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Curriculum-Based Scale for Assessing Mathematical Confidence: Insights from Eighth-Grade Students in Jordan

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ABSTRACT
This study aimed to examine the degree of mathematical confidence among eighth-grade students in Jordan. To achieve this, a Mathematical Confidence Scale (MCS) was developed and validated based on curriculum content and a model proposed by Dowling (1978). The MCS was administered to 1007 eighth-grade students in Jordan and showed that their overall mathematical confidence is generally low, with differences across content areas (algebra, geometry, probability and statistics), the level of cognitive demand, and the context of the problem (realistic versus abstract). The results indicated that students are more confident in solving geometric problems compared to algebra and “probability and statistics” problems. The results also indicated that students are more confident in solving problems in real contexts than in abstract ones, and they have higher confidence in tasks involving understanding and comprehension than in those requiring computational procedures, and application and problem-solving. The students’ gender and living region do not significantly influence their degree of mathematical confidence. The study presented a methodology for developing a MCS, which could serve as a model for creating similar scales in other educational contexts. The findings may also assist educational policymakers in Jordan in making informed decisions to help boost students’ mathematical confidence.

KEYWORDS
Mathematical confidence; eighth-grade mathematics; Jordanian curriculum.

INTRODUCTION

Students' self-confidence and trust in their learning abilities are essential for academic success, as they foster positive attitudes and motivation, encouraging them to recognize their strengths and weaknesses and enhance their learning (Bandura et al., 1996; Li et al., 2024). This, in turn, allows teachers to modify their discourse, pacing, or scaffolding strategies and improve overall teaching quality, as confident students give immediate and accurate feedback on their learning (Levin, 2016; Levrini et al., 2019). In the academic context, self-confidence is conceptualized as an individual's belief in their capabilities to perform academic tasks (National Research Council, 1994). Confident students find it easier to engage with the learning process and environment, as they are better able to participate in classroom activities, learn from mistakes, persevere through challenges, and seek help when needed (Febrianto et al., 2022). Overall, a student's confidence in their abilities supports the creation of a learning environment that promotes optimal performance in learning activities (Komarraju & Nadler, 2013). Mathematical confidence is an integral part of studies on attitudes toward learning mathematics and academic self-concept (Pierce & Stacey, 2004). It plays a vital role in shaping students' attitudes toward learning mathematics and their ability to succeed in it (Alkhateeb et al., 2022; Marsh et al., 2005; Schoenfeld, 2014a). Students' self-view as a capable learner is closely associated with mathematical confidence. This association is critical for motivation and perseverance, as well as in adopting efficient learning strategies in mathematics (Marsh & Martin, 2011; Pierce & Stacey, 2004). Students' typical low confidence in mathematics is clearly evident in the TIMSS results (Mullis et al., 2008). Between eighth and fourth grade, TIMSS data indicated higher confidence among fourth-graders. This finding suggests that as students' progress in their studies, their confidence in learning mathematics diminishes.

Therefore, developing scales for mathematical confidence is a necessary step toward gaining a deeper understanding of the student's learning experience and guiding teaching to support both affective and cognitive domains (Niepel et al., 2022; Stankov et al., 2014).

Since eighth grade is the primary assessment point for overall education quality and the effectiveness of mathematics instruction in Jordan, as it is the grade most targeted by international tests including Trends in International Mathematics and Science Study (TIMSS) and the Jordanian National Tests (Ababneh et al., 2024), and considering the important role of mathematical confidence in students' performance, it is worthwhile to develop and implement a curriculum-based scale for mathematical confidence at this grade to assess its degree among students.

To the best of the authors' knowledge, based on a systematic search through databases, especially ProQuest, no previous study has been conducted in the Jordanian context that develops a scale for mathematical confidence and uses it to assess the degree of mathematical confidence among Jordanian students. However, a study by Afari et al. (2024) utilized data from the TIMSS 2019 (Fishbein et al., 2021) to investigate the association between eighth-grade students' mathematical confidence and their mathematical performance. Although other related constructs, such as mathematical competence and mathematical efficacy, have been examined in studies within the Jordanian context, assessing mathematical confidence remains a gap in the literature. Therefore, this study contributes to the existing body of literature by developing a curriculum-based MCS for eighth-grade students in Jordan and utilizing it to assess their degree of mathematical confidence. It also aims to use the developed scale to identify strengths and areas for improvement in students' mathematical confidence across three key areas: firstly, the mathematics content for eighth grade, including algebra, geometry, "probability and statistics"; secondly, the level of cognitive demands involved in eighth-grade mathematics (computational procedures, understanding and comprehension, application, and problem solving); and thirdly, the contexts in which mathematical problems are presented in the curriculum, including both realistic and abstract scenarios. Additionally, the study seeks to explore the impact of gender and region on eighth-grade students' mathematical confidence in Jordan. The following research questions guide this study.

- What is the degree of mathematical confidence among eighth-grade students in Jordan?
- Is there a statistically significant difference at the significance level (0.05) in the mathematical confidence degree of eighth-grade students in Jordan attributed to gender (male, female)?
- Are there statistically significant differences at the significance level (0.05) in the mathematical confidence degree of eighth-grade students in Jordan attributed to region (north, central, south)?

LITERATURE REVIEW

Mathematical confidence

Pierce and Stacey (2004, p.290) define mathematics confidence as "a student's perception of their ability to attain good results and their assurance that they can handle difficulties in mathematics". Similarly, Afifah and Kusuma (2021) define it as an individual's belief in their ability to learn mathematics, understand and comprehend mathematical concepts, solve problems effectively, and apply these skills in various aspects of life, all within a specific context—not necessarily in a general one. Therefore, a student might be confident in one mathematical area but not in another (Stankov et al., 2014).

