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Research Article

The role of beliefs about teaching and assessment as mediating variables between beliefs about the nature of mathematics and characteristics related to the teaching profession

Mailizar Mailizar[1], Mutia Fariha[2], Rahmah Johar[3] and Rini Oktavia[4]

[1]*Graduate School of Mathematics and Applied Sciences, Universitas Syiah Kuala, Indonesia (ORCID: 0000-0003-4084-311X)*
[2]*Department of Mathematics Education, Universitas Syiah Kuala, Indonesia (ORCID: 0000-0003-0021-1249)*
[3]*Department of Mathematics, Universitas Syiah Kuala, Indonesia (ORCID: 0000-0003-3622-6813)*
[4]*Department of Mathematics Education, Universitas Syiah Kuala, Indonesia (ORCID: 0000-0002-5864-0858)*

The professional character of mathematics teachers is influenced not only by their ability to manage learning but also by their beliefs about the subjects they teach. These beliefs include beliefs about the nature of mathematics (BNM), beliefs about mathematics learning (BTM), and beliefs about assessments (BAM). Together, these beliefs shape the professional character of teachers (CTP). Research indicates that BNM serves as a foundational aspect of teachers' beliefs in mathematics and significantly influences both BTM and BAM. However, there has been a lack of studies addressing how BNM affects CTP, either directly or indirectly, with BTM and BAM as mediators. This study investigates how BTM and BAM mediate the relationship between BNM and CTP. Data were collected from 160 elementary school teachers via an online questionnaire, and the relationships were analyzed using PLS-SEM methods. The findings revealed that BNM significantly affects CTP when mediated by both BTM and BAM simultaneously, while direct effects of BNM on CTP, and effects using either BTM or BAM alone, were not significant. These results indicate that focusing on both BTM and BAM is essential for enhancing the professional character of mathematics teachers. Educational institutions and teacher training centers should consider these mediators in curriculum development. Further research is recommended to explore these dynamics in greater depth, accounting for various teacher characteristics.

Keywords: Beliefs about the nature of mathematics; Beliefs about teaching mathematics; Beliefs about assessment; Characteristics of the teaching profession

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1. Introduction

The effectiveness of mathematics instruction is influenced not only by how teachers present the material but also by their strong belief in the subject matter being taught (Beswick, 2006; Ernest, 1989; Maasz & Schlöglmann, 2009; Thompson, 1992). Teachers' beliefs about mathematics can affect whether they have a positive or negative outlook on the material they teach (Al Umairi, 2024). As a result, these beliefs significantly impact the quality of learning in the classroom (Nisbet & Warren, 2000).

Address of Corresponding Author

Mailizar Mailizar, PhD, Universitas Syiah Kuala, Jl. Teuku Nyak Arief Darussalam, Banda Aceh, Aceh, 23111, Indonesia.

mailizar@usk.ac.id

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Teachers' beliefs regarding mathematics are thought to significantly influence their professional identities and practices in teaching the subject (characteristics of teaching professionalism) (Golafshani, 2013; Macnab, 2003; Schoen & LaVenia, 2019; Wilkins, 2008). This connection forms a model of teacher professional development proposed by Mcdonough & Clarke (2005). Completed by Ernest's theory while mathematical knowledge is essential for mathematics educators, differing beliefs about mathematics and about teaching it can lead to variations in teachers' professional attitudes (Ernest, 1994).

Three aspects of teacher beliefs regarding mathematics include beliefs about the nature of mathematics (BNM), beliefs about teaching and learning mathematics (BTM), and beliefs about assessment in mathematics learning (Ernest, 1994; Videnovic, 2021). These three aspects are interconnected and play a significant role in shaping teachers' attitudes toward mathematics and its instruction. BNM pertains to teachers' perceptions of the rules, facts, and concepts of mathematics, which are integral to human culture and continue to evolve (Ernest, 1994). BTM encompasses teachers' understanding of mathematics learning concepts, pedagogical methods, and the roles of both teachers and students in the educational process. Furthermore, BTM highlights the importance of assessment within mathematics learning activities, reflecting on the outcomes of these activities and the mathematics skills being developed (BAM) (Boz, 2008; Purnomo, 2017; Videnovic, 2021).

