Accelerating the acquisition of knowledge structure to improve performance in internal control reviews

A. Faye Borthick a,∗, Mary B. Curtis b,1, Ram S. Sriram a,2

a School of Accountancy, 35 Broad St. 5th Floor, POB 4050, Georgia State University, Atlanta, GA 30302-4050, USA
b Department of Accounting, University of North Texas, Denton, TX 76203-5219, USA

Abstract

We demonstrated that knowledge structure training is effective in imparting transaction flow and control objective knowledge structures and that knowledge structure mediates the relationship between structure training and performance in internal control reviews. A performance degradation associated with participant-task structure incompatibility arose at the point of situation model building rather than during application of knowledge structure in the judgment task. Higher-knowledge structure participants, but not lower-knowledge structure participants, performed better when their knowledge structures and case structures were compatible.

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Introduction

The passage of the Sarbanes-Oxley Act (US Congress, 2002) in the US and similar legislation in other countries signified increased prominence for internal control reviews in financial statement audits. Standards related to Section 302 of the act, which requires managers to sign statements verifying the completeness and accuracy of financial reports, and Section 404, which requires managers and auditors to attest to the effectiveness of internal controls for financial reporting, have significantly increased the demand for internal control reviews and those with the knowledge and training to perform such reviews. Nature and extent of knowledge structure have been found to be significantly related to auditor performance in the review of internal control (Curtis & Viator, 2000; Frederick, 1991; Frederick, Heiman-Hoffman, & Libby, 1994).

∗ Corresponding author. Tel.: +1 404 651 4472; fax: +1 404 651 1033.
E-mail addresses: borthick@gsu.edu (A.F. Borthick), curtism@unt.edu (M.B. Curtis), rsriram@gsu.edu (R.S. Sriram).
1 Tel.: +1 940 565 4266; fax: +1 940 565 3803.
2 Tel.: +1 404 651 4464; fax: +1 404 651 1033.
reviews may not always possess adequate knowledge structure or the appropriate structure (Choo, 1989; Frederick et al., 1994; Tubbs, 1992). Although knowledge structure appears to develop over time, as accountants gain experience, past research suggests that internal control reviews are generally performed by auditors with an average of 1.5 years of audit experience (Bonner & Pennington, 1991), and anecdotal evidence suggests that the demands for Sarbanes-Oxley Section 404 reviews may be lowering this average experience level. Furthermore, participating in internal control reviews does not appear to provide much opportunity to learn from feedback due to infrequent performance and lack of criteria for assessing judgment effectiveness (Bonner, Libby, & Nelson, 1997). The accounting literature suggests that less experienced accountants may not develop much knowledge structure during training and may have little opportunity to develop knowledge structure from experience, resulting in a potential lack of appropriate structures for specific tasks and potentially handicapped performance of those tasks. The concern is, therefore, how well accountants can perform tasks like reviewing internal control early in their careers, before they have had the opportunity to develop experience-induced knowledge structures.

The importance of knowledge structure to the performance of accounting tasks (Vera-Muñoz, Kinney, & Bonner, 2001) and the fact that some firms appear to be re-designing their audit methodologies to employ different structures (Lemon, Tatum, & Turley, 2000) creates the opportunity to determine if there are alternative ways to enable knowledge structure development. Because the audit environment is becoming more complex due to increased computerization and integration of application systems, expanded emphasis on detecting fraud, and added requirements for attesting to the completeness and accuracy of financial reports, the performance of some audit tasks will likely become less amenable to simplistic repetition of standard audit procedures. Although Kopp and O’Donnell (2005) found that training was helpful in providing knowledge structure for participants with no accounting knowledge, essentially “blank slates”, redirecting accountants’ existing knowledge structure through instruction has not been addressed. To investigate the effect of the extent and form of knowledge structure, we tested whether sufficient knowledge structure can be inculcated through short, intensive instruction to make a significant difference in the way in which participants structure their knowledge and in their performance of internal control reviews. To explore the development of knowledge structure more thoroughly, we contrasted typical training for acquiring knowledge content with that specifically designed to inculcate knowledge structure to determine whether the latter can be effective in improving performance in internal control review.

This research responds to Day, Arthur, and Gettman’s (2001) call to “present expert knowledge structures to trainees as part of the training paradigm” (1030) rather than simply letting trainees infer knowledge structure on an idiosyncratic basis.

Although knowledge structure has been an attribute in studies of accounting tasks, the training to knowledge structure to performance links have not been completely addressed. For example, although they examined the effect of knowledge structure on performance, neither Nelson, Libby, and Bonner (1995) nor Bonner, Libby, and Nelson (1996) trained for knowledge structure because their participants (experienced auditors) had already developed the relevant knowledge structures through experience. Because they trained participants to the point of demonstrating perfect knowledge structures, Bonner et al. (1997) did not investigate performance as a function of knowledge structure varying along a continuum from low to high. Dearman and Shields (2001) evaluated the effect of two types of knowledge structure on performance where there was a preferred knowledge structure (activity-based costing) for decision making but did not find a link between prior training and the development of knowledge structure. Because prior research has not specifically sorted out the joint effect of training on the development of knowledge structure and the effect of knowledge structure on performance, we specifically address the plausibility of designing training experiences to impart relevant knowledge structure to improve performance.

Providing further support for the need for effective intervention in the development of knowledge
structure, this research demonstrates the extent to which performance can be compromised by compatibility conflicts between knowledge and task structures. By crossing two different knowledge structures in training and performance tasks, we provide insight into the potential performance problems created when an auditor does not have adequate structure or possesses only structures that are incompatible with the task structure. This research extends the findings of Nelson et al. (1995), Bonner et al. (1996), and Bonner et al. (1997) regarding the interaction of knowledge and task structures by exploring the role of knowledge structure in the creation of mental problem representations prior to solving a problem.

