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Empirical Evidence on the Relative Efficiency of Worked Examples versus Problem-Solving Exercises in Accounting Principles Instruction

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ABSTRACT: This study tested the relative efficiency of teaching material presented in the worked examples form of instruction compared to problem-solving exercises. Tests were also conducted to determine if subjects' prior exposure to accounting instruction affects results. Teaching materials were developed in Computer-Based Learning (CBL) format for one introductory accounting topic completed by 93 subjects. Response measures included test performance, learning effort, and instructional efficiency consisting of the combined measured performance and learning effort. The study results indicate that worked examples were more efficient than problem-solving exercises for students with no prior knowledge of accounting, while being equally efficient for those with prior knowledge.

INTRODUCTION

This study compares two approaches to learning a highly structured topic in introductory accounting via the use of Computer-Based Learning (CBL) materials.[1] The CBL material was designed in two formats: worked examples and problem-solving exercises.[2] Worked examples and problem-solving approaches were selected as these instruction methods have shown to be potentially most powerful in the cognitive load theory research for highly structured areas of learning such as mathematics, physics, and engineering (Sweller et al. 1998; Renkl and Atkinson 2003); however, debate also exists between the benefits of worked examples and problem solving (Sweller 1999; Tuovinen and Sweller 1999; Sweller et al. 1998; Kalyuga, Chandler, and Sweller (2001); Kalyuga, Chandler, Tuovinen, and Sweller 2001). Both CBL formats included instructions with detailed and instant feedback to guide and assist learning (Kulhavy and Stock 1989; Mason and Bruning 1999).

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[1] The CBL in this study relates to the use of CBL in one highly structured topic area of accounting, and not to an entire course of accounting. The topic area in this instance was period-end adjustments (or balance-day adjustments as they are known in the Australia). The conclusions of this study are therefore based on CBL for only this one topic area and are only intended to be generalized, at best, to other highly structured accounting tasks.

[2] Current forms of CBL accounting material are not produced in different versions (see Nicholson 1997).

The study extends and enhances the extant accounting education literature by comparing the CBL material in the problem-solving and worked examples formats and examining these instructional techniques using the learning efficiency paradigm developed in the cognitive load theory literature (Sweller et al. 1998).[3] The cognitive load theory paradigm reports that instructional efficiency is best estimated by a measure that combines performance and effort (Paas and van Merriënboer 1993) and much recent research in a number of disciplines has utilized this emerging paradigm (Paas et al. 2003).

Prior research linking cognitive psychology and accounting has noted the importance of effort measures when analyzing how students learn, and the need to include effort with learning (see Libby and Tan 1994; Cloyd 1997; Rose and Wolfe 2000; Bryant and Hunton 2000). For example in modeling the determinate of audit expertise, Libby and Tan (1994, 715) wrote, "particularly important omissions include the effect of effort ... on learning. Effort also determines the degree to which people acquire knowledge." In the Rose and Wolfe (2000) study, a limitation expressed by the authors was that effort was captured using time (duration) expended on the practical problems. Bryant and Hunton (2000) further stated that if educators are to make judicious choices regarding the specific educational technology to employ in a given circumstance, it is important that they understand how certain learner attributes such as prior knowledge and mental effort, suggested in cognitive theory, affect learners.

Mental effort is considered as the total amount of controlled cognitive processing that a subject is engaged in (Schneider and Shiffrin 1977; Paas and van Merriënboer 1993) and is best measured in the cognitive load theory paradigm directly by asking the learner to introspect and quantify the learning effort levels applied to learning tasks (Paas et al. 2003). The intensity of effort being expended by learners is the essential measure of a reliable estimate of cognitive load. Therefore, a key factor in this study is the reporting of an effective effort measure for accounting (Libby and Tan 1994; Rose and Wolfe 2000; Bryant and Hunton 2000) in the context of cognitive load theory. This study obtains measures of effort and performance from students with both prior and no prior accounting experience. The paper then uses the principles established in the cognitive load theory to compute, evaluate, and then compare the efficiency of both the problem-solving and worked examples instructional approaches.

In the remaining sections of the paper, the literature is reviewed and the research hypotheses developed in relation to cognitive load theory, performance, instructional efficiency, and the affect of prior knowledge on worked examples and problem-solving approaches. The methodology of the study is then outlined and the results presented and analyzed in terms of a student's prior accounting knowledge. Finally, the discussion summarizes the findings and outlines the learning implications of this study.

