Impact of Structure of Early Practice on Student Performance in Transaction Analysis

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ABSTRACT

In introductory accounting textbooks, virtually all end-of-chapter problems on transaction analysis follow the same familiar format: a collection of transactions performed by a given business during a specified time period. Modern research-based models of human cognitive architecture suggest, however, that this format is suboptimal for novice students. An approach better aligned with this learning research would give students practice with one transaction type at a time *before* proceeding to problems involving a mixture of transaction types. An experiment was conducted to test this hypothesis by randomly assigning students in an introductory financial accounting course to one of two practice conditions: conventional textbook problems and "targeted practice" in which transactions were grouped by type. All students were then given a conventional textbook problem as a post-test. During the practice phase, students in the targeted practice group analyzed transactions in less time and with greater accuracy than students who worked conventional problems. On the post-test, the total scores of the two groups were statistically equivalent, thus the targeted practice group achieved the same level of performance more efficiently. However, on transactions requiring knowledge transfer, the targeted practice group was notably better, indicating these students were better able to apply knowledge gained during practice to a broad variety of transaction scenarios. The implications of this study are straightforward and powerful: by making a very simple modification to the format of transaction analysis problems given to students early in the learning process, better learning outcomes can be obtained.

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INTRODUCTION

Transaction analysis is one of the most important topics for students in the introductory financial accounting course, as well as one of the most difficult. Transaction analysis, as part of the accounting cycle, is a crucial piece of the foundation upon which the student's understanding of (and subsequent success in) accounting will depend (Turner, Holmes, & Wiggins, 1997).

In introductory accounting textbooks, virtually all end-of-chapter problems on transaction analysis follow the same familiar format: a collection of transactions performed by a given business during a specified time period (*e.g.* the month of August). This has a natural, intuitive appeal of corresponding to a "real-life" business situation. The transactions in a typical problem usually span a variety of types a business regularly encounters (issuing stock, earning revenue, purchasing equipment, *etc.*), thus giving students practice in a realistic context with a number of different types of transactions they need to learn.

However, research in cognitive load theory (Clark, Nguyen, & Sweller, 2006), which concerns the relationships between working memory function and learning, suggests this approach may in fact be suboptimal for novice students. While the transactions in a textbook problem are all related by virtue of belonging to the same business, they are typically only weakly related or unrelated with respect to the underlying concepts required for their analysis, with each transaction solved differently. Cognitive load theory indicates that giving students such high-variability problems too early in the learning process could have a depressing effect on learning outcomes by potentially obscuring connections between relevant accounting concepts and the processes of analyzing different transaction types.

Furthermore, despite the tremendous attention rightly devoted by instructors and researchers alike to pedagogy of the accounting cycle and its constituent components, the prevailing structure of textbook problems for transaction analysis does not appear to be based on or supported by rigorous research studies. Here, common opinion appears to be accepted implicitly, and no alternate approaches to practice problem format seem to have been investigated. To be clear, the ability to analyze a diverse set of transactions performed by a business in a given accounting period is an absolutely essential goal for beginning students to attain. Of interest here is the question of the most efficient *path* for reaching this goal.

The purpose of this work is to investigate the efficacy of a very simple alternate approach that is better aligned with modern research-based models of how memory works: giving students "targeted practice" with transaction types one at a time, *before* proceeding to problems involving a mixture of transaction types.

THEORY AND HYPOTHESIS DEVELOPMENT

Cognitive load theory (CLT) (Clark, Nguyen, & Sweller, 2006; Sweller, 1994; Sweller, van Merriënboer, & Paas, 1998) is a branch of cognitive psychology which leverages what has been learned about human cognitive architecture to improve instructional design. A central principle in CLT is that working memory capacity is very limited, able to attend only to a small number of different items simultaneously when performing a task (such as solving an accounting problem). When working memory capacity is exceeded, "cognitive overload" results and learning is depressed. Instructional materials design should explicitly take this property into account to avoid making the student devote limited mental processing resources to information that is not directly relevant to the learning goal (called "extraneous cognitive load"). This is particularly relevant for novices (such as beginning accounting students) who have not yet formed more sophisticated knowledge structures ("schemas"). Experts are able to use schemas effectively as a single unit in working memory to reduce cognitive load (such as when an accounting instructor constructs a journal entry).

CLT has a successful history of improving instructional efficiency in several disciplines (Clark, Nguyen, & Sweller, 2006). Unlike many instructional design approaches, which often come down to little more than intuition or personal opinion, CLT is solidly evidence-based, with its principles and recommendations derived from numerous controlled empirical research studies. While many CLT findings are consistent with *a priori* expectation, others can be counterintuitive, running contrary to "conventional wisdom."