We found that training designed to impart a particular knowledge structure resulted in greater levels of knowledge structure than did typical classroom training with no structure orientation. With respect to knowledge structure training, knowledge structure, and performance, we found that knowledge structure mediates the structure training to performance relationship, with participants possessing greater knowledge structure performing better in a review of internal control. The results indicate that knowledge structure training can be effective in imparting knowledge structure that improves performance. Finally, in crossing two types of knowledge structure, we found that compatibility of an individual’s knowledge structure with the task structure is associated with better performance in internal control reviews.

**Theory and hypothesis development**

Knowledge content is information stored in memory, while knowledge structure is the organizational structure of that knowledge content (Libby, 1995). Although the Libby and Luft (1993) model of determinants of judgment performance in accounting did not distinguish knowledge structure from knowledge content, the structure of one’s knowledge in memory has been thought to be “a relevant dimension of expertise” (Choo, 1989, p. 112) as early as Weber’s (1980) study of EDP auditors’ recall of computer controls. Indeed, Libby (1995, p. 181) noted that “knowledge structure, as well as knowledge content, is an important determinant of audit judgment performance”.

We begin by examining the theoretical justification for whether typical internal control structures, transaction flow and control objective, might be inculcated through training and whether knowledge structure might mediate the relationship between structure training and performance. Finally, we examine the cognitive theory associated with whether knowledge structure-task structure compatibility might affect performance.

**Knowledge structure as a function of training and pre-existing knowledge**

“As auditors gain experience, their knowledge grows and becomes more organized in memory” (Bedard & Chi, 1992, p. 73). Libby (1995) defined experience as a variety of activities, including completing tasks, reviewing the work of others, reading formal audit guides, and participating in training exercises. Bonner and Pennington (1991), however, suggested that those performing internal control reviews have relatively little actual task experience and that opportunities to learn from task experiences in the field are limited.

Consistent with the view of internal control reviews not being rich sources for learning, inexperienced auditors have been found to possess relatively weak knowledge structure. For example, Frederick et al. (1994) found that auditors with an average of four years of experience free sort financial statement errors on an audit objective dimension, but accounting students sort the errors in 3 Accounting research has characterized two patterns of knowledge structure for internal control: transaction flow, a schematic representation in which high-level categories represent major sequential steps in a transaction cycle and lower level categories comprise detailed sequential steps in a sub-process, and control objective, a taxonomic representation in which high-level categories represent control objectives such as authorization or validity of transactions and lower level categories comprise the detailed steps in an accounting system that pertain to that control objective (Frederick, 1991). A third knowledge structure identified in the accounting literature, but not referenced in this study, is transaction cycle, in which categories correspond to accounting sub-systems such as purchasing or revenue.
ways that corresponded to neither an audit objective nor a transaction cycle dimension. Tubbs (1992) found that as auditors gained experience, audit objectives became more salient to them, suggesting that the knowledge structure of audit objective developed with experience. Similarly, Libby and Frederick (1990) determined that experienced auditors had a well-defined audit objective dimension to their knowledge structure that inexperienced auditors did not have. Curtis and Viator (2000) found that computer audit managers also possessed more internal control knowledge structure dimensions and more extensively developed structural dimensions than computer audit staff. Given these findings, the ability of instruction to impart knowledge structure, as a surrogate for experience, might be helpful in the improvement of auditors’ ability to perform internal control reviews.

Research in education and psychology supports the effectiveness of instruction in the acquisition of knowledge structure (Champagne, Gunstone, & Klopfer, 1985; Chi & Rees, 1983; Day et al., 2001; Kozlowski et al., 2001). In accounting, Bonner et al. (1997) were able to inculcate knowledge structure related to financial statement errors in students, which they assessed through cophenetic correlations of card sorts. Their results suggest that these subjects applied their newly learned structure in an experiential learning task two days later. Other research has found that exposure to concepts presented in a particular order may be enough to impart structure. For example, in a study of auditors' retrieval of internal controls from memory, Frederick (1991) found that the order in which controls were presented to participants affected how they clustered their recall. These studies did not, however, evaluate different types of instruction. Kopp and O’Donnell (2005) demonstrated that those with no knowledge of a subject area develop structure as they gain knowledge of a task. If less-experienced auditors possess relatively poor knowledge structure (Frederick et al., 1994; Tubbs, 1992) or inappropriate knowledge structure for the task at hand (Ellifsen, Knechel, & Wallage, 2001), specially-designed instruction may be necessary to bridge the gap between the structure that auditors have and the structure they need to perform internal control reviews. Given the potential for explicit structure training to impart knowledge structure, we propose:

**H1:** Novice accountants receiving internal control instruction in a knowledge structure will exhibit greater internal control knowledge structure for the pattern of structure in which they were trained (transaction flow or control objective) than those receiving instruction with no structure orientation.

**Performance as a function of knowledge structure**

Several studies in accounting have explored the role of experience and training in improving task performance. The studies have not, however, indicated whether the cognitive psychology explanation of the mediating role of knowledge structure is a valid interpretation of the causal mechanisms. Accounting studies have explored the link between training and structure (Bonner et al., 1997) and between structure and performance (Bonner et al., 1996; Curtis & Viator, 2000; Dearman & Shields, 2001; Nelson et al., 1995), but a mediating relationship has not been demonstrated. To evaluate the effectiveness of structure training on performance through the effect of knowledge structure on performance, we propose, as depicted in Fig. 1:

**H2:** Knowledge structure mediates the relationship between knowledge structure training and performance.

**Compatible versus incompatible knowledge structures**

The existence of two knowledge structures relevant to internal control reviews, transaction flow and control objective, prompts the question of whether it matters which knowledge structure an auditor possesses. Past research suggests that knowledge structure-task structure compatibility can affect performance (Bonner et al., 1996; Nelson et al., 1995; Vera-Muñoz, 1998). Although compatibility of a problem representation and the analysis
approach for solving it has been associated with better performance for accountants with relevant domain experience (Vera-Muñoz et al., 2001), the effect of knowledge structure and context compatibility during creation of a problem representation is unknown.

