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APPLYING AN INSTRUCTIONAL LEARNING EFFICIENCY MODEL TO DETERMINE THE MOST EFFICIENT FEEDBACK FOR TEACHING INTRODUCTORY ACCOUNTING

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ABSTRACT

Feedback is an important part of the learning process; however, prior research is inconclusive regarding the appropriate amount and type of feedback for effective schema. The present study examines the efficiency of rich and basic feedback in computer-based learning (CBL) materials used in an introductory accounting topic based on a student's prior knowledge of accounting. In the context of cognitive load theory, the results showed that the rich feedback was significantly more useful for students with no prior knowledge, and that there was no significant difference between the rich and basic feedback for students with a prior knowledge.

Key Words: Feedback, Computer-Based Learning (CBL), Cognitive Load Theory, Instructional efficiency.

Data Availability: Data are available upon request from the author

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INTRODUCTION

This paper expands the extant instructional feedback literature by applying the well-established cognitive load theory to determine the most efficient feedback from either rich or basic forms. While research into feedback has a long and well documented history,[1] this study is the first to apply cognitive load learning efficiency measures (which combine effort and performance) with feedback types. The paper reports an experiment where efficiency was assessed using computer-based learning (CBL) materials in an introductory accounting topic. In the CBL materials, the students were presented with information, asked questions, and provided with either rich or basic feedback dialogue. The rich feedback contained both verification and elaboration, while the basic feedback simply informed whether answers were "incorrect" or "correct." Verification is a judgement of whether an answer is correct or incorrect, while elaboration is the informational component providing relevant cues to guide the learner toward a correct answer, or expand a correct answer (Kulhavy and Stock, 1989).[2] Smith and Ragan (1993) noted that along with practice, feedback is among the most instructionally robust experiences that teachers and course designers can arrange for learners.

CBL was chosen as the delivery medium to evaluate feedback because computer-based delivery is an effective means of instruction, and the most frequently cited benefit of using CBL is the immediate feedback after a response (see Kulhavy and Wager, 1993; Dempsey et al., 1993; Mason and Bruning, 1999; Cerpa et al., 1996; Morrison et al., 1995; Wager and Wager, 1986; Sales, 1988; Smith and Ragan, 1993). Kulhavy and Wager (1993) noted that each screen of computer material can be thought of as a frame of information, and feedback can be effectively incorporated at each stage and can guide students without face-to-face teacher support (see Butler and Winne, 1995; Kulhavy and Stock, 1989). CBL methodology is effective as the feedback need not be presented until the student has engaged with the educational task. Once the requisite programming is in place, computers can provide immediate feedback to individual students, and this feedback can remain unbiased, accurate, and non-judgemental, irrespective of student characteristics or the nature of the response. CBL allows for the opportunity of a 1:1 ratio between the computer and the individual learner with minimal human interaction, and therefore attention to feedback is likely to be even more important than in traditional classroom instruction (Mason and Bruning, 1999 Fletcher-Flinn and Gravatt, 1995; Morrison et al., 1995; Ross and Morrison, 1993).

In terms of accounting education, the use of CBL material has a long history (see McKeown, 1976) and the role and contribution of CBL remains an issue of interest (McCourt et al., 2000; Halabi et al., 2000; Lane and Porch, 2002). CBL's use in accounting has been an effective way to learn, as the feedback allows students to be engaged both cognitively and physically, and prior research has found that the performances of students using CBL compares favourably when analysed against other teaching methods in post-test experiments (Bryant and Hunton, 2000; Rebele et al., 1998; Groomer, 1981; Rawlingson and Sangster, 1992; Sangster, 1992; Jensen and Sandlin, 1992;

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[1]Mason and Bruning (1999) quote the work of E.L Thorndike (1913) to reinforce this point.

[2]This paper uses the terms rich feedback to describe elaboration feedback, and basic feedback to describe verification feedback.

Togo and McNamee, 1995; McInnes et al., 1995; Rose and Wolfe, 2000; McCourt et al., 2000; Halabi et al., 2000; Lane and Porch, 2000).

In the remaining sections of this paper the literature is reviewed and the research hypotheses developed in relation to feedback types combined with performance, effort and instructional efficiency. The methodology of the study is then outlined and the results presented and analysed in terms of a student's prior accounting knowledge. Finally, the discussion and conclusion summarises the findings and outlines the learning implications of this study, as well as its limitations.

HYPOTHESIS DEVELOPMENT

Performance

In terms of relating performance to feedback types, Mason and Bruning (1999) noted that while several studies have found that providing elaboration feedback did not influence performance levels, a larger body of research shows enhanced learning in response to richer feedback (see Mason and Bruning, 1999 for summaries of these studies, and also Whyte et al., 1995; Pridemore and Klein, 1995; Azevedo and Bernard, 1995; Morrison et al., 1995). Pridemore and Klein (1995) stated that feedback should be designed to give students extra-instructional information to help them relate new information to their current knowledge base. In a meta analysis of 22 studies, Azevedo and Bernard (1995) noted that the most effective feedback conditions were those that were elaborate. Morrison et al. (1995) stated that some prior studies have suggested that elaboration feedback often results in no significant improvement over basic feedback, but requires a considerable development and implementation cost.