Research related to mathematics teacher beliefs shows that increasing BNM affects BTM (Alkhateeb, 2019; Dayal & Lingam, 2020; Forgasz & Leder, 2008; Jackson, 2017; Viholainen et al., 2014; Zakaria & Musiran, 2015). Increasing knowledge of mathematics can also increase BAM (Nisbet & Warren, 2000) and is considered to have an impact on the level of professional thinking of teachers in evaluating the implementation of learning methods used in the classroom. However, the author has not found any research related to the direct or indirect effects of BNM as a basic aspect of teachers' mindsets towards mathematics that have an effect on characteristics of teacher professionalism (CTP).

In preliminary research utilizing a straightforward path model that featured only direct relationships, the author observed that BNM had no direct effect on CTP or BAM's effect on CTP. In this analysis, BNM demonstrated a significant direct impact solely on BTM. This finding is noteworthy because BNM represents the foundational thinking of mathematics teachers, which should, in theory, influence their professional development in teaching practices. By revising the model to position BTM as a mediating variable between BNM and CTP, the author discovered that the effect of BNM on CTP through BTM mediation was indeed significant. These initial findings suggest that BTM serves as a mediator in the relationship between BNM and CTP. However, there is a lack of existing research or models addressing this topic, resulting in no foundational literature to support this assumption.

Considering that BAM, as a dimension of mathematics teacher beliefs, does not significantly impact CTP, the author is interested in investigating whether it also serves as a mediator for BNM, similar to BTM. This new assumption prompts the author to conduct an analysis using real data. The goal of this study is to explore and predict the roles of BTM and BAM as mediating variables in the relationship between BNM and CTP. The results of this study are expected to provide information on the role of BTM and BAM in improving the professional character of teachers. This information is expected to be useful for the development of mathematics education curricula and teacher training in the future. To guide the research, the research problem in this study is "What is the role of BTM and BAM as mediating variables to describe the effect of BNM on CTP?

1.1. Relationship between Variables

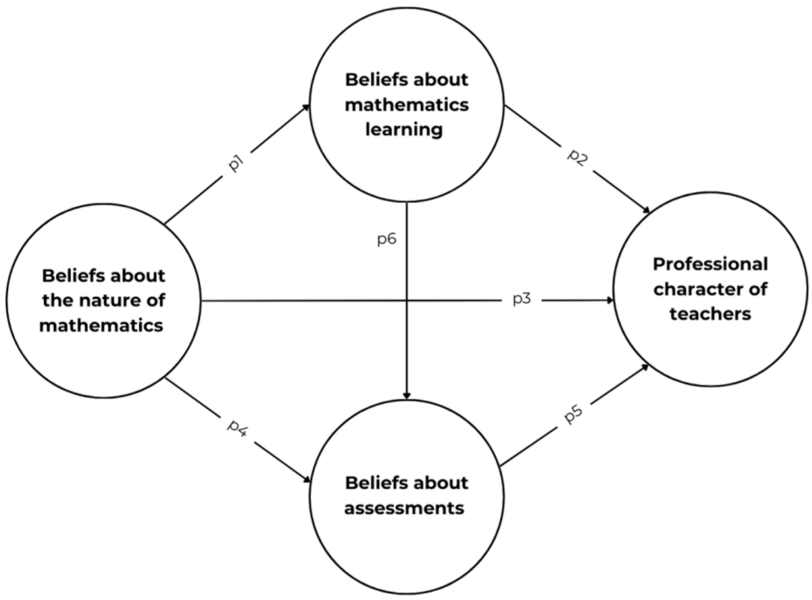
Since there is currently no path model explaining the relationship between mathematics teachers' beliefs and their professional characteristics, the author introduces a related model depicted in Figure 1. This model is based on the connections between mathematics teacher beliefs and professional growth Mcdonough & Clarke (2005), as well as the impact of beliefs on teaching practices by Ernest (1994) and Videnovic,(2021). The models shows that beliefs are key in developing teachers' professional characteristics, which in turn influence their classroom management. Additionally, research by Beswick (2012) and Felbrich et al. (2014) shows that beliefs in mathematics significantly affect teaching effectiveness, while Palacios & Garcia (2018) establish a link between beliefs about teaching and beliefs about assessment.

