two subtests: goal orientation (mastery-avoidance orientation, performance-approach orientation, mastery-approach orientation, performance-avoidance orientation) and achievement motivation (fear of failure motivation, pursuit of success motivation).

Zeng Xianguo (2003) classified the motivation for learning mathematics into five basic types and found that the intensity of various motivations for vocational high school students to learn mathematics, from strong to weak, was: forced motivation, ideal motivation, dependent motivation, cognitive motivation, and self-actualization motivation. Li Zhenqun (2020) developed the "High School Students' Mathematics Learning Motivation Characteristics Survey Questionnaire," which includes three dimensions: cognitive motivation, external motivation, and need for achievement in mathematics.

2.4. Research Objective

Building on the foundation of existing learning motivation assessments and recognizing the need for more specialized tools for younger demographics, this study aimed to develop and validate a predictive questionnaire tailored to measure the mathematics learning motivation of middle-grade elementary school students. Reflecting the multidimensional nature of motivation captured in contemporary research, our questionnaire incorporates dimensions such as cognitive drive, ego-enhancement drive, and affiliative drive, directly inspired by Ausubel's achievement motivation theory and adapted for cultural relevance and age appropriateness. The objective was to fill the existing gap in motivation assessment tools available for elementary students in China, providing a robust instrument that can accurately evaluate motivational constructs and potentially guide educational strategies to enhance student engagement and academic success in mathematics.

3. Method

3.1 Participants

In this study, a randomized selection process was used to choose 510 participants from the third and fourth grades at two schools: Xuefeng Elementary School located in Suzhou, Anhui Province, and Jiangzhong Elementary School in Rugao, Jiangsu Province. The selection aimed to represent the diverse student populations of these regions. Prior to data collection, comprehensive explanations of the study's objectives, procedures, and potential benefits were provided to all participants and their guardians to ensure clarity and transparency. Informed consent forms, detailing the participants' rights and the confidentiality measures in place, were distributed and signed, thereby ensuring that all participants or their legal guardians had willingly agreed to partake in the study after receiving all necessary information.

3.2 Measurement

This questionnaire was primarily compiled referring to Ausubel's achievement motivation theory. It consists of three dimensions: cognitive drive, ego-enhancement drive, and affiliative drive, with a total of 49 items. Cognitive drive refers to students' desire to cognize, understand, and master knowledge, as well as articulate and solve problems, including 26 items, such as "I am very interested in mathematics; mathematics is my hobby." Ego-enhancement drive refers to the need to win a certain social status through one's own efforts and achievements, including 14 items, such as "I study hard in mathematics to get good grades." Affiliative drive refers to the need to perform well in learning or work to obtain approval or recognition from elders (such as parents and teachers) or authorities, including 9 items, such as "I study hard in mathematics because I don't want to let down my teachers' efforts. The scale adopts a Likert 5-point scale, ranging from "Completely Disagree" to "Completely Agree," scored as 1-5 points. Students select one option based on their actual situation for each question, with higher scores representing stronger motivation. Items 4, 5, 16, 23, 32, and 34 are reversely scored.

3.3 Procedures

The study initiated with a content analysis of each item on the questionnaire, which was developed based on insights gathered from interviews with students and teachers, as well as a review of various existing questionnaires. This initial draft underwent multiple revisions by a team of eight graduate students in psychology and was rigorously evaluated by two psychology professors to ensure robust content validity. Data collection was structured into two distinct phases. The first phase involved administering the questionnaire to 129 participants to conduct independent samples t-tests and item-total correlation analyses.

This initial stage was crucial for assessing the items and selecting those that were statistically valid. The subsequent phase included a larger cohort of 381 participants to further validate the questionnaire items. This stage involved conducting additional independent samples t-tests, item-total correlation analyses, calculations of Cronbach's Alpha to assess reliability, and analyses of the correlation degrees between factors. This methodical two-phase approach was designed to ensure the questionnaire's validity and reliability in measuring the intended psychological constructs.

3.4 Data Analysis

The data analysis for this study was conducted in two sequential phases to ensure comprehensive validation of the questionnaire items. In the first phase, the questionnaire was administered to a sample of 129 participants. Statistical analysis was carried out using SPSS version 26.0 and the SPSSAU online analysis platform to perform independent samples t-tests and item-total correlation analyses. These techniques were employed to identify and refine statistically valid items. In the second phase, the study expanded to include 381 participants, providing a broader base to verify the initial findings. This phase involved further application of independent samples t-tests and item-total correlations, supplemented by reliability testing through Cronbach's Alpha and correlation analyses among different factors. These analyses were crucial in assessing the internal consistency of the questionnaire and the interrelationships among the measured constructs, ensuring the tool's reliability and validity for subsequent educational and psychological assessments.