HYPOTHESIS DEVELOPMENT

Cognitive Load Theory

According to Sweller et al. (1998) cognitive load theory is based on the assumption that learners have limited processing capacity and the proper allocation of cognitive resources is critical to learning. The main purpose of cognitive load theory is to provide a framework for instructional design and to facilitate effective schema construction. For learning to be effective, learners must devote mental resources to activities directly related to schema construction and automation, other-

[3] This study does not attempt to analyze the benefit of CBL materials, or their role and contribution to accounting education. For a review of CBL materials in accounting education see, for example, McKeown (1976), Groomer (1981), Jensen and Sandlin (1992), Sangster (1992), McInnes et al. (1995), Rebele et al. (1998), Boyce (1999), McCourt Larres and Radcliffe (2000), Halabi et al. (2000), Bryant and Hunton (2000), and Lane and Porch (2002).

wise learning might be inhibited (Kalyuga, Chandler, Tuovinen, and Sweller 2001). Within the cognitive load theory literature, there are a number of instructional methods that can be used to assist with schema construction, two being problem-solving exercises and worked examples.

In the problem-solving process students are presented with a question and asked to work out a solution. In this situation, students act as independent learners and solve problems by reading the instructions, with little or no teacher guidance. Sweller (1988) noted that problem solving is efficient as this process enables students to find their own solutions. Worked examples are where appropriate steps to a question and the solution are presented before a student completes similar problems (Kalyuga, Chandler, and Sweller 2001). Representative problems are solved by either reading through the fully worked solutions or watching a tutor demonstrate the procedure. Past research has shown that worked examples are an effective form of guided practice particularly for difficult content (Sweller 1999; Tuovinen and Sweller 1999; Sweller et al. 1998; Sweller and Cooper 1985; Zhu and Simon 1987; Rieber and Parmley 1995).

The dominant view in the cognitive load theory literature on the relative merits of worked examples versus problem solving was summarized by Kalyuga, Chandler, and Sweller (2001, 7), who stated that the results of prior studies "demonstrated that a cognitive structure resulting from instruction emphasizing practice with partly or completely worked-out problems is a more efficient knowledge base for solving problems than one resulting from instruction based on conventional problem solving." Their general conclusion was that the literature supported the view that worked examples potentially lead to a reduction of cognitive load (effort) and increased facilitation of learning when compared to conventional problem solving.

Applying this theory to accounting materials leads to the first two hypotheses (expressed in alternative form) tested in this study, being:

H1a: Students completing worked examples operate with lower levels of cognitive load (effort) than students completing the problem-solving form of instruction.

H1b: Students completing worked examples perform better than students completing the problem-solving form of instruction.

Accounting, Worked Examples, and Prior Knowledge

A number of studies in accounting education have noted the importance of worked examples and prior knowledge in schema creation. In terms of worked examples, Bonner and Walker (1994) reported that worked examples may be used as a potential substitute for understanding rules. Wynder and Luckett (1999) also noted that worked examples are of particular interest to novice accountants as they constitute an important source for understanding and performing various tasks without the need to use detailed verbal or written instructions. In a study investigating the location of explanations in a computerized decision aid for taxation, Rose and Wolfe (2000) found that the acquisition of knowledge is enhanced when explanations are available as worked examples.

In relation to prior knowledge, Bryant and Hunton (2000) reported that prior subject knowledge was an important learner attribute. Learning occurs when individuals are able to imbed new information into existing schemas and create meaningful relationships among these schemas. In terms of prior accounting experience, it has been shown that prior studies in accounting have an influence on accounting education at university (Farley and Ramsay 1988; Keef and Hooper 1991; Krausz et al. 1999), and audit performance (Bonner and Lewis 1990; Libby and Tan 1994). This leads to the following two hypotheses (expressed in alternative form):

H2a: Students with prior accounting knowledge[4] operate with lower levels of cognitive load (effort) than those with no prior accounting knowledge.

H2b: Students with prior accounting knowledge perform better than those with no prior accounting knowledge.