Moreover, mathematical confidence is tied to accuracy; therefore, it is often measured *after* a student answers a question because it reflects their level of certainty about the correctness of their answer **(**Stankov et al., 2014). Considering the confidence-accuracy relation highlights constructs such as *overconfidence*, which reflects high confidence but a wrong answer, and *underconfidence*, which reflects low confidence but a correct answer. Mathematical confidence is not simply a static personality trait of the learner, but rather a dynamic construct influenced by context and shaped through dialogue, interaction, and cognitive engagement (Levine et al., 2016). That is, students' mathematical confidence is shaped by momentary thinking processes, when the affective aspect is integrated with the ability to discipline themselves while performing a mathematical task. This confidence creates a belief system that influences a learner's behaviour toward learning mathematics, boosts their motivation to learn, and the adoption of effective learning strategies (Asanre & Chinaka, 2024; Marsh & Martin, 2011; Pierce & Stacey, 2004; Schoenfeld, 2014b). The Teaching for Robust Understanding (TRU) framework by Schoenfeld (2014a) outlines dimensions for effective mathematics teaching, including the Agency, Authority, and Identity (AAI) dimension. This dimension emphasizes that students' self-perception as capable learners and thinkers significantly influences their engagement and performance. The framework views mathematical confidence as a measurable construct that is essential for fostering a productive disposition and academic persistence (Schoenfeld, 2014b). Sullivan and McDonough (2007) highlight the importance of mathematical confidence as a key factor influencing learner behavior in applying math activities. These behaviors include believing in having a mathematical mind that thinks deductively, feeling capable of analyzing information and drawing conclusions through logical reasoning, solving math problems efficiently and effectively, feeling confident in completing tasks easily in the classroom, attempting to read and interpret graphs and charts, and inferring, writing, and representing mathematical formulas. Low mathematical confidence can lead to adverse reactions to mathematics, causing individuals to give up on learning the subject; therefore, there is a need to help students build their confidence in learning mathematics (Brown, et al. 2008). These research findings are echoed in policy documents issued by NCTM, particularly *in "Principles and Standards for School Mathematics" (2000) and "Principles to Actions" (2014), which highlight the importance of creating environments where students see themselves as capable mathematical thinkers, thereby* fostering a positive self-concept and resilience in solving problems.

Many studies have examined how mathematical confidence can be nurtured. Granello et al. (2025) conducted a narrative systematic review, in which active learning strategies, including collaborative problem-solving, peer discussion, and guided inquiry, were reported to boost mathematical confidence among middle-school students. According to Maclellan (2014), teachers must attempt to improve their students' self-confidence by using various teaching methods, providing positive feedback, and facilitating opportunities for success. Moreover, multiple factors that mathematics teachers must follow to build mathematical confidence were reported by Jagals and van der Walt (2012). These factors encompass (1) gradual introduction of mathematical concepts, (2) utilization of concrete models and real-life examples to elucidate mathematical concepts and render them available to visualize and grasp by students, (3) the promotion of students to inquire about unexplored issues and the facilitation an of interactive learning environment, (4) provision of opportunities to implement what students have acquired through problem-solving and practical activities, (5) the supply of constructive feedback, (6) the presentation of mathematical problems where students can implement their knowledge and improve their understanding, (7) the motivation of students to brainstorm solutions and elucidate their ideas, nurturing critical thinking and effective mathematical communication, and (8) the reduction of anxiety by facilitating a supportive learning environment that helps students overcome math-related anxiety, thereby boosting their confidence and skills.

THEORIES ON MATHEMATICAL CONFIDENCE

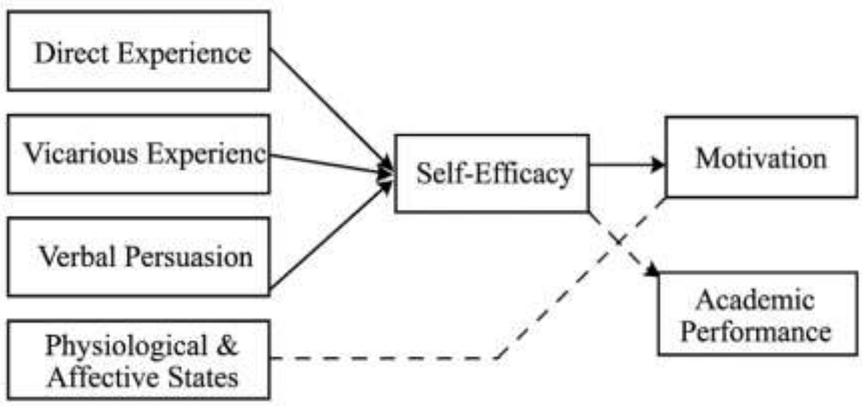
Perceived Self-Efficacy Theory

Bandura's (1977) Theory of Perceived Self-efficacy is a leading theory explaining individual behavior across many fields, especially mathematics education (Ningsih & Hayati, 2020). This theory addresses a person's conviction in their ability to succeed in a specific subject, such as mathematics. According to this theory, the interaction among individual, social, and cultural factors is pivotal to its construction (Pajares & Schunk, 2002). Accordingly, students' perseverance in attaining goals is affected by the perceived self-efficacy. Higher levels of perseverance are observed among students with high self-efficacy, whereas failure is associated with objective or external causes. Nevertheless, failure can be linked to personal issues and low capabilities among students with low perceived self-efficacy (Rajagukguk & Hazrati, 2021). Bandura (1986, 1997) described perceived self-efficacy as the belief in one's own capabilities, including the ability to confront anticipated challenges and perform the task successfully.

Lippke (2020) cited Bandura's four proposed sources that affect an individual's perceived self-efficacy. Figure 1illustrates that these sources encompass vicarious experience, direct experience, social persuasion, and physiological feedback.

Figure 1.

Bandura's perceived self-efficacy theory of motivation



(Adapted from Lippke, 2020)

Researchers have found that *direct experience* is the most pivotal source of perceived self-efficacy. After completing a task, a person's belief in their ability to replicate that success in the future has substantially increased. When people have a successful background, they become more confident and better equipped to confront challenges. One can explain this finding by citing these experiences, as individuals can acquire skills and knowledge through them to achieve their goals (Bandura, 1997; Schunk, 2012).

A solid source of building perceived self-efficacy is *vicarious experiences,* which encompass learning through modeling and observation. To acquire novel skills and learn how to apply them in similar cases, individuals can observe others' behavior and how challenges are addressed. Additionally, individuals can benefit from vicarious experiences by reading, listening to advice, and watching educational videos (Bandura, 1997).

To shape our beliefs about our abilities, we can turn to *verbal persuasion*, which encompasses verbal encouragement. A trusted person, such as a teacher, parent, or expert, can persuade us by boosting our self-confidence and our ability to complete complex tasks. Several factors determine the effectiveness of persuasion. They encompass the source's personality, credibility, the content of the message, and the method of delivery. Apart from external persuasion, researchers cite perceived self-persuasion as pivotal, as individuals can readily achieve their goals when they are convinced of their ability (Bandura, 1997; Schunk, 2012).