Accounting education researchers who have examined the effects of practice combined with various types of feedback on the acquisition of knowledge, have largely restricted this investigation to comparing two forms of feedback: outcome feedback and explanatory feedback (Herz and Schultz, 1999; Bonner and Walker, 1994; Wynder and Luckett, 1999; Hirst and Luckett, 1992). Outcome feedback provides information about the outcome or correct answer (similar to verification as described by Kulhavy and Stock, 1989) and explanatory feedback provides an explanation of why the outcome occurred (similar to elaboration as described by Kulhavy and Stock, 1989). Hirst and Luckett (1992) noted that some feedback is better than none, and also that outcome feedback when supported with explanatory feedback leads to the most improved learning environment. Bonner and Walker (1994) also noted that outcome feedback does not promote procedural knowledge acquisition. In contrast, feedback providing an explanation of the properties of the task or such feedback combined with outcome feedback generally promotes better acquisition of knowledge than outcome feedback alone (Earley, 2001).

With the general theory on the relationships between feedback types and performance being inconclusive, the present study will examine the following hypothesis (expressed in the alternative form):

H1a: Students receiving rich feedback perform better than students receiving basic feedback.

In relation to prior knowledge, previous educational studies have shown that prior accounting knowledge is clearly beneficial in first year university accounting (Farley and Ramsay, 1988; Keef and Hooper, 1991; Krausz et al., 1999). This leads to the following hypothesis (expressed in the alternative form):

> **H1b:** Students with prior accounting knowledge perform better than students with no prior knowledge.

Smith and Ragan (1993) noted that a student's prior knowledge may greatly influence the amount and content of feedback needed. Learners with extensive prior knowledge may require only correct/incorrect (basic) feedback, while learners with limited knowledge may require more extensive information, hints and guidance. Conversely, this extra information might actually inhibit more informed learners (Clariana, 1990). Clark (1993) however found no learning differences between low ability learners (students identified as academically disadvantaged) receiving basic or rich feedback types. Morrison et al. (1995) reported that rich feedback may be more beneficial than no feedback for lower level learning, but the feedback effects become weaker when higher order understanding is the learning goal. The anticipated gains of detailed feedback may be counterbalanced by inappropriate processing and the greater element interactivity in the problems. In relation to inexperienced accountants, Stuart (2004) found that analytical skills are usually improved through teaching methodology that includes training and practice with explanatory feedback rather than no feedback.

This leads to the final hypothesis (expressed in the alternative form) about the interaction between prior knowledge and feedback types:

> **H1c:** Students with a prior knowledge of accounting will exhibit smaller performance gains from receiving rich feedback instead of basic feedback than do students with no prior accounting knowledge.

Cognitive Load / Effort

Cognitive load theory is concerned with the development of instructional methods that efficiently use people's limited cognitive processing capacity to stimulate their ability to acquire and apply new knowledge and skills (Sweller et al., 1998). The optimal investment of cognitive resources for mental processing is termed the germane cognitive load (Sweller et al., 1998).

In the cognitive load paradigm, "effort" refers to the cognitive capacity that is actually allocated to accommodate the demands imposed by a task. As mental effort can reveal important information about cognitive load that is not necessarily reflected in performance measures, a combination of the intensity of mental effort being expended by learners and the level of performance attained by learners constitutes a better estimator of instructional efficiency, i.e. cognitive performance achieved for a given amount of learning effort (Sweller et al., 1998). From the cognitive load perspective, basic feedback may not involve a great deal of mental processing, yet may not add sufficiently to schema development because of its brevity, resulting in a higher effort to understand the work. Rich feedback may add an extra processing load to working memory, and the detailed nature may enhance schema formation with less effort to understand the work. Rich feedback may also lead to a "redundancy effect" (Chandler and Sweller, 1991; Kalyuga et al., 1999;

Mayer et al., 2001; Renkl and Aitkinson, 2003). Applying this theory leads to the following hypothesis (expressed in the alternative form):

> **H2a:** Students receiving rich feedback operate with lower levels of effort than students receiving basic feedback.

Learners with different prior knowledge will exert different amounts of effort to complete tasks, and students can compensate for an increase in task complexity by investing more effort, thereby maintaining performance. Paas et al. (2003) argued that it is 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, whereas the other reaches the same answer with minimum effort. This leads to the following hypothesis (expressed in the alternative form):

> **H2b:** Students with prior accounting knowledge operate with lower levels of effort than students with no prior knowledge.

Even though previous accounting studies have examined effort (Libby and Tan, 1994; Rose and Wolfe, 2000; Bryant and Hunton, 2000; Halabi, 2005), research has not linked effort with alternative feedback forms and prior knowledge. Therefore, this study will test the following hypothesis (expressed in the alternative form) about the interaction between prior knowledge and rich and basic feedback:

> **H2c:** Students with a prior knowledge of accounting will exhibit smaller differences in effort from receiving rich feedback instead of basic feedback than do students with no prior accounting knowledge.

Instructional Efficiency

In the cognitive load theory literature, the instructional efficiency measure developed by Paas and van Merriënboer (1993) involves the conversion of raw mental effort data and raw performance measures to z-scores (standardising those measures across conditions) and combining the z scores using the following equation:

$$E \text{ (instructional condition efficiency)} = (Z \text{ test} - Z \text{ effort}) / \sqrt{2}. \text{ [Formula 1]}$$

"Z test" is the performance z score, and "Z effort" is the effort rating scale z score. Using this formula, if performance and rating z scores are equal, the efficiency is 0 ($E = 0$); if the performance z score is higher than the effort rating z score, the instructional efficiency is positive ($E > 0$); and if the performance z score is lower than the effort rating z score, the instructional efficiency is negative ($E < 0$). These z scores can be displayed and represented in a graph (see Figure 1 - adapted from Paas, et al., 2003). Figure 1 shows a line representing the null efficiency condition ($E = 0$). Shifts to the upper left of the co-ordinate system indicate an increase in efficiency (higher performance in relation to less invested mental effort) and shifts to the lower right indicate a decrease in efficiency (lower performance in relation to more invested mental effort). This approach for the investigation of instructional efficiency of feedback is adopted in this paper.