The problem-solving literature suggests that, before they can solve a problem or make an inference, accountants must comprehend the business situation. Comprehension entails constructing a mental representation, or situation model, of the described state of affairs, which becomes the basis for situated action, the making of an inference or decision in context (Barsalou, 1999; Zwaan & Radvansky, 1998). Because individuals are actively trying to make sense of the situation, mismatches between incoming stimuli and one’s active knowledge structure make the assimilation process more difficult, reducing the selection and encoding of information and thus one’s ability to make inferences with the information (Kintsch, 1988). If one’s knowledge structure is incompatible with the way the context is presented, comprehension may be faulty, which may lead to inadequate situation models. Failures in constructing representations could occur whenever a significant amount of external information must be acquired from the problem context rather than retrieved from long-term memory.

Preparing for situated action, individuals seek information relevant to current needs and goals (Rumelhart, 1984; Greeno, 1998). To the extent one exists, the retrieved knowledge structure guides this active seeking. Elaboration, reading between the lines, is easier if the individual has knowledge of the task and the knowledge is organized in a form similar to that of the presentation of the context (Bower, Black, & Turner, 1979). When the pattern of an individual’s existing knowledge structure does not coincide with the structure of the problem context, mismatches between the structure of incoming data and the existing knowledge structure seem inevitable (Davis & Davis, 1998; Vera-Muñoz et al., 2001).

The extent of an individual’s knowledge structure also affects situation model construction. While building mental models of a situation, individuals with a relevant knowledge structure can assemble the model by first retrieving a relevant knowledge structure from long-term memory (Davis & Davis, 1998; Ericsson & Kintsch, 1995; Vera-Muñoz et al., 2001), whereas individuals without a relevant knowledge structure must construct their models essentially from scratch (Gernsbacher, 1997; Zwaan & Radvansky, 1998). Individuals with no or little existing knowledge structure would not be hindered by this incompatibility because their lack of knowledge structure precludes it.

Given the potential for an individual’s existing knowledge structure to enable the construction of situation models, we expect an interaction between extent of knowledge structure and compatibility of context and knowledge structures. Mismatches between knowledge structure and the structure of incoming data should interfere with high-structure individuals’ ability to select relevant information and map it onto their knowledge structures (Voss, Vesonder, & Spilich, 1980). Mismatches should not, however, interfere with low-structure individuals’ encoding of data because they have no pre-existing knowledge structures. Building their situation models from scratch, low-structure individuals should not be subject to the interference that those with
pre-existing knowledge structures experience. This relationship is the following hypothesis:

**H3:** Individuals with greater knowledge structure will exhibit enhanced performance in making inferences about internal control when their knowledge structure is compatible with the structure of the context; those with less knowledge structure will exhibit less performance differential.

**Method**

**Design**

The hypotheses were tested in a between-subjects design in an experiment in which participants made inferences about internal control based on situations in two different companies. For a portion of the sample, knowledge structure (transaction flow or control objective) was imparted through training, while control group participants did not receive structure-oriented training. Knowledge structure extent was assessed as the cophentic correlation of participants’ internal control sorts with the perfect grouping for each structure (transaction flow or control objective).

**Participants**

Participants were students enrolled in a senior-level accounting information systems (AIS) course. All students had taken junior-level courses in financial and managerial accounting. The number of participants by experimental condition appears in Table 1.

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group: structure untrained</td>
<td>56</td>
</tr>
<tr>
<td>Treatment group: structure trained</td>
<td></td>
</tr>
<tr>
<td>Transaction flow structure</td>
<td>72</td>
</tr>
<tr>
<td>Control objective structure</td>
<td>69</td>
</tr>
<tr>
<td>Total: structure trained</td>
<td>141</td>
</tr>
<tr>
<td>Total: all participants</td>
<td>197</td>
</tr>
</tbody>
</table>

Investigating the development of knowledge structure and its effect on performance requires research participants possessing knowledge structures sufficiently varied to permit the potential effect to be detected. Participants in the AIS course are ideal for this study because of its focus on the acquisition of knowledge structure by novice auditors. Using inexperienced auditors, such as senior-level accounting students, is more likely to let the inculcation of knowledge structure be apparent. To facilitate generalization to all areas of accounting and all firms, it is useful to employ participants who have not gone through firm training and thus have not been influenced by a particular firm’s approach to reviewing internal control.

**Procedure**

The experiment was begun during a regular class period at the beginning of coverage of internal control, at the midpoint of a course in accounting information systems. This timing was chosen so that participants would have an understanding of accounting systems and procedures but no systematic knowledge of internal control from the course. The protocol included three conditions: regular-classroom instruction with no structure training (control) and two forms of structure training (treatments). On a random basis, intact sections of the course were assigned to structure training or to the control condition. Within sections, sub-conditions were randomized across participants.

Participants in the structure-training conditions received an envelope containing the experimental materials. The consent form informed participants that the purpose of the experiment was to...
improve instruction on internal control. Participants completed the sequence of tasks shown in the right column in Fig. 2 for their condition.

