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Instructional design innovation in distance learning to improve student learning performance

Endra Murti Sagoro*, Sony Warsono, Jogiyanto Hartono, Wuri Handayani
Universitas Gadjah Mada, Indonesia
*Corresponding Author: endra.murti.s@mail.ugm.ac.id

ABSTRACT

This study investigates the application of instructional design innovations to improve student learning performance, focusing specifically onthe learning materials and teaching methods. The introductory accounting course was taken as the object of study because it is a compulsory subject at the Faculty of Business. Cognitive load theory (CLT) and scaffolding theory were employed in explaining and developing the hypotheses. This study examined student learning performance gaps on instructional design innovation through learning materials (mathematics vs. traditional) and scaffolding (soft vs. hard). This study adopted a 2 x 2 experimental design involving 166 new undergraduate students at Universitas Negeri Yogyakarta in Indonesia. The research findings demonstrated that the instructional design of mathematics-based accounting learning effectively improves student learning performance during distance learning. Meanwhile, the use of scaffolding did not generate any significant differences in student learning performance during distance learning.

Keywords: student learning performance, Cognitive Load Theory, scaffolding, instructional design, distance learning

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INTRODUCTION

This study investigates the effectiveness of instructional design in online learning systems to improve student learning performance. Information technology plays an important role in supporting learning in higher education institutions. The Merdeka Belajar Kampus Merdeka (MBKM) program policy provides opportunities for students to study in various study programs, even across universities. This policy has an impact on changes in the learning system. Distance learning through learning management systems is one of the phenomena in the framework of implementing the MBKM program. On the one hand, distance learning becomes more flexible in terms of time, location, and class size (de Oliveira et al., 2018). Moreover, distance learning can help students learn independently and minimize social contact and physical contact with others. The use of this learning system certainly has an impact on learning performance that should be considered by educational institutions (Guney, 2009; Oguguo et al., 2020). On the other hand, the use of distance learning has negative impacts such as increasing stress or pressure (Wirkus et al., 2021; Yang et al., 2021; Yasmin et al., 2020), increasing cognitive load (Rajput, 2020; Schmitt et al., 2021; Tzafilkou et al., 2021), hindering the achievement of learning competencies (Widarto, Wijanarka, & Wibowo, 2024), reducing learning motivation, and reducing learning performance (Engzell et al., 2021; Tan, 2021).

Accounting is one of the courses offered in the MBKM program, so it can be taken by students from various study programs. These courses are an essential subject at the Faculty of Business in many higher education institutions (Barhamzaid & Alleyne, 2018; Stivers et al., 2011; D. L. Warren & Young, 2012). Yet, teaching basic accounting has become a challenging issue

for lecturers due to the learning material of this course covering the various transactions (Fang & Slavin, 2015). To analyze the transactions, students should understand the double-entry system as the basic material in accounting (Samuel et al., 2017). Double entry based on the arrangement of entries with equal amounts of debits and credits from two different accounts is the basis of modern accounting (Sangster, 2016). Accounting equations are very important material in basic accounting learning and should be delivered correctly prior to teaching other accounting materials (Scofield & Dye, 2009). The rules of debits and credits are an embodiment of the accounting equation. Hence, the teaching activities of this subject should be designed using an appropriate learning model to achieve effectiveness for the courses (Dunlosky et al., 2013; Entwistle & Brennan, 2011; Gilbert, 2018).

Learning the rules of debits and credits has been emphasized on memorization methods, such as the mnemonic method (Laing, 2010; Palm & Bisman, 2010), and simplification methods using the accounting equation (Zhou & Lamberton, 2020). One of the shortcomings of the memorization method is the high level of boredom and the possibility of the emergence of excessive cognitive load, especially when distance learning is carried out online by a Learning Management System (LMS). Simplification methods using accounting equations are difficult to explain the complexity of business transactions. Many students are confused in applying debit and credit rules (Lloyd & Abbey, 2009; VanZante, 2013; Zhang et al., 2020), especially when complex transactions involve elements of revenue and expense. Thus, instructional designs for supporting learning activities can be constructed to effectively improve understanding of complex learning materials and assignments (Mostyn, 2012).

