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The Non-Intellectual Norm of Middle School Students' Mathematics Learning and Its Grade Evaluation Standard: Taking Tianjin as an Example

Guangming Wang,[1] Jian Li,[2] Jingxian Jian[3]

1. *Tianjin Normal University, Tianjin 300387, China*
2. *People's Education Press, Beijing 100081, China*
3. *Nankai Elementary School, Tianjin Eco-City, Tianjin 300467, China*

Abstract. *Using the "Middle School Student Mathematics Learning Non-intellectual Questionnaire," a total of 1,400 middle school students in 11 districts and counties of Tianjin were surveyed. According to the data, using the raw score normalization method and the formula "T = 50+10×Z", the non-intellectual overall and sub-dimension norm table of middle school student math learning were established, and the corresponding grade evaluation standard was determined. Using the results of this study, two types of application case analysis of class and individual were carried out, and corresponding suggestions were put forward based on the analysis results.*

Best Evidence in Chinese Education 2021; 7(1):907-922.
Doi: 10.15354/bece.21.ar007.

How to Cite*: Wang, G., Li, J. & Jian, J. (2021). The non-intellectual norm of middle school students' mathematics learning and its grade evaluation standard: Taking Tianjin as an example. Best Evidence in Chinese Education, 7(1):907-922.*

Keywords*: Middle School Student; Mathematics; Non-Intellectual; Norm; Grade Evaluation Standard*

About the Authors: *Jian Li, Postdoctoral Research Station Researcher, Institute of Curriculum and Textbooks, People's Education Press, Beijing 100081, China. Email: 471460647@qq.com;*

About the Authors: *Jingxian Jian, Math Teacher, Nankai Elementary School, Tianjin Eco-City, Tianjin 300467, China. Email: 541151139@qq.com.*

Correspondence to: *Guangming Wang, Professor, Chief, Faculty of Education, Tianjin Normal University, Tianjin 300387, China. Email: bd690310@163.com.*

Funding: *This study was supported by the Tianjin Teaching Achievement Cultivation Project "Development and Practical Application of Mathematics Learning Evaluation Tools" (project #: PYJJ-036).*

Conflict of Interests*: None.*

NON-INTELLECTUAL factors, as an essential part of influencing students' learning and development, have received extensive attention in the fields of education and psychology. Studies have shown that there is a positive correlation between non-intellectual factors of mathematics learning and mathematics academic performance (Lv et al., 1995; Wang, 2004; Zhang, 2012). Besides, non-intellectual factors are important influencing factors of mathematics learning efficiency (Wang et al., 2014; Wang et al., 2015; Wang et al., 2017; Wang & Yang, 2015). Although there are many non-intellectual evaluations of middle school students' mathematics learning in previous studies (Cao et al., 2015; Yang et al., 2015), they lacked a unified evaluation basis and reference, and the measurement results cannot be analyzed under the same reference standard. Therefore, it is indispensable to study the non-intellectual norm of middle school students in mathematics. Based on the "Middle School Student Mathematics Learning Non-intellectual Questionnaire," this study established the middle school student math learning non-intellectual norm and its grade evaluation standard and conducted a case analysis of this result.

Methods

Research Tools

This study chose the "middle school student math learning non-intellectual questionnaire" as the survey tool. The questionnaire is a five-level Likert scale, consisting of five main dimensions (motivation, emotion, attitude, willpower, personality) and polygraph questions, all of which have good reliability and validity (Wang & Li, 2020).

Sample Selection

The study selected 1,400 6th- and 7th-grade students in 11 districts and counties of Tianjin to conduct a survey, and a total of 1,400 questionnaires were returned. First, through manual inspection, 56 questionnaires with regular and identical answers were deleted; then, 58 invalid questionnaires were deleted with the help of polygraph questions, and finally, 1,286 valid questionnaires were obtained, with an effective rate of 91.86%.

Data Processing

When entering data, the A-E options were counted as 5-1 point, and the reverse questions were counted as 1-5 points. After data entry was completed, use SPSS software for data processing. Calculating the sufficient sample's percentile rank determined the correspondence between the original score and the percentile rank. And then checked the normal distribution table with the help of percentile rank to get its corresponding standard score. To ensure the convenience of reading the score, the standard score was converted using the formula "$T=50+10\times Z$" to establish a non-intellectual norm table.