In the two structure-training conditions, participants completed the following tasks in one session:

- Free sort 20 internal controls
- Receive regular classroom instruction on internal control (two weeks)
- Immediate performance: Read first internal control case and make inferences
  - Complete education and experience questionnaire
  - Free sort 20 internal controls
  - Receive debriefing

Four weeks after this session, participants received a second internal control case to read and make inferences on, followed by another debriefing session.

Fig. 2. Timeline of experimental tasks: control group and treatment group participants.
about it (immediate performance), completed an education and experience questionnaire (a distractor task), and free sorted the 20 internal controls again. Over the next two weeks, these participants received regular-classroom instruction on internal control.

At all times during data collection, one of the researchers was present to answer participants’ questions, but they were not allowed to communicate with each other. Participants proceeded through the tasks at their own pace. Debriefing included showing participants how to rearrange the sentences in their training materials and cases to transform them into the other order and discussing responses to the performance questions for the case. Participants were assured that neither order was privileged—they were just different organizations of the same text. Participants kept their training material, case, and case questions. Immediate performance scores of structure-trained participants were used to test H3 in order to obtain a fully-crossed design (2 x 2) with respect to structure training (two structures) and case structure (two structures).

In the regular-classroom protocol, participants completed the sequence of tasks shown in the left column in Fig. 2. They free sorted 20 internal controls on the first class day of coverage of internal control. On the last day of two weeks’ instruction in internal control, they read a case about a company’s purchasing policies and procedures, evaluated internal control in the case (immediate performance), completed an education and experience questionnaire (a distractor task), and free sorted the 20 internal controls again.

Four weeks after beginning the instruction, participants in all conditions (regular-classroom instruction and structure-trained) read a second internal control case about a company’s accounts payable system and evaluated internal control in the case by making 24 inferences about it (subsequent performance). The questions comprised 25% of the points on the final examination for the course, which was worth a fourth of the course grade. To avoid the possibility of privileging one knowledge structure over the other one, the case on the final examination had neither a transaction flow nor a control objective structure. Before they began the first experimental session, both control and treatment group participants were made aware that the final examination would contain a different case about internal control with the same kinds of questions. Thus, the motivation for students to work hard in the initial experimental session and in the regular instruction was that the first case was an integral part of their learning about internal control that would enable them to achieve a better course grade. Subsequent performance scores from all participants were used to test H2 because the test required structure-trained and structure-untrained participants, and this approach afforded control group participants the same performance practice as structure-trained participants on the immediate performance case. Because subsequent performance occurred four weeks after the end of all internal control instruction and structure training, we believe the test is stronger than one based on performance occurring sooner.

Materials and measures

The 20 controls that participants sorted were adapted from Frederick’s (1991) list of 33 internal controls from the purchasing cycle. The controls, listed in Appendix A by both knowledge structures, were presented in the form of a packet with each control printed on a different slip of paper. The first slip in the packet contained directions to

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6 Instruction was based on internal control coverage in the textbook Accounting Information Systems (Leitch, R. A., & Davis, K. R. Englewood Cliffs, NJ: Prentice-Hall). Like other textbooks for the course, its coverage of internal control had neither a transaction flow nor a control objective organization.

7 Although the immediate performance measure for the control group is not necessary for hypothesis testing, it is required to provide the control group with the same learning experience as the treatment group.

8 Because the training varied within course sections in the structure-training protocols as a function of which one of the two different structural forms participants received, the instructors of those sections were prepared to adjust students’ final exam scores to compensate for assigned conditions. Because performance did not vary as a function of training structure type, no score adjustments were required. The potential for unequal treatment did not arise in the regular-classroom protocol because there was no variation of the treatment within sections.
“put the slips into groups such that the internal controls go together in some way.” The directions also asked participants to write a name for each group on one of the blank slips provided at the end of the packet and attach it to the group. A random order for the controls was generated such that no two controls from the same transaction flow phase or the same control objective category were adjacent. A different random order for the 20 controls, with the same adjacency constraint, was generated for the second free sort (conducted with a second packet) that participants completed after the immediate performance case.

Each of the two versions of training material on internal control for purchasing functions consisted of five pages of text explaining typical purchasing policies and procedures and controls associated with them. The material presented concepts of internal control in the context of purchasing functions. One version was organized by the transaction flow phases of purchasing, receiving, accounts payable, and cash disbursement/reconciliation, while the second version was organized by the control objectives of accuracy, authorization, completeness, and validity. Except for transition words or phrases, the two versions contained identical sentences—only the organizations differed.

Each of the two versions of the case on which the immediate performance measure was based explained how one company conducted purchasing functions. Participants answered 24 questions requiring inferences about the strength of internal control in the company.9 One version of the case was organized by the transaction flow phases of purchasing, receiving, accounts payable, and cash disbursement/reconciliation, while the second version was organized by the control objectives of accuracy, authorization, completeness, and validity. Except for transition phrases, the two versions contained the same sentences.

For the subsequent performance measure, participants completed, four weeks after the last classroom session on internal control, an internal control case based on a conversation between company and auditor personnel about proposed changes to a company’s accounts payable system and related internal control issues. In order to avoid privileging either knowledge structure over the other, this case had neither a transaction flow nor a control objective organization—it was structure neutral. Participants read the case and made 24 inferences about the strength of internal control.

It is possible for effects of knowledge structure-task structure incompatibilities to arise at the point where a mental representation of the situation is created or at the point where the mental representation is applied to make a judgment. To permit distinguishing between these two effects, we varied both the structure of the case as explained above and the structure of the questions comprising the performance task on the case. Specifically, the questions were constructed to possess a transaction flow or a control objective knowledge structure and were manipulated within participants. For both cases, half the inference questions invoked a transaction flow knowledge structure, and half, a control objective knowledge structure. If a knowledge structure-task structure conflict occurs at the point at which the problem representation is applied to the performance task, participants should perform well on questions structured compatibly with their knowledge structure and less well on questions structured incompatibly. If, instead, a conflict occurs during construction of the mental representation of the situation, no performance differential should be associated with question structure.