The present study adopts the cognitive load theory approach to measuring efficiency, and combining this with the hypotheses already postulated with regard to effort and performance, the following hypotheses (expressed in the alternative form) supplement those developed:

H3a: Students receiving rich feedback operate with higher levels of instructional efficiency than students receiving basic feedback.

H3b: Students with prior accounting knowledge operate with higher levels of instructional efficiency than students with no prior accounting knowledge.

H3c: Students with a prior knowledge of accounting will exhibit smaller differences in levels of instructional efficiency from receiving rich feedback instead of basic feedback than do students with no prior accounting knowledge.

METHODOLOGY

Two-way ANOVA's were used to test the hypotheses. The ANOVA's identified the variables simultaneously associated with the dependant variable, and the separate influence of each variable on the dependant variable. Partial eta squared, t-tests and the instructional efficiency graphs are also reported to assist in judging the practical significance of the results.

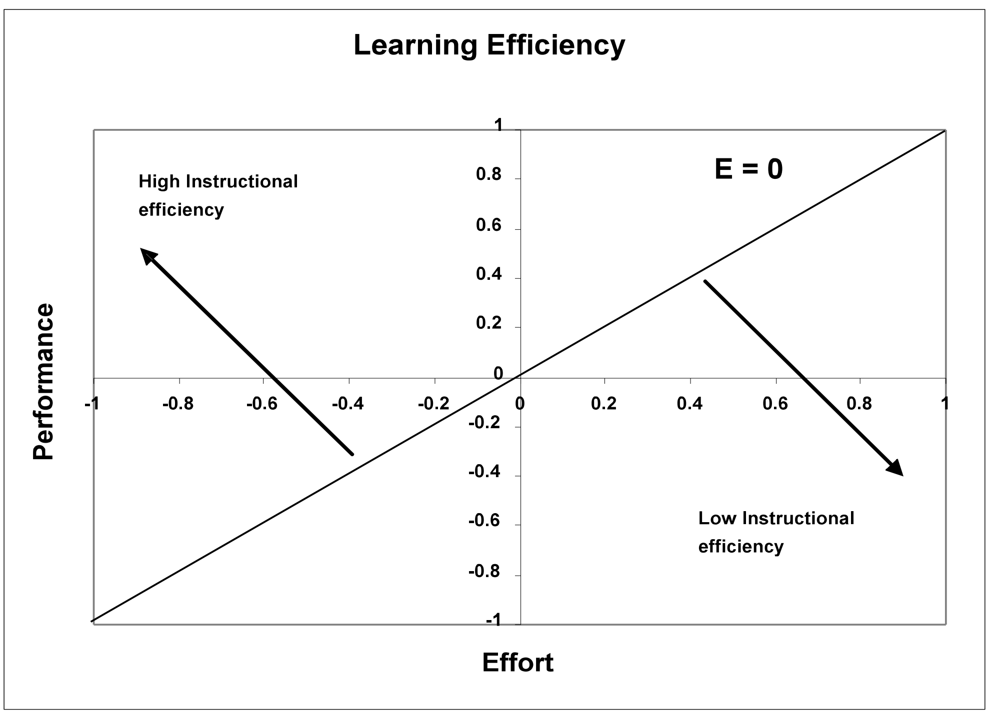

Figure 1: Learning efficiency conditions

Participants

The study was conducted on 86 students enrolled in an introductory accounting course at a large Australian university. Demographic information showed that 42 were male, and 44 female. Ages ranged between 17 and 27 years, with the mean being 19.7 years[3].

Materials

Four instruments were developed. The first was a questionnaire that sought demographic information, including whether students had previously studied accounting. The second instrument was the accounting CBL material (developed using Toolbook). The CBL material and feedback was designed in-house and covered the period-end adjustments topic. The CBL materials and the feedback were developed and refined over a number of semesters. Before being used in the present study, the materials were piloted on a small group of students as a final accuracy check. The third instrument was an evaluation of the effort expended in completing the CBL material. Effort was measured by a five point Likert scale where 1 = very low effort, and 5 = very high effort[4]. The final instrument was a diagnostic test that examined understanding of the topic area.

Procedure

The experiment was conducted over three weeks. The first week involved a lecture given to all students on the topic. At the beginning of the lecture, students were told that the tutorial work to follow would involve completing CBL material, and that participation was voluntary. Students who elected to participate then completed the demographic information (the first instrument) and returned this to the instructor. At the completion of the lecture, students were asked not to prepare any work for that following week's tutorial.

Before the second week the instructor had analysed the responses to the demographic information and divided students into two groups - those that had some prior knowledge of accounting and those with no prior knowledge[5].

During the second week, all students were taken to a computer lab, given the CBL material on CD-ROM, an accompanying effort evaluation sheet, and asked to work through the tutorial at their own pace while completing the evaluation of effort[6].

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[3]Independent samples t-tests were conducted on gender and found no statistical differences in regards to the dependant variables of performance, effort and learning efficiency. Therefore, the remaining analysis is done on the total number.