Psychological and Affective States significantly influence an individual's level of physiological arousal and cognitive focus, which in turn impact perceived self-efficacy and achievement. Positive emotions, such as enthusiasm and self-confidence, increase arousal and direct attention toward tasks, enhancing performance. Negative emotions, such as anxiety and fear, elevate stress and distract attention, negatively affecting performance (Bandura, 1997).

Expectancy-Value Theory

Expectancy-Value Theory (EVT) (Atkinson, 1957, 1964) is one of the most prominent psychological theories that explains human motivation, especially in educational contexts. According to this theory, the interplay between the expectancy of success and the perceived value of the task drives motivation and behavior. Expectancy of success involves the individual's belief about succeeding in the task, whereas the perceived value of the task refers to the individual's evaluation of the task's vitality (Wigfield & Eccles, 2000). An integral part of expectancy is *ability beliefs* within the EVT, which substantially impact learners' motivational orientations toward academic tasks. Eccles (2005) reported that these beliefs are associated with individuals' perceptions of their own competence in specific tasks, thus mainly determining their expectations for success. A close association exists between ability beliefs and perceived self-efficacy. Students with a higher level of task-specific confidence, rooted in their ability's precise judgements, can exhibit effortful behavior, resist challenges, and achieve superior academic outcomes (Wigfield et al., 2009). Nonetheless, avoidance tendencies, diminished persistence, and an increased susceptibility to failure-related anxiety are evident for students with lower confidence (Pajares & Schunk, 2002). Furthermore, achievement trajectories can be predicted by examining the interaction between ability beliefs and effort. A student with strong ability beliefs and adequate effort can exhibit optimal performance, whereas engagement and success expectations are substantially reduced due to low confidence, irrespective of task value (Eccles & Wigfield, 2002).

Based on the principles of EVT, studies recommend enhancing students' success expectations by setting realistic, achievable goals, which increases students' feelings of success and accomplishment (Fielding-Wells et al., 2017; Griffee & Templin, 1997; Latham & Locke, 2007). Additionally, providing positive feedback helps students feel valued by highlighting their strengths and progress, while breaking tasks into smaller steps gradually allows them to experience a sense of accomplishment and improve their self-confidence (Criss et al., 2024). Mathematics must be connected to real-life situations and students' personal and professional goals to improve the value of mathematics tasks, thereby rendering them more relevant to students. Students should be given opportunities to participate in task selection to help them be involved in the learning process and to have some control over their task choices (Trautwein et al., 2012).

Attribution theory

Attribution theory, originally conceptualized by Heider (1958) and later by Kelley (1971) and Weiner (1971, 1979), explains how individuals perceive and interpret the underlying causes of their success or failure in their daily activities, particularly in academic contexts. Weiner's model identifies three main dimensions of causal attribution: *perceived locus of causality* (internal versus external), *stability* (stable versus unstable), and *controllability* (controllable versus uncontrollable). Table 1 shows the *categorization of causal attributions by locus and stability dimensions*.

Table 1.

Categorization of causal attributions by locus and stability dimensions

		Stability dimension	
		Unstable cause (temporary)	Stable cause (permanent)
Perceived locus of causality	Internal cause	Effort Mood Fatigue	Ability Intelligence
	External cause	Luck Chance Opportunity	Task difficulty

(Adapted from Weiner, 2005)

These dimensions collectively influence motivation, emotions, and expectations regarding future success (Schmitt, 2015). For example, attributing academic success to a student's own effort reflects an internal, unstable, and controllable causality that promotes continuity and resilience. In contrast, attributing failure to poor academic ability reflects an internal, stable, and uncontrollable causality that can often lead to learned helplessness and decreased motivation. These two attribution patterns are not merely cognitive explanations; they also contribute to emotional responses such as pride, guilt, or shame, depending on the perceived cause of failure or success. Weiner (1979) noted that students who frequently attribute failure to uncontrollable factors, such as task difficulty or luck, are less likely to adopt corrective strategies, which undermines their academic confidence and negatively impacts their achievement.

When applying the attribution theory to mathematical confidence, we examine how students interpret their success or failure in solving mathematical problems. The impact of this attribution on self-confidence varies depending on whether it is internal or external. Internal attribution, which relates to personal ability, means that when a student attributes their success in solving a mathematical problem to their mental ability or knowledge, they become more confident in their ability to solve other problems (Kloosterman, 1988). Conversely, if they attribute their failure to their lack of ability, they lose confidence. External attribution, which relates to surrounding circumstances, such as the help of others, may make a student feel less confident in their ability to repeat their success. Attributing their failure to external factors, such as the difficulty of the problem or lack of time, may help maintain their confidence (Kloosterman, 1988). To apply this theory in practice, it is important to promote positive internal attributions in students. This can be achieved by emphasizing the effort made and connecting success to the strategies used to solve problems. Negative comparisons between students should also be avoided, as they can cause lower-performing students to feel less confident. Additionally, students should be supported in coping with negative external attributions. This can be done by objectively analyzing the reasons for failure and providing emotional support to highlight that failure is a normal part of learning. Opportunities to try again should be offered, along with appropriate support to help them overcome difficulties.

Dowling’s 1978 scale for mathematical confidence

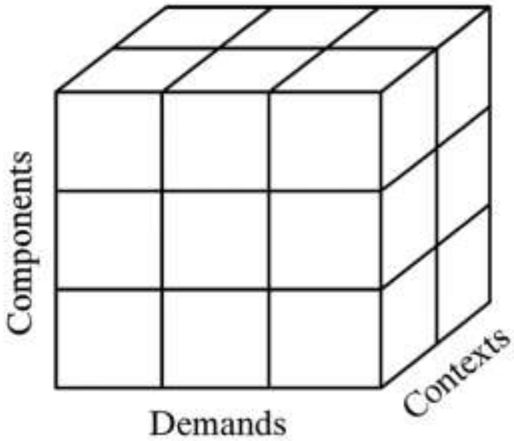
Although assessing confidence reliably is challenging because students might exaggerate it to gain teacher approval, avoid negative attention, or enhance their status among peers (Nurmi et al., 2003), incorporating mathematical confidence into educational assessment is a crucial step toward better understanding students’ academic experiences and guiding instruction to support both psychological and cognitive growth (Niepel et al., 2022; Stankov et al., 2014). The policy document titled "Principles to Actions: Ensuring Mathematical Success for All," issued in the United States of America by the National Council of Teachers of Mathematics (NCTM), provides a strong foundation for further research into mathematical confidence and support, including tools that assess students’ confidence as part of a comprehensive student assessment (NCTM, 2014).