Questions with a transaction flow knowledge structure posed an actual or potential activity from the company’s processes and asked participants to infer its most likely effect on internal control objectives, e.g.:

Not having separate purchasing and receiving functions could result in:

(a) incomplete invoice processing;
(b) unauthorized purchase orders;
(c) invalid receiving report quantities;
(d) errors during data entry.

Questions with a control objective knowledge structure posed an internal control objective and asked participants to infer the activity in the

9 The control objective version of the case and the 24 inference questions are available in Curtis and Borthick (1999).
transaction flow that would be the most consistent with achieving the control objective for the company, e.g.:

The best way to improve control over accuracy of transactions would be to:

(a) have vendors send their invoices directly to NYCCC for input and processing;
(b) improve data editing and validation by the regional computer software;
(c) review record counts for the transactions transmitted from the region to NYCCC;
(d) increase the frequency of creating backup files at the regional offices.

Questions alternated between the two structures. Participants received one of two orders of the questions: one order began with a question with a transaction flow structure and the other, with a question with a control objective structure.

Consistent with prior studies, knowledge content was measured and included in the analysis of the relationship between structure and performance in the test of H2 and in post-hoc analyses for H3. The measure for participants’ pre-training knowledge content was the average of their scores on the two examinations in the course preceding the experiment. The measure for participants’ post-training knowledge content was the average of knowledge-dependent questions on the final exam, completed in the same session as the second case (subsequent performance).

An education and experience questionnaire asked participants about their education and work experience and their reaction to the experiment. Because the participants might have taken an auditing course and thus have already studied internal control, the questionnaire contained specific questions about that course.

Cophenetic correlations

Each free sort grouping was coded into a 20 × 20 similarity matrix with a “1” for controls grouped together and “0” otherwise. Ideal transaction flow and control objective groupings, shown in Appendix A, were coded similarly. Cophenetic correlations (Sneath & Sokal, 1973) as employed in Frederick et al. (1994), Nelson et al. (1995), and Bonner et al. (1996) were computed for each participant by correlating the free sort groupings, made at the beginning of the experiment, to each of the two ideal patterns, one for the transaction flow structure and one for the control objective structure, as discussed in Choo and Curtis (2000). Similarly, cophenetic correlations were computed for the post-experiment control sort groupings. This resulted in four cophenetic correlation measures for each participant.

Results

Performance invariants

We performed analyses to identify any unexpected effects in the experimental manipulations for performance. There was no order effect on performance related to which form of the performance questions (transaction flow-structured question or control objective-structured question) appeared first in the alternating sequence (immediate performance $t = 1.58, p = 0.21$; subsequent performance $t = 0.173, p = 0.67$), which allows us to conduct subsequent analyses without regard to question order on the performance means appearing in Table 2.

There was also no significant performance difference between training structures for the two question structures (immediate performance: transaction flow $t = 0.47, p = 0.62$; control objective $t = 0.017, p = 0.98$; subsequent performance: transaction flow $t = 0.026, p = 0.97$; control objective $t = 0.635, p = 0.53$). This result means that performance of participants trained in one knowledge structure was comparable to that of participants trained in the other knowledge structure, which permits conducting subsequent analyses with a single total score for immediate performance and a single total score for subsequent performance.

Because some participants had taken or were taking an auditing course at the time of the experiment, we examined whether auditing course experience affected performance. There was no relationship between auditing course experience and performance (questions with transaction flow
structure: $F = 0.21, p = 0.81$; questions with control objective structure: $F = 1.19, p = 0.31$).

**H1: Effectiveness of structure training**

We tested the hypothesis that structure training is effective in imparting transaction flow and control objective knowledge structures by comparing participants’ pre-training and post-training free-sort groupings with the ideal cophenetic correlations for the two structures. Training would be successful if structure-trained participants’ post-experiment groupings showed significant improvement for the structure in which they were trained. To determine whether comparable structure improvements could be realized with regular-classroom instruction, we performed the same comparison for the control group of participants receiving instruction with no structure orientation (structure-untrained) and then compared the differences in improvement between structure-trained and structure-untrained participants.

As shown in Table 3 (Panel A), structure-trained participants exhibited significant improvement in knowledge structure for the structure for which they were trained. For participants trained for transaction flow structure, the mean improvement was 0.088 ($t = 3.68, p < 0.001$). For participants trained for control objective structure, the mean improvement was 0.208 ($t = 6.91, p < 0.001$).
For structure-untrained participants (Table 3, Panel B), transaction flow structure decreased by a mean of 0.137 ($t = 5.30, p < 0.001$), and control objective structure increased by a mean of 0.053 ($t = 2.01, p = 0.05$). To demonstrate that structure training is associated with greater structure improvements than regular-classroom instruction, we compared the differences in mean changes (Table 3, Panel C). For transaction flow structure, structure-trained participants improved significantly more than structure-untrained participants, with a mean difference of 0.225 ($0.088 - (-0.137)) $ ($t = 6.36, p < 0.001$). For control objective structure, structure-trained participants improved significantly more than structure-untrained participants, with a mean difference of 0.155 ($0.208 - 0.053$) ($t = 3.74, p < 0.001$).

From these results, we conclude that participants can be trained for structure knowledge and that the resulting structure is greater than that achieved through regular-classroom instruction. These results support H1, that training specifically designed to impart knowledge structure will result in greater development of knowledge structure than training with no structure orientation.