Table 1. Non-Intellectual Level Evaluation Standards for Mathematics Learning.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 128	PR < 3.27
Middle and Lower	32 ≤ T < 44	128 ≤ X < 157	3.27 ≤ PR < 26.83
Middle	44 ≤ T < 56	157 ≤ X < 181	26.83 ≤ PR < 70.53
Middle and Upper	56 ≤ T < 68	181 ≤ X < 201	70.53 ≤ PR < 95.80
Excellent	T ≥ 68	X ≥ 201	PR ≥ 95.80

Table 2. "Motivation" Dimension Grade Evaluation Standards.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 31	PR < 3.27
Middle and Lower	32 ≤ T < 44	31 ≤ X < 40	3.27 ≤ PR < 25.74
Middle	44 ≤ T < 56	40 ≤ X < 47	25.74 ≤ PR < 69.52
Middle and Upper	56 ≤ T < 68	47 ≤ X < 54	69.52 ≤ PR < 96.19
Excellent	T ≥ 68	X ≥ 54	PR ≥ 96.19

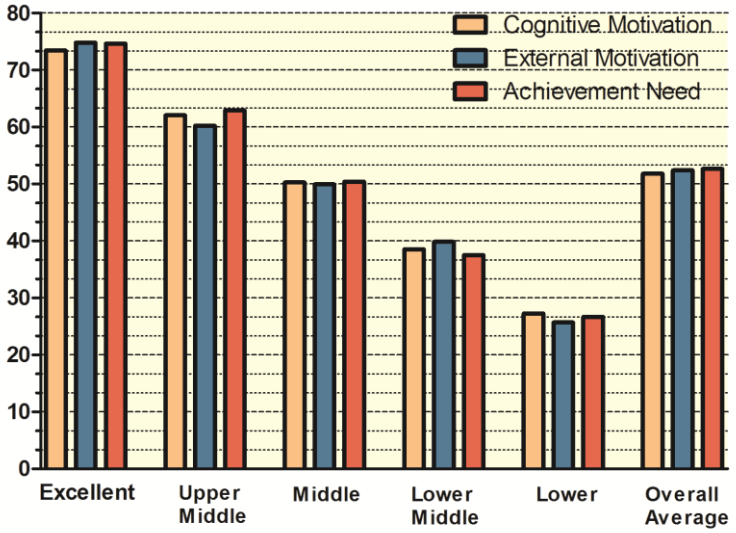

Figure 1. The T-Score Chart of the Sub-Dimension of the "Motivation".

According to the normal distribution theory, 99.74% of the values under the standard normal distribution fall within the interval [-3, 3], so first divided [-3, 3] into five equal intervals, and then used the formula "T=50+ 10×Z" to get the corresponding T score interval, and then divided it into five different levels. Finally, the T score interval was converted into a percentile grade interval to complete the grade evaluation standard's establishment.

Results

Mathematics Learning Non-Intellectual Norm and Its Grade Evaluation Standard

A middle school student's mathematics learning non-intellectual norm (table omitted) and its corresponding Grade Evaluation Standard (see **Table 1**) are established according to the norm's construction method through data sorting and analysis. The research was carried out from five main dimensions to diagnose the non-intellectual influence of students' mathematics learning more precisely.

"Motivation" Dimension Norm and Its Grade Evaluation Standard

According to the norm construction method, we established the "motivation" dimension norm (table omitted). Second, divided the "motivation" dimension horizontally, and then formulated the corresponding grade evaluation standard (see **Table 2**). Finally, we calculated the average scores of students of different levels in the sub-dimensions of "cognitive motivation," "extrinsic motivation," and "achievement need" under the "motivation" dimension (see **Figure 1**).

