MATHEMATICS-BASED TEACHING MODEL AND INSTRUCTORS’ FINANCIAL ACCOUNTING PERFORMANCE: AN EXPERIMENTAL STUDY

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MATHEMATICS-BASED TEACHING MODEL AND INSTRUCTORS’ FINANCIAL ACCOUNTING PERFORMANCE: AN EXPERIMENTAL STUDY

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Abstract

Double entry bookkeeping (DEB) and the rules of debit and credit (RDC) are first contained in a mathematical book. Using this basic premise, this study develops a mathematics-based teaching model (MBTM) and examines its impact on instructors’ financial accounting performance. This study employed a quasi-experimental method with 43 accounting instructors as participants. The findings indicate that the implementation of the MBTM resulted in a significant improvement in instructors’ performance. Furthermore, the teaching experience had a positive effect on instructor performance, particularly when combined with the MBTM approach. Previous empirical research has aimed to compare traditional (preparer) and innovative (user) teaching approaches for the introductory accounting course. In line with this objective, the present empirical study introduces the MBTM as an innovative teaching model and assesses its effectiveness. This study is the first of its kind to implement the innovative mathematics-based teaching model (MBTM) specifically designed based on the history of accounting. It is worth noting that the study also utilized accounting instructors as research subjects, a less commonly employed approach in previous research endeavors.

Keywords: first course in accounting, mathematics-based teaching model (MBTM), instructors’ performance, teaching experience
Abstrak

Pembukuan berpasangan (Double entry bookkeeping) dan aturan debit dan kredit (rules of debit and credit) pertama kali dimuat dalam buku matematika. Berdasarkan premis dasar ini, penelitian mengembangkan model pengajaran berbasis matematika (mathematics-based teaching model/MBTM) dan menguji dampaknya terhadap kinerja instruktur akuntansi keuangan. Penelitian ini menggunakan metode eksperimen kuasi dengan melibatkan 43 orang instruktur akuntansi sebagai partisipan. Temuan menunjukkan bahwa implementasi MBTM menghasilkan peningkatan yang signifikan dalam kinerja instruktur. Selain itu, pengalaman mengajar memiliki efek positif pada kinerja instruktur, khususnya jika digabungkan dengan pendekatan MBTM. Penelitian empiris sebelumnya bertujuan untuk membandingkan pendekatan pengajaran tradisional (penyusun) dan inovatif (pengguna) untuk mata pelajaran pertama dalam akuntansi. Sejalan dengan tujuan ini, penelitian empiris ini mengusulkan MBTM sebagai model pengajaran yang inovatif dan menguji keefektifannya. Penelitian ini adalah yang pertama menerapkan model pengajaran MBTM yang dirancang khusus berdasarkan sejarah akuntansi. Perlu dicatat bahwa penelitian ini juga menggunakan instruktur akuntansi sebagai subjek penelitian, pendekatan yang jarang digunakan dalam upaya penelitian sebelumnya.

Kata kunci: pengantar akuntansi, model pengajaran berbasis matematika, kinerja instruktur, pengalaman mengajar

INTRODUCTION

The first course in accounting has been an interesting research topic studied over three decades. The main topics generally address financial accounting subjects. The teaching model used in the financial accounting subjects until the late 1980s was known as the traditional (preparer) approach in contrast to the innovative (user) approach (Diller-Haas 2004; Williams 2011). The traditional approach primarily focuses on the practical application of bookkeeping in recording transactions (Chiang et al. 2014). However, this approach has faced substantial criticism in the literature. Scholars have argued that the bookkeeping perspective offers a limited understanding of accounting principles (Saudagaran 1996) and is deemed inefficient in terms of time utilization (Chiang et al. 2014).

Previous empirical research seeks to compare the traditional (preparer) and the innovative (user) approaches. Using a survey design administered to 33 accounting departments, Diller-Haas (2004) finds that 71% of the accounting departments continue to use the traditional approach in the first course in accounting. Fowler (2006) has concluded that the impact of using an innovative teaching approach on students' critical thinking and evaluation skills is similar to the impact of using the traditional approach. In an explanatory study by Palm and Bisman (2010), it was found that the content of the first course in accounting generally remains traditional, with a primary focus on the debit-credit mechanism. Using a quasi-experimental design, Chiang et al. (2014) indicate that there is no significant difference between the impacts of the traditional and innovative teaching approaches.