**H2: Knowledge structure as a mediating variable between training and performance**

Hypotheses 2 proposed that knowledge structure mediates the relationship between structure training and performance as depicted in Fig. 1. We tested the hypothesized mediation with Holmbeck’s (1997) strategy of using regression results to satisfy Baron and Kenny’s (1986) four conditions for mediation. For the structure measure for structure-trained participants, we used the post-training cophenetic correlation for the structure for which they were trained. Table 3 (Panel A) shows the means by trained knowledge structure. For structure-untrained participants, we used the larger of their post-training cophenetic correlations. Table 3 (Panel D) shows the means by structure. The performance measure was the subsequent performance measure (Table 2), which was participants’ score on the second internal control case. We included post-training knowledge content (Table 2) as a covariate in the regressions to adjust for its effect on performance (Holmbeck, 1997).

The first condition for mediation, that the predictor knowledge structure training (yes/no) be significantly associated with the mediator knowledge structure, is satisfied in the regression in Table 4 (Panel A) in which structure training is significantly related to post-training knowledge structure ($F = 6.02, p = 0.007$). The second condition, that the predictor structure training be significantly associated with the dependent measure performance, is satisfied in the regression in Table 4 (Panel C) in which structure training is significantly related to performance ($F = 3.10, p = 0.039$). The third condition, that the mediator knowledge...
structure be significantly associated with the dependent variable performance, is satisfied in the regression in Table 4 (Panel B) in which knowledge structure is significantly related to performance ($F = 7.62, p = 0.003$). The fourth condition, that the predictor knowledge structure training have less of an impact on the dependent measure performance after controlling for the mediator knowledge structure, is satisfied by comparing the significance of the structure training variable in the regressions in Table 4 (Panels B and C). Structure training is less associated with performance when knowledge structure is controlled for (Panel B: $F = 1.65$, $p = 0.100$) than when knowledge structure is not controlled for (Panel C: $F = 3.10$, $p = 0.039$), which satisfies the last condition for mediation.

Finding that knowledge structure mediates the relation between structure training and performance supports H2 and offers an explanation for how structure training is related to performance. Structure training develops knowledge structure, which influences performance, which makes knowledge structure the generative mechanism through which knowledge structure training affects performance. The absence of interaction between the knowledge content covariate and the other independent variables suggests that knowledge content and knowledge structure are separate determinants of performance.

**H3: Compatibility effects associated with knowledge structures**

Hypothesis 3 proposed that participants with greater knowledge structure would perform better in the evaluation of internal control when their knowledge structure was compatible with case structure than when it was incompatible with case structure. Those with less knowledge structure would exhibit no performance differential. We tested the hypothesis in an analysis of variance on performance of structure-trained participants on the first internal control case (immediate performance, means in Table 5 (Panel A)). Participants were designated as high-knowledge structure or low-knowledge structure based on a median split on the individuals’ trained knowledge structures. Table 5 (Panel B) presents the contrast results (Buckless & Ravenscroft, 1990).

In the immediate performance task, half of the structure-trained participants received cases
structured compatibly with their structure training and half received cases structured in the opposite pattern from their structure training. As predicted, high-knowledge structure participants performed significantly better when the structure of the case they received was compatible with their structure training than when the case structure was incompatible with their structure training ($F = 3.89, p < 0.025$). On the other hand, there was no significant difference in performance ($F = 1.56, p < 0.12$) for low-knowledge structure participants. These results support H3.

Our theoretical discussion proposed that the knowledge structure-task structure performance degradation engendered by structure mismatches is caused by the development of incomplete mental models of the case situation. To rule out alternative explanations, such as that the degradation occurs when the model is used rather than when it is built or that the degradation is caused by a deficiency in one of the two structures, we employed two post-hoc analyses. First, to determine whether performance problems occurred at the point when the mental model is used, we evaluated performance by trained knowledge structure by question structure. There was no significant performance difference by question structure (immediate performance: transaction flow $t=0.47, p=0.62$; control objective $t=0.017, p=0.98$; subsequent performance: transaction flow $t=0.026, p=0.97$; control objective $t=0.635, p=0.53$). These results suggest that knowledge structure-task structure incompatibility problems did not occur at the point where participants applied a knowledge structure in the judgment task.

Second, we evaluated whether one structure was associated with superior performance. Performance was not significant as a function of the type of structure participants possessed, when the analysis was based on trained knowledge structure ($F(1,139)=0.22; p=0.64$) or when the analysis was based on participants’ higher structure score ($F(1,139)=0.720; p=0.488$). From a Duncan’s means test, the performance means (0.597 for transaction flow, 0.608 for control objective, Table 2) were not significantly different. This outcome is consistent with Bonner et al. (1997), who found that, for novices, the form of their knowledge structure was not related to their subsequent learning from experience or their ability to apply existing knowledge to a judgment task, and with Kopp and O’Donnell (2005), who found no significant effect for type of structure training on performance. The result is also consistent with Curtis and Viator (2000), who found that both types of structure were related to computer auditor performance in the evaluation of internal control.

**Post-hoc analysis of knowledge structure gains**

Other factors related to the development of knowledge structure during instruction include pre-existing knowledge content and structure. Studies in psychology and elsewhere have shown that individuals with greater pre-existing levels of knowledge content and structure leave training sessions with greater absolute levels of knowledge and structure (Champagne et al., 1985; Fiske & Dyer, 1985; Kraiger, Salas, & Cannon-Bowers, 1995; Waller & Felix, 1984). To instantiate these general findings in the context of internal control, we evaluated the impact of pre-existing knowledge structure and knowledge content on post-training knowledge structure.