2. Method

2.1. Research Design

This study uses a quantitative approach with an analysis focus on the relationship between BNM and CTP. BNM is considered an endogenous variable that has direct and indirect effects on BTM, BAM, and CTP. The analysis will examine the direct and indirect effects of BNM and CTP. This analysis will utilize a path model constructed using PLS-SEM, based on the interrelationships among the variables (BNM, BTM, BAM, and CTP). The model is presented in Figure 1. Given the study's objective to investigate and predict the roles of BTM and BAM as mediating variables between BNM and CTP, the author suggests two distinct pathways: one connecting BNM to CTP through BTM, and another through BAM. While the path from BNM to BTM to CTP has been examined, the path from BNM to BAM to CTP represents a novel discussion. Referring to Figure 1, there is a path that illustrates the relationship between BNM and CTP via both BTM and BAM simultaneously. In the path BNM to BTM to BAM to CTP, BTM and BAM function as multiple mediators for the relationship between BNM and CTP.

Figure 1
Model of the relationship path



In our analysis, we are examining six paths that illustrate the effects from one variable to another. These paths are: BNM to BTM, BTM to CTP, BNM to CTP, BNM to BAM, BAM to CTP, and BTM to BAM. The direct effect values for each path are denoted as p1, p2, p3, p4, p5, and p6. When there are mediating variables, the effects on those paths are represented by the multiplication of the direct effect values, which are based on our data processing results. For example, the path BNM to BTM to CTP is represented by p1.p2, and the path BNM to BAM to CTP is represented by p4.p5. Additionally, the path BNM to BTM to BAM to CTP is represented by p1.p6.p5. The significance of the mediating effects in our analyzed model is based on the explanations provided by Hair et al. (2021) and Esposito et al. (2010). There are five types of roles of mediating variables in the model to be analyzed, namely:

1) Complementary mediation: Both the indirect effect and the direct effect are significant and point in the same direction.

2) Competitive mediation: Both the indirect effect and the direct effect are significant, but they point in opposite directions.

3) Indirect-only mediation: Only the indirect effect is significant, while the direct effect is not significant. Indirect-only mediation is also known as full mediation, indicating that a variable has a significant effect when mediated by another variable.

4) Direct-only non-mediation: Only the direct effect is significant, while the indirect effect is not significant.

5) No-effect non-mediation: Neither the direct nor the indirect effect is significant.

2.1. Sample

A random sample was selected from elementary school teachers in Aceh, Indonesia. The sample consisted of 160 participants who took part in an online survey. 13% of the sample were graduates with a degree in mathematics education, 31.8% were graduates with a degree in elementary school teaching (who also taught mathematics at the elementary school), 50.6% were not graduates of mathematics education or elementary school teaching (but were classroom teachers), and 4.7% were non-education graduates. The sample size used in this study took into account the minimum path coefficient expected in the path model, which is 0.2 with a statistical power of 0.8. A sample size of 160 is considered to meet the minimum sample size requirements, whether using the inverse square root method, gamma exponential method, ten times rule, or G*Power as recommended for PLS-SEM data analysis methods.