In the context of cognitive load theory, a result that combines the effect of prior discipline knowledge with the relative benefits of worked examples was obtained by Tuovinen and Sweller (1999), who stated that worked examples assist students' learning more than problem solving, particularly for students with no prior experience (see also, Paas et al. 2003; Renkl and Atkinson 2003). For students with experience in the subject area, the advantage of worked examples over problem solving was often reduced (see also, Kalyuga, Chandler, and Sweller 2001). This leads to the following two hypotheses (expressed in the alternative form) about the interaction between prior experience and instruction format:

H3a: Students with prior accounting knowledge will exhibit smaller differences in cognitive load (effort) for worked examples versus problem-solving exercises than will students with no prior accounting knowledge.

H3b: Students with prior accounting knowledge will exhibit smaller performance gains from completing worked examples instead of problem-solving exercises than do students with no prior accounting knowledge.

Instructional Efficiency

Determining cognitive load is difficult for researchers, because within the limits of their cognitive capacities, students can compensate for an increase in task complexity by investing more effort, thereby maintaining performance. Paas et al. (2003) stated that it is quite feasible for two people to attain the same performance levels by one working laboriously through a very effortful process to arrive at the correct answer, while the other reaches the same answer with a minimum of effort. Sweller et al. (1998, 266) wrote, "Based on these arguments, a combination of the intensity of mental effort being expended by learners and the level of performance attained by learners, constitutes the best estimator of instructional efficiency."

Sweller et al. (1998) outline a number of techniques that have been used to quantify cognitive load. These measures can be classified into three categories: subjective, physiological, and task-and performance-based. For the purposes of this study, subjective ratings were used. Subjective measures assess cognitive load (effort) by rating scales and are based on the assumption that learners are able to introspect on their cognitive processes and report on mental load accurately (Gopher and Braune 1984). Rating scales have been used extensively in past cognitive load studies (Paas et al. 2003), and independent research by Gimino (2002) validated the use of rating scales to capture effort in the cognitive load theory context, even though the number of points on the scales has differed.

The technique widely used in the cognitive load theory literature to measure instructional efficiency is based on the conversion of self-reported mental effort data and performance measures to z-scores (standardizing those measures across conditions). The z-scores are then combined in the following formula:

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[4] The definition of "prior accounting knowledge" adopted in this experiment is that students should have completed and passed an accounting subject during the prior year, being at a high school (or equivalent level) before entering this university.

$$E = (P - R) / \sqrt{2} \quad (1)$$

where:

E = instructional condition efficiency;
P = performance z-score; and
R = effort rating scale z-score.

Using this formula, if performance and effort rating z-scores are equal ($P = R$), then efficiency is 0 ($E = 0$); if the performance z-score is higher than the effort rating z-score ($P > R$), then instructional efficiency is positive ($E > 0$); and finally, if the performance z-score is lower than the effort rating z-score ($P < R$), then instructional efficiency is negative ($E < 0$). Using the cognitive load theory approach to measure efficiency, and combining this with the directional hypotheses already postulated with regard to effort and performance, the following three hypotheses (expressed in the alternative form) supplement those already developed:

H4a: Students completing worked examples operate with higher levels of instructional efficiency than students completing problem-solving exercises.

H4b: Students with prior accounting knowledge operate with higher levels of instructional efficiency than those with no prior accounting knowledge.

H4c: Students with prior accounting knowledge exhibit smaller differences in levels of instructional efficiency when completing worked examples versus problem-solving exercises than do students with no prior accounting knowledge.

METHODOLOGY

All the hypotheses are tested by two-way ANOVAs at the 5 percent significance level (this level being chosen to give an appropriate balance between the risks of Type I and Type II errors given the sample sizes). For the effect size, as defined by Cohen (1988), the partial eta squared (where available) and t-test (again at the 5 percent significance level) are reported to assist in judging the practical significance of the results.

Participants

Participants in the study were 93 on-campus students enrolled in Introductory Accounting A at Monash University, Australia. Demographic information for this sample showed that the mean age was 20.03 years; 45 percent (n = 42) were male and 55 percent (n = 51) were female, and 52 percent (n = 48) had prior knowledge of accounting, while 48 percent (n = 45) had no prior knowledge. The subjects were drawn from two separate groups of students (group 1 consisting of 42 students and group 2 consisting of 51 students) who were studying the same subject. The demographic characteristics of the students were similar and all aspects of the procedure for administering the study were exactly the same, including the person administering the study.[5] Because of the diverse academic admission pathways of the students, there was no common measure of academic ability at time of admission. Hence, academic ability could not be included as an explanatory variable, but rather was controlled for by use of randomized allocation to groups.