Table 6 reports the effect of pre-training knowledge structure, knowledge content (average percent correct on two examinations preceding the experiment), and the presence/absence of structure training on post-training knowledge structure. The only significant interaction was between type of training (structured-trained and structure-untrained) and pre-training knowledge structure ($F(1)=11.10, p=0.001$), which is consistent with increased structure from structure training but no structure change from regular classroom training. There were significant effects for pre-training knowledge structure ($F(1)=24.66, p<0.001$) and pre-training knowledge content ($F(1)=4.77, p=0.030$).

The pre- and post-sort cophenetic correlations for the trained structures had a positive correlation coefficient of 0.55 ($p<0.001$), which supports the premise that “the rich get richer” in training contexts. But the correlation coefficient was negative ($-0.40, p<0.001$) between (1) the increase in the cophenetic correlation from the pre- to the post-experiment sort and (2) the pre-experiment
cophenetic correlation. Thus, although those with less initial structure exited training with less structure, on average, than those with greater levels of initial structure, the amount of improvement was actually greater for participants with less structure initially.\footnote{Pre-experiment cophenetic correlations may be biased upward because of the way they were constructed (the higher of the initial two values). Any reversion to the mean in post-experiment cophenetic correlations would bias against these results.}

Combined with previous analyses, a pattern of structure development can be identified. Those entering the structure training session with greater knowledge structure and content departed the training experience with greater knowledge structure than those entering the training session with less knowledge structure and content. Those with less knowledge structure and content initially, however, exhibited greater improvements in knowledge structure than those with greater initial knowledge structure and content. This is consistent with learning curve theory (McNamara, Kintsch, Songer, & Kintsch, 1996), suggesting that greater learning occurs for those lower on the learning curve and that learning tapers off with experience. Therefore, it appears that structure training is useful for those possessing structure initially and, more importantly, may be an effective approach for helping those with impoverished structures catch up.

**Discussion**

This study evaluated the relationship between structure training and performance in the review of internal control. Consistent with research in other fields, knowledge structure was associated with performance, which supports the premise that the more available knowledge is, the more usable it is in a judgment task. Structure-trained participants developed greater transaction flow and control objective knowledge structures than structured-untrained participants. A test of mediation demonstrated that knowledge structure mediated the relationship between structure training and performance.

Our results show that accountants can acquire either a transaction flow knowledge structure or a control objective knowledge structure through focused instruction that makes the knowledge structure explicit. We believe that the direct approach to structure training used here represents an improvement on Day et al.’s (2001) approach of permitting participants to infer knowledge structure in idiosyncratic ways through experience. Indeed, this study responds to the call for trainers to “present expert knowledge structures to trainees as part of the training paradigm” (Day et al., 2001, 1030). This study also improved on Day et al.’s (2001) design by assessing knowledge structure before and after training. Day et al. (2001) had only a post-measure, which precluded examining how knowledge structures changed during training. Although the extent of knowledge structure was associated with performance in making inferences about internal control, the particular form of the knowledge structure, i.e., transaction flow or control objective, was not associated with performance. This result is consistent with Bonner et al.’s (1997) results for inexperienced financial auditors, Kopp and O’Donnell’s (2005) results for accounting principles students, and Curtis and Viator’s (2000) results for computer auditors.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>df</th>
<th>F</th>
<th>p (1-tail)</th>
</tr>
</thead>
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<td>Pre-training knowledge structure</td>
<td>1.016</td>
<td>1</td>
<td>24.66</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pre-training knowledge content</td>
<td>0.196</td>
<td>1</td>
<td>4.77</td>
<td>0.030</td>
</tr>
<tr>
<td>Structure trained (yes/no)</td>
<td>0.009</td>
<td>1</td>
<td>0.211</td>
<td>0.647</td>
</tr>
<tr>
<td>Interaction: structure trained (yes/no) ¤ pre-training knowledge structure</td>
<td>0.457</td>
<td>1</td>
<td>11.10</td>
<td>0.001</td>
</tr>
<tr>
<td>Error</td>
<td>7.906</td>
<td>192</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The performance degradation experienced by those with incompatible knowledge structure and case structure comprises further evidence of the need for effective means of imparting knowledge structure. To support the need for effective intervention in the development of knowledge structure, this research demonstrated the extent to which performance can be compromised by incompatibility between knowledge and task structures. By crossing two different knowledge structures in training and performance tasks, we provided insight into the potential performance problems engendered when an auditor does not have adequate structure or possesses a structure that is incompatible with the structure of a task. High-knowledge structure individuals were more impeded by incompatible knowledge and narrative structures than low-knowledge structure individuals. This result is consistent with the reading comprehension and expertise literatures—high-structure, but not low-structure, individuals are affected by incompatibilities between knowledge structure and narrative text structure. The particular type of structure for that knowledge, however, was not associated with performance of these less experienced participants on a structure-neutral task, which is consistent with Bonner et al.’s (1997) results for inexperienced auditors.

With respect to the effect of compatibility between knowledge structure and problem representation on performance, we reached a conclusion similar to that of Vera-Muñoz et al. (2001). That is, incompatibility between knowledge structure and problem representation degraded performance for participants with greater knowledge structure in a domain. A difference between Vera-Muñoz et al. (2001) and our study is that Vera-Muñoz et al. (2001) had no measure of the “mediating variables (knowledge structures and procedural knowledge)” (Vera-Muñoz et al., 2001, p. 423) while our approach measured them directly and performed a mediation test (H2) showing knowledge structure as the generative mechanism through which knowledge structure training improves performance.

The results are independent of whether questions in the performance task had a transaction flow knowledge structure or a control objective knowledge structure. This means that the performance degradation engendered by mismatches between participants’ knowledge structures and task structure arose at the point where participants were building their mental models of the situations represented in the cases. The results support the theory that knowledge structure facilitates the construction of a mental problem representation, particularly when the knowledge structure matches the case structure. Once participants had an adequate problem representation, the structure of the questions requiring them to apply that problem representation were relatively unimportant.