[4]This study measured effort using Likert scales, similar to most of the other cognitive load studies (Paas et al., 2003). The usefulness of this technique has been widely validated (Gimino, 2002).

[5]Students were allocated to the "prior knowledge of accounting" group if they had studied some accounting during the prior year at an equivalent of their final year of schooling or higher. This boundary was based on previous research which indicate prior accounting studies are clearly beneficial in first year accounting (Farley and Ramsay, 1988; Keef and Hooper, 1991; Krausz et al., 1999).

[6]The students who had a prior knowledge of accounting were provided with CBL materials designed in the problem solving format, while the students with no prior knowledge were provided with CBL materials designed in the worked examples format. Halabi et al. (2005) noted that problem solving exercises are numerically more efficient for

The CBL material contained nine period-end adjustments[7]. The layout for entering the answers was provided and students had to complete the blanks after following the instructions. After each stage, when students entered their answers, the computer responded with either rich or basic feedback. If the answer was incorrect, the rich feedback would provide clues and ask the student to try again, while the basic feedback simply provided an incorrect response with the instruction to try again[8]. If the answer was correct, the richer feedback would confirm the correct response and provide various forms of elaboration and an instruction to go to the next stage. The basic feedback simply provided confirmation of the correct response, and an instruction to go to the next stage (see Table 1 for examples of the rich and basic feedback used). The stage-by-stage filling on a computer screen with guidance and immediate feedback allowed students to process a small number of elements at a time, given limited working memory capacity (see Sweller et al., 1998).

The students in the computer lab worked in isolation, and the administrator instructed there to be no collaboration when completing the work, though students could ask assistance of the staff member. Before beginning the tutorial, the instructor physically checked that the version of feedback the students were receiving (that is, either rich or basic) was noted on the evaluation sheet. As the students completed each adjustment they completed the effort evaluation instrument[9]. When the students completed the CBL tutorial, they handed in the effort evaluation sheets and left the room. There were no teacher instructions provided, except that students should work on the CBL material at their own pace. Table 2 provides a summary of the how students worked through the CBL material and the evaluation of effort.

The third week involved a diagnostic test on the tutorial topic. The diagnostic test lasted for around half an hour and was completed during normal lecture time. The test was collected and marked after the lecture.

RESULTS

The results and analysis are based on 86 students who 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,

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students with prior accounting knowledge and worked examples leading to later problem solving are significantly more efficient for students with no prior accounting knowledge. These findings are also supported in the cognitive load theory literature (Kalyuga et al., 2001a; Renkl and Atkinson, 2003; Tuovinen and Sweller, 1999; Kalyuga et al., 2001b; Paas et al., 2003).

[7]For the problem solving CBL, students had to complete all nine general journal entries and after each adjustment, up-date a new trial balance. For the worked examples CBL, the first three adjustments and their solutions were provided and students were required to analyse these before completing the remaining six general journal entries and up-dating the trial balance (see the worked examples literature in Sweller et al., 1998).

[8]Students were allowed three attempts to get the answer correct. If they were incorrect after their third response, the answer was provided.

[9]Students were asked how much mental effort they put into both completing the general journal entry and then adjusting the trial balance. For the problem solving CBL, this was asked on nine occasions. For the worked examples CBL, students were asked their mental effort in understanding the first three adjustments and related trial balance, and then their effort in completing the next six adjustments. Therefore, effort information was sought on nine occasions.

TABLE 1

Examples of the Comparisons of Rich and Basic Feedback

Situation	Basic Feedback	Rich Feedback
1. Entering a correct account name as a debit entry	Correct (see appendix 1)	Well done. A debit to wages is correct. You should know how this account is classified. Make sure your spelling is correct throughout this exercise (see appendix 2).
2a. Entering an incorrect account name as a credit entry (first attempt)	Incorrect. Please try again.	Incorrect. Please try again. Remember the account you are after is a current liability.
2b. Entering an incorrect account name as a credit entry (second attempt)	Incorrect. You have one more chance to get this correct.	Incorrect. You have one more chance to get this correct. The account you are after related to the wages owing.
2c. Entering an incorrect account name as a credit entry (third attempt)	Incorrect. The answer is Accrued Wages.	No, that is not correct. The correct answer is Accrued Wages, a current liability. The correct entry will be completed for you. Make sure your spelling is correct throughout this exercise.
3. Entering the correct amount to update the trial balance	Correct. Now add the new account and the amount in the yellow shaded area.	Well done. You needed to increase the amount by $500 to recognise some extra wages have been incurred. Now add the new account and the amount in the yellow shaded area.
4. Entering the incorrect amount to update the trial balance (first attempt)	Incorrect. Try again.	Sorry, that is not correct. Please check your original general journal entry, by clicking on the "Previous general Journal entry."
5. Entering the correct amount to update the trial balance	Correct.	Correct. Well done. You need to add $500 to the credit side, but make sure the trial balance still balances
6. Attempting to continue when not all the information is correct	One or more of the entries on this page are missing or incorrect.	One or more of the entries on this page are missing or incorrect. You need to have adjusted wages expense and added a new account name and amount. Please check your inputs with the right mouse button. You will not be able to proceed with the next adjustment, until everything is correct.