Based on **Figure 1**, combined with the definition of the concepts and questions of the sub-dimensions of mathematics learning motivation (Wang & Li, 2020), students of different levels have the following characteristics: "Excellent" students are curious about mathematics and like to study and explore; They have a vital purpose in learning mathematics and are eager to highlight their talents in mathematics learning. "Middle and upper" students are interested in exploring mathematics knowledge, are motivated to learn, and like to participate in activities that can show their mathematics learning ability. "Middle" students have specific goals and motivation to learn mathematics and show interest in learning mathematics and a desire to succeed. "Middle and lower" students do not like to participate in math learning activities, show less desire for performance, do not like inquiry, and are more inclined to accept learning. "Low-level" students lack interest in mathematics learning, hardly participate in math learning activities, and are unwilling to show their mathematics learning ability.

Table 3. "Emotion" Dimension Grade Evaluation Standard.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 25	PR < 3.03
Middle and Lower	32 ≤ T < 44	25 ≤ X < 33	3.03 ≤ PR < 23.59
Middle	44 ≤ T < 56	33 ≤ X < 41	23.59 ≤ PR < 72.08
Middle and Upper	56 ≤ T < 68	41 ≤ X < 48	72.08 ≤ PR < 96.35
Excellent	T ≥ 68	X ≥ 48	PR ≥ 96.35

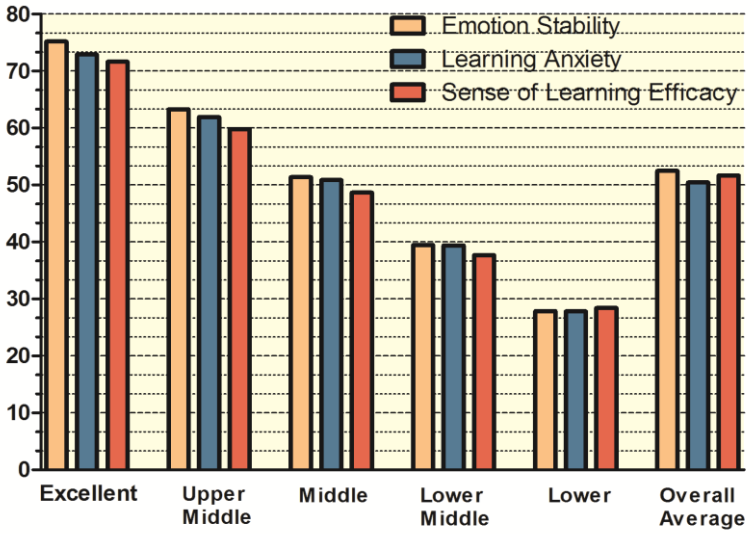

Figure 2. The T-Score Chart of the Sub-Dimension of the "Emotion".

Table 4."Attitude" Dimension Grade Evaluation Standard.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 32	PR < 3.19
Middle and Lower	32 ≤ T < 44	32 ≤ X < 39	3.19 ≤ PR < 24.57
Middle	44 ≤ T < 56	39 ≤ X < 45	24.57 ≤ PR < 69.75
Middle and Upper	56 ≤ T < 68	45 ≤ X < 49	69.75 ≤ PR < 93.39
Excellent	T ≥ 68	X ≥ 49	PR ≥ 93.39

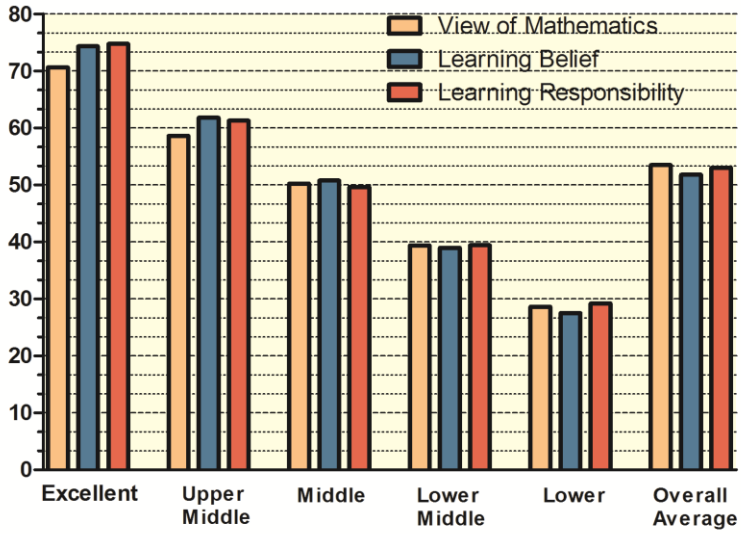

Figure 3. The T-Score Chart of the Sub-Dimension of the "Attitude".