A stream of research has investigated the factors influencing performance in the field of educational accounting. For example, Akaaboune et al. (2022) examined the role of Remote Proctoring, Vinson et al. (2022) investigated the impact of the grift, Lawson-Body et al. (2022) explored the role of the fourth Blackboard-supported BSC perspective, which focuses on learning and innovation. Additionally, Bérubé and Gendron (2022) examined the role of critical pedagogy and Fauziah et al.
(2018) investigated the influence of tournament team games. Berry and Routon (2020) investigated the role of a soft skill-based curriculum in accounting. Warsono et al. (2019) highlighted that teaching methods are a significant predictor of instructor performance. Sangster (2023) discussed the relevance of Luca Pacioli’s concept, which is based on a mathematical approach, as a fundamental aspect of accounting understanding. Furthermore, Rossi and Sangster (2022) along with Sangster (2022) emphasized the significance of integrating Luca Pacioli’s mathematics-based approach into the curriculum to foster comprehension and enhance performance.

This empirical study proposed the use of mathematics-based teaching model (MBTM) as part of innovative teaching model, and tested its effectiveness. This study examines whether MBTM is effective in improving accounting instructors’ performance. This innovative MBTM is consistent with the perspectives discussed by Phillips and Heiser (2011), Ellerman (2014), and Sangster (2018), emphasizing the importance of recognizing the role of mathematics in accounting as a basis for effective teaching in a principle-based approach. Furthermore, Nahartyo et al. (2020), Rohma and Zakiyah (2022), Rohma (2022) and Rohma et al. (2023) highlight the influence of individuals’ experiences in shaping their behavior and performance. To further strengthen the findings on the effectiveness of MBTM in enhancing instructor performance, specific studies have also investigated the impact of work experience on instructor performance following the implementation of this approach.

This study employs a quasi-experimental design involving accounting instructors in Indonesia as participants. To mitigate potential experimental errors, the design incorporates a pre-test to ensure the comparability of participants’ initial understanding, considering that prior knowledge can influence performance outcomes. The findings of this study demonstrate the effectiveness of MBTM in enhancing instructors' performance. Furthermore, this study reveals that the instructors’ work experiences mediate the impact of MBTM on their performance. The primary contributions of this study lie in introducing MBTM as an innovative teaching model for financial accounting courses and investigating its efficacy using instructors as the study subjects.

This study is structured as follows. Section 2 provides an overview of the proposed innovative teaching model, known as MBTM, by reviewing relevant literature and developing hypotheses. Section 3 outlines the research methodology employed in the study. Moving forward, Section 4 presents the data analysis, which includes the application of paired-sample t-tests and regression analysis. Finally, the last section concludes the study and offers a discussion of the findings.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

As a mathematics professor who taught at several universities (Hatfield 1924) and published a number of pure mathematics books (Sangster et al. 2007), Luca Pacioli documented DEB Double entry bookkeeping (DEB) and the rules of debit and credit (RDC) in his mathematics treatise Summa de Arithmetica, Geometria, Proportioni et Proportionalita (hereafter, Summa). Luca Pacioli had been teaching mathematics courses at some universities for at least 30 years when Summa was published (Sangster et al. 2007). Thus, historically, there was a strong relationship between mathematics and the renowned accounting academic disciplines of DEB and RDC.
While there is a recognized connection between accounting and mathematics (Sangster 2022), it is noteworthy that only a limited number of contemporary accounting scholars incorporate mathematics as a teaching method when covering topics like DEB and RDC in financial accounting courses (Rossie and Sangster 2022). On the one hand, prevailing financial accounting textbooks often illustrate accounting equations to convey the concept of DEB (Sangster 2023), implying that many accounting educators perceive DEB as a mathematical construct. On the other hand, existing textbooks frequently fall short in explaining the relationship between RDC and mathematics (Wood et al. 2021, Warsono et al. 2019), with RDC often being regarded as an inviolable rule.

Mathematics-based Teaching Method

Traditional approach and innovative approach were commonly used to teach the first course in accounting. Until the end of the 1980s, the traditional approach was widely employed. The approach was heavily criticized for failing to teach the concept in terms of technical procedures. Following on from the end of the twentieth century, many novel approaches were proposed. According to Chiang et al. (2014), one of the novel approaches is the use of accounting equations to assess the overall impact of the transaction on the entity. Phillips and Heiser (2011) investigated the use of accounting equations in the first course in accounting to improve journal learning.

Sangster et al. (2014) explain that using Pacioli's pedagogy can increase accounting understanding. In addition, Sangster (2022) explains that a revolution is needed in the accounting curriculum in higher education based on Pacioli's mathematical approach. In addition, Nunes et al. (2014) explain that using relevant double-entry bookkeeping can be the primary basis for understanding accounting. Thus, one of the innovative learning methods for meeting the call for a learning approach is using the mathematics-based DEB learning method. A more logical DEB rationalization process is expected to become a fundamental understanding that affects accountant performance.