Although numerous studies have explored online accounting education, several gaps remain in the literature. There is a theoretical limitation in explaining how effective instructional designs can be applied to online learning for complex accounting topics, such as debit and credit rules. Most existing theories are general and have not considered the specific characteristics of fundamental accounting materials, which require a deep conceptual understanding (Mostyn, 2012; Sangster, 2016). Additionally, research examining the impact of instructional designs on students' learning performance of debit and credit rules, particularly in the context of online learning, is still limited. Previous studies have primarily focused on students' perceptions of distance learning without delving into the cognitive aspects involved in mastering complex accounting topics (Liu et al., 2022).

Departing from the problems that have been described in the previous paragraphs, this research investigates the application of accounting learning instructional design innovations in distance learning, especially in terms of learning materials and methods to improve student learning performance. Besides that, this research also raises three argumentative novelties with some critical reasoning. Firstly, this research applies an instructional design of accounting learning based on a mathematics approach to reduce the students' cognitive load. The instructional design is in the form of delivering materials based on Traditional Accounting Equations, hereinafter abbreviated as TAE, and Mathematics-Based Accounting Equations, hereinafter abbreviated as MBAE. In learning accounting equations, complex tasks await students, especially when various types of transactions are presented. To overcome these problems, accounting teachers can apply CLT when compiling learning designs (Sithole, 2018). Research on CLT has been at an extensive level, and its application is very wide in instructional design applications in various disciplines. However, the number of such studies in the accounting education literature is still very rare (Mostyn, 2012). In fact, CLT has contributed in the form of accounting material design guidelines (Sithole, 2018). Therefore, this research aims to measure differences in student learning performance in the experimental class that applies CLT-based instructional design innovations.

Hypothesis 1: There are distinctions in terms of student learning performance between the variations of accounting learning instructional designs that are applied

Secondly, the accounting equation with a mathematical approach reflects the "law of funds", which describes "the use of funds = source of funds" (Carson, 1949; Nicol, 1968;

Warsono, 2017). Students need to understand that all transactions, both simple and complex, only relate to expenses and revenue. The company manages funds from various sources in the form of liabilities, equity, and/or revenue, and then these funds are used in the form of assets and expenses. Moving the cost element to the left side of the equation indicates that assets and expenses are included as expenses. This transfer uses mathematical rationality to make accounting equations simpler to explain why elements of assets and expenses should receive the same treatment in relation to debit and credit provisions, which are based entirely on mathematical logic (Warsono, 2015; Warsono et al., 2024). Learning mathematics related to equations and positive and negative symbols has been obtained by students at elementary and secondary levels. Moving the cost element to the left side of the equation removes the negative symbol on the right side of the equation. The absence of a negative sign in the accounting equation can make the information easier for new students to understand so that it will be easier for them to learn accounting equations based on a mathematical approach compared to traditional accounting equations. The ease of learning the material can certainly improve student learning performance. Thus, the second hypothesis proposed in this research is outlined as follows.

> Hypothesis 2: The learning performance of students who apply the mathematical approach is better than the learning performance of students who apply the traditional approach.

Thirdly, this research also considers the role of scaffolding in the innovation of effective accounting instructional design in distance learning. The instructional design of learning must adjust students' abilities so that the learning process is in line with what is explained in Scaffolding Theory (ST). Based on prior studies, the proper application of scaffolding can provide sufficient encouragement to students to complete assignments, especially when the assignment is in the Zone of Proximal Development (Orey, 2010). Scaffolding is one of the principles of effective learning that allows lecturers to accommodate the needs of individual students (Larkin, 2001). If the scaffolding is managed properly, it will act as an enabler, not as a disabler (Benson, 1997).

> Hypothesis 3: There are differences in learning performance between students who use hard and soft scaffolding.