Several tools are available to assess students’ overall attitudes toward learning mathematics. However, to precisely identify and diagnose specific areas in mathematics where students encounter difficulties or lack confidence, it is essential to develop tools that focus on clearly defined mathematical content, a specific level of cognitive demand, and particular problem contexts. Consequently, several tools have been developed to measure mathematical confidence, with a prominent one that meets these conditions being the MCS, developed by Dowling (1978).

The design of Dowling (1978) scale is based on a three-dimensional model: the first dimension includes the areas of mathematical content targeted for instruction (arithmetic, algebra, and geometry); the second dimension involves the level of cognitive demand required for solving mathematical problems (computational procedures, understanding and comprehension, application, and problem solving); and the third dimension distinguishes different problem contexts (abstract and concrete), as shown in Figure 2.

Figure 2.

Dimensions of the Dowling 1978 mathematical confidence scale



The development of the MCS was based on the targeted mathematical content of the National Longitudinal Study of Mathematical Ability (NLSMA), a research initiative conducted in the United States during the 1960s. The mathematical content dimension included three mathematical domains: arithmetic, algebra, and geometry. The second dimension involved three levels of cognitive demands in mathematical content: computational procedures, "understanding and comprehension", and "application and problem solving". The third dimension encompasses two types of mathematical problem contexts: abstract and concrete. Therefore, creating the MCS involved designing items across these three dimensions, resulting in 18 items (3×3×2). Dowling used previously tested items and data on psychometric properties—difficulty and discrimination—to select items that effectively cover the three dimensions. The selected items had medium difficulty coefficients, ranging from 0.30 to 0.80, and discrimination coefficients above 0.20. Not only did she evaluate the items' parameters from previous studies, but also re-administered the confidence scale alongside the test items with the same group of students to confirm that the students' confidence levels in mathematical ability reflected their actual ability to solve problems. Thus, the MCS consisted of two parts: The first part included a set of questions, each with a five-point Likert-type response scale (I have complete confidence, I have high confidence, I have medium confidence, I have low confidence, I have no confidence). Through this choice, the examinee expressed their confidence in their ability to solve the problem. The second part included questions from the MCS in the first part, and the examinee was asked to actually solve them and select the correct answer from four options, one of which was the correct answer. The second part was corrected, difficulty and discrimination coefficients were calculated, appropriate medium-difficulty items were retained, and the data were used to verify the validity of the correlation criterion by finding a correlation coefficient between the student's mathematical confidence on the MCS and their mathematical performance on the same items of the MCS to ensure that mathematical confidence was reinforced by mathematical ability to solve.

To ensure the validity of the MCS, Dowling employed procedures to confirm its logical validity and content validity. She consulted experts in mathematics education to verify that the items were clearly and straightforwardly worded to facilitate students' understanding and to ensure that all items directly measured confidence in mathematics. Accordingly, a pilot sample was taken where Dowling used the MCS items and the related mathematics test. Piloting and arbitration findings suggested that the three dimensions of the model were based on selected items and included mathematical content, levels of cognitive demand, and types of context. The test items yielded an average discrimination index of 0.54, demonstrating good discrimination, and an average difficulty coefficient of 0.39, revealing moderate difficulty. To verify the concurrent validity of the MCS, Dowling examined its correlation with students' performance and reported a correlation of 0.54. Moreover, a correlation existed with the Mathematics Attitudes Scale, which was concurrently administered with the MCS, yielding a correlation coefficient of 0.57, indicating a "good" value. Thus, a relatively strong positive association existed between students' expressions of confidence and their actual performance in solving mathematical problems. Dowling also determined the internal consistency reliability of the MCS using Cronbach's alpha, which yielded a value of 0.788. Most scholars consider a Cronbach's alpha above 0.70 to be generally acceptable, with values exceeding 0.80 being excellent. Hence, the MCS with a value of 0.788 has good reliability. This Cronbach's alpha value suggests that the items are consistent and effectively measure mathematical confidence.

The MCS comprises two sections: the first section gathers demographic information about the participants, and the second section comprises 18 items that evaluate mathematical confidence on a five-point Likert scale (5: complete confidence, 4: high confidence, 3: medium confidence, 2: low confidence, 1: no confidence). The chosen option reflects participants' confidence in their ability to solve each item. All item scores are combined to yield a total score ranging from 18 to 90 that demonstrates the degree of mathematical confidence.

METHOD

Participants

The educational system in the Hashemite Kingdom of Jordan consists of two main stages: basic, which is mandatory for students aged 6 to 15 years (grades 1-10), and secondary, which includes grades 11 and 12, where students can choose either an academic or vocational track. The study population consisted of eighth-grade students, typically aged 13–14 years, enrolled in public basic schools during the second semester of the 2024-2025 academic year. Hence, it comprised 135,434 male and female students, according to the Ministry of Education data (Jordanian

Ministry of Education, 2024). We used a stratified cluster sampling method to select the sample from the three geographical regions of Jordan (north, center, south), with schools within each region selected randomly to participate in the study. The sample consisted of 1050 male and female students. Forty-three incomplete responses were discarded, while 1007 responses were retained and used for analysis and answering the study questions. The northern region represented the Irbid Education Directorate, with 320 copies of the MCS distributed. Of these, 302 complete copies were kept, and 18 incomplete copies were discarded. The central region included four education directorates: Madaba (south of Amman), Sahab (east of Amman), Muwaqqar (east of Amman), and Al-Qweismeh (central Amman). A total of 520 copies were distributed, with 503 complete responses retained and 17 incomplete responses discarded. The southern region represented the Karak Education Directorate, with 210 copies distributed. Of these, 202 complete copies were kept, and 17 incomplete copies were discarded. Table 2 shows the distribution of the study sample by region and gender.

Table 2.

Distribution of study participants by geographic region and gender.

Region	Male (n)	Male (%)	Female (n)	Female (%)	Total (n)	Total (%)
North	151	15%	151	15%	302	30%
Center	252	25%	251	25%	503	50%
South	101	10%	101	10%	202	20%
Total	504	50%	503	50%	1007	100%

Study tool: developing, validating, and administering the MCS

A MCS was purposefully designed and validated for this study based on the model proposed by Dowling (1978). This model was chosen because of its strong theoretical foundation that clearly distinguishes the concept of mathematical confidence from other related psychological constructs, especially attitudes towards mathematics. Upon reviewing the process of developing this scale in its original form, it became clear that it is highly suitable for the objectives of the current study, as it focuses directly on mathematical confidence in the context of the mathematics curriculum that the students are studying.