CLT has begun to be applied in accounting education as well. Halabi, Tuovinen, and Farley (2005) examined the relative instructional efficiency of studying worked-out examples versus doing problem-solving exercises and found that the former is more efficient than the latter for novice learners. Halabi (2006) compared the efficiency of basic and rich feedback in computer-based learning materials from a CLT perspective, finding rich feedback was significantly more useful for students with no prior accounting knowledge. Most recently, Blayney, Kalyuga, and Sweller (2009) investigated the impact of teaching complex spreadsheet models for various accounting topics, finding that introducing the material as isolated elements rather than teaching the fully interacting form at the outset benefitted lower expertise learners more.

With respect to the present work, it was stated that practicing initially with transactions targeted by type is more consistent with the principles of CLT than prevailing practice and thus should lead to improved learning outcomes. Explanation of this claim leads to development of the hypotheses of this study. It is well established that novice learners usually benefit more when more explicit instructional guidance is provided (Kirschner, Sweller, & Clark, 2006). Specifically, having students construct solutions entirely on their own before they have acquired sufficient knowledge in the domain is counterproductive to learning. In this case, students resort to inefficient means-end search strategies (Sweller, 1988), trying to work backward from the goal to the given information since they do not yet possess the schemas enabling them to work forward directly from the given information to the goal. The issue is not whether they can ultimately succeed in reaching a correct solution this way (they often can); the problem is that this method consumes an excessive amount of limited working memory resources with activities

that do not contribute to development of the schemas in long-term memory needed for mastery, and thus learning is depressed. Sweller, Mawer, and Howe (1982) found it is possible under these conditions for students to engage in problem-solving activities for extended periods and learn almost nothing.

In contrast, practicing each transaction type separately before attempting problems containing varied transactions should reduce extraneous cognitive load for the novice. Since the student knows all transactions will be of the same type, the need for solution search with each new transaction is eliminated. Not only is the solution strategy better reinforced since it is applied several times in a row (instead of not knowing when it will be needed again, as in conventional textbook problems), the first transaction(s) solved can serve as a guide for the other transactions of the same type. This frees more working memory for learning the structure of the solution itself and its relation to accounting concepts, which is what is essential to schema development.

This approach has another important aspect in common with CLT instructional design recommendations developed from research studies in other disciplines. By keeping the transaction type constant and varying the business scenario (targeted practice), rather than keeping the business scenario constant and varying the transaction types (conventional problems), variability in the *surface features* of examples studied (specific types of services rendered, assets purchased, expenses incurred, *etc.*) is achieved while illustrating the *same* underlying concept. This has been shown to increase students' ability to apply what they learned to situations *different* from those practiced (Paas, 1992; Paas & van Merriënboer, 1994). The knowledge gained was more transferable because practice was deliberately structured to facilitate abstraction of the concepts from the examples.

Based on this analysis, we propose the following hypotheses:

H1: Practicing transactions by type before working problems involving multiple transaction types will lead to more efficient learning of transaction analysis.

H2: Practicing transactions by type before working problems involving multiple transaction types will lead to more transferable learning of transaction analysis.

"More efficient learning" is defined as achieving better performance with the same investment of effort or achieving the same level of performance with less effort, *i.e.* greater performance per unit effort.

Despite these potential benefits argued from CLT, potential drawbacks to this approach can also be argued. For example, a targeted practice approach might facilitate or even encourage simplistic rote memorization of solution patterns rather than deeper conceptual reasoning. Keeping the transaction type fixed might also hinder development of the vitally important ability to *recognize* a transaction's type by reading its description, since the type is already known. Finally, targeted practice lacks the "real-world" aspect that makes conventional textbook problems appealing, although this criticism is perhaps not as strong as the others, for two reasons. First, the issue is not whether to replace conventional problems with targeted practice

altogether, but merely at the start. Methods that manage cognitive load for beginners are no longer needed as learners gain expertise and can even become counterproductive if continued for too long (Kalyuga, Ayres, Chandler, & Sweller, 2003). Second, it has been pointed out that a greater value is often assumed for "authentic" learning tasks than is justified by empirical research studies (Kirschner, Sweller, & Clark, 2006), owing to a failure to distinguish a discipline's epistemology from its pedagogy (Kirschner, 1992).