Table 5. "Willpower" Dimension Grade Evaluation Standards.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 17	PR < 2.72
Middle and Lower	32 ≤ T < 44	17 ≤ X < 23	2.72 ≤ PR < 25.27
Middle	44 ≤ T < 56	23 ≤ X < 28	25.27 ≤ PR < 72.38
Middle and Upper	56 ≤ T < 68	28 ≤ X < 32	72.38 ≤ PR < 96.35
Excellent	T ≥ 68	X ≥ 32	PR ≥ 96.35

Table 6. "Personality" Dimension Grade Evaluation Standards.

Grade	T Score	Raw Score X	Percentile Rank PR
Low-Level	T < 32	X < 15	PR < 3.27
Middle and Lower	32 ≤ T < 44	15 ≤ X < 20	3.27 ≤ PR < 26.59
Middle	44 ≤ T < 56	20 ≤ X < 24	26.59 ≤ PR < 71.23
Middle and Upper	56 ≤ T < 68	24 ≤ X < 27	71.23 ≤ PR < 92.22
Excellent	T ≥ 68	X ≥ 27	PR ≥ 92.22

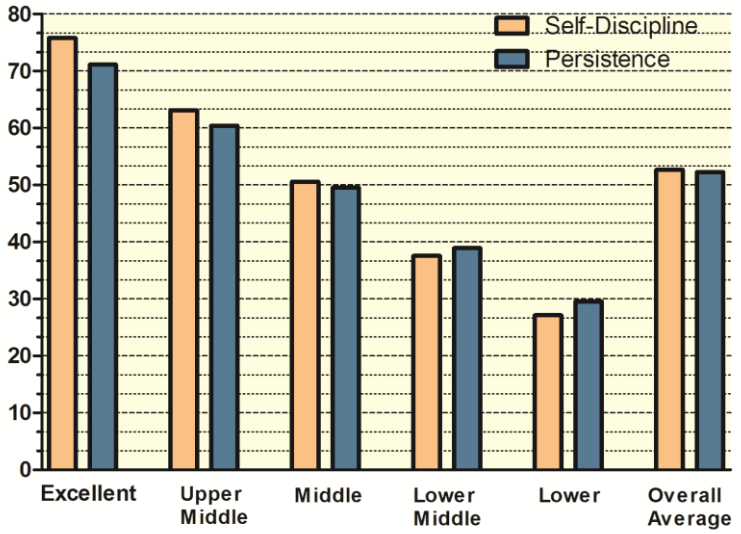

Figure 4. The T-Score Chart of the Sub-Dimension of the "Willpower".

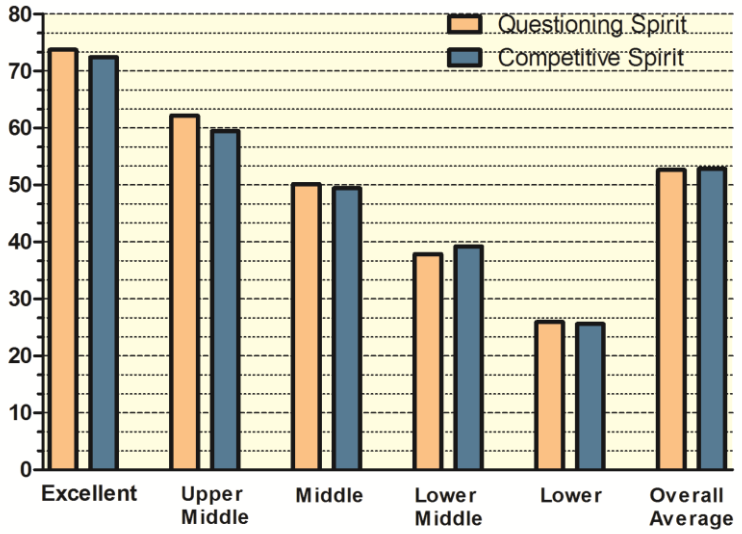

Figure 5. The T-Score Chart of the Sub-Dimension of the "Personality".