This study develops an innovative teaching model called MBTM. There are two main characteristics in the MBTM, namely the use of accounting equation formula and the use of RDC fact-based rationality. The following is a brief description of each of the superior characteristics of MBTM that set it apart from traditional approaches.

The first innovative approach in teaching accounting is the utilization of the accounting equation formula. According to the existing DEB (debit-credit) theory, assets represent the resources controlled by the firm, and their funds originate from liabilities and equity. In accounting, revenues, expenses, and dividends are considered elements that reflect the firm's business activities (revenues and expenses) and distribution of dividends. These three elements are part of the equity element, where revenues increase equity while expenses and dividends decrease it. The logical framework of the expanded accounting equation, based on this understanding, is widely incorporated in modern accounting textbooks. Equation 1 represents the basic accounting equation, while equation 2 represents the expanded...
accounting equation, also known as Conventional logic.

Many accounting textbooks use the basic accounting equation (equation 1) to analyze transactions which cause changes in the revenue, expense, and dividend elements (Ainsworth and Deines 2004; King et al. 2001; Porter and Kaplan 2001; Warren et al. 2002; Libby et al. 2004; Williams et al. 2007; Anthony et al. 2007). Several textbooks use the expanded accounting equation, see Figure 2 (Horngren et al. 2002; Weygandt et al. 2008). Contrary to the traditional approach used in existing textbooks, MBTM adopts a different formulation of the accounting equation. Instead of the expanded accounting equation "Assets = Liabilities + Equity + Revenues - Expenses - Dividends," MBTM utilizes the equation "Assets + Expenses + Dividends = Liabilities + Equity + Revenues." This rearrangement places the Expenses and Dividends elements on the left side of the equation. Ingram (1998) introduced equation 3, which simplifies the understanding of credits and debits. In this research, the formulation represented by equation 3 is referred to as Mathematical logic.

Prior literature (Subramanyam and Wild 2009; Anthony et al. 2007) argue that the basic accounting equation can be assumed as a representation of the sources and uses of funds. The left side of equation 3 reflects the uses of funds, while the right side reflects the sources of funds. The company uses the funds to get assets or property, to pay expenses and/or share dividends with funds taken from the sources of liabilities, equity, and/or revenues. This mathematical logic can be used consistently to explain the basic accounting equation (equation 1) and the expanded accounting equation (equation 3) as well.

The application of equation 3 simplifies the explanation of why the assets, expenses, and dividends elements should be treated similarly in relation to the rule of debit and credit (RDC), despite their inherent differences. Assets represent future benefits derived from sources, while expenses and dividends indicate a reduction in assets (FASB 1985). By following this rationale, MBTM is grounded in the law of funds theory, which posits that the use of funds must always be equal to the sources of funds (Warsono 2017).

The RDC logic is the second aspect addressed in MBTM. Many accounting textbooks tend to describe RDC as merely “a part of the vocabulary of accounting” (Wallace 1997), “language” (Pincus 1997), or “nothing more than pluses and minuses” (Ingram 1998). In turn, the study of RDC is considered excessively narrow and procedural (Patten and William 1990; Nelson 1995; Saudagaran, 1996), it requires students to memorize (Pincus 1997; Ingram 1998), it poses a risk of misrepresentation to students regarding accounting (Pincus 1997; Diller-Haas

\[
\text{Assets} = \text{Liabilities} + \text{Equity} + \text{Revenues} - \text{Expenses} - \text{Dividends} \quad (1)
\]

\[
\text{Assets} + \text{Expenses} + \text{Dividends} = \text{Liabilities} + \text{Equity} + \text{Revenues} \quad (2)
\]

**Figure 2. Expanded Accounting Equation – Conventional Logic**

\[
\text{Assets} + \text{Expenses} + \text{Dividends} = \text{Liabilities} + \text{Equity} + \text{Revenues} \quad (3)
\]

**Figure 3. Expanded Accounting Equation – Mathematical Logic**
and it meets “instructors on unfamiliar turf, likely in a “land'' the students hope to visit never again” (Warren and Young 2012). In turn, the RDC is treated as an inheritance knowledge that is increasingly irrelevant in this modern era. However, this perspective has been criticized for being narrow, procedural, and requiring students to memorize without fully understanding the underlying principles (Patten and William 1990; Nelson 1995; Saudagaran 1996). It has been argued that this approach poses a risk of misrepresenting accounting to students and puts instructors in an unfamiliar and undesirable teaching environment (Pincus 1997; Diller-Haas 2004; Warren and Young 2012). As a result, RDC is seen as an outdated knowledge that is becoming increasingly irrelevant in the modern era.