[5] Independent sample t-tests were conducted to determine if there were any differences in the two groups of students used. There were no significant differences in terms of age, gender, prior knowledge of accounting, and other dependant variables such as student effort during learning, marks obtained in the test, and learning efficiency.

Instruments

Three instruments were developed. The first (a questionnaire) sought demographic information on the students, including whether they had previously studied accounting and their computer experiences. The second was an evaluation of the effort expended when completing the instructional material. In the present study, the subjective effort measures used to estimate student effort were based on a Likert scale where 1 = very low effort, 2 = low effort, 3 = middle effort, 4 = high effort, and 5 = very high effort. The final instrument was a diagnostic test that examined understanding of the topic and tutorial work.

Procedure

The study was conducted in three stages, over three weeks, with one stage completed each week. In the first stage, all students were given a lecture on the topic.[6] At the beginning of this lecture the students were told that the tutorial work to follow would involve completing a CBL exercise, and that student participation was voluntary. The students who elected to participate then completed the first instrument (the demographic questionnaire) before the lecture had begun. After the lecture, all students were asked not to prepare any work for the upcoming tutorial, as the work would be provided.

During the second stage, the students were taken to a computer lab, given a CD-ROM (which contained a particular week's tutorial work adapted to CBL format), an effort evaluation sheet, and then instructed to work through the tutorial at their own pace. The participating students were randomly assigned to either the CBL problem-solving exercise or the CBL worked example material. The questions were the same for both CBL formats. The students worked in isolation in the computer lab. The administrator instructed that there be no collaboration between students when completing the CBL, though students could ask questions of the tutor (tutor assistance was available in the lab throughout the session). Before beginning the computer exercise, the instructor physically checked that the version of CBL the students were completing coincided with the evaluation of effort instrument. When the students completed the CBL exercise, they returned the CD-ROM and the evaluation of effort to the administrator and left the room. There were no teacher instructions provided, except that students should work on the material at their own pace. Students read the CBL material and then completed the exercises and the effort evaluation sheet.

The CBL tutorial material presented students with a trial balance and eight period-end adjustments. For the problem-solving exercises, students had to complete all eight period-end adjustments and then post new balances into the trial balance. At each stage (i.e., first, completing the period-end adjustment, and second, updating the trial balance) the students were given immediate feedback and were not able to proceed until the correct answer was received. After completing the period-end adjustment, the students introspected the amount of mental effort expended to complete this task. Then after updating the trial balance with the new account balances, the students again recorded their effort. The total responses of mental effort from the 16 stages (eight from the period-end adjustments and eight from the related postings into the trial balance) were combined and averaged.

For the worked examples exercise, students were provided with solutions to the first three period-end adjustments and their related trial balance postings. The students then had to complete the remaining five period-end adjustments. The students introspected the amount of mental effort expended to understand the first three period-end adjustments and then the updated trial balance. The students then recorded their effort to complete the remaining five adjustments and the updating of the trial balance. The total responses of mental effort from the 16 stages (eight from the period-end adjustments and eight from the related postings into the trial balance) were again combined and averaged.

[6] This lecture was given to both groups by the same instructor.

The third and final stage (the third week) involved a diagnostic test on the tutorial topic. The test was administered during the lecture class that followed the tutorial. The diagnostic test lasted for about 30 minutes. The test was collected after the lecture, graded, and then returned in time for the next lecture.

RESULTS

The results and analysis are based on 93 students.[7] These 93 students had completed all aspects of the study, i.e., they had attended the lecture, had completed the CBL tutorial work, had sat the diagnostic test, and had not done any extra studying for the test.[8]

Cognitive Load

The mean levels of cognitive load (effort) required to carry out the exercises across the two types of instruction and for the differing levels of prior accounting knowledge are shown in Table 1.