Two caveats of the experiment should be noted. First, research participants were seniors in a university accounting program. An advantage of using these inexperienced participants is that because they do not have high levels of knowledge structure initially, it is possible to assess the effects of structure training. Because the participants were inexperienced, we did not attempt to generalize the results to experienced auditors. The inability to generalize to experienced auditors does not threaten the applicability of the results to the inexperienced auditors that typically perform internal control reviews (Bonner & Pennington, 1991). Second, a potential limitation is the performance task, which asked participants to make inferences on specific aspects of an internal control system rather than characterize internal control strengths and weaknesses and their implications for fairness of financial reports. We selected the performance task to provide an objective measure of performance on internal control review based on participants’ constructed problem representations.

**Implications**

An implication of these results for practitioners is that auditors might be able to perform some specific audit tasks earlier in their careers if they received explicit training in the knowledge structures germane to the tasks. Accelerating the acquisition of expertise in auditors’ careers is desirable because of increasing demands for audit efficiency and effectiveness, growing sophistication of accounting systems, evolving demands for documentation of the adequacy of internal control prompted by the
Sarbanes-Oxley Act (US Congress, 2002), emerging real-time access to corporate databases (Wallman, 1997), and decreasing time horizons for performing audits.

Preparing accountants for their future careers could include ensuring they acquire appropriate knowledge structures, during college education and professional training. This would entail identifying relevant knowledge structures for the decisions germane to the topic under instruction, designing learning experiences that impart the desired knowledge structures, and ensuring that the instruction was effective. This approach might enable improvements in addressing several known problem situations resulting from the use of inappropriate knowledge structures for a task. For example, it might help auditors (1) avoid known judgment biases such as assessing the likelihood of error causes with non-additive probabilities, (2) adjust beliefs for hypotheses about causes of misstatements after eliminating a hypothesis (Asare & Wright, 1995), and (3) recognize the diluting effect that irrelevant information tends to have on the judgments of less experienced auditors (Shelton, 1999).

An implication for academicians and practitioners is the extension of these findings to working paper (WP) reviews. WP reviews share the situation model-building requirements of internal control reviews. Although most managers and partners reviewing WPs have developed firm-specific WP knowledge structures through years of experience with their firms, this is not always the case. For example, when firms merge, when upper-level auditors change firms, and when changes in audit processes lead to changes in the WP format, auditors’ knowledge structures could be incompatible with the resulting WP format. Such incompatibilities could increase the difficulty of performing adequate WP reviews.

An implication for practitioners of the success of our structure training is that the relative lack of feedback and thus limited opportunities to learn from experience might be overcome through appropriate instruction to acquire or enhance the relevant knowledge structures. In this study, novices were able, in about 2 h, to improve their knowledge structures significantly. Focused instruction of this kind might enable novice auditors to enhance their performance, particularly for tasks employing structures not typically developed in college. Accelerating task performance in an accountant’s career might enable organizations to achieve gains in efficiency and effectiveness.

In conclusion, the success of our knowledge structure training suggests it might be beneficial for college courses and professional training to incorporate explicit instruction for relevant structures to help novice accountants learn to think with task-appropriate structures whenever the need occurs. This kind of instruction ought to result in better prepared accountants with the potential to assume more responsible tasks sooner in their careers. Thus, it might be productive to investigate knowledge structures for tasks besides internal control review because of the potential for focused instruction in knowledge structures to improve performance.

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Appendix A

Internal controls by transaction flow

Purchasing

1. Purchase orders are authorized.
2. There are written authorization procedures and limits of buying power.
3. There is an approved list of suppliers.
4. Input control is adequate to ensure correct entry of data for purchase orders.
5. Purchase orders are accounted for.

Receiving

1. Access to receiving areas is authorized and controlled.
2. Access to recording goods received is restricted to those authorized.
3. Goods received are physically verified.
4. Receiving reports are accounted for.

Accounts payable

1. Invoices are matched to receiving reports.
2. Invoices are checked for prices, quantities, and mathematical accuracy.
3. Batch totals of invoices entered are compared to totals of invoices recorded.
4. Receiving reports are matched to purchase orders.
5. Invoices are matched to purchase orders.

Cash disbursement/reconciliation

1. Funds disbursers are authorized by the board of directors.
2. Funds disbursers review supporting evidence before releasing payments.
3. Aborted payments are marked to prevent their being treated as valid payments.
4. Paid invoices are effectively cancelled.
5. Assets are periodically inspected and reconciled to the records.
6. Payments are accounted for.

Internal controls by control objective

Accuracy

1. Input control is adequate to ensure correct entry of data for purchase orders.
2. Invoices are checked for prices, quantities, and mathematical accuracy.
3. Batch totals of invoices entered are compared to totals of invoices recorded.
4. Assets are periodically inspected and reconciled to the records.

Authorization

1. Purchase orders are authorized.
2. There are written authorization procedures and limits of buying power.
3. There is an approved list of suppliers.
4. Access to receiving areas is authorized and controlled.
5. Access to the means of recording goods received is restricted to those authorized.
6. Funds disbursers are authorized by the board of directors.

Completeness

1. Purchase orders are accounted for.
2. Receiving reports are accounted for.
3. Receiving reports are matched to purchase orders.
4. Invoices are matched to purchase orders.
5. Payments are accounted for.

Validity

1. Aborted payments are marked to prevent their being treated as valid payments.
2. Invoices are matched to receiving reports.
3. Goods received are physically verified.
4. Paid invoices are effectively cancelled.
5. Funds disbursers review supporting evidence before releasing payments.

References