Several scholars have studied RDC from a mathematical perspective (Peters and Emery 1978; Scorgie 1989; Ellerman 1985, 2014). Despite the criticisms of the traditional approach to teaching the debit-credit mechanism, there is still a lack of a clear explanation for the rational basis behind it that is widely accepted by accountants. The concept of the accounting equation, which is rooted in algebraic equations (Ellerman 2014), consists of two sides: the left and right sides. Pacioli used the terminologies 'per' (debits) and 'a' (credits) to refer to the left and right positions (Littleton 1928; Peters and Emery 1978). As a result, most modern accounting textbooks define debits as the left side and credits as the right side (Anthony et al. 2007; Williams et al. 2007; Weygandt et al. 2008). Furthermore, the definitions of debits and credits (left and right) are closely linked to the accounting equation as an algebraic equation. In order to maintain balance in the equation, accounting employs RDC. Therefore, the RDC serves as a manifestation of double-entry bookkeeping. Entries are made on both sides of the equation, with debits recorded on the left side and credits recorded on the right side. The application of the RDC to each element and account is determined by their position in the accounting equation.

Accounting employs RDC because the primary function of accounting is to provide financial information in which the financial instrument is always positive to everyone and can never be negative. The absence of a negative number in monetary units corresponds to the facts. Littleton (1927) and Edwards (1960) confirm that a monetary unit was one of the factors causing the development of DEB. Consequently, the use of negative numbers to reflect financial information is not allowed. Therefore, to record the decrease in monetary units, the early initiator of DEB originated the idea of using two sides and moving what would be a negative unit on one side to the other side, where it is positive. Using this mechanism, a decrease in monetary value can be represented by a positive number that, due to the meaning of the side on which it is placed, carries the meaning of a decrease.

Hypothesis Development

The use of the DEB theory is called the law of funds which is easy to understand and is presented in an accounting equation that is formulated consistently (Warsono 2017). This is contrary to the accounting equation used in traditional methods which use inconsistent theory. Furthermore, the accounting equation used in mathematics based on the Luca Pacioli approach is used to help students understand RDC (Sangster 2023; Sangster et al. 2022). Using MBTM, RDC rests on the provision that all elements and accounts that represent elements on the left side of the equations have the same RDC. Similarly, RDC rules are the same for elements and accounts that represent elements on the right side of the equations (Nunes et al. 2014; Wood et al. 2021; Sangster 2023). In summary, the use of the mathematics-based teaching model (MBTM) is expected to facilitate the
rationalization process in accounting and enhance instructors’ understanding of the subject matter, leading to improved performance. Additionally, instructors are likely to convey the learning materials more effectively to students. Based on these expectations, the following hypothesis is proposed:

**H1: Instructors’ performance will be higher after being exposed to the mathematics-based teaching model (MBTM) compared to their performance before exposure to MBTM.**

Working experience is an important asset for accounting instructors. Boyle et al. (2015) explain that experienced accounting teachers are capable of providing good information, opinions, and views about roles and to integrate their professional abilities with institutional characteristics. Some studies have also successfully proven that teaching experiences positively influence students’ achievement (Adeyemi 2008; Akinsolu 2010, Ewetan and Ewetan 2015). Therefore, experiences owned by accounting instructors do not only influence the institutions but also the students’ increasing achievement as the main output of education. To enhance educational quality and student achievement, it is crucial to focus on the qualities of instructors. Louws et al. (2017) emphasize that the learning environment created by instructors is a critical factor in educational improvement.

Kini and Podolsky (2016) performed a review of thirty research articles related to teaching experiences. They figured out that instructors’ effectiveness tends to increase with increasing experience. Their study indicated that the more experienced the instructors are in teaching, the more effective their performances. Furthermore, Kyndt et al. (2016) believe that during their late-career term, instructors tend to be more confident on their abilities and possess a high working satisfaction. In this context, the term refers to the length of time an instructor has been teaching, and it is assumed that during the term, instructors have conviction, trust, and satisfaction in their work accomplishment. As a result of their familiarity with various teaching materials, more experienced instructors are more effective and confident when teaching. The use of MBTM can make it easier to understand the rules of debits and credits, minimizing confusion in the identification of debit or credit accounts. Inducing MBTM will facilitate the rationalization of accounting transactions and high teaching experiences will give instructors a great deal of knowledge so that it will be easier to understand complex transactions. The implementation of MBTM promotes the enhancement of instructor performance by improving their understanding and proficiency in delivering learning materials. Based on this, the following hypothesis is proposed:

**H2: Instructors’ teaching experiences have a positive influence on their teaching performances after being exposed to the mathematics-based teaching model (MBTM).**

**RESEARCH METHOD**

**Design**

This study applied the experimental research design to predict that MBTM creates an increase on accounting instructors’ performances. The experimental design employed was a quasi-experimental design with the workshop’s participants, who consist of accounting instructors as the research subjects. The research subject recruitment process used flyers distributed through e-mail and printed forms in all vocational high schools in Indonesia. This was done to ensure that the subjects in this study were randomly selected. In addition, the flyers also included information that the workshop was to be held specifically for accounting instructors. This information
was to ensure that the subjects who would later register as workshop participants were in line with the criteria of the research subjects as accounting scholars.

**Experimental Tasks**

Participants receive an experimental module divided into three levels of MBTM module. First, the MBTM module for the basic level explains the accounting cycle in service companies, which includes several sub-topics such as accounting and IFRS, transaction analysis, credit debit mechanisms, account-focused recording, transaction preparation, journalizing, book-transfer, finance report preparation, semi-accrual recording system, and balance sheet utilization. Second, the MBTM module for the intermediate level explains the accounting cycle in trading companies, which includes several sub-topics such as: basic accounting knowledge, general business provisions and accounting treatment, a system for recording trade goods, methods for calculating the cost of goods sold, a perpetual system: method special identification, FIFO, LIFO, weighted average, and LIFO method periodic recording system.

The LIFO method is not allowed under PSAK 14. However, it is still presented in the module of an experimental task to provide the basic concept of implementing MBTM on the differences in the inventory cost flow method. Meanwhile, the questions to measure instructor performance is adjusted to the standard by not including LIFO. Third, the MBTM module for the advanced level explains the accounting cycle in manufacturing companies, which includes several sub-topics such as the characteristics and accounting of manufacturing companies, accounting for the cost of raw materials, labor, and factory overhead, accounting for the completion and sale of finished products, financial report preparation, calculating the cost of finished products and process systems using the FIFO method and weighted average, and accounting for the cost of finished products and process systems using the FIFO method and weighted average.

After getting the module and getting treatment in the tutorial explanation guide from the experimenter, instructor performance is measured using 30 questions. In terms of participants' behavior, the answers can be categorized into two aspects: rigor and thoroughness. Rigor was measured by calculating the ratio of correct answers to the total number of choices selected by the participants. Thoroughness, on the other hand, represents the level of attentiveness and meticulousness exhibited by the participants when answering the provided questions. It is important to note that participants were not required to learn the selected questions based on the thoroughness assessment. The researcher designed the exam with 18 highly challenging questions, requiring participants to demonstrate a high level of thoroughness during the examination. The thoroughness value of each participant was determined by dividing the number of questions they answered correctly by the total of 18 thoroughness questions.

The performance variable in this study was assessed based on the final score obtained by each participant. A score of 4 (four) was assigned for each correctly answered question. In cases where participants answered the questions incorrectly, a score of -4 (minus four) was assigned. If no answer was provided, a score of 0 (zero) was assigned. It is important to note that the total score at the end was not allowed to be negative; instead, the minimum possible score was set to 0 (zero).

**Experimental Procedure**

This study was designed as a workshop to optimize randomization.
Workshop invitations were distributed to all accounting instructors in Indonesia via letters addressed to the principals of vocational high schools in each public and private agency registered with the Directorate General of Primary and Secondary Education of Indonesia. Participants registered voluntarily so the possibility of error and randomization can be minimized. This workshop was explicitly designed and rewards were provided to all participants who followed all stages thoroughly. Furthermore, to reduce the threat of demographic characteristics, this study tested the effect of demographic characteristics, specifically age, on instructor performance.

The workshop titled "Accounting Practice Teaching" was conducted over a period of three consecutive days, involving active participation from all participants and experimenters. Attendance of all workshop sessions was mandatory for the participants. The first session served as a pre-test to assess the participants' initial abilities before the implementation of the mathematics-based teaching model (MBTM). In the second session, the participants were introduced to the MBTM through learning materials and were exposed to the application of mathematical accounting in the context of service, trading, and manufacturing enterprises. During each workshop session, the participants were provided with modules containing practice questions and were requested to answer them. The third session involved the administration of a post-test to evaluate the participants' abilities after the implementation of the mathematical accounting learning method. It is important to note that only participants who attended all workshop sessions were included as subjects in this research. The experimental procedure is illustrated in Figure 4.