4. Results and Discussions

4.1 The First Phase

In the initial phase of this research, Study 1 involved a total of 129 participants, each responding to a questionnaire consisting of 49 items.

a. Critical Ratio Value

The participants' responses were sorted by total scores, designating the top 27% to the high-score group and the bottom 27% to the low-score group. An independent samples t-test was conducted for each of the 49 items to assess the differences between these groups. As presented in **Table 1**, all items showed significant t-values, indicating marked differences across all items between the high and low-score groups. This statistical validation led to the decision to retain all 49 items for further analysis.

b. Item-Total Correlation

Critical ratio values, while valuable, are not sufficient on their own for comprehensive item analysis. Item-total correlation is another crucial metric that evaluates the relationship between individual item scores and the aggregate score of the questionnaire. This metric is essential for assessing whether items are congruent with the overall construct, with higher correlations indicating a well-integrated item. In this research, correlation analysis was performed on the 49 items of the questionnaire. As shown in **Table 2**, most items demonstrated correlation coefficients above the 0.3 threshold, suggesting strong construct alignment. Exceptions were items 16 and 43, which had correlations below 0.3 and were subsequently removed from the questionnaire. This left a refined set of 47 items for further investigation in Study 2.

c. Reliability Analysis

Reliability testing was conducted on the 47 items retained after the item-total correlation analysis. This evaluation yielded a Cronbach's Alpha coefficient of 0.957, demonstrating that the questionnaire exhibits excellent reliability for subsequent applications.

4.2 The Second Phase

During the second phase of the study 2, 381 valid questionnaires were organized by their total scores. each responding to a questionnaire consisting of 47 items.

a. Critical Ratio Value

The highest scoring 27% were placed in the high group, and the lowest scoring 27% in the low group. Subsequently, independent samples t-tests were applied to each of the 47 items retained from the first phase for these groups. The findings, presented in Table 4, consistently showed significant t-values across all items, confirming distinct differences between the high and low scoring groups.

Table 1. Critical Ratio Values for Each Questionnaire Item in Study 1

Items	*t*	Items	*t*	Items	*t*	Items	*t*
Q1	6.191***	Q14	9.585***	Q27	7.242***	Q40	9.743***
Q2	3.309***	Q15	9.629***	Q28	5.979***	Q41	4.939***
Q3	6.931***	Q16	1.461***	Q29	7.258***	Q42	8.035***
Q4	5.284***	Q17	3.532**	Q30	5.552***	Q43	3.153**
Q5	3.379**	Q18	9.010***	Q31	8.213***	Q44	7.681***

Q6	8.367***	Q19	11.388***	Q32	2.330*	Q45	10.346***
Q7	7.061***	Q20	7.596***	Q33	10.146***	Q46	7.564***
Q8	9.766***	Q21	11.338***	Q34	2.908**	Q47	6.614***
Q9	5.399***	Q22	9.225***	Q35	9.387***	Q48	7.102***
Q10	9.723***	Q23	2.695**	Q36	3.465**	Q49	10.392***
Q11	5.400***	Q24	5.528***	Q37	10.363***		
Q12	9.284***	Q25	8.306***	Q38	8.776***		
Q13	7.907***	Q26	8.930***	Q39	9.195***		

***p<0.001, **p<0.01, *p<0.05

Table 2. Correlation Coefficients between Individual Items and the Total Score

Items	***r***	**Items**	***r***	**Items**	***r***	**Items**	***r***
Q1	0.693**	Q14	0.571**	Q27	0.575**	Q40	0.737**
Q2	0.525**	Q15	0.635**	Q28	0.563**	Q41	0.475**
Q3	0.601**	Q16	0.248**	Q29	0.709**	Q42	0.570**
Q4	0.543**	Q17	0.336**	Q30	0.599**	Q43	0.249**
Q5	0.432**	Q18	0.794**	Q31	0.499**	Q44	0.693**
Q6	0.675**	Q19	0.719**	Q32	0.324**	Q45	0.812**
Q7	0.459**	Q20	0.634**	Q33	0.711**	Q46	0.706**
Q8	0.638**	Q21	0.694**	Q34	0.342**	Q47	0.718**
Q9	0.640**	Q22	0.597**	Q35	0.625**	Q48	0.579**
Q10	0.658**	Q23	0.314**	Q36	0.349**	Q49	0.747**
Q11	0.497**	Q24	0.515**	Q37	0.777**		
Q12	0.584**	Q25	0.500**	Q38	0.614**		
Q13	0.525**	Q26	0.683**	Q39	0.725**		