METHOD

To test the above hypotheses, a study was conducted with students enrolled in an introductory financial accounting course at a major California university (N = 88). All students were taught by the same instructor. Students ranged in age from 18 to 27 years, with a mean age of 20.3 years, and were divided approximately equally by gender (52.3% male). This was the first accounting course for 84.0% of students, and 83.0% had a business-related major (though none were accounting majors); the rest were non-business majors or were undeclared.

Students were randomly assigned to one of two practice conditions: conventional textbook-format problems (N = 44) and targeted practice, in which transactions were grouped by type (N = 44). The structure of the two practice conditions is illustrated in Figure 1. The conventional group was given three problems of six transactions each, with each problem containing one transaction from each of six different types[1]. The targeted practice group was given the same set of eighteen transactions, except grouped so that all three transactions of a given type (*e.g.* issuing stock) occurred back-to-back. Students were required to determine the effect on the accounting equation and construct the journal entry for each transaction. Following the practice phase, all students (regardless of practice condition) were given the same post-test consisting of a single conventional problem with ten transactions. Some post-test transactions were of the same types practiced, while others were unlike those in the practice set in order to investigate impact on transferability of learning. The practice session and post-test were conducted in a single 50-minute class period.

INSERT FIGURE 1 ABOUT HERE

Students practiced transactions within an online software tutorial system (Johnson, Phillips, & Chase, 2009), which gave feedback on their answers and allowed them to correct their mistakes, and kept a detailed record of performance for later analysis. This enabled insight on the hypotheses to be gained during the practice phase as well from the post-test. The post-test was administered in a conventional pencil-and-paper fashion.

RESULTS AND DISCUSSION

Transaction Analysis Practice

Performance during the practice phase was assessed in two ways: as the percentage of transactions correctly analyzed and as time spent per transaction. Since students had the

[1] The transaction types were issuing stock for cash, purchasing equipment with cash and credit, receiving cash advance for services, prepaying insurance, paying expenses in cash, and receiving cash on account.

opportunity to correct any mistakes after reviewing feedback from the tutorial system, for the purpose of this analysis an answer was counted as correct only if no errors were made. No credit for partially correct solutions was awarded.

Table 1 summarizes the performance of the two groups. Results are broken down by the first, second and third transactions attempted within the given types.[2] Panel A gives the mean percentages of correct answers and time spent per transaction, while Panel B gives the *p*-values from between-subjects *t*-tests of statistical significance (a significance level of $p = 0.05$ was used throughout). Not only does this show the trajectory of progress during practice, average performance on the first transaction of each type (Transaction A1, B1, C1, *etc.* in Figure 1) gives a baseline comparison between the two groups of students (similar to a pre-test), since on the first transaction any potential effect due to difference in the treatment conditions would not yet be manifested.

INSERT TABLE 1 ABOUT HERE

On the first transaction of each type, there is no statistically significant difference between the conventional and targeted practice groups in percentage of correct answers or time spent. This is evidence the two student groups are equivalent and thus any statistically significant differences observed later are more likely due to the different treatment conditions. Performance on these first transactions also shows considerable room for improvement, with initial accuracy around only 40% for the accounting equation effect and less than 75% for journal entries. This is likewise favorable to detection of potential treatment differences by the experiment.

On the second transaction of each type, both groups improve substantially, as expected since both were engaging in tutored practice (Johnson, Phillips, & Chase, 2009). For the accounting equation, the conventional group's correct solutions increased 23.3 percentage points and mean time per solution decreased by 39.6 seconds. However, the targeted practice group's progress was much greater on both measures: an improvement of 42.4 percentage points and 48.2 seconds, respectively. For the accounting journal, the conventional group improved by 12.3 percentage points and 17.1 seconds between the first and second transactions, while the targeted group improved by 20.7 percentage points and 20.3 seconds. As seen in Panel B, these performance differences between the two groups were statistically significant in all four cases: (accuracy, time) × (accounting equation, accounting journal). Again, these differences are not explainable by intrinsic differences in the student groups.

On the third transaction of each type, both groups continued to improve, particularly on the accounting equation effect. Gains are less than before; one reason is that a ceiling effect is clearly occurring for solution times for both groups. A ceiling effect is also occurring for the targeted practice group (though not necessarily for the conventional group) for percentage of correct solutions, since there is not enough room for the initial improvements to be repeated. The difference between the conventional and targeted practice conditions is still statistically significant for accounting equation and accounting journal solutions and for accounting equation

[2] For simplicity, averages over the six transaction types are presented. Though there was some variation by individual transaction type in quantitative performance details, the same qualitative trends were observed.

solution time. For accounting journal solution time, which appears to be near convergence, the difference is not significant.