The development of the MCS involved a careful analysis of the eighth-grade mathematics curriculum for the second semester, taught in Jordanian schools during the 2024-2025 academic year, to identify characteristics of each of the three dimensions of the Dowling model. The first MCS dimension encompassed three areas, namely algebra, geometry, and “probability and statistics”, which were targeted mathematical content of the curriculum. The second dimension addressed the levels of cognitive demand of the curriculum. It had “computational procedures,” “understanding and comprehension,” and “application and problem solving.” The abstract contexts and realistic contexts of mathematical problems in the curriculum were addressed in the third dimension. Consequently, 18 mathematical items in the MCS depicted these three dimensions.

For the 18 mathematical items in the MCS, we developed a table of specifications. To achieve this goal and verify its accuracy, we collaborated with content experts specializing in mathematics. These experts had extensive experience in teaching eighth-grade students (four male and four female teachers). Based on the experts' feedback, we revised the table accordingly. Per experts' suggestions, we integrated items not only from national and international tests but also from the student book and workbook. Subsequently, we gathered a pool of test items from these sources, with three items per block in the model, yielding 54 items (3×18). What followed was a review of these items by the same content experts to evaluate the mathematics test's content validity, which would be pivotal for developing the MCS. The experts verified the items' conformity to the specification table and their accuracy. Then, a team of 14 judges with expertise in mathematics education, measurement, and evaluation reviewed the draft of the MCS. Six eighth-grade mathematics teachers, three supervisors specializing in mathematics at the Ministry of Education, one faculty member specializing in mathematics education, and four faculty members specializing in measurement and evaluation at Jordanian universities formed the team. They assessed the clarity of the MCS items, the appropriateness of the language employed, and the relevance of the items to the Jordanian context and eighth-grade students. During this stage, necessary revisions were made, and some items were altered based on the judges' feedback. The MCS items were piloted on a sample of 84 male and female students outside the study sample. The pilot sample was selected to be as representative as possible of the study community. The weakest items in terms of difficulty and discrimination were excluded as elaborated in the subsequent paragraphs, leaving the best item for each block in the model, which resulted in 18 remaining items.

Table 3.

Difficulty coefficients and discriminant significance of the selected 18 items based on the responses of the pilot sample

Item	Difficulty (Pj)	Discrimination (rjx)	Factor loadings	Item	Difficulty (Pj)	Discrimination (rjx)	Factor loadings
C1	0.62	0.45	0.78	C10	0.67	0.53	0.76
C2	0.54	0.35	0.87	C11	0.61	0.33	0.75
C3	0.43	0.41	0.77	C12	0.52	0.38	0.76
C4	0.51	0.41	0.92	C13	0.51	0.39	0.78
C5	0.64	0.36	0.79	C14	0.67	0.40	0.78
C6	0.45	0.44	0.75	C15	0.31	0.30	0.76
C7	0.56	0.22	0.78	C16	0.57	0.42	0.80
C8	0.48	0.40	0.87	C17	0.62	0.33	0.90
C9	0.61	0.38	0.74	C18	0.57	0.52	0.73

According to Dowling's criteria for selecting the mathematical items included in the MCS, it is required that the difficulty coefficients of the items have average values ranging between 0.30 and 0.80, and discrimination coefficients exceeding 0.20. Table 3 shows the difficulty coefficients represented by the percentage of students who answered correctly on the selected 18 items and the discrimination indicators by calculating the "corrected item total correlation" between the students' performance on the item and their performance on the test as a whole after excluding the item from it.

It is noted from Table 3 that all the values of the difficulty coefficients for the items exceed the minimum acceptable limit for the difficulty coefficient (0.30), with an average difficulty of 0.55. Also, the discrimination coefficients for all items exceed the minimum acceptable limit for discriminatory significance, 0.20, with an average discriminatory significance of 0.39 for the items, which indicates that all items are suitable to be included in the MCS. The Component Matrix derived from Principal Component Analysis (Jolliffe, 2002) prior to rotation revealed strong factor loadings on the first component, ranging from 0.73 to 0.92. Robust associations between most items and the primary component are markedly visible in these values. Conversely, loadings on the second component were minimal, ranging from -0.05 to 0.06, indicating a negligible contribution. Thus, a unidimensional structure of the scale is supported, as most items load substantially on the first component, whereas the second component demonstrates trivial loadings. Hence, a clear and parsimonious factorial structure is apparent in the instrument, implying that a single underlying construct is captured in all items. To verify internal consistency, we calculated the Cronbach's alpha for the items of the developed MCS. The Cronbach's alpha value was 0.87, indicating that the MCS measures mathematical confidence with high accuracy and reliability, rendering it a suitable tool for research and for measuring mathematical confidence, as reported by Hambleton and Swaminathan (1985). We used the TIMSS Attitude Scales (Marsh et al., 2013) as a criterion to verify the concurrent criterion-related validity of the MCS. The same students evaluated both the developed MCS and the TIMSS Attitude Scales, allowing us to determine the Pearson correlation coefficient between the total scores of these scales. The Pearson correlation coefficient was 0.86 and was statistically significant at the 0.05 level, revealing a high positive relationship between Mathematical Confidence and attitudes towards learning mathematics. This finding verifies the good concurrent criterion-related validity of the developed MCS. We conducted exploratory factor analysis using Principal Component Analysis to demonstrate the factorial structure validity of the MCS. We used Guttman's criterion to determine the number of factors, in which a factor was considered principal if its eigenvalue was more than or equal to 1 (Kaiser, 1960). Table 4 illustrates the factor analysis of the MCS.

We note from Table 4 that there are two principal factors in the developed MCS whose eigenvalues are greater than one, at 10.68 and 5.06, respectively. The percentage of variance explained by these factors is 59.31% and 28.09%, respectively. Merenda (1997) states that the final decision in determining the number of scale factors often depends on the amount of variance explained by the resulting factors. That is, if the total variance explained by the factors is less than 50%, it causes an imbalance in the structure of the measured subject (Hair et al., 2012). Here, we note that the total variance explained is 87.40%, which exceeds 50%, indicating the validity of the factorial structure.

Table 4.