TABLE 2

Procedure to Work Through the CBL Material and the Evaluation of Effort

Step	Activity
1	Insert the CD.
2	Click on Exercise.
3	Read the instructions carefully, and examine the beginning trial balance.
4	Complete the general journal entry by placing the correct account name and amount in the spaces provided. Check your entries by clicking with the right mouse.
5	When the general journal is correct, update your trial balance with the correct balances.
6	Complete the effort evaluation by recording the mental effort put into completing both the general journal entry and the adjusted trial balance.
7	Do this for all nine adjustments.
8	When the exercise is complete, hand in the effort evaluation.

and had not done any extra studying for the test. While some attrition occurred (sixteen students who had completed the initial questionnaire did not go on to complete either the tutorial work or the test, representing a drop out rate of 16%), this was primarily because students were absent on the days that the stages of the study were undertaken. Internal validity was not threatened, as a high percentage (84%) of students completed all stages.

Performance

The mean levels of performance on the diagnostic test across the two feedback types and for the differing levels of prior knowledge are shown in Table 3. The data summarised in Table 3 is analysed using a two-way ANOVA. These results are presented in Table 4.

Table 4 shows that for the feedback type main effect, the null form of H1a cannot be rejected at the 5% significance level, $F(1, 82) = 1.133$, $p = 0.290$. Thus, it cannot be concluded that students receiving rich feedback perform better than students receiving basic feedback. The F result for the prior accounting knowledge main effect and the results from Table 3 show that the null form of H1b can be rejected at the 5% significance level $F(1, 82) = 13.237$, $p < 0.001$. Thus, it can be concluded that the performance of students with a prior knowledge was significantly higher than those with no prior knowledge. The partial eta squared indicates that using the best estimate available, differences in prior knowledge account for 13.9% of the variation in performance. Finally, for the interaction effect, test results are not statistically significant $F(1, 82) = 0.431$, $p = 0.513$, and thus the null form of H1c cannot be rejected at the 5% level.

Cognitive Load / Effort

The mean levels of effort required to carry out the exercises across the two feedback types and for the differing levels of prior accounting knowledge are shown in Table 5. The data

TABLE 3

Diagnostic Test (Performance) Mean Scores and Standard Deviations

	Feedback Type								
	Rich Feedback			Basis Feedback			Total		
Accounting Knowledge	Mean	SD	N	Mean	SD	N	Mean	SD	N
Prior Knowledge	11.14	3.38	21	10.85	2.96	20	11	3.15	41
No Prior Knowledge	9	3.82	26	7.76	2.74	19	8.47	3.47	45
Total	9.95	3.75	47	9.34	3.22	39	9.68	3.51	86

Note that the maximum marks available in the diagnostic test were 15

TABLE 4

Two-way ANOVA Examining the Relationship of Performance with Rich and Basic Feedback and Prior Knowledge of Accounting

Tests of Between-Subjects Effects : Dependent Variable: Mark in Diagnostic Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	154.151[a]	3	51.384	4.693	0	0.147
Intercept	7959.363	1	7959.36	726.959	0	0.899
Rich / Basic Feedback	12.4	1	12.4	1.133	0.29	0.014
Prior Knowledge	144.928	1	144.928	13.237	0	0.139
Rich / Basic * Prior Knowledge	4.722	1	4.722	0.431	0.51	0.005
Error	897.806	82	10.949			
Total	9110.75	86				
Corrected Total	1051.956	85				

[a] R Squared = .147 (Adjusted R Squared = .115)

summarised in Table 5 is analysed using a two-way ANOVA and the results are presented in Table 6.

Table 6 shows that for the feedback type main effect, the null form of H2a can be rejected at the 5% significance level, $F(1, 82) = 9.360$, $p = 0.003$. Thus, it can be concluded that the effort of students receiving rich feedback is significantly lower than students receiving basic feedback. The partial eta squared indicates that using the best estimate available, feedback type explains 10.2% of the variation in effort.

The F result for the prior accounting knowledge main effect, and the results from Table 5 show that the null form of H2b can also be rejected at the 5% significance level $F(1, 82) = 33.694$,

$p < 0.001$. Thus, it can be concluded that the effort of students with a prior knowledge was significantly higher than those with no prior knowledge. The partial eta squared indicates that using the best estimate available, differences in prior knowledge account for 29.1% of the variation in effort.

TABLE 5

Effort Mean Scores and Standard Deviations

	Feedback Type								
	Rich Feedback			Basis Feedback			Total		
Accounting Knowledge (and CBL)	Mean	SD	N	Mean	SD	N	Mean	SD	N
Prior Knowledge (Problem Solving CBL)	3.27	0.12	21	3.32	0.1	20	3.29	0.1	41
No Prior Knowledge (Worked Examples CBL)	3.39	0.15	26	3.52	0.13	19	3.44	0.15	45
Total	3.33	0.15	47	3.41	0.15	39	3.37	0.15	86

Note that the 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.

TABLE 6

Two-way ANOVA Examining the Relationship of Effort with Rich and Basic Feedback and Prior Knowledge of Accounting

Tests of Between-Subjects Effects : Dependent Variable: Effort

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.710[a]	3	0.237	14.081	0	0.34
Intercept	965.726	1	965.726	57450.444	0	0.999
Rich / Basic Feedback	0.157	1	0.157	9.36	0	0.102
Prior Knowledge	0.566	1	0.566	33.694	0	0.291
Rich / Basic * Prior Knowledge	0.038	1	0.038	2.287	0.13	0.027
Error	1.378	82	0.017			
Total	980.67	86				
Corrected Total	2.088	85				

[a] R Squared = .147 (Adjusted R Squared = .115)

Finally for the interaction effect, although the cell means appear to exhibit interaction, test results are not statistically significant F (1, 82) = 2.287, p = 0.134, and thus the null form of H2c cannot be rejected at the 5% level. Cell-to-cell comparisons (t-tests) show that the differences in the effort of students with a prior knowledge completing the rich and basic feedback is not significant (p = 0.203), while for students with no prior knowledge of accounting, the difference in feedback type is significant (p = 0.004), with effort being lower for rich feedback compared to basic.