Performance should ultimately converge to a limiting value as a function of the amount of practice, and thus with more practice the conventional group would be expected to catch up in the long run. This is not the issue, however. Rather, it is whether the amount of practice needed to reach a desired level of performance is less for targeted practice. From Table 1, the targeted group performed slightly better on the *second* transaction than the conventional group did on the *third* transaction. The statistically significant advantage of the targeted group directly supports the first hypothesis (H1), that beginning with targeted practice will lead to more efficient learning.

As an aside, this raises the interesting possibility of using a software system to *predict* performance on the next transaction by extrapolation. Convergence behavior as a function of the number of transactions could readily be modeled by a simple curve with a small number of parameters empirically fit to performance data of the individual student and/or from historical experience with large numbers of students. In practice, this could be used to let students know when they have reached the point where doing more transactions is not likely to yield significant additional benefit.

Overall, it is noted that both groups performed substantially better on the accounting journal than the accounting equation (though by the third transaction the gap has nearly closed for the targeted group). Investigation of causes of this difference is beyond the scope of the present study. However, Heiser and Phillips (2009) have recently studied factors related to this issue and found that requiring students to document accounting equation effects before writing journal entries improved journalizing performance, which is consistent with the present observation.

The faster, more accurate performance of the students engaging in targeted practice is evidence of more efficient schema development. CLT would explain this result as the variability of surface details while working through several transactions possessing the same underlying essence helping students grasp that essence better than conventional problems, where successive transactions are often unrelated. However, a counterargument could be made that while "assembly-lining" transactions can produce better performance during practice, it does not necessarily follow that students will also do better when they must *recognize* the transaction types on their own (*e.g.* conventional textbook problems), since this is not strictly necessary in the targeted practice condition. In fact, targeted practice may even hinder development of the important ability to recognize transaction types, since they are always given. The ultimate determination must be made by performance on the post-test, which was in conventional textbook format. In particular, the hypothesis of improved knowledge transferability (H2) is tested by the post-test.

Transaction Analysis Post-Test

All students were administered the same conventional textbook-format problem as a post-test, which required writing accounting equation effects and journal entries as in the practice

phase. Since the post-test was administered on paper rather than online, this provided a check against the possibility of the targeted group's advantages during the practice phase being caused by an unintentional modality effect; unless the trends observed during practice are reversed on the post-test, they are not likely to have been artifacts potentially caused by details of the online system. This also meant that recording time spent per transaction on the post-test was impractical, and so percentage of correct answers was the only performance measure. Post-test results are given in Table 2.

INSERT TABLE 2 ABOUT HERE

The targeted group's post-test average was 4.7 percentage points higher than the conventional group on accounting equation effects and 1.6 percentage points higher on journal entries. These differences were not statistically significant, which means the groups were statistically equivalent on overall performance. These results further support H1, since equivalent performance was achieved by the targeted group with more efficient practice preparation. Importantly, this finding extends support of H1 to the case where the student must *recognize* the transaction type. Targeted practice did not compromise ability to recognize transaction type. This supports the prediction from CLT that focusing initially on each transaction type separately helps students grasp the essence of the transaction better, rather than leading to shallow, rote learning.

It is also very interesting to note that since the post-test was a textbook-format problem, the conventional group was tested in the *same* format as they practiced, but the targeted group was tested in a *different* format than practiced and yet achieved equivalent performance. This is further evidence that the superior performance of the targeted group during practice was not merely a superficial effect limited to the "assembly line" format, and gives indirect support of the knowledge transferability hypothesis, H2.

The direct test of H2 is provided by the post-test transactions which were of different types than in the practice set and thus required application or "transfer" of knowledge to new situations. For example, all transactions during practice involved cash, while the post-test contained some non-cash transactions.[3] Note that solutions memorized by rote would be of no value for transfer transactions, and thus these shed further light on the nature of learning acquired through targeted practice.

On transactions requiring knowledge transfer, the targeted practice group outperformed the conventional group by 11.3 percentage points on accounting equation effects and 6.9 percentage points on journal entries. The targeted group's advantage on the accounting equation was marginally statistically significant ($p = 0.057$). This suggests that the targeted practice students were better able to apply the knowledge they gained during practice to a variety of transaction situations, consistent with the prediction from CLT that initial targeted practice should build more solid, transferable schemas.