Factor analysis of the MCS

Factor	Eigenvalue	Explained Variance	Cumulative Percentage of Explained Variance
1	10.68	59.31%	59.31%
2	5.06	28.09%	87.40%

The final version of the MCS consists of two parts: the first includes demographic information about the respondents (students' gender and the region in which they reside), and the second represents the 18 mathematical items. A five-point response scale follows each item (5: complete confidence, 4: high confidence, 3: medium confidence, 2: low confidence, 1: no confidence), and students were asked to check the box that best represents their confidence in their ability to solve the item. After presenting the MCS instructions and explaining their importance, participants were asked to respond to the MCS items. After presenting the scale instructions and explaining their importance, participants were given copies of the MCS and asked to respond to the scale items.

Data Analysis Procedures

The data were processed using the Statistical Package for the Social Sciences (SPSS) software as follows: To address the first research question in this study (What is the degree of mathematical confidence among eighth-grade students in Jordan?), the arithmetic mean and standard deviations of the students' degree on the MCS were calculated. For the second research question (Is there a statistically significant difference at the significance level (0.05) in the degree of Mathematical Confidence among eighth-grade students in Jordan attributable to gender?), a t-test for two independent samples was employed. To address the third research question (Are there statistically significant differences at the significance level (0.05) in the degree of Mathematical Confidence among eighth-grade students in Jordan attributable to region (north, central, south)?), a one-way ANOVA test was used. The dependent variable in this study is the degree of mathematical confidence among eighth-grade students in Jordan, which is an ordinal categorical variable, with a score calculated by summing the total marks of 18 items in the MCS, ranging from 18 to 90 points. The two independent variables are nominal categorical variables: the student's gender and the region where the student lives (north, center, and south).

FINDINGS

This section presents an overall degree of the mathematical confidence, followed by a breakdown of the degree across the three dimensions of mathematical confidence based on the three dimensions of the MCS: (1) Areas of mathematical content, including algebra, geometry, “probability and statistics”; (2) The cognitive demands, including computational procedures, “understanding and comprehension,” and “application and problem solving”; (3) The contexts of the mathematical problems, including abstract and realistic contexts.

Overall degree of mathematical confidence

To determine the overall degree of mathematical confidence among eighth-grade students, the means and standard deviations were calculated for the mean values of the 18 items, as shown in the bottom row of Table 5 (see appendix).

It is clear from Table 5 that the average degree of mathematical confidence for all items is 2.67, with a standard deviation of 0.73. These values indicate a generally weak degree of mathematical confidence among students because the statistic’s value is negative (t=-14.48) and statistically significant at the significance level (α=0.05) with degrees of freedom (df=1006). The mean values for the items ranged from 2.27 to 3.07. The degree of mathematical confidence was weak for all items on the MCS, except for items C18, C8, and C10, which showed an average degree of confidence. These three items assess mathematical confidence in the ability to solve questions in realistic contexts related to geometry, and “probability and statistics”.

Degree of mathematical confidence in the content domain

To investigate the degree of mathematical confidence based on the content domain, the mean and standard deviation for items in algebra, geometry, and “probability and statistics” were calculated separately, as shown in Table 6.

Table 6.

Degree of mathematical confidence among eighth-grade students in Jordan within the mathematical content domain.

Mathematical topic	Items	Mean	SD	t -value	Probability Value (P)	Degree
Algebra	C1-C6	2.64	0.73	-15.64	<0.0001	Weak
Geometry	C7-C12	2.73	0.89	-9.80	<0.0001	Weak
Probability and Statistics	C13-C18	2.64	0.68	-16.93	<0.0001	Weak
Degree of overall mathematical confidence		2.67	0.73	-14.48	<0.0001	Weak

Table 6 shows that the mean values of the mathematical confidence degree among eighth-grade students in the content domain ranged between 2.64 and 2.725. The overall degree of mathematical confidence across all content areas was weak because the value of the t-statistic was negative and statistically significant at the significance level (α = 0.05) with degrees of freedom (df = 1006). In the algebra domain, the item with the lowest mean was C2, with a mean of 2.27, a standard deviation of 1.38, and a weak degree of mathematical confidence. The item with the highest mean was C4, with a mean of 2.79, a standard deviation of 0.88, and a weak degree of mathematical confidence. In the geometry domain, the item with the lowest mean was C11, with a mean of 2.44, a standard deviation of 1.11, and a weak degree of mathematical confidence. The item with the highest mean was C8, with a mean of 3.07, a standard deviation of 1.27, and a medium mathematical confidence degree. In the “probability and statistics” domain, the item with the lowest mean was C16, with a mean of 2.42, a standard deviation of 1.17, and a weak mathematical confidence degree. The item with the highest mean was C18, with a mean of 3.07, a standard deviation of 1.26, and a moderate level of mathematical confidence.

Degree of mathematical confidence based on cognitive demands

To investigate the degree of mathematical confidence based on the levels of cognitive demands, the means and standard deviations for students’ responses were calculated for three groups of scale items, each representing one level of mathematical cognitive demand: computational procedures, understanding and comprehension, application, and problem solving, as shown in Table 7

Table 7.

Degree of mathematical confidence among eighth-grade students in Jordan within the cognitive demands domain.

Mathematical topic	Items	Mean	SD	t -value	Probability Value (P)	Degree
Computational procedures	1, 2, 7, 8, 13, and 14*	2.61	0.69	-17.81	<0.0001	Weak
Understanding & comprehension	3, 4, 9, 10, 15, and 16	2.77	0.83	-8.86	<0.0001	Weak
Application & problem solving	5, 6, 11, 12, 17, and 18	2.61	0.79	-15.40	<0.0001	Weak
Degree of overall Mathematical confidence		2.67	0.73	-14.48	<0.0001	Weak

* For simplicity, this table and subsequent tables refer to items using numbers (1–18) instead of alphanumeric symbols (C1–C18).

Table 7 shows that the mean values of the mathematical confidence degree among eighth-grade students in the domain of the cognitive demands ranged from 2.61 to 2.77. The overall degree of mathematical confidence across all three levels of cognitive demand was weak because the t-statistic value was negative and statistically significant at the significance level (α=0.05) with degrees of freedom (df=1006). In the “computational processes” category, the item with the lowest mean was C2, with an arithmetic mean of 2.27, a standard deviation of 1.38, and a weak degree of mathematical confidence. The item with the highest mean was C8, with a mean of 3.066, a standard deviation of 1.27, and an average degree of mathematical confidence. In the “understanding and comprehension” category, the item with the lowest mean was C16, with a mean of 2.42, a standard deviation of 1.16, and a weak mathematical confidence degree. The item with the highest mean was C10, with a mean of 3.04, a standard deviation of 1.276, and a medium mathematical confidence degree. In the application and "problem solving" category, the item with the lowest mean was C17, with a mean of 2.42, a standard deviation of 1.11, and a weak mathematical confidence degree. The item with the highest mean was C18, with an arithmetic mean of 3.07, a standard deviation of 1.26, and a moderate level of mathematical confidence.