"Emotion" Dimension Norm and Its Grade Evaluation Standard

First, establish the "emotion" dimension norm according to the norm construction method (table omitted). Secondly, divide the "emotion" dimension horizontally, and then formulate the corresponding grade evaluation standard (see **Table 3**). Finally, calculate the average scores of students of different levels in the sub-dimensions of "emotional stability," "learning anxiety," and "learning efficacy" under the "emotion" dimension (see **Figure 2**).

Based on **Figure 2**, combined with the conceptual definition and questions of each sub-dimension of emotion (Wang & Li, 2020), it was found that students of different levels have the following characteristics: "Excellent" students have reasonable control over their emotions and can effectively control and regulate their emotions; they like to learn mathematics, basically do not have negative emotions, and have a high sense of learning efficiency. "Middle and upper" level students understand themselves and occasionally produce destructive emotions but can control and adjust them in time; they have less negative emotions when learning mathematics, they recognize their ability to learn mathematics, and have the confidence to learn math well. "Middle" students can be aware of their destructive emotions and control them, but will not adjust them; they will become anxious because they are worried about not being able to learn mathematics and are optimistic about their ability to learn mathematics, but think they need to work hard. "Middle and lower" students can perceive their own deficient or excessive emotions, but they cannot control and regulate them well and need help from others. They will have negative emotions such as fear and tension when they study mathematics, and they lack confidence in their math level. "Low-level" students will have deficient or excessive emotions due to learning mathematics, but they can hardly perceive and control their emotions and need guidance from others; they have repulsive emotions toward math learning and lack positive emotional experience.

"Attitude" Dimension Norm and Its Grade Evaluation Standard

According to the norm construction method, establish the "attitude" dimension norm (table omitted). Secondly, divide the "attitude" dimension horizontally, and then formulate the corresponding grade evaluation standard (see **Table 4**). Finally, calculate the average scores of students of different levels in the sub-dimensions of "view of mathematics," "belief in learning," and "sense of learning responsibility" under the "attitude" dimension (see **Figure 3**).

Based on **Figure 3**, combined with the concept definition and questions of each sub-dimension of attitude (Wang & Li, 2020), it is found that students of different levels have the following characteristics: "Excellent" students believe that mathematics is a valuable subject; mathematics learning should be systematic and comprehensive, and rules and skills need to be summarized in time; learning mathematics must emphasize

methods, strive to avoid errors, and always actively complete mathematics tasks with quality and quantity. The "Middle and upper" level students have a more objective understanding of mathematics knowledge and value; they believe that learning mathematics must know how to summarize the methods that suit them and actively complete math learning tasks. "Middle" students can correctly understand mathematics and the meaning of learning mathematics, but their learning enthusiasm is average; they think that learning mathematics does not require too many skills, and students can complete learning tasks but lack initiative. "Middle and lower" students have a somewhat subjective and one-sided understanding of mathematics knowledge and value; they believe that they can learn mathematics by rote and can complete their learning tasks under supervision. "Low-level" students have some deviations in their understanding of mathematics; they think that learning mathematics is meaningless and cannot understand mathematics more profoundly, and they think that mathematics learning does not need to be methodological and hardly complete the learning tasks actively.

"Willpower" Dimension Norm and Its Grade Evaluation Standard

According to the norm construction method, establish the dimension norm of "willpower" (table omitted). Secondly, divide the dimension of "willpower" horizontally, and then formulate the corresponding grade evaluation standard (see **Table 5**). Finally, calculate the average scores of students of different levels in the sub-dimensions of "self-discipline" and "persistence" under the "willpower" dimension (see **Figure 4**).