Instructional Efficiency

The mean levels of instructional efficiency as determined by formula [1] across the two feedback types, and the differing levels of prior knowledge are reported in Table 7. Table 7 shows that for students with and without a prior knowledge of accounting, the rich feedback was the more

TABLE 7

Instructional Efficiency Mean Scores and Standard Deviations

	Feedback Type								
	Rich Feedback			Basis Feedback			Total		
Accounting Knowledge	Mean	SD	N	Mean	SD	N	Mean	SD	N
Prior Knowledge	0.75	0.83	21	0.49	0.82	20	0.62	0.83	41
No Prior Knowledge	-0.2	1.01	26	-1.05	0.87	19	-0.56	1.02	45
Total	0.2	1.04	47	-0.23	1.14	39	0.01	1.1	86

TABLE 8

Two-way ANOVA Examining the Relationship of Instructional Efficiency with Rich and Basic Feedback and Prior Knowledge of Accounting

Tests of Between-Subjects Effects : Dependent Variable: Instructional Efficiency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.035[a]	3	12.678	15.75	0	0.368
Intercept	0.007	1	0.007	0.009	0.92	0
Rich / Basic Feedback	6.085	1	6.085	7.56	0	0.085
Prior Knowledge	33.333	1	33.333	41.409	0	0.338
Rich / Basic * Prior Knowledge	1.669	1	1.669	2.074	0.15	0.025
Error	65.203	81	0.805			
Total	103.244	85				
Corrected Total	103.238	84				

[a] R Squared = .147 (Adjusted R Squared = .115)

efficient means of instruction (i.e., the higher efficiency value). The data summarised in Table 7 is analysed using a two-way ANOVA and the results are presented in Table 8.

Table 8 shows that for the feedback type main effect, the null form of H3a can be rejected at the 5% significance level, $F(1, 82) = 7.560$, $p = 0.007$. Thus, it can be concluded that the instructional efficiency of students receiving rich feedback is significantly higher than students receiving basic feedback. The partial eta squared indicates that using the best estimate available, feedback type explains 8.5% of the variation in instructional efficiency.

The F result for the prior accounting knowledge main effect and the results from Table 7 show that the null form of H3b can also be rejected at the 5% significance level $F(1, 82) = 41.409$, $p < 0.001$. Thus, it can be concluded that the instructional efficiency of students with a prior knowledge was significantly higher than those with no prior knowledge. The partial eta squared indicates that using the best estimate available, differences in prior knowledge account for 33.8% of the variation in instructional efficiency.

Finally, for the interaction effect, although the cell means appear to exhibit interaction, test results are not statistically significant $F (1, 82) = 2.074$, $p = 0.154$, and thus the null form of H3c cannot be rejected at the 5% level.

By applying the instructional efficiency formula to students based on their prior knowledge background, comparisons show the difference in the instructional efficiency of students with a prior knowledge completing the rich (mean efficiency = 0.17 standard deviation = 1.05) and basic feedback (mean efficiency = - 0.18 standard deviation = 1.02) is not significant ($p = 0.281$). For students with no prior knowledge of accounting, the difference in feedback type is significant ($p = 0.005$), with instructional efficiency being higher for rich feedback (mean efficiency = 0.35 standard deviation = 1.00) compared to basic (mean efficiency = -0.48 standard deviation = 0.85). These results are graphically displayed in Figure 2 (for students with a prior knowledge) and Figure 3 (for students with no prior knowledge).

GENERAL DISCUSSION AND CONCLUSION

This paper has extended research into feedback and specifically applied cognitive load theory to analyse whether rich or basic feedback is more efficient in an introductory accounting subject. Researchers continue to debate the most appropriate format of feedback for efficient learning. In this case, the analysis of the most efficient feedback was conducted based on a student's prior knowledge, and CBL was the tool to examine the feedback alternatives.

The results of the study are somewhat varied. In relation to students with prior subject knowledge, there was no significant difference in learning efficiency between rich and basic feedback. This result suggests that basic feedback may be sufficient for efficient learning and that the rich feedback is equally as useful. The extra feedback provided to students with a prior knowledge provided no significant benefit, but did not hinder learning. For students with no prior knowledge, the instructional efficiency results indicate that rich feedback is clearly more useful and the difference was statistically significant. The brevity of the basic feedback put extra pressure on the working memory (evidenced by significantly greater effort levels) and resulted in an inefficient learning environment. Learners with no accounting knowledge in this instance benefited from elaboration and verification feedback. This result has reinforced prior studies in feedback that have shown that students with no prior experience in the discipline benefit most from rich feedback