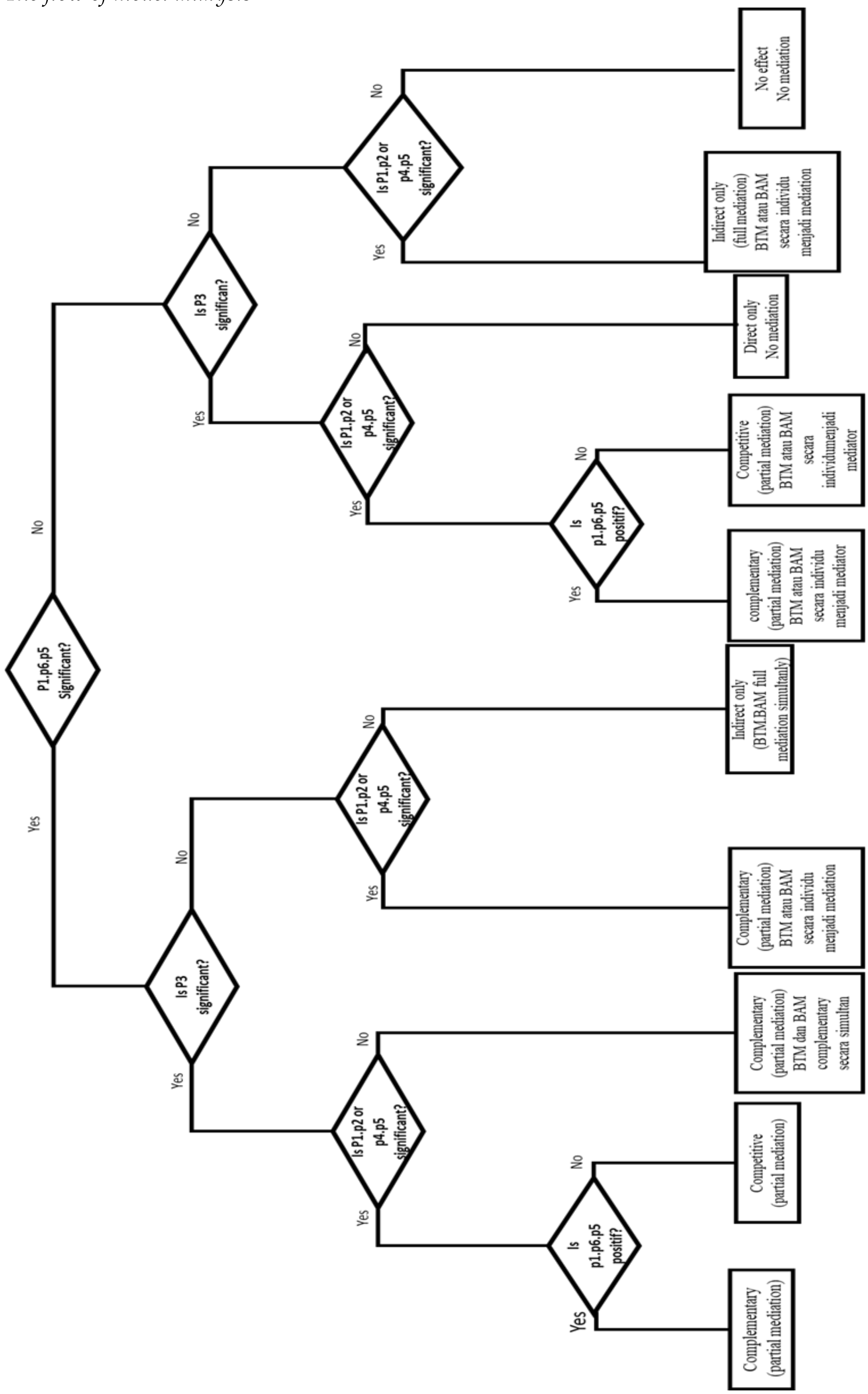
2.2. Research Instruments

The data collection instruments include questionnaires with statements for BNM, consisting of 9 indicators, BTM with 11 indicators, BAM with 10 indicators, and CTP with 12 indicators. The questionnaires for BNM, BTM, and BAM use the mathematics teacher beliefs instrument developed by Purnomo (2017). These questionnaires cover aspects of BNM, BTM, and BAM and have been separately evaluated with good reliability (Cronbach's alpha > 0.6), making them suitable for assessing mathematics teacher beliefs (BNM, BTM, BAM). A questionnaire developed by Yaratan and Muezzin (2016) was used to collect data for CTP. The CTP questionnaire has a Cronbach's alpha value > 0.8, indicating its usability for assessing mathematics teacher CTP. The 42 indicators are combined into a single instrument with separate sections to streamline the process. The instrument is completed online using Google Forms.

2.3. Data Analysis

This study uses Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the data, and Smart PLS 3 software to process the data. The analysis consists of two stages: the outer model test and the inner model test. Outer model analysis to assess the validity and reliability of the model that describes the relationship between variables and their indicators based on data. The outer model analysis includes evaluating factor loadings or outer loading should be greater than 0.6, Cronbach's alpha and Composite Reliability should be 0.7 to 0.95, and Average Variance Extracted (AVE) greater than 0.5. The inner model analysis involves examining the values of R^2 and Q^2 to ensure the model accurately represents the data. R^2 analysis to see how much influence exogenous variables have on endogenous variables. In this study, R^2 shows the magnitude of the influence given by BNM to BTM, BAM, and CTP. The R^2 value is expected to be more than 0.25 to indicate a moderate to substantial influence. Q^2 analysis to show how well the model explains the information available based on the data. The Q^2 value is expected to be more than 0. The research focuses on evaluating the roles of BTM and BAM as mediating variables on the impact of BNM on CTP and follows the diagram in Figure 2 for testing. The analysis uses criteria from Hair et al. (2021) and Hair and Alamer (2022) and utilize bootstrapping to determine the significance of the path relationships in the model, including direct effect, specific indirect effect, and total effect.