Degree of mathematical confidence based on context

To investigate the degree of mathematical confidence based on the contexts of the mathematical problems, the means and standard deviations for students' responses were calculated for two groups of scale's items, each representing one type of context: abstract context and realistic context, as shown in Table 8.

Table 8.

Degree of mathematical confidence among eighth-grade students in Jordan within the context domain.

Type of context	Items	Mean	SD	t -value	Probability Value (P)	Degree
Abstract	1, 3, 5, 7, 9, 11, 13, 15, and 17	2.62	0.69	-17.63	<0.0001	Weak
Realistic	2, 4, 6, 8, 10, 12, 14, 16, and 18	2.75	0.82	-11.00	<0.0001	Weak
Degree of overall mathematical confidence		2.67	0.73	-14.48	<0.0001	Weak

Table 8 shows that the mean values of the mathematical confidence degree among eighth-grade students based on the context domain ranged from 2.61 to 2.72. The overall degree of mathematical confidence across the two types of contexts was weak because the t-statistic value was negative and statistically significant at the significance level ($\alpha=0.05$) with degrees of freedom ($df=1006$). In the abstract context, the item with the lowest mean was C17, with a mean of 2.42, a standard deviation of 1.11, and a weak mathematical confidence degree. The item with the highest mean was C15, with a mean of 2.82, a standard deviation of 0.86, and a weak mathematical confidence degree. In the realistic context, the item with the lowest mean was C2, with a mean of 2.27, a standard deviation of 1.38, and a weak mathematical confidence degree. The item with the highest mean was C18, with a mean of 3.07, a standard deviation of 1.26, and a medium mathematical confidence degree.

Degree of mathematical confidence based on gender

Investigating whether there are statistically significant differences at the significance level (0.05) in the degree of mathematical confidence among students attributed to gender involved extracting the arithmetic means and standard deviations of mathematical confidence degrees for each gender (male, female). Then, a t-test was used to compare the average performance of the two groups. Table 9 presents the results of this comparison.

Table 9.

T-test on the effect of student gender on mathematical confidence

Gender	Number	Mean	SD	Degree of freedom (df)	t-value	Probability Value (P)
Male	527	2.70	0.73	1005	1.30	0.194
Female	480	2.63	0.73			

Table 9 shows that the probability value (0.194) is greater than 0.05, which negates the influence of the student's gender on his degree of mathematical confidence at the significance level (0.05).

Degree of mathematical confidence based on region

The first step in investigating whether there are statistically significant differences at the 0.05 significance level in the degree of mathematical confidence among students attributed to the region was calculating the means and standard deviations of the degree of mathematical confidence for each region category (north, center, and south), as shown in Table 10.

Table 10.

Averages and standard deviations of the degree of mathematical confidence by region

Region	Number	Mean	SD
North	297	2.64	0.73
Center	507	2.66	0.74
South	203	2.71	0.72

Table 11.

Results of the one-way analysis of variance for the mean values of the mathematical confidence degree attributed to the region

Variance	Sum of squares	Degree of freedom (df)	Mean	F-statistic	Probability Value (P)
Between-Groups	0.57	2	0.28	0.59	0.53
Within-Groups	536.89	1004	0.54		
Total	537.46	1006			

Table (10) shows that there are very small apparent differences between the averages of the mathematical confidence degree of eighth-grade students in Jordan across the three regions (north, central, and south). The average mathematical confidence degree was 2.64 for students in the northern region, 2.66 for students in the central region, and 2.71 for students in the southern region. To determine whether these differences were statistically significant at the

0.05 level, a one-way analysis of variance (ONE-WAY ANOVA) was conducted. Table 11 presents the results.

Table 11 shows that the probability value (0.5880) is greater than (0.05), which indicates that the differences in the degree of mathematical confidence are not statistically significant at the significance level (0.05), depending on the region, meaning that the region has no effect on the degree of mathematical confidence.

DISCUSSION

This study aimed to investigate the degree of mathematical confidence among eighth-grade students in Jordan. A local version of the MCS, originally developed by Dowling (1978), was developed based on the content of the mathematics curriculum taught in the schools of the Jordanian Ministry of Education for the second semester of the 2024-2025 academic year. A descriptive approach was used to examine the psychometric properties of the developed MCS, applying the principles of Classical Test Theory (CTT) to verify the MCS's validity. The developed scale was administered to a sample of 1007 eighth-grade students in Jordan. Their mathematical confidence was assessed by calculating descriptive statistics, including the mean and standard deviation of their responses. The analysis of this data set has answered the first research question of this study, which concerns the degree of mathematical confidence among eighth-grade students in Jordan.

The results showed that the average degree of mathematical confidence among eighth-grade students in Jordan is 2.67 with a standard deviation of 0.73, indicating a weak degree of mathematical confidence. The degree of mathematical confidence on all items of the MCS is generally weak, except for three items where the level was average. These items involved realistic contexts, with a cognitive demand that did not reach the level of "application and problem solving" but focused on "computational procedures", and "understanding and comprehension", representing the lower levels of Bloom's taxonomy. This finding aligns with the results of the 2023 TIMSS study, which showed that nearly a third of eighth-grade students in Jordan lacked mathematical confidence, negatively affecting their mathematical performance (TIMSS & PIRLS International Study Center, 2023). The TIMSS study found a significant 60-point difference in performance between students classified as having mathematical confidence and those classified as not, indicating a strong positive relationship between mathematical confidence and performance. Additionally, it revealed that the degree of mathematical confidence among eighth-grade students in Jordan was close to the global average.

Despite this overall weakness, the study's inter-comparisons revealed some variation among eighth-grade students' mathematical confidence based on content areas (algebra, geometry, "probability and statistics"), level of cognitive demand ("computational procedures", "understanding and comprehension", and "application and problem solving"), and context of the problem (abstract or realistic). Students' mathematical confidence in solving geometry problems was higher than in algebra, and "probability and statistics." This may be attributed to the fact that learning geometry often depends on visual perception and drawing, which are closer to sensory thinking. Therefore, students tend to feel more confident when solving geometry problems compared to Algebra and statistics, which, on the other hand, tend toward symbolic abstraction, making them more cognitively challenging for some students, as noted in Jupri (2017).