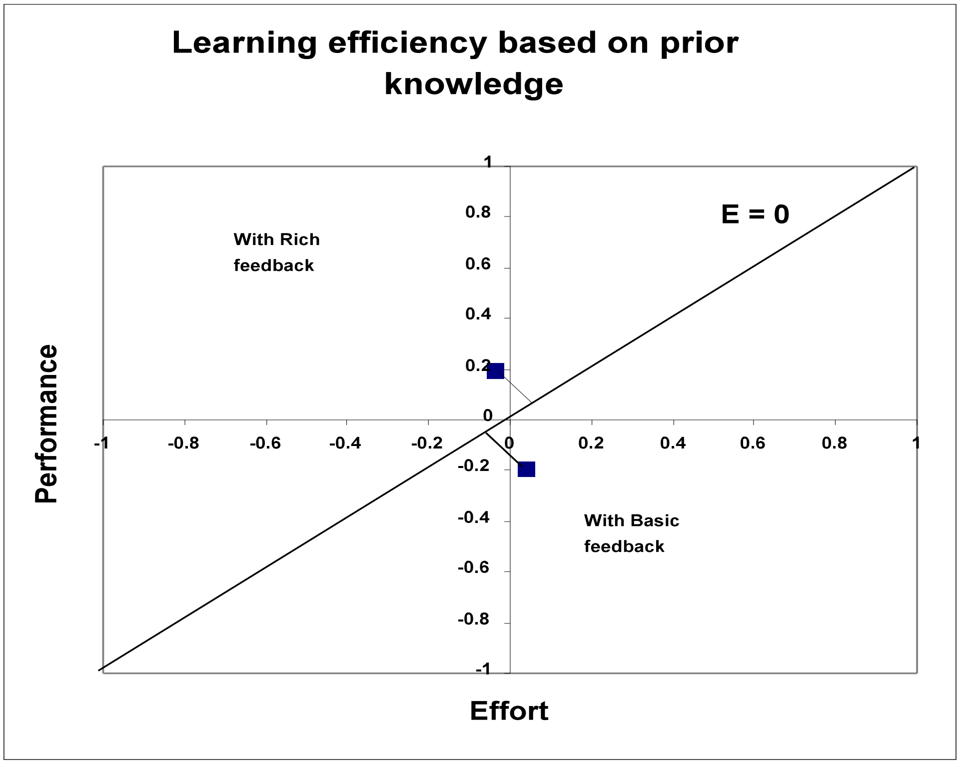

Figure 2: Learning Efficiency for Students with a Prior Knowledge of Accounting Comparing Rich and Basic Feedback

compared to basic feedback (Tuovinen and Sweller, 1999; Kalyuga et al., 2001a; 2001b). For students with no prior knowledge, the richer feedback is generally less demanding on one's limited processing capacity, requires less effort, and leads to more efficient schema development.

Kulhavy and Stock (1989) noted that it is how well the feedback properties are adapted to a learner's needs that is most important. This research therefore has implications for instructors, students and educational developers that go beyond designing CBL materials and deciding when to use CBL programs in classes. The results of this study could be applied to other methodologies such as face-to-face teaching or printed materials.

This research can assist instructors of introductory accounting classes where the student population usually comprises a mix of some with prior accounting knowledge and others with no prior knowledge. Understanding the background of students enables instructors to tailor individual feedback and decide when to use basic or rich feedback. This research also suggests that rich feedback would be a particularly good way to begin new instruction, and as students become more familiar with the subject, instructors could then choose to provide either basic or rich feedback.

This research may be extended beyond individuals to groups of students. A more efficient way of teaching introductory accounting could be to divide classes based on students' prior knowledge. When addressing larger student groups, instructors can apply the results of this study by providing rich feedback to students with no prior knowledge, and for students with prior knowledge, the feedback may be varied between rich and basic feedback. To expand the findings beyond the introductory class, when instructors are revising classes taught earlier in the semester, the feedback

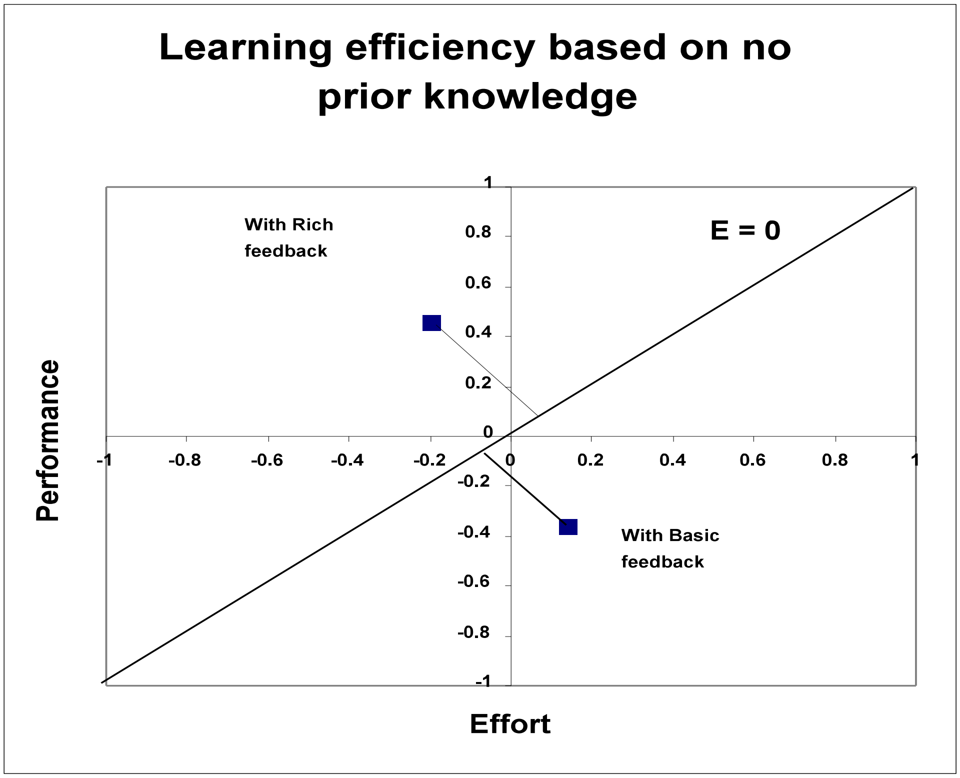

Figure 3: Learning Efficiency for Students with No Prior Knowledge of Accounting Comparing Rich and Basic Feedback

and explanations may be briefer than when the subject was initially taught. Prior knowledge in this case is assumed based on prior teaching.