Furthermore, the performance of accounting students can be improved if the lecturers are able to properly design learning designs. We argue that CLT is an essential theory because it influences the design of instructional materials to accommodate students' cognitive architecture. Thus, this research identifies the cognitive constraints of new students when learning complex tasks so that it is expected to increase their learning efficiency (Sweller, 1988). Furthermore, Scaffolding Theory (ST) was applied to the instructional design developed in this research sinceST emphasizes that social interaction plays a fundamental role in the development of student cognition (Vygotsky, 1978; Wertsch, 1991). In addition, the use of scaffolding can affect student learning performance (Phillips & Heiser, 2011; Zhou & Lamberton, 2020). This research developed accounting equation material based on a mathematical approach and an accounting equation based on a traditional approach accompanied by the application of learning methods using soft and hard scaffolding. Innovation in MBAE materials and the use of scaffolding aimed to improve student learning performance. Then the instructional learning design was divided into four variations, which were tested in four different experimental classes. Two classes were tested by applying the MBAE with soft and hard scaffolding, respectively. Meanwhile, the other two classes were tested by applying TAE with soft and hard scaffolding. This was conducted because variations in instructional design have a close relationship with student learning performance (Cattaneo et al., 2017; Munawaroh, 2017; Sartika et al., 2021). Thus, the application of variations in accounting learning instructional design by considering CLT and ST can produce different student learning performances.

METHOD

This research aims to examine learning innovation in complex accounting materials based on CLT and ST by explaining the relationship between variations in accounting learning and scaffolding on student learning performance. This research employed a 2 x 2 factorial experimental design to investigate causality between variables and reduce interference with extraneous variables through appropriate randomization techniques (Nahartyo & Utami, 2016; Shadish et al., 2002). In more detail, this research aims to examine the effectiveness of accounting learning innovations with complex learning materials. Furthermore, the development of learning design variations was carried out to assess the relationship between learning design and student learning performance. Due to the pandemic conditions, an online experimental design specifically, an LMS, was used to collect data. Table 1 describes the experimental design that was applied.

Table 1. Experiment design

Instructional Design		Method	
		Soft Scaffold (B1)	Hard Scaffold (B2)
Material	Math-based Accounting Equation (A1)	Cell 1 (A1B1)	Cell 2 (A1B2)
	Traditional Accounting Equation (A2)	Cell 3 (A2B1)	Cell 4 (A2B2)

Cell 1 and cell 2 are experimental classes that apply MBAE using soft and hard scaffolding. On the other hand, cell 3 and cell 4 are experimental classes that apply TAE using soft and hard scaffolding. According to the theory of equation (i), the accounting equation in cells 1 and 2 refers to the law of funds, which describes the sources of funds on the right side of the equation and the types of uses of funds on the left. However, the accounting equation in cells 3 and 4 refers to equation theory's (ii) law of assets.

(i) Assets + Expenses = Liabilities + Equity + Revenue (Law of Funds/MBAE)
(ii) Assets = Liabilities + Equity + Revenue – Expenses (Law of Assets/TAE)

This research applied two learning designs for four meetings with a duration of one hundred minutes for each meeting. The design of accounting learning considers transaction analysis material and accounting equations. Learning materials and learning methods were developed as a form of manipulation of instructional design innovations to assess student learning performance by considering cognitive load. The MBAE approach is an innovative learning material that is recommended for learning accounting equation material for various types of transactions. The MBAE approach shifts the cost element to the left side of the accounting equation, referring to the law of funds (Carson, 1949; Nicol, 1968; Warsono, 2017). Furthermore, collaborative learning between students and lecturers as facilitators marks the use of soft scaffolding (Schmidt, Rotgans, & Yew, 2011). The application of soft scaffolding emphasizes collaborative learning through chat and discussion forums on the LMS platform. Furthermore, the use of student worksheets represents hard scaffolding (Schmidt et al., 2011). Then the hard scaffolding emphasizes the discussion on transaction analysis and accounting equations with the help of student worksheets.

This research involved new students of the accounting study program from Universitas Negeri Yogyakarta, Indonesia. A total of 166 students were involved in this research. They were divided into four classes as randomized research subjects. Randomization was conducted with a manual drawing based on student data obtained from the academic division so that each subject has the same opportunity to occupy each class. Furthermore, this research initiated an experimental procedure through notification of electronic messages to research subjects to receive an LMS enrollment key to taking accounting lessons with different treatments. In other words, each class has the same material load but with a different instructional design. The pre-test was carried out as a benchmark for students' basic abilities in working on accounting equations. The questions were in the form of multiple choice, and several cases were considered as pilot tests. In

addition, the results of the pre-test described whether there were differences in student learning performance or not prior to being given treatment.