Figure 2
The flow of model analysis



3. Results

The analysis of the outer model indicates that some indicators have an outer loading value (loading factor) of less than 0.6. A loading factor value of less than 0.6 suggests that the indicator is unreliable in describing its relationship with other indicators. This shows that the model is not valid in describing the relationship between variables and indicators. The invalid model indicated by the outer loading of less than 0.6 is also supported by the AVE value of less than 0.5 in BNM and BTM. This value indicates that the indicator is not yet reliable in describing the model.There are 9 indicators that have outer loading value of less than 0.6. To increase validity and reliability, these indicators are removed from the construct. The results of the analysis of the model after removing the indicators show that there is no outer loading that is less than 0.6 as presented in Table 1 and Figure 3. Nine indicators are removed: BNM 6, BNM 7, BNM 8, BNM 9, BTM 8, BTM 9, BTM 10, BTM 11, and CTP 2. The output results of construct reliability and validity are presented in Table 2.

Table 1
Outer loading (loading factor) model

	BAM	*BNM*	*BTM*	*CTP*
BAM1	0.760			
BAM10	0.709			
BAM2	0.841			
BAM3	0.835			
BAM4	0.866			
BAM5	0.776			
BAM6	0.749			
BAM7	0.681			
BAM8	0.694			
BAM9	0.783			
BNM 1		0.834		
BNM 2		0.796		
BNM 3		0.834		
BNM 4		0.868		
BNM 5		0.837		
BTM1			0.669	
BTM2			0.848	
BTM3			0.828	
BTM4			0.672	
BTM5			0.777	
BTM7			0.878	
CTP1				0.648
CTP10				0.797
CTP11				0.791
CTP12				0.806
CTP3				0.615
CTP4				0.836
CTP5				0.869
CTP6				0.819
CTP7				0.810
CTP8				0.818
CTP9				0.824

Figure 3

Result of outer model (path result)

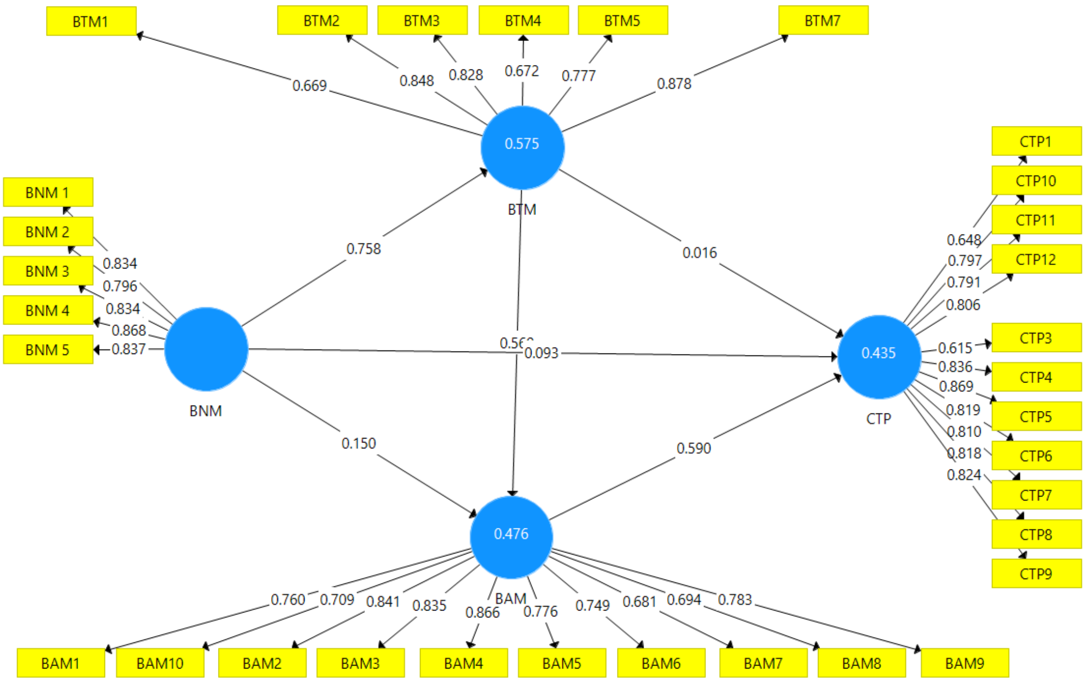


Table 2 shows that the path model has acceptable indicator reliability values, with no Cronbach's alpha and composite reliability values below 0.7. Both Cronbach's alpha and composite reliability values are greater than 0.7, and there are no values greater than 0.95, which indicates that the path model is reliable for depicting the relationships between BNM, BTM, BAM, and CTP. An indication of composite reliability surpassing 0.95 suggests strong consistency across indicators, which may impact the model's validity. This is further supported by the AVE values, greater than 0.5 for all variables, indicating acceptable validity for each available indicator.