Based on **Figure 4**, combined with the definition of the concepts and questions of the sub-dimensions of willpower (Wang & Li, 2020), it is found that students of different levels have the following characteristics: "Excellent" students can formulate corresponding math learning plans and review plans based on their own and can complete learning tasks in strict accordance with the plan and review them in time, never give up quickly, and have a persevering learning spirit. "Middle and upper" level students are able to complete their self-made study plan more seriously, remind themselves to concentrate when studying mathematics, maintain a state of listening carefully, and be able to persist in studying mathematics. "Middle" students can basically implement their mathematics learning plan, and sometimes the plan will fail or appear without conscientiousness; when learning mathematics, they cannot maintain the learning state for a long time and occasionally need teacher reminders. "Middle and lower" students will occasionally implement mathematics study plans carefully; they cannot guarantee full energy, comfortable slack, and lack of perseverance when studying mathematics. "Low-level" students seldom study and review as planned and hardly make a study plan; they tend to get distracted when studying mathematics and tend to give up or escape when they encounter learning difficulties.

"Personality" Dimension Norm and Its Grade Evaluation Standard

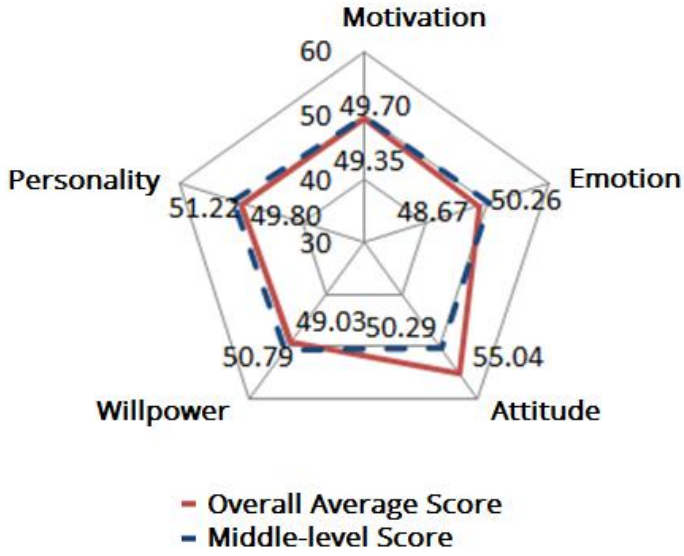

Figure 6. The T-Score Chart of Five Main Dimensions of Non-Intellectual Mathematics Learning of the Tested Class.

According to the norm construction method, establish the "personality" dimension norm (table omitted). Secondly, divide the "personality" dimension horizontally, and then formulate the corresponding grade evaluation standard (see **Table 6**). Finally, calculate the average scores of students of different levels in the sub-dimensions of "questioning spirit" and "competitive spirit" under the "personality" dimension (see **Figure 5**).

Based on **Figure 5**, combined with the definition of the concept of each sub-dimension of personality and the questions (Wang & Li, 2020), it is found that students of different levels have the following characteristics: "Excellent" students are good at asking questions; when they are inconsistent with others or books, they dare to question teachers or authorities; they are not to be left behind in mathematics learning, strive to show themselves, be aggressive, and eager to surpass others. "Middle and upper" students, when they are inconsistent with others or books, often have questions, ask questions, like competition, and hope to surpass other students. "Middle" students can show a psychological tendency to surpass others, and occasionally ask questions when their views are inconsistent with those of others or books. "Middle and lower" students occasionally have questions when studying mathematics, but they rarely raise doubts; although they want to surpass others in mathematics learning, they are not good at expressing themselves. "Low-level" grade students are not good at expressing their opinions, basically do not ask questions, have no willingness to show, surpass others, and do not care about math scores.

Application Cases of Norm and Grade Evaluation Standard

Class Application Case

Non-Intellectual Diagnosis of Mathematics in the Subject's Class

In this study, a total of 44 7th-grade students from Tianjin of China were selected as subjects, and 40 valid questionnaires were returned, with an effective rate of 90.9%. The 40 students in the class were regarded as a whole, and a comparative analysis with the students in the city was carried out to understand the group's general level of non-intellectual mathematics learning. The original non-intellectual average score of mathematics learning among the subjects was 166.10, which exceeded 42.15% of middle school students in Tianjin of China. Comparing it with **Table 1**, the subjects' non-intellectual mathematics learning was at the middle level in Tianjin. The non-intellectual dimension T scores of the subjects in mathematics learning were: 49.70 (motivation), 48.67 (emotion), 55.04 (attitude), 49.03 (willpower), 49.80 (personality). Starting from the five main dimensions, further diagnosis and analysis of the subject class were made. From **Figure 6**, in the dimension of motivation, the subject's class was equivalent to the "middle" level of middle school students in Tianjin; it was slightly lower than the "middle" level of middle school students in the city in terms of emotion, willpower, and personality; The class of the subjects was significantly higher than the "middle" level of the city's middle school students.