Similarly, the study showed that their confidence in solving mathematical problems that require “understanding and comprehension” exceeds their confidence in solving problems that involve “computational procedures” or “problem-solving skills”. When students handle multiple algorithms or lengthy steps, they are prone to errors in performing accurate calculations. This issue can lead to anxiety that adversely impacts students’ confidence in procedural tasks, dissimilar to comprehension tasks, promoting free thinking (Foster, 2017). This finding may apply to the Jordanian context because, according to the TIMSS 2023 National Report for Jordan, eighth-grade students engage in limited math practice(National Center for Human Resources Development, 2025). We have observed low confidence in math problem-solving observed in this study, as emphasized in that report. This finding can be attributed to multiple factors, including the dominance of direct instruction in Jordanian schools and the scarcity of active teaching strategies, exploration, problem-solving, and higher-order thinking problems, as noted previously (Altarawneh et al., 2023; National Center for Human Resources Development, 2025). These findings align with previous research demonstrating that confidence depends on task complexity and teaching style (e.g., Betz & Hackett, 1983; Dowling, 1978).

Students’ confidence in solving problems in realistic contexts was higher than in abstract contexts, according to our findings. This finding can be explained by psychological perception: problems in real-world contexts are perceived as more relevant to students’ daily lives, making them more comfortable and confident when solving them (Foster et al., 2022). A clear goal or tangible issue is often evident in these problems, enabling students to understand expectations better and build greater confidence in navigating them. However, students’ experiences and reality do not align well with abstract problems because they rely on symbols and abstractions, with disconnected associations, undermining confidence and leading to hesitation.

The second and third research questions of our study addressed the effect of gender and residency on eighth-grade students’ mathematical confidence in Jordan. Using the descriptive-comparative (causal-comparative) approach and inferential statistics (t-test and one-way ANOVA), we found that neither students’ gender nor the school's region influenced their degree of mathematical confidence ($p>.05$). This finding reveals that students’ low mathematical confidence is independent of gender or the school’s region. Similarly, Yoo (2018) reported no significant gender difference in math confidence in Singapore ($p > .05$). Raabe and Block (2024) recently noted that girls’ mathematical confidence aligns with their grades, whereas boys underestimate their abilities. Moreover, it is not ability but social factors that determine the confidence gap, with boys depending more on peer validation, and girls internalizing their performance. Therefore, girls who face social pressure may not have lower math ability, contradicting the evidence of harmful peer norms.

What distinguishes the current study is its effort to fill the gap caused by the lack of research on developing a curriculum based MCS for eighth-grade students in Jordan, based on the Dowling (1978) model, and its use in assessing mathematical confidence degree among these students. This provides the Ministry of Education's mathematics development programs with diagnostic data on areas of weakness and opportunities for improvement in mathematical confidence, guiding decision-making with real data. Such insights enable the creation of effective training programs to enrich the learning environment and boost students' mathematical confidence, which can significantly influence their performance in large-scale national and international assessments. It also supports designing motivational programs that encourage students to see mathematics as an enjoyable and exciting subject, such as competitions. The study recommends conducting similar research to explore the degree of mathematical confidence among students in other grades in Jordan, especially those involved in international assessments, like fourth and tenth grades. It also suggests examining other factors influencing mathematical confidence, such as teachers' experience and professional qualifications. Additionally, the study advocates for using the MCS developed here by other researchers to assess eighth-grade students' confidence.

CONCLUSION

In light of the study's results, it is clear that mathematical confidence among eighth-grade students in Jordan is a crucial educational factor that requires attention as a key element in explaining the gap between cognitive potential and actual performance in mathematics. The results revealed a general weakness in confidence levels, especially in algebra and "probability and statistics", compared to relatively higher levels in geometry. This suggests that the visual and tangible spatial nature of geometric content helps students understand better and enhances their mathematical confidence. In contrast, the abstract nature of algebra and statistics challenges their mathematical confidence. The study also showed that the quality of the educational environment plays a vital role in fostering confidence. Students' confidence tends to increase when problems are set in real-life contexts or activities that require understanding, while confidence declines when problems are abstract or require application of knowledge or problem-solving skills. The lack of statistically significant differences between genders and across the three regions of Jordan indicates that similar educational conditions influence this variable. This underscores the need for targeted interventions that go beyond regional or gender differences to review both the content and teaching methods. The development of a MCS based on curriculum content and the Dowling (1978) model represents an important methodological contribution that could be adopted in future local and international educational studies. On a global scale, this study could serve as a model for investigating mathematical confidence as a component independent of other concepts more commonly discussed in educational literature, such as mathematical competence or anxiety. This paves the way for developing educational intervention strategies grounded in a precise understanding of students' strengths and weaknesses in mathematical confidence at the level of each mathematical topic, rather than the subject as a whole.

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APPENDIX

Table 5.

Degree of mathematical confidence among eighth-grade students in Jordan

Items	Mean	SD	t -value	Probability Value (P)	Degree
C1	2.72	1.45	-6.08	<0.0001	Weak
C2	2.27	1.38	-16.75	<0.0001	Weak
C3	2.82	0.86	-6.67	<0.0001	Weak
C4	2.79	0.88	-7.64	<0.0001	Weak
C5	2.44	1.10	-16.27	<0.0001	Weak

Items	Mean	SD	t -value	Probability Value (P)	Degree
C6	2.80	0.87	-7.38	<0.0001	Weak
C7	2.54	1.01	-14.51	<0.0001	Weak
C8	3.07	1.27	1.64	0.10	Medium
C9	2.72	1.51	-5.93	<0.0001	Weak
C10	3.04	1.28	1.06	0.29	Medium
C11	2.44	1.11	-16.07	<0.0001	Weak
C12	2.55	1.60	-9.06	<0.0001	Weak
C13	2.63	1.14	-10.08	<0.0001	Weak
C14	2.45	1.11	-15.88	<0.0001	Weak
C15	2.82	0.86	-6.51	<0.0001	Weak
C16	2.42	1.16	-15.95	<0.0001	Weak
C17	2.42	1.11	-16.54	<0.0001	Weak
C18	3.07	1.26	1.75	0.08	Medium
Degree of overall mathematical confidence	2.67	0.73	-14.48	<0.0001	Weak