The difference in accounting journal performance was greater on transfer transactions than for the post-test overall, but was not statistically significant. This may be due in part to the

[3] The transfer transaction types were rendering services on credit, paying cash on account, prepaying rent, incurring expenses on credit, paying wages in cash, and paying dividends in cash.

scaffolding for journalizing provided by first determining the accounting equation effects (Heiser & Phillips, 2009), which would be beneficial to both groups.

CONCLUSION

This study investigated the impact of a simple modification to the way beginning students practice transaction analysis. Since modern evidence-based models of learning suggest the format of conventional textbook problems is not optimal for novice students, an experiment was conducted which tested conventional problems against a practice structure better aligned with cognitive load theory.

The experimental results showed that initially practicing each transaction type in isolation gives two main benefits. First, the evidence strongly showed that this increases learning efficiency, enabling students to reach the same level of performance with *less* study time than by working conventional textbook problems. Second, the evidence also suggested that students are better able to apply knowledge of transaction analysis acquired in this way to new transaction types not previously practiced.

These experimental findings run counter to common practice and conventional instructional opinion. However, a clear theoretical basis provided by CLT predicts exactly the outcome observed, because of reduction in the novice's extraneous cognitive load that does not contribute to learning. Furthermore, the current practice embodied in end-of-chapter textbook problems does not appear to have rigorous pedagogical research studies backing it. The approach may have been based in part on an assumption that "real world" problems lead to better learning, which is often not justified in practice (Kirschner, 1992). Any counterintuitive quality of the current results may therefore stem from an appeal to tradition or intuition more than evidence.

The implications of this study for instructional practice are simple and powerful. It is important to note the results do *not* imply that conventional textbook problems should be discarded, but rather that beginning with targeted practice *before* transitioning to conventional problems builds stronger knowledge of the accounting concepts, thereby providing an improved *path* to mastery of the very same textbook problems. Incorporation of targeted practice is also more convenient than it might first appear, as little change is required. For example, although textbooks are not set up for targeted practice, transactions from existing textbook problem material can simply be sorted by the instructor for initial practice assignments. Informing students that this approach has been shown to lead to better learning with less effort may also have a positive motivational effect.

Though this study was conducted with an online system that gave detailed, process-oriented feedback, it is not expected that the advantage of targeted practice should be exclusive to this context. For example, targeted practice is also expected to give better outcomes with one-on-one personal tutoring or even with simple outcome-based (right/wrong) feedback, which could be achieved merely by providing an answer key to be checked after each transaction. The magnitude of differential benefit is of course expected to depend on the specific feedback mechanism, characterization of which could be a topic for future research. Research on application of the targeted practice concept in other areas of accounting education may also

prove fruitful in empowering instructors to make better pedagogical decisions that are informed by rigorous evidence.

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Table 1
Transaction Analysis Practice Performance

Panel A: Performance by Condition and Transaction Attempt

	Percentage Correct			
	AE		AJ	
	Conv	Targ	Conv	Targ
Transaction 1	43.8	38.1	74.0	72.4
Transaction 2	**67.1**	**80.5**	**86.3**	**93.1**
Transaction 3	**78.7**	**90.4**	**90.6**	**95.3**

	Mean Time (s)			
	AE		AJ	
	Conv	Targ	Conv	Targ
Transaction 1	84.3	84.3	43.7	41.8
Transaction 2	**44.7**	**36.1**	**26.6**	**21.5**
Transaction 3	**32.8**	**27.4**	21.1	20.2

Panel B: Two-Sample *t*-Tests of Performance Measures

	p-Value			
	Percentage Correct		Mean Time	
	AE	AJ	AE	AJ
Transaction 1	0.192	0.679	0.993	0.619
Transaction 2	< 0.001	0.013	0.001	0.001
Transaction 3	< 0.001	0.042	0.002	0.422

Note: Conv = conventional group, Targ = targeted practice group. AE = effect on accounting equation, AJ = accounting journal entry. Values in bold mean the difference between the two practice conditions was statistically significant ($p < 0.05$).

Table 2
Transaction Analysis Post-Test Scores

	Percentage Correct					
	AE			AJ		
	Conv	Targ	*p*	Conv	Targ	*p*
Total	68.9	73.6	0.293	78.4	80.0	0.696
Transfer	58.0	69.3	0.057	72.3	79.2	0.153

Note: Conv = conventional group, Targ = targeted practice group. AE = effect on accounting equation, AJ = accounting journal entry.

Figure 1
Structure of Practice Conditions