The experiment began with the opening and registration of participants. They were then instructed to complete an initial test consisting of thirty multiple-choice accounting questions, covering topics related to servicing, merchandizing, and manufacturing firms. The test was conducted using a computerized system and aimed to assess the participants' level of prior knowledge before receiving any treatment. Each participant could immediately view their individual scores upon completion of the test. To minimize the risk of cheating, the distribution of learning modules was provided after the initial test session. The participants received manipulation of the mathematics-based teaching model (MBTM) at different levels, including basic, intermediate, and advanced, over a period of three days. Once all the manipulations were completed, the participants were asked to take a final test to determine if there was any improvement in their performance. The participants were able to view their test scores immediately after completion. At the end of the session, the participants were requested to provide demographic information.

Participants
The participants in this study were accounting instructors from vocational
high schools. The choice of vocational high school instructors was based on the argument presented by Zilic (2018) that vocational high schools place greater emphasis on the practical application of accounting in the business world. However, previous research has indicated that graduates of vocational high schools may have limitations in contextual reasoning and show no significant difference in competitiveness in the workforce compared to senior high school graduates (Zilic 2018). This suggests that vocational high school instructors face higher task demands and require special attention. As vocational high schools prioritize practical applications, it is important for vocational high school accounting instructors to have a solid understanding of accounting practices at the basic and secondary levels. The research design took the form of a workshop and accounting practices with the aim of aligning the initial perceptions among accounting instructors.

Operational Definition and Measurement

Dependent variables in this study is financial accounting performance measured by observing participant’s ability to answer the thirty questions given. The measurement was as follows: wrong (−4), unanswered (0), and true (+4). First, independent variable is an MBTM, the teaching approach based on mathematical model. Second, independent variable is teaching experiences variable was measured using demographic questions about participants’ teaching experience. Participants’ teaching experiences were categorized into four groups: Category 1 comprises participants with less than one year of teaching experience, category 2 comprises participants with 2-5 years of teaching experience, category 3 comprises participants with 6-10 years of teaching experience, category 4 comprises participants with more than 10 years of teaching experience.

Furthermore, in addition to the main variables, an additional analysis was conducted to supplement the study. The performance variable was assessed through rigor testing, which involved calculating the score based on the number of correct answers divided by the total number of answered questions. Thoroughness, on the other hand, was measured by evaluating the participants’ accuracy in answering the provided questions. The participants were not informed about the highly tricky questions used for the accuracy assessment. The accuracy score for each participant was determined by dividing the number of correctly answered questions by the total number of accuracy-related questions, which amounted to ten. Apart from examining the dependent and independent variables, as well as the additional tests of rigor and thoroughness, the study also considered an extraneous variable, namely the age of the participants. In this study, only the demographic characteristic of age was considered. This decision aligns with Kenny et al.'s (2016) assertion that age can influence functional capacity and human performance. However, initial analysis revealed no significant relationship between age and instructor performance after the implementation of MBTM. This
RESULT AND ANALYSIS

The study initially involved a total of 45 participants. However, data from only 43 participants were used in the analysis due to two participants not completing the entire workshop and practice activities, which were set as criteria for inclusion in the study. Out of the 43 participants, 3 were male and 40 were female. The average teaching experience of the participants was 6-10 years as accounting instructors. Specifically, 6 participants had 1-5 years of experience, 10 participants had 6-10 years of experience, and 27 participants had more than 10 years of experience. Regarding age, the average age range of the participants was between 36-45 years. More specifically, there was 1 participant aged 18-25 years, 10 participants aged 26-35 years, 18 participants aged 36-45 years, and 14 participants aged over 46 years.

test the proposed hypotheses, the researchers employed the paired sample t-test and multiple regression tests. Before conducting the hypothesis testing, several assumptions needed to be met, including the assumption of normality. Normality testing was performed using the Kolmogorov-Smirnov test, and the results are presented in Table 1.

The findings indicate that the residual value is 0.530 (p > 0.05), suggesting that the normality assumption is satisfied. This suggests that the error term follows a normal distribution. Since the study only had one treatment group (MBTM), a homogeneity test was not necessary as there was no comparison between multiple groups.

Hypothesis 1 states that there are differences in instructors' performances before and after receiving the MBTM. To test this hypothesis, the researchers employed the paired-sample t-test to examine the differences in instructors' performances before and after the manipulation. The results of the test are presented in Table 2.