While this study has a number of important implications, it is not without its limitations. The limitations in turn provide opportunities for further research. The findings of this study are based on only one highly structured accounting topic. The results therefore cannot be generalized to all CBL materials, all accounting topics, or all teaching methodologies. Further, the conclusions are only applicable to this student cohort. To extend the external validity, other highly structured introductory accounting topics could be tested in a similar manner with CBL materials or another teaching methodology. Introductory accounting courses provided many opportunities to use rich and basic feedback, particularly as many topics are practical and solutions have clearly correct or incorrect answers (with opportunities to extend basic feedback). The measure of "prior knowledge" used in this study was based on whether students had studied and passed accounting at their final high school year (or equivalent). An extension of this may be to categorise the prior knowledge learners into high or low achievers, and determine whether basic or rich feedback is more efficient. In terms of other measures of general cognitive ability, this study chose not to use variables such as tertiary entrance rank, motivation levels, student age, or demographic background, and these are further opportunities for research. While this study collected some demographic data, analysing these with the current variables would have left very small numbers. Finally, while the cell sizes in the present study were satisfactory for statistical testing, larger samples may have found statistically significant results.

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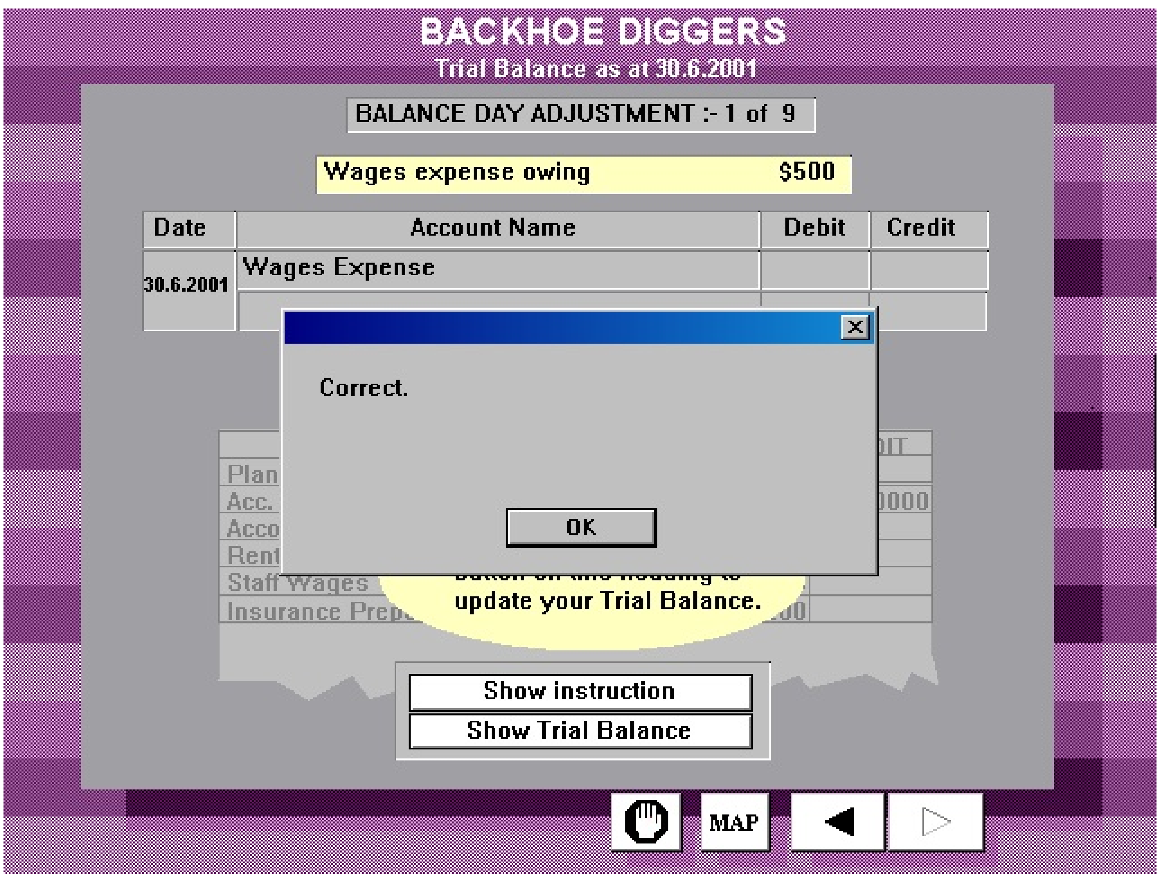
APPENDIX 1

Completing a Section of the Balance Day Adjustment with a Correct Entry (Wages Expense) and Basic Feedback



APPENDIX 2

Completing a Section of the Balance Day Adjustment with a Correct Entry (Wages Expense) and Rich Feedback