Suggestions for Improvement of Non-Intellectual Mathematics Learning in the Tested Class

The analysis shows that the subjects' non-intellectual math learning is at the "middle" level in Tianjin as a whole, and the five main dimensions of motivation, emotion, attitude, willpower, and personality are all at the "middle" level in Tianjin. Overall, the students in this class have a strong sense of responsibility for learning and are competitive; their learning anxiety, persistence, and questioning spirit are slightly lower than Tianjin's "middle" level. In mathematics teaching, teachers should enhance students' perception of the intrinsic value and fun of mathematics learning and guide students to effectively regulate and monitor their learning activities through positive learning attitudes and emotional experience (Du & Liu, 2017). It is also suggested that the teacher make full use of the students' strong sense of responsibility and competitive spirit. Studying mathematics often encounters difficult problems, and some students tend to be afraid of difficulties and give up. In response to this kind of phenomenon, on the one hand, teachers can provide students with "scaffolding" to reduce the difficulty of the problem; on the other hand, they can help students improve their ability to learn math-

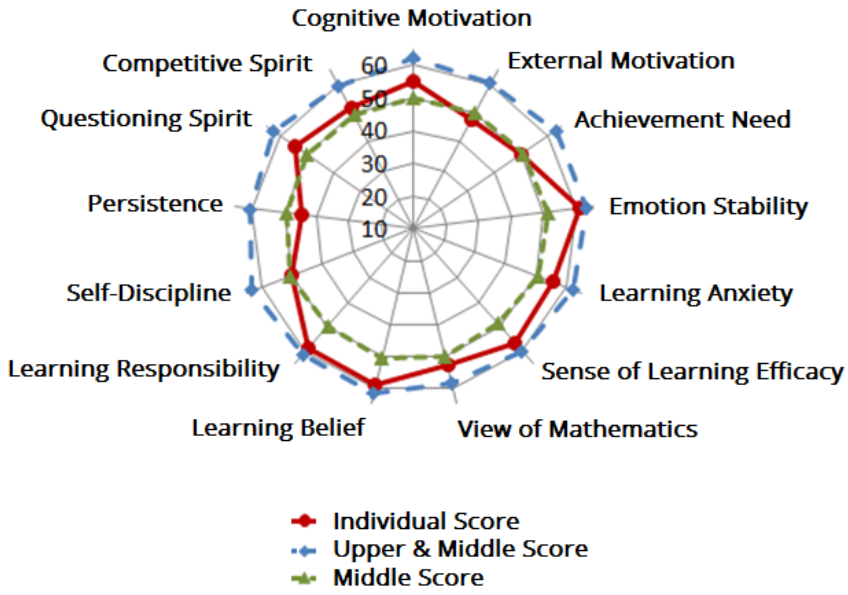

Figure 7. The T-Score Chart of the 13 Sub-Dimensions of Non-Intellectual Mathematics Learning of Individual Subjects.

ematics to achieve the purpose of solving problems. Besides, teachers should also pay attention to encouraging students to speak positively, question boldly, and always pay attention to students' psychological state to help students with learning difficulties deal with destructive emotions in time.