The data summarized in Table 1 is analyzed using a two-way ANOVA and the results for the instruction main effect show that the null form of H1a can be rejected at the 5 percent significance level, $F(1,89) = 4.66$, $p = 0.017$. Hence, it can be concluded that the cognitive load (effort) of students completing the worked examples is significantly lower than for students completing the problem-solving exercises. The partial eta squared indicates that using the best estimate available, instruction type explains 5.0 percent of the variation in effort. This is consistent with a small to moderate effect size of 0.343.

The F result for the prior accounting study main effect, shows that the null form of H2a can also be rejected at the 5 percent significance level, $F(1,89) = 70.2$, $p < 0.001$. Hence, it can be concluded that the cognitive load (effort) of students with prior accounting knowledge was significantly lower than those with no prior accounting knowledge. The partial eta squared indicates that using the best estimate available differences in prior accounting knowledge explain 44.1 percent of the variation in effort. This is consistent with a large effect size of 1.702.

The F result for the interaction effect indicates that the null form of H3a can be rejected at the 5 percent level, $F(1,89) = 3.72$, $p = 0.029$. The partial eta squared indicates that the interaction effects explain 4.0 percent of the variation in effort, which is consistent with a moderate-to-large effect size

TABLE 1
Cognitive Load (Effort) Mean Scores and Standard Deviations

	Accounting Knowledge								
	Prior Knowledge			No Prior Knowledge			Total		
Type of Instruction	Mean	SD	n	Mean	SD	n	Mean	SD	n
Problem Solving	3.27	0.13	22	3.63	0.17	22	3.45	0.24	44
Worked Examples	3.27	0.17	26	3.50	0.18	23	3.37	0.21	49
Total	3.27	0.15	48	3.56	0.19	45	3.41	0.22	93

Lower mean scores indicate the lower effort. Effort was based on a Likert scale of 1 = very low effort, 2 = low effort, 3 = middle effort, 4 = high effort, and 5 = very high effort.

[7] While some attrition occurred (nine students in the first group, and 14 in the second who had completed the initial questionnaire did not go on to complete either the tutorial work or the test, representing a total drop-out rate of 18 percent), this was primarily because students were absent on the days that the stages of the study were undertaken.

[8] On the diagnostic test a question was asked whether students had studied for the test. If students had studied, then they were eliminated from the analysis.

of 0.758. Cell-to-cell comparisons (t-tests) show that the difference in the cognitive load (effort) of students with a prior knowledge of accounting completing the problem-solving or worked examples is not significant ($p = 0.982$); while for students with no prior knowledge of accounting, the difference in instruction type is significant ($p = 0.016$, effect size = 0.759) with effort being lower for worked examples compared to problem-solving exercises. The difference in the effort means is illustrated in Figure 1.

Performance

The mean levels of performance on the diagnostic test across the two instruction types and for the differing levels of prior accounting knowledge are shown in Table 2.

The data summarized in Table 2 is analyzed using a two-way ANOVA and the results show that for the instruction main effect, the null form of H1b cannot be rejected at the 5 percent significance level, $F(1,89) = 0.499$, $p = 0.291$. Thus, it can be concluded that students completing the worked examples perform no better than students completing the problem-solving form of instruction.

The F result for the prior accounting study main effect and the results from Table 2 show that the null form of H2b can be rejected at the 5 percent significance level, $F(1,89) = 33.73$, $p < 0.001$. Hence, it can be concluded that the performance of students with prior accounting knowledge was significantly higher than those with no prior accounting knowledge. The partial eta squared indicates

FIGURE 1
Mean Cognitive Load (Effort) by CBL Type and Level of Prior Accounting Knowledge