### Table 1

<table>
<thead>
<tr>
<th>Normality test</th>
<th>N</th>
<th>Kolmogorov-Smirnov Z</th>
<th>Asymp. Sig (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>43</td>
<td>0.809</td>
<td>0.530</td>
</tr>
</tbody>
</table>

Source: Analyzed primary data

### Table 2

<table>
<thead>
<tr>
<th>Mean N SD SE Mean t Sig.</th>
<th>Pre-Test</th>
<th>Post Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.583 43 1.255 0.191</td>
<td>0.823 43 0.953 0.145</td>
</tr>
</tbody>
</table>

Note: Significant at the 5% levels
Source: Analyzed primary data

finding provides confidence that any changes in instructor performance observed can be attributed to the manipulation of the teaching model, rather than demographic factors.
The findings indicate that there is a statistically significant difference in the average performance of accounting instructors before and after receiving the MBTM manipulation. The average performance before the manipulation was 0.5829, which was lower than the average performance after the manipulation, which was 0.8233. These results suggest that, on average, the MBTM has the potential to improve the performance of accounting instructors. The paired-sample t-test conducted on the hypothesis ($p > 0.032$) demonstrates statistical significance at a 95% confidence level. Therefore, it can be concluded with confidence that there are indeed differences in the performances of accounting instructors after receiving the MBTM manipulation, providing support for H1.

Meanwhile, H2 proposed that instructors' teaching experiences positively influence their teaching performances after MBTM induction, as shown in Table 3. The findings indicate that accounting instructors' working experiences improve their performance, with a significance level of $p>0.048$. With a confidence level of 95%, inducing MBTM encourages instructors' performance improvement. Therefore, Hypothesis 2 is statistically supported. The findings of hypothesis 2 are further supported by the additional analysis results in Table 3, which show that instructors' teaching experiences have no significant effect on instructor performance prior to being induced by MBTM. This finding suggests that MBTM plays a more important role in explaining instructor performance than experience effects. This finding supports the importance of MBTM manipulation in explaining instructor performance. Table 3 also demonstrates that age has no effect on accounting instructors' performance.

The statistical test for hypothesis shows that there is a difference in accounting instructors' performance before and after obtaining MBTM manipulation. Accounting instructors' average performance before and after obtaining MBTM was lower. These findings support the findings of Sangster et al. (2014), who found that incorporating a mathematical model (Pacioli) into accounting learning can improve accounting understanding and, as a result, student performance. Furthermore, this study supports the views of Saudagar (1996) and Rankin et al. (2003), who argue that changes in accounting learning models must be implemented. Accounting education that is monotonous and focuses solely on memorizing will make it difficult for students to understand accounting in the business world.

The mathematics-based expanded accounting equation used in this study is beneficial to the instructors. The equation is a method in MBTM based on the law of funds that can assist instructors in memorizing the rules of debits and credits. Thus, the mathematics-based teaching model (MBTM) in financial accounting subjects encourages individuals to be more careful and thorough in order to improve the instructors' performances. The performance of the instructors in this study was measured using the scores of answered questions on the DEB after the

### Table 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sign</th>
<th>$\beta$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td>0.343</td>
<td>0.624</td>
</tr>
<tr>
<td>Age</td>
<td>+</td>
<td>-0.490</td>
<td>0.057</td>
</tr>
<tr>
<td>Experience</td>
<td>+</td>
<td>0.566</td>
<td>0.048**</td>
</tr>
</tbody>
</table>

Dependent Variable: Performance before being induced by MBTM

| Experience | +    | 2.404  | 0.103 |

Note: Significant at the 5% levels
Table 4

The effect of MBTM on different levels of rigor and thoroughness

<table>
<thead>
<tr>
<th></th>
<th>Rigor</th>
<th></th>
<th>Thoroughness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>N</td>
<td>SD</td>
</tr>
<tr>
<td>Pre_Test</td>
<td>0.059</td>
<td>43</td>
<td>21.907</td>
</tr>
<tr>
<td>Post_Test</td>
<td>0.063</td>
<td>43</td>
<td>16.656</td>
</tr>
</tbody>
</table>

Source: Analyzed primary data

introduction of mathematical treatments. Warsono (2017) explains that the application of a mathematical perspective can be used to answer basic questions logically and is easily accepted by many communities. Vangermeersch (1997) adds that debits and credits in the accounting learning process are non-negotiable.