Table 2

Construct reliability and validity

	Cronbach's Alpha	*Composite Reliability*	*AVE*
BAM	0.924	0.936	0.596
BNM	0.890	0.919	0.695
BTM	0.871	0.904	0.613
CTP	0.938	0.947	0.622

The results of the inner model testing indicate that BNM has an R^2 value of 0.476 for BAM, 0.575 for BTM, and 0.435 for CTP. According to the PLS-SEM criteria (Hair et al., 2011), these values are considered moderate, meaning that BNM can explain 47.6% of the changes in BAM, 57.5% of the changes in BTM, and 43.5% of the changes in CTP. The model also shows good Q^2 values, with 0.270 for BAM, 0.339 for BTM, and 0.258 for CTP. Predictive relevance (Q^2) greater than 0 indicates that the model's generated observations are relevant and suitable for use.

Based on the findings, the relevant model effectively predicts the relationship between BNM, BTM, BAM, and CTP. The total effect values in bootstrapping unequivocally indicate significant total effects for each path, as illustrated in Table 3. These total effects represent the cumulative value of both the direct and indirect effects of a path in the model. Furthermore, the sequence of paths aligns consistently with the results of bootstrapping which involved 1000 subsamples.

Table 3
Total effect and its significance based on bootstrapping

	Original Sample (O)	*Sample Mean (M)*	*Standard Deviation (STDEV)*	*T Statistics (|O/STDEV|)*	*p-Values*
BAM → CTP	0.590	0.612	0.115	5.126	0.000
BNM → BAM	0.582	0.585	0.065	8.956	0.000
BNM → BTM	0.758	0.760	0.040	18.998	0.000
BNM → CTP	0.448	0.448	0.063	7.093	0.000
BTM → BAM	0.569	0.572	0.117	4.864	0.000
BTM → CTP	0.352	0.363	0.096	3.679	0.000

In Table 3, the original sample [O] represents the effect value on a sample of size N=160, while the sample mean [M] provides an estimate of the average effect on each subsample generated through bootstrapping. It is noteworthy that the standard deviation [STDEV] of the effect does not surpass the O value, suggesting that the model effectively characterizes the effect on the data. This finding is further supported by the *p*-value, indicating a statistically significant level of significance.

In the model presented in Figure 1, it is important to determine whether the significance arises from the direct effect or the indirect effect. According to the model, the path model has an indirect effect on the relationship between BNM and CTP, which is mediated by BTM and BAM (p1.p2, p4.p5). To address this issue, the analysis of the role of BTM and BAM as mediating variables for the effect of BNM on CTP involves examining the total indirect effect and specific indirect effect as recommended in the mediation analysis in PLS-SEM (Hair et al., 2021; Hair & Alamer, 2022). The total indirect effect values are shown in Table 4, indicating that the paths involving the mediating variables also have significant total indirect effects. Total indirect effect refers to the overall indirect impact received by a variable through the mediating variables from multiple paths. Therefore, a thorough analysis of the model should include examining direct effects (path coefficients) and specific indirect effects, as presented in Tables 5 and 6.

Table 4
The total value of the indirect effect

	Original Sample (O)	*Sample Mean (M)*	*Standard Deviation (STDEV)*	*T Statistics (|O/STDEV|)*	*p-Values*
BNM → BAM	0.432	0.433	0.088	4.932	0.000
BNM → CTP	0.355	0.368	0.087	4.065	0.000
BTM → CTP	0.336	0.352	0.11	3.049	0.002

Table 5
Specific indirect effects values

	Original Sample (O)	*Sample Mean (M)*	*Standard Deviation (STDEV)*	*T Statistics (|O/STDEV|)*	*p-Values*
BNM→BTM→BAM (p1.p6)	0.432	0.433	0.088	4.932	0.000
BNM→BAM→CTP (p4.p5)	0.089	0.095	0.074	1.199	0.231
BTM→BAM→CTP (p6.p5)	0.336	0.352	0.11	3.049	0.002
BNM→BTM→BAM→CTP (p1.p5.p6)	0.254	0.267	0.082	3.11	0.002
BNM→BTM→CTP (p1.p2)	0.012	0.006	0.098	0.124	0.901