This research employed ANOVA through the homogeneity of variance prerequisite test to investigate the causal effect and the post hoc test to explore the difference in the mean of each variable (Nahartyo & Utami, 2016; Shadish et al., 2002).

FINDINGS AND DISCUSSION

Findings

Table 2 demonstrates the average student learning performance in the four classes before and after being given treatment. Students in the first and second classes were treated with MBAE material that included hard scaffolding in the form of student worksheets in a sequential manner and soft scaffolding in the form of collaborative learning. Students in the third and fourth classes, on the other hand, were treated with TAE material that included both hard scaffolding in the form of student worksheets and soft scaffolding in the form of collaborative learning. Descriptive statistical data in Table 2 shows the average difference in student learning performance in each class both before and after the treatment.

Table 2. Descriptive statistics on learning performance

Instructional Design Variations	N	Mean		Deviation Standard		Minimum Score		Maximum Score	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
MBAE_Soft	41	54.9024	72.6585	9.88637	8.48118	40.00	61.00	91.00	97.00
MBAE_Hard	42	54.1667	70.1667	11.5355	10.8895	35.00	51.00	95.00	98.00
TAE_Soft	41	55.9512	66.7805	7.15525	9.08436	40.00	52.00	70.00	86.00
TAE_Hard	42	55.6905	64.0238	8.36802	8.22100	43.00	48.00	80.00	82.00
Total	166	55.1747	68.3916	9.33093	9.72268	35.00	48.00	95.00	98.00

The average value of student learning performance in the MBAE class, which uses soft scaffolding, after being given treatment, gained the highest score compared to other classes. This represents that the MBAE instructional design and the use of soft scaffolding proved to be the most effective compared to other instructional designs. Then the ANOVA test was employed to further discover whether there is a difference between student learning performances in each class. This test aims to overcome the possibility of sampling error in descriptive statistical tests as described in the methods section. Prior to the ANOVA test, it is necessary to do a homogeneity test first. The results of the homogeneity of variance test using Levenes' test for equality of variances in Table 3 show that student learning performance has Sig. 0.275 > 0.05. This shows that student learning performance in the four classes has a homogeneous variance so that the ANOVA test can be applied.

Table 3. Levenes' test for equality of variances on student learning performance

Levene Statistic	df1	df2	Sig.
1.304	3	162	.275

Table 4. ANOVA test results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1786.495	3	595.498	6.985	.000
Within Groups	13811.053	162	85.253		
Total	15597.548	165			

Table 4 demonstrates the value of Sig.= 0.000 < 0.05. This indicates that at a significant level of 0.05, there is a significant difference between student learning performances in the four classes. Thus, the first hypothesis, which states that there are differences in student performance between variations in accounting learning instructional design, is supported.

Table 5. Comparison of student performance in each experimental class

(I) Variation of Learning Design	(J) Variation of Learning Design	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
MBAE_Soft	TAE_Hard	8.63473*	202.711	.001	29.079	143.615
	MBAE_Hard	249.187	202.711	.680	-32.349	82.187
	TAE_Soft	5.87805*	203.929	.043	.1168	116.393
MBAE_Hard	TAE_Hard	6.14286*	201.487	.028	.4506	118.351
	TAE_Soft	338.618	202.711	.428	-23.406	91.130
	MBAE_Soft	-249.187	202.711	.680	-82.187	32.349
TAE_Soft	TAE_Hard	275.668	202.711	.605	-29.701	84.835
	MBAE_Hard	-338.618	202.711	.428	-91.130	23.406
	MBAE_Soft	-5.87805*	203.929	.043	-116.393	-.1168
TAE_Hard	MBAE_Hard	-6.14286*	201.487	.028	-118.351	-.4506
	TAE_Soft	-275.668	202.711	.605	-84.835	29.701
	MBAE_Soft	-8.63473*	202.711	.001	-143.615	-29.079