Thus, the existence of MBTM based on the law of funds that is relatively simple to understand makes it easy for accounting instructors to understand the material, which has an impact on the improvement of their performance scores. Furthermore, the study discovered that the teaching method not only affects the instructors' performance in completing the task, but also increases their level of rigor and thoroughness. This is consistent with the explanation provided by Ball and Forzani (2009), who argue that "the careful use of physical materials as a model is to explain mathematical procedures." The principle emphasizes that mathematics provides objective answers that require students to increase their rigor and thoroughness.

The results of the statistical tests conducted in this study indicate that the teaching experiences of accounting instructors have an influence on their performances. These findings are in line with previous studies conducted by Kini and Podolsky (2016) and Kyndt et al. (2016), which also suggest that instructors' effectiveness tends to increase with the accumulation of teaching experience. In this study, the performance score of instructors was based on their post-test scores after receiving the MBTM treatment. This suggests that instructors' teaching experiences can motivate them to engage in new MBTM learning experiences, which subsequently contribute to the improvement of their performances. However, these findings contradict the results reported by Richter et al. (2011), who proposed a non-linear relationship between instructors' desire to learn new things and their level of teaching experience. Richter et al. (2011) observed a decrease in instructors' interest in learning methods as their experience increased. On the other hand, Krečič and Grmek (2008) found no significant differences in instructor perceptions of the importance of cooperative learning based on different levels of teaching experience.

**Additional Analysis**

Hypothesis 1 is supported by the difference in instructors’ performances before and after obtaining MBTM manipulation with the average values of 0.5829 and 0.8233, respectively. This indicates that MBTM can improve the instructors’ performances. The mathematics-based learning procedure concerned with numbers encourages individuals to be more careful and meticulous in performing their duties. As Ball and Forzani (2009) explain, "in this example, the teacher educator is providing the student teachers with a detailed model of the careful use of physical materials to explain mathematical procedures." Therefore, the study conducted additional tests in Table 4 to determine the role of mathematical accounting learning methods in instructors' level of rigor and thoroughness.
The findings in Table 3 show that there is an average difference in rigor on the instructors before and after obtaining MBTM manipulation. The results of this descriptive analysis show that, on average, instructors' rigor in answering questions is higher after obtaining MBTM manipulation, at 6.33998, than before obtaining manipulation, which is 5.9606. Furthermore, the analysis results show that the average score of accounting instructors' thoroughness in answering questions increases from 3.255 to 36.046 after obtaining MBTM manipulation. As a result of the descriptive analysis, MBTM is able to increase the instructors' rigor and thoroughness in completing the accounting test on average.

CONCLUSION

This study found that the equation is a method in MBTM based on the law of funds that is relatively simple to understand, making it easy for accounting instructors to understand the material, which has an impact on the improvement of their performance scores. Furthermore, the teaching method not only affects the instructors' performance in completing the task, but it also raises their level of rigor and thoroughness. Accounting instructors' performance is influenced by their teaching experiences. This suggests that the instructors' teaching experiences can motivate them to learn new MBTM learning lessons that will help them improve their performance.

This study has three major implications. The first is from the standpoint of fund law. This study provides theoretical implications that implementing mathematical concepts in accounting rationalization that emphasize the balance between sources of funds and the use of funds can facilitate the logic of fundamental accounting essential equation thinking. Second, this study incorporates Pacioli's mathematics-based approach to rationalizing basic accounting equations, which was requested in previous research. These three studies discuss the implications of applying Pacioli's logic to textbooks to improve user comprehension, particularly for beginners learning basic accounting concepts.

This study recognizes a number of limitations that should be considered. To begin, due to the varied and inconclusive findings in previous research on the relationship between gender and performance, the study did not include gender as a control variable. As a result, the influence of gender on accounting instructors' performance was not investigated in this study. Second, the accounting instructors' performance may have been influenced by the participants' heterogeneous age distribution. Younger generations, who have greater access to updated information, such as changes in accounting standards, may perform differently than older generations. The study, however, did not specifically test the relationship between age and performance. Future research could investigate this relationship and conduct sensitivity analysis to determine the optimal age range for improving instructors' performance. Third, there were indications of heteroscedasticity in the age variable, which should be taken into account when interpreting the findings of this study. Although age was not the primary focus of the study, readers should use caution when interpreting the findings. Finally, the study did not conduct sensitivity analysis on the impact of working experiences on performance. It is possible that there is a non-linear relationship between working experiences, certification achievements, and performance outcomes. Future research could use sensitivity testing to determine the optimal point of working experience that improves performance.
REFERENCES