Table 6
Direct effect value (path coefficient)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	p-Values
BAM→CTP (p5)	0.590	0.612	0.118	4.998	0.000
BNM→BAM (p4)	0.150	0.153	0.114	1.318	0.188
BNM→BTM (p1)	0.758	0.76	0.037	20.385	0.000
BNM→CTP (p3)	0.093	0.081	0.105	0.881	0.379
BTM→BAM (p6)	0.569	0.571	0.118	4.81	0.000
BTM → CTP (p2)	0.016	0.006	0.129	0.125	0.901

Based on Table 4 and Table 5, the BNM to CTP has a significant total effect and total indirect effect (total effect = 0.448, total indirect effect = 0.355). However, these results differ from the direct effect value of BNM to CTP (p3) in Table 6, which shows that the direct effect of BNM to CTP is minimal and insignificant (p3 = .093). With these results, it can be assumed that there is no direct effect of BNM on CTP. Examination of the effect of BNM on CTP with BTM as a mediator (p1.p2) also shows is weak and insignificant effect (0.012). The effect of BNM on CTP through BAM as a mediator (p4.p5) is also not significant, with a value of .089. This analysis shows that individually, BTM and BAM do not act as mediators that can facilitate the effect of BNM on CTP.

Our analysis examined the combined impact of BTM and BAM as mediating variables for the influence of BNM to CTP, yielding distinct results (p1. p5. p6) as illustrated in Table 5. Path analysis showed that when BTM and BAM simultaneously and linearly mediated the effect of BNM on CTP, both significantly strengthened the effect of BNM on CTP from a direct effect of 0.093 to a specific indirect effect value of 0.254. Moreover, the significant indirect effects of path BNM→BTM→BAM (p1.p6) and path BTM→BAM→CTP (p6.p5) are presumed to substantially contribute to the significant of the indirect effect of the path BNM→BTM→BAM→CTP (p1.p6.p5). These findings emphasize the important role of BTM and BAM as mediating variables which magnifies the impact of BNM on CTP when connected linearly and simultaneously.

To analyze and conclude the role of BTM and BAM in mediating the influence of BNM on CTP, the author has summarized the analysis as presented in Table 7. The conclusion is based on the analysis flow that has been depicted in Figure 2. This is done to explain the path effects and draw conclusions about the role of BTM and BAM in the model specifically.

Table 7
Summary of the analysis of the mediation effects of BTM and BAM

Path	*Condition*
p1.p6.p5 (BNM→BTM→BAM→CTP) (the effect of BNM on CTP is mediated by BTM and BAM simultaneously)	significant
p3 (BNM→CTP) (direct effect of BNM on CTP)	not significant
p1.p2 (BNM→BTM→CTP) (effect of BNM on CTP with BTM as a mediating variable individually)	not significant
p3.p4 (BNM→BAM→CTP) (effect of BNM on CTP with BAM as a mediating variable individually)	not significant

The findings presented in Table 7 highlight that the influence of BNM on CTP is predominantly indirect, with a significant indirect effect observed only when mediated by both BTM and BAM. While the direct effect of BNM on CTP lacks significance, the indirect effect of BNM on CTP is not substantial when mediated by BTM or BAM individually. This shows that the effect of BNM on CTP is solely indirect (indirect only). Consequently, BTM and BAM serve as full mediators working linearly and simultaneously to optimize the effect of BNM on CTP.

4. Discussion

The purpose of this study is to gather information about the roles of BTM and BAM as mediating variables in the effect of BNM on CTP. The roles of BTM and BNM as mediating variables between BNM and CTP in the proposed model form paths with more than one mediating variable, which is known as multiple mediation. Testing paths with mediating variables can be analyzed by considering the value of indirect effects through specific indirect effect analysis(Carrión et al., 2017; Esposito et al., 2010; Hair et al., 2021). Specific indirect effect analysis focuses on specific paths that have mediating variables, allowing the observation of the trend of effects on the variables and the mediating role as an intermediary of the effect from the exogenous variable to the endogenous variable.

The direct effect of BNM as the mental foundation of mathematics teachers on CTP in this study is weak and not statistically significant. The author did not find any discussion regarding the direct effect of BNM on CTP, making comparisons with previous findings impossible. Furthermore, in addition to the minimal and statistically insignificant direct impact on CTP, the influence of BNM on BAM is also minimal and not statistically significant. Due to the limited literature on the direct relationship between BNM and CTP or BAM, this phenomenon remains unexplained.