Note: *. The mean difference is significant at the 0.05 level

To discover which instructional design makes a significant contribution, a post hoc test analysis was conducted to test hypothesis 2 and hypothesis 3. The post hoc test analysis using the Scheffe method in Table 5 indicates that there are differences in student learning performance in MBAE classes using soft scaffolding compared to student learning performance in the TAE class using hard scaffolding. It is indicated by the value of Sig. of 0.001 < 0.05 with a mean difference of 8.63473. This represents that student learning performance in the MBAE class using soft scaffolding is better than the student learning performance in the TAE class using hard scaffolding. Thus, the second hypothesis is fully supported. Furthermore, there are differences in student learning performance in the MBAE class using soft scaffolding compared to student learning performance in the TAE class using soft scaffolding. It is indicated by the value of Sig. of 0.043 < 0.05 with a mean difference of 5.63473, which represents that student learning performance in the MBAE class using soft scaffolding is better than student learning performance in the TAE class using soft scaffolding. Thus, the results of the analysis also fully support hypothesis 2.

Moreover, Table 5 demonstrates that there are differences in student learning performance in the MBAE class using hard scaffolding compared to the student learning performance in the TAE class using hard scaffolding. This is indicated by the value of Sig. of 0.028 < 0.05 with a mean difference of 6.14286, which represents that student learning performance in the MBAE class using soft scaffolding is better than student learning performance in the TAE class using soft scaffolding. This finding indicates that hypothesis 2 is supported. Furthermore, it is known that the comparison between student learning performance in the MBAE class using hard scaffolding and student learning performance in the TAE class using soft scaffolding shows the value of Sig. of 0.428 > 0.001 with a mean difference of 3.38618. Although the value of Sig. > 0.001, it is known that the average student learning performance in the MBAE class using the hard scaffolding is higher than the student learning performance in the TAE class using the soft scaffolding. Thus, hypothesis 2 is also supported.

The next analysis is in terms of the use of soft scaffolding and hard scaffolding in learning, which is expected to improve student learning performance. The tests were carried out to find out which scaffolding is the most effective compared to other scaffoldings. Table 5 demonstrates that there is no difference in student learning performance in the MBAE class using soft scaffolding compared to student learning performance in the MBAE class using hard scaffolding. This is indicated by the value of Sig. of 0.680 > 0.05. Moreover, there is no difference in student learning performance in the TAE class using soft scaffolding compared to student learning performance in the TAE class using hard scaffolding. It is indicated by the value of Sig. of 0.605 > 0.05. Thus, hypothesis 3 is not supported. This represents that the use of scaffolding in the form of collaborative learning and scaffolding in the form of student worksheets on MBAE and TAE

materials cannot be compared in terms of effectiveness in improving student learning performance.

Furthermore, to discover which instructional design innovation is the most effective compared to other instructional designs, it can be seen from the value of the largest mean difference. The findings of the multiple comparison test in table 5 demonstrate that student learning performance in the MBAE class with soft scaffolding ranks first, while student learning performance in the TAE class with hard scaffolding is the lowest compared to student learning performance in the other three classes. Thus, the instructional design of MBAE learning with soft scaffolding can be a solution to overcome cognitive load and to improve student learning performance.

Discussion

The findings in this research have coined empirical evidence that variations in instructional design in accounting learning affect differences in student learning performance. This finding is in line with the results of prior research, which stated that variations in instructional design represented in learning methods affect student performance (Shaftel & Shaftel, 2005; Sargent et al., 2011; Phillips & Heiser, 2011; Brink, 2013). These findings suggest that lecturers should consider appropriate instructional design so that student learning performance can be optimized. Inappropriateness in choosing a learning design can lead to stagnation and even a decrease in student learning performance.

This research expands the scope of CLT and ST research, especially in the accounting field. CLT identifies novice learners' cognitive barriers when learning complex tasks and provides learning methods to improve their learning performance (Sweller, 1988). The main focus of CLT is to reduce ICL and ECL levels so that students' working memory does not overload quickly. The learning materials in this research were designed by considering CLT by reducing the cognitive load of students. This was done by shifting the cost element to the left side of the accounting equation by removing the negative symbol and incorporating the cost element into the expense section. The findings in this research indicate that student learning performance in the MBAE class is better than the student learning performance in the TAE class. In other words, it can be concluded that MBAE innovation is in line with CLT principles. In addition, it can be stated that the adaptation of mathematics to study accounting material is a representation of the principle of borrowing and reorganizing (Sweller, 2011, 2020). Therefore, it is clinically proven that mathematical rationality makes accounting equations simpler to explain why elements of assets and expenses should receive the same treatment in relation to debit and credit provisions, which are based entirely on mathematical logic (Warsono, 2015). Thus, it is highly recommended that mathematics-based accounting learning design be adopted in accounting learning.