***p<0.001, **p<0.01, *p<0.05

This led to the decision to retain all 47 questionnaire items for further evaluation. **Table 3** showed the critical ratio values for each of the 47 items on the questionnaire. These values confirm the items' effectiveness in distinguishing between the different groups, validating the structural integrity of the questionnaire.

b. Item-Total Correlation

Correlation analysis was performed to assess the relationship between the 47 items retained from previous analyses and the total score of the questionnaire. The results, displayed in **Table 4**, indicated that the correlation coefficients for items 4, 22, and 31 were below the threshold of 0.3, suggesting insufficient alignment with the overall construct. Consequently, these items were excluded from the questionnaire. In contrast, the correlation coefficients for all other items exceeded 0.3, affirming their appropriateness for inclusion in the final instrument.

c. Reliability Analysis

Reliability analysis was performed on the 44 items that were retained after item deletion based on the item-total correlation analysis. This assessment yielded a Cronbach's Alpha coefficient of 0.949, indicating high reliability of the questionnaire. Additionally, the Cronbach's Alpha coefficients for the four distinct dimensions—Cognitive Drive, Self-Enhancement Drive, Affiliated Drive, and the overall questionnaire score—were all above 0.7, further confirming the reliability of each dimension. Detailed reliability coefficients are presented in **Table 5**.

d. Correlation Coefficients between Factors

In line with psychological measurement theory, this study examined the correlations among the different dimensions of the questionnaire to assess construct validity. Ideally, each dimension should moderately correlate with the others, demonstrating that each contributes uniquely to the overall scale while maintaining distinctiveness. Moreover, the correlations between each dimension and the total questionnaire score should exceed those among the dimensions themselves, an indicator of good construct validity.

For a well-structured questionnaire, correlations between dimensions and the total score are expected to range from 0.3 to 0.8, while inter-dimensional correlations should lie between 0.1 and 0.6. The findings from this study, as displayed in **Table 6**, affirm that the questionnaire meets these criteria, thereby confirming its construct validity. These correlations provide strong evidence that the questionnaire is well-constructed, with each factor contributing significantly to the overall measure and retaining sufficient independence to justify their separate inclusion.

This study's classification of learning motivation into cognitive drive, self-enhancement drive, and affiliated drive, as informed by the theoretical frameworks of Ausubel and the broad discourse on motivational dynamics, offers a sophisticated approach to understanding how different types of motivation impact academic achievement (Cheng Hong, Liu; Ching Yuan, Chang; Ting Yen, Hsu; Chiu, 2005). These categories reflect a deep appreciation for the complex and multifaceted nature of motivation, acknowledging both internal and external origins as well as their capacities to be enduring or superficial. The nuanced approach to motivational classification acknowledges the dichotomous nature of motivation, as discussed in broader educational psychology literature, including intrinsic versus extrinsic motivation, and general versus specific motivation(Zhou, 2011). This complexity is crucial in interpreting how motivational factors influence learners in specific and general contexts, affecting both short-term engagement and long-term educational outcomes.

Table 3. Critical ratio values for each item in the questionnaire

Items	*t*	Items	*t*	Items	*t*	Items	*t*
Q1	12.94***	Q13	14.03***	Q25	18.54***	Q37	12.99***
Q2	13.47***	Q14	18.47***	Q26	9.15***	Q38	15.69***
Q3	11.01***	Q15	21.15***	Q27	12.79***	Q39	15.79***
Q4	4.58***	Q16	11.12***	Q28	14.94***	Q40	11.15***
Q5	5.53***	Q17	16.84***	Q29	11.25***	Q41	11.47***
Q6	15.03***	Q18	15.48***	Q30	14.25***	Q42	12.31***
Q7	8.77***	Q19	9.42***	Q31	4.47***	Q43	16.00***
Q8	10.77***	Q20	16.21***	Q32	15.32***	Q44	13.83***
Q9	9.15***	Q21	13.71***	Q33	5.14***	Q45	11.69***
Q10	17.55***	Q22	3.24**	Q34	17.39***	Q46	14.74***
Q11	11.16***	Q23	9.91***	Q35	9.80***	Q47	17.42***
Q12	11.87***	Q24	12.27***	Q36	19.02***		