The direct effect of BNM on BTM is highly significant, displaying a substantial effect size of 0.736. Following this, the direct effects of BTM on BAM and BAM on CTP are significant. However, although BNM has a high effect on BTM, the results of the analysis show that the effect of BNM on CTP when mediated by BTM is very small and insignificant. The same condition applies to BAM. BNM has a small and insignificant effect on BAM. Although BAM has a significant effect on CTP, the effect of BNM on CTP, when mediated by BAM, is insignificant. Thus, it can be assumed that BTM and BAM individually cannot play a role as mediators to strengthen the effect of BTM on CTP, although the total effect shows that BNM has a significant effect on CTP (see Table 4).

The series of direct effect significance, based on the results of the analysis in this study, namely from BNM to BTM, BTM to BAM, and BAM to CTP (see Table 6) shows that the effect of BNM to CTP is effective only indirectly. Strengthening beliefs about the nature of mathematics in teachers which then increases beliefs about mathematics learning is not significant enough to increase teachers' beliefs about their profession. The significant impact of teachers' beliefs about the nature of mathematics on teachers' beliefs about their profession is when teachers realize the importance of assessment in learning to show the benefits of the learning they manage for students' life skills in the future. The information that can be taken from this analysis is that beliefs about learning and assessment in mathematics learning can act as mediator variables that need to be given serious consideration in increasing teachers' beliefs about their profession as mathematics teachers who can convey facts, concepts, rules or the nature of mathematics with full awareness.

The significant improvement in this research begins with enhancing teachers' beliefs and knowledge about the nature of mathematics, including its epistemology, which is part of their belief like mathematics (Ernest, 1989a). This improvement then directly affects the increase in their confidence in teaching and learning mathematics in the classroom. The increase in confidence in teaching mathematics then directly influences the improvement of teachers' confidence in assessing mathematics learning. Ultimately, the improvement in confidence in assessing mathematics learning is expected to drive the professional development of mathematics teachers, both in their role as educators and as individuals in their perception of mathematics. As per the findings of Tamba and Wiputra (2021), the enhancement of mathematics teachers' beliefs in the epistemology (nature) of mathematics plays a pivotal role in shaping their beliefs regarding mathematics instruction. This, in turn, fosters confidence in the assessment practices integral to mathematics education. The teachers' convictions about teaching and assessment in mathematics subsequently drive their selection of suitable strategies, methods, and models for mathematics instruction, constituting a crucial factor in the enhancement of teachers' professional expertise.

Mathematics teachers need to increase their beliefs about the nature of mathematics, as recommended by Mapolelo and Akinsola (2015) because it can have an impact on their ability to teach mathematics effectively. Beliefs about the nature of mathematics, including mathematics beliefs, can influence a teacher's professional attitude and their ability to manage and implement mathematics instruction (Ren & Smith, 2018). This assumption is supported by the findings of this research, which indicate that the effect of beliefs about the nature of mathematics becomes more significant on a teacher's professional characteristics when mediated together by their beliefs about mathematics learning and beliefs about assessment. This suggests that beliefs about the nature of mathematics should be a crucial consideration in enhancing the professionalism of teachers in teacher education institutions and training institutions related to teacher professional development. The lack of publications discussing this matter provides impetus for future research.

5. Conclusion

The direct effect given by beliefs about the nature of mathematics on the professional character of teachers is not significant. Likewise, the indirect effect is mediated by beliefs about teaching or beliefs about assessment partially. Based on data analysis, in this study, it was concluded that beliefs about teaching and assessment have a significant role as mediating variables together in strengthening the effect of beliefs about the nature of mathematics on the professional characteristics of teachers. These results, it shows that beliefs about teaching and beliefs about assessment in mathematics learning together become full mediation in strengthening the effect of beliefs about the nature of mathematics on the professional characteristics of teachers. With the limited research related to this, it is an encouragement to conduct future research related to considerations in developing teacher education curricula.

Author contributions: All the authors contributed significantly to the conceptualization, analysis, and writing of this paper.

Declaration of interest: The authors declare that no competing interests exist.

Data availability: The data generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical declaration: All participants provided informed consent prior to their involvement in the study. They were informed about the study's purpose, procedures, and their right to withdraw at any time without consequence.

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