In contrast to CLT, the use of scaffolding in accounting equation learning did not indicate any significant difference in student learning performance. However, when viewed based on the difference in mean scores, student learning performance in classes using soft scaffolding is clinically proven to be higher than student learning performance using hard scaffolding. This indicates that the opportunity to collaborate is very valuable for students (Chen & Law, 2016) because when they encounter difficulties, they can collaborate and receive explanations from other students or lecturers to overcome these problems (Johnson, Johnson, Stanne, & Garibaldi, 1990; Slavin, 1996). Therefore, a solution to the problem can be discovered (Teasley, 1995).

The absence of differences in student performance on the two scaffoldings also proves that the two types of scaffolding are equally needed by students. Soft scaffolding can be effective under some conditions, but not in others. Likewise with hard scaffolding. Tabrizi et al. (2019) postulated that soft scaffolding has a positive effect on students' reading comprehension ability. Soft scaffolding is effective in asymmetrical conditions; however, it is not effective in symmetrical conditions. In contrast, hard scaffolding is effective in both symmetrical and asymmetrical conditions (Tabrizi et al., 2019). These two types of scaffolding are needed by students in achieving success in learning (Saye & Brush, 2002). Thus, the two scaffoldings can complement each other in several conditions related to the demographic aspects of students.

However, this research did not consider this aspect, so it becomes an opportunity for further research.

This research strengthens experimental evidence that an accounting instructional design that considers CLT is clinically proven to improve student learning performance. In other words, instructional design by borrowing and organizing mathematics can effectively reduce students' cognitive load. Therefore, this research implies that mathematics-based accounting instructional design is feasible to be adopted in distance learning.

CONCLUSION

This research aims to investigate the application of accounting instructional design in improving student learning performance in distance learning. In line with this objective, the results of the research demonstrate that there is a difference in the mean scores on student learning performance between those using the MBAE design and the TAE design. Post hoc testing supports MBAE design, with collaborative learning resulting in better student learning performance than other instructional designs. Thus, this research sharpens the explanation and validation of CLT and ST in the context of learning accounting in distance learning. This instructional design innovation for accounting learning is carried out by moving the cost element to the left side of the accounting equation and eliminating negative symbols in the equation to reduce students' cognitive load. Therefore, it is easier for students to understand the mechanism of debit and credit and how to analyze transactions. Hence, the MBAE design is highly recommended to be adopted by lecturers, curriculum staff, and policymakers in universities to improve student learning performance.

In addition to making a positive contribution in the realm of accounting learning, this research also has several limitations. First, the research subjects involved in this research came from a homogeneous group of students. This has the potential to reduce the generalizability of the research results, as this research does not prioritize population generalization. Additionally, his research focuses more on proving a causal relationship between various variations of learning approaches and the use of scaffolding on student learning performance. However, further research is expected to pay more attention to demographic variables that have the potential to explain research results. So, it is expected that further research can expand the sample with research subjects from students outside the accounting study program or even high school/vocational students. Second, the objective of this research is still limited to reducing ICL and ECL without paying attention to optimizing GCL so that student involvement in learning can increase. This also opens further research opportunities to examine the use of learning methods that can increase student involvement in learning, such as gamification (Moncada & Moncada, 2014). Third, the soft scaffolding is only provided for facilitating discussion and chatting activities in the LMS. Even though collaboration can be carried out well, the absence of verbal and visual communication makes the scaffolding less effective. As a result, it is highly recommended for further research to use online meeting applications such as Zoom, Google Meet, or Webex to support collaborative learning. Finally, there are drawbacks to the hard scaffolding that is utilized in the form of student worksheets. For this reason, more research is advised to examine the efficacy of scaffolding in enhancing student learning performance using alternative forms of hard scaffolding. Furthermore, it is feasible to do additional research to compare the learning outcomes of students who use two different kinds of scaffolding simultaneously and those who do not.

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