Individual Application Cases

Non-Intellectual Diagnosis of Subject's Individual Mathematics Learning

After understanding the situation with the tested class's mathematics teacher and obtaining the students' consent, a tested class student who had studied hard but had not satisfactory results was selected as the research object. The non-intellectual dimension T scores of the student's mathematics were: 55.10 (cognitive motivation), 47.60 (external motivation), 50.30 (achievement need), 61.60 (emotional stability), 55.60 (learning anxiety), 56.90 (sense of learning efficacy), 52.80 (view of mathematics), 59.30 (learning belief), 58.80 (learning responsibility), 49.80 (self-discipline), 44.70 (persistence), 54.30 (competitive spirit), 51.60 (questioning spirit). The overall original average score of the student's non-intellectual math learning was 176. According to **Table 1**, he was

at the "middle" level of Tianjin middle school student, and further diagnosis and analysis of each sub-dimension would be continued.

Figure 7 shows the T scores of the thirteen sub-dimensions of non-intellectual mathematics learning. Simultaneously, combined with the data analysis in **Table 2** to **Table 6**, this student's cognitive motivation was significantly higher than the city's "middle" students' level. The external motivation was slightly lower than the level of the city's "middle" students. Achievement needs to be comparable to the average level of the city's "intermediate" students. The students' emotional stability, learning anxiety, and sense of learning efficacy were significantly higher than the city's "middle" level students but slightly lower than the city's "middle and upper" level students. The students' learning beliefs and responsibility was slightly lower than the city's "middle and upper" students and significantly higher than the city's "middle" level students. The student's view of mathematics was slightly higher than the level of the city's "middle" students and lower than the city's "middle and upper" students. The student's self-discipline was slightly lower than the city's "middle" level students, and its persistence was lower than the city's "middle" level students. The students' questioning spirit and competitive spirit were slightly higher than those of the city's "middle" level students.

Suggestions for Non-Intellectual Improvement of Subject' Individual Mathematics Learning

The non-intellectual level of the student's mathematics learning is at the "middle" level in Tianjin, and the dimensions of motivation, willpower, and personality are all at the "middle" level in Tianjin, while the two dimensions of emotion and attitude are at the "middle" level in Tianjin. The analysis shows that this student's external motivation sub-dimensions and persistence sub-dimensions need to be further improved. Studies have shown that learning motivation can directly affect academic achievement and indirectly affect academic achievement by transforming motivations and learning behavior (Gao & Chen, 2017). Therefore, learning motivation can directly or indirectly affect students' mathematics learning performance. So it is necessary to strengthen students' learning motivation for students' math learning.

The external motivations of students' math learning mainly come from schools, teachers, and parents. Many schools will commend students with outstanding performance or progress, which is an effective way to strengthen students' external motivation. In addition, because students' persistence in learning is affected by many factors, teachers and parents can also stimulate their motivation through spiritual rewards. When students learn mathematics, teachers and parents should be good at discovering students' progress and shining points and giving timely praise and encouragement to be spiritually encouraged and affirmed and then more motivated to learn mathematics. Simultaneously, teachers are the guides and collaborators of students, and they have a significant influence on students (Gao & Chen, 2017). In the process of mathematics learning, teachers should consciously cultivate students' perseverance character; pay attention to the differences between individuals and teach students per their aptitude;

encourage students to find role models in the class and learn from the students with strong willpower around them; thereby creating a good class learning atmosphere.

Establish a non-intellectual norm for middle school students' math learning, so as to facilitate the comparison between different dimensions of non-intellectual factors of students' math learning. After the subjects were tested, some studies only performed descriptive statistics and level comparisons of questionnaire scores. It is difficult to use the scores of subjects to explain their objective performance level on non-intellectual. This research makes up for this deficiency. However, norm research results have certain regional and time-sensitive limitations. These research results are based on middle school students in Tianjin of China, so they can only be used for reference in Tianjin and other areas with similar education levels. With the rapid development of the times, the non-intellectual factors of students' mathematics learning in different periods may also undergo group changes. Therefore, the norm and grade evaluation standard established by our study need to be updated regularly.

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Received: 25 December 2020
Revised: 11 January 2021
Accepted: 20 January 2021

The Chinese version of this article has been published in Theory and Practice of Education 2020, 40(20):44-48. The English version has been authorized for being publication in BECE by the author(s) and the Chinese journal.

王光明, 李健, 简婧娴. (2020). 初中生数学学习非智力水平常模及其等级评价标准研究: 以天津市为例 . 教育理论与实践, 40(20):44-48.