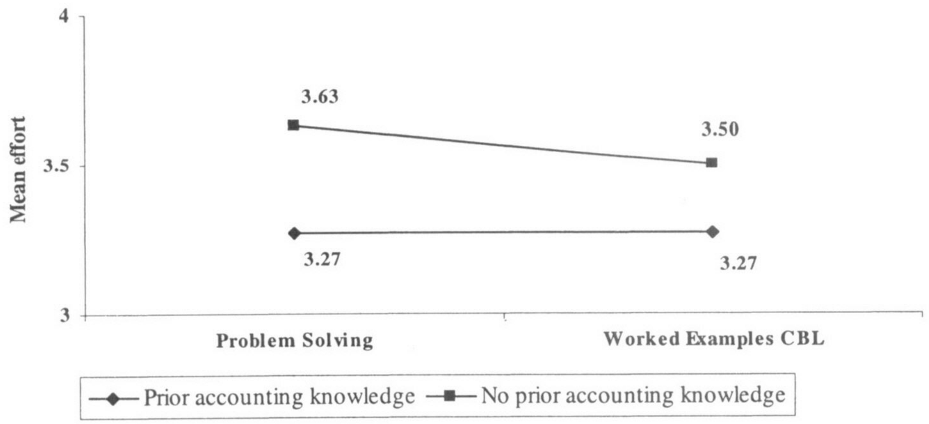


TABLE 2
Diagnostic Test (Performance) Mean Scores and Standard Deviations

	Accounting Knowledge								
	Prior Knowledge			No Prior Knowledge			Total		
Type of Instruction	Mean	SD	n	Mean	SD	n	Mean	SD	n
Problem Solving	10.45	2.37	22	7.59	1.79	22	9.02	2.53	44
Worked Examples	10.17	1.96	26	8.32	1.50	23	9.30	1.98	49
Total	10.30	2.14	48	7.96	1.67	45	9.17	2.25	93

The maximum grade on the diagnostic test was 15.

that using the best estimate available differences in prior accounting knowledge explain 27.5 percent of the variation in performance. This is consistent with a large effect size of 2.335.

For the interaction effect, although the cell means appear to exhibit interaction, test results are not statistically significant $F(1,89) = 1.60$, $p = 0.105$. Thus, the null form of H3b cannot be rejected at the 5 percent level.

Instructional Efficiency

The mean levels of instructional efficiency (as measured by Equation (1)) across the two instructional types and for the differing levels of prior accounting knowledge are shown in Table 3.

Table 3 shows that the more efficient means of instruction (higher performance for less invested effort) for students with a prior knowledge of accounting were the problem-solving exercises. For students with no prior knowledge of accounting, the more efficient instruction was the worked examples exercises.

The data summarized in Table 3 is analyzed using a two-way ANOVA, and the results show that for the type of instruction main effect the null form of H4a can be rejected at the 5 percent significance level, $F(1,89) = 4.61$, $p = 0.017$. Hence, it can be concluded that the instructional efficiency of students completing the worked examples is significantly higher than for students completing the problem-solving exercises. The partial eta squared indicates that instruction type explains 4.9 percent of the variation in instructional efficiency. This is consistent with a small effect size of 0.291.

The F result for the prior accounting study main effect and the results from Table 3 show that the null form of H4b can be rejected at the 5 percent significance level, $F(1,89) = 118.72$, $p < 0.001$. Hence, it can be concluded that the instructional efficiency of students with prior accounting knowledge was significantly higher than those with no prior accounting knowledge. The partial eta squared indicates that differences in prior accounting knowledge explain 57.2 percent of the variation in instructional efficiency. This is consistent with a large effect size of 2.187.

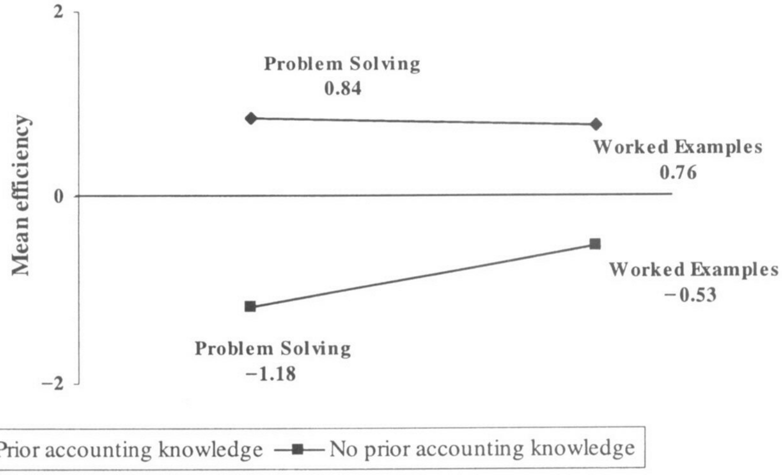
The F result for the interaction effect indicates that the null form of H4c can be rejected at the 5 percent level, $F(1,89) = 6.00$, $p = 0.008$. The partial eta squared indicates that the interaction effects explain 6.3 percent of the variation in instructional efficiency, which is consistent with a moderate-to-large effect size of 0.844. Cell-to-cell comparisons by t-tests show that the difference in the instructional efficiency of students with a prior knowledge of accounting completing either the problem-solving or worked example exercises is not significant ($p = 0.656$); while for students with no prior knowledge of accounting, the difference in instructional efficiency across instructional type is significant ($p = 0.006$, effect size = 0.856), with worked examples being the more efficient. The difference in the instructional efficiency means is illustrated in Figure 2.