Table 4. Correlation Coefficients between Each Item and the Total Score

Items	***r***	**Items**	***r***	**Items**	***r***	**Items**	***r***
Q1	0.630**	Q13	0.514**	Q25	0.664**	Q37	0.563**
Q2	0.576**	Q14	0.676**	Q26	0.408**	Q38	0.637**
Q3	0.570**	Q15	0.697**	Q27	0.548**	Q39	0.712**
Q4	0.245**	Q16	0.472**	Q28	0.680**	Q40	0.555**
Q5	0.325**	Q17	0.737**	Q29	0.596**	Q41	0.524**
Q6	0.633**	Q18	0.613**	Q30	0.528**	Q42	0.623**
Q7	0.408**	Q19	0.435**	Q31	0.247**	Q43	0.741**
Q8	0.443**	Q20	0.659**	Q32	0.713**	Q44	0.708**
Q9	0.598**	Q21	0.555**	Q33	0.305**	Q45	0.637**
Q10	0.667**	Q22	0.236**	Q34	0.651**	Q46	0.667**
Q11	0.446**	Q23	0.580**	Q35	0.434**	Q47	0.679**
Q12	0.452**	Q24	0.500**	Q36	0.644**		

Table 5. Reliability in study 2

Dimension	**Cognitive Drive**	**Self-Enhancement Drive**	**Affiliated Drive**	**Total**
Alpha	0.919	0.857	0.785	0.949

Table 6. Correlation between Factors and the Total Questionnaire

	factor1	**factor2**	**factor3**
factor1	1		
factor2	0.776**	1	
factor3	0.726**	0.806**	1
total	0.959**	0.900**	0.848**

***p<0.001, **p<0.01, *p<0.05

Our methodical item analysis aimed to refine the questionnaire by removing items that failed to discriminate effectively between different levels of motivation. This was based on comparing the mean scores of items between students with relatively high and low total scores. This rigorous approach to item analysis ensures that the questionnaire is both efficient and capable of capturing essential aspects of motivation as evidenced by its ability to distinguish between high and low scorers. Throughout Study 1 as the first phase, and Study 2 as the second phase, the study meticulously assessed the reliability and validity of the questionnaire. Initial reliability tests in Study 1 led to the removal of items with insufficient correlation coefficients, enhancing the tool's focus and effectiveness. Study 2 further refined the instrument, ensuring that all retained items displayed strong correlations with the total score, thus confirming their relevance and contribution to the overall construct of learning motivation.

By adopting this methodological rigor, the study aligns with the historical context and contemporary needs highlighted by researchers like Biggs (2001), who developed and refined educational tools to assess learning strategies and motivation across various educational stages. Our study extends this tradition by focusing specifically on younger learners, addressing a notable gap in the existing assessment tools that often overlook the unique motivational profiles of elementary students.(Lin, Wei; Huang, Binxin; Qian, Qian; Huang, 2020). In conclusion, this comprehensive approach not only corroborates the multidimensional nature of learning motivation described by Maslow and Atkinson but also enhances our understanding of how motivation functions in educational settings. The successful application and validation of this questionnaire offer a valuable resource for educators and psychologists seeking to foster an environment that nurtures both the cognitive and emotional development of young learners.

This study's primary limitation is its geographic and demographic specificity, focusing only on middle-grade elementary students from two regions in China, which may restrict the generalizability of the results to other settings. Additionally, its cross-sectional design does not capture changes in student motivation over time, limiting the ability to observe developmental and longitudinal dynamics in motivational changes. Future research should broaden the demographic and geographic scope of the study and include longitudinal elements to track changes in motivation over time. Confirmatory Factor Analysis (CFA) is recommended to further validate the questionnaire's measurement model and ensure the constructs' robustness across various populations. This approach will deepen the understanding of motivational structures and enhance educational practices by confirming the tool's efficacy in diverse educational contexts.

5. Conclusions

This study has successfully developed and validated the "Mathematics Learning Motivation Questionnaire for Middle-Grade Elementary School Students," which effectively measures the mathematics learning motivation through three distinct dimensions: cognitive drive, self-enhancement drive, and affiliated drive. The questionnaire has demonstrated basic reliability and validity, making it a valuable tool for future educational research focused on enhancing mathematical engagement among elementary students. However, the study faced limitations due to its regional focus on schools in Nanjing, Nantong, and Hefei, which restricts the external validity of the findings and limits their generalizability to other regions or broader demographic groups. Additionally, time constraints during the study's design phase resulted in a tool that, while effective, may still lack optimal discriminant validity. These limitations suggest the need for further refinement of the questionnaire and expanded research to include a broader geographic sample and more rigorous validity testing. Future studies are encouraged to broaden the demographic and geographic scope of the research, include longitudinal elements to capture changes in motivation over time, and employ confirmatory factor analysis to ensure the robustness of the questionnaire's constructs across different populations. By addressing these areas, subsequent research can contribute to a more nuanced understanding of educational motivation, enhancing the ability to effectively support student learning and achievement in diverse educational settings.

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