TABLE 3
Instructional Efficiency Mean Score and Standard Deviations

	Accounting Knowledge								
	Prior Knowledge			No Prior Knowledge			Total		
Type of Instruction	Mean	SD	n	Mean	SD	n	Mean	SD	n
Problem Solving	0.84	0.70	22	–1.18	0.88	22	–0.17	1.29	44
Worked Examples	0.76	0.65	26	–0.53	0.65	23	0.15	0.92	49
Total	0.79	0.67	48	–0.85	0.83	45	0.00	1.11	93

Mean values are based on Equation (1) where $E = (P - R) / \sqrt{2}$.

FIGURE 2
Mean Instructional Efficiency Measures by CBL Type and Level of Prior Accounting Knowledge



DISCUSSION AND CONCLUSION

This study sought to extend research into CBL and accounting education by determining the most efficient CBL design for a highly structured introductory accounting topic for students with and without a prior knowledge of accounting. The CBL material was developed in two formats: problem-solving exercises and worked examples. Instructional efficiency measures from cognitive load theory were used where both performance and the effort measures were analyzed (Paas and van Merriënboer 1993). Effort is an important determinant of learning, and researchers in accounting have called for this type of cognitive research, particularly in relation to educational technology (Bryant and Hunton 2000).

Based on the present results, the clear implication is that those teaching highly structured topics in introductory accounting should use the worked examples form of CBL, in preference to problem solving for students with no prior accounting knowledge. This is based upon the findings from the instructional efficiency measure in the cognitive load theory paradigm that worked examples are a more efficient learning methodology. The instructional efficiency measure has shown that the greater learning efficiency is a result of a significantly lower level of effort, rather than a higher level of performance from such students.

The present study also found no difference in the instructional efficiency measures for students with prior accounting knowledge completing the problem-solving and worked examples exercises. Prior research by Kalyuga, Chandler, and Sweller (2001) found that for students with experience in the subject area the advantage of worked examples over problem solving was often reduced. Given that the results of this study find no significant difference in learning efficiency between these instructional types, worked examples or problem-solving exercises could be used for students with prior accounting knowledge when teaching highly structured topics in introductory accounting. While Table 2 has shown that in this instance the students undertaking the problem-solving type of instruction attained a slightly higher mean grade than worked examples, this difference was not statistically significant.

This study has also reinforced prior cognitive load studies in other structured tasks such as mathematics, physics, and engineering that have shown that students with no prior experience in the discipline benefit most from the use of worked examples compared to problem solving (Tuovinen and Sweller 1999; Kalyuga, Chandler, and Sweller 2001; Kalyuga, Chandler, Tuovinen, and Sweller 2001). Worked examples are particularly beneficial to students with little established schema in that they offer guidance and enable instructors to demonstrate solution approaches. Worked examples are generally less demanding on one's limited processing capacity, do not require as much cognitive load (effort) as problem-solving exercises, and result in more efficient schema development, as evidenced in this and other cognitive load studies (Tuovinen and Sweller 1999; Kalyuga, Chandler, and Sweller 2001; Kalyuga, Chandler, Tuovinen, and Sweller 2001). Worked examples would appear a particularly good way to begin instruction for students with no prior knowledge.

While this study was based on CBL materials, if the results could be extended to other teaching methods (for example face-to-face, or printed materials), as would appear logical, then the obvious implication is that introductory accounting instructors should make use of worked examples. Worked examples clearly benefit students with no prior knowledge, and are not harmful to students with prior knowledge. Introductory accounting textbooks contain many illustrations of how to complete problems and, if the findings of this study could be extended, instructors should ensure that all students spend time examining worked examples, with an appropriate level of effort. Finally, textbook authors should also keep in mind that worked examples are an important source of learning to all students, and ensure that these continue to appear in introductory texts.

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