An Application of Contemporary Learning Theory to Online Course Textbook Selection

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Abstract

For most online classes, textbooks and printed materials remain the primary and preferred source of content. In a post-secondary environment of severe budget constraints, the application of contemporary learning theory to textbook selection and instructor-developed materials is an opportunity to improve online learning outcomes while simultaneously containing institutional and student costs. This may be particularly useful at the community college level, where the majority of online classes are offered and student backgrounds are most diverse. This article reviews the background of contemporary learning theory and shows how it can be applied to capitalize on the opportunity presented.

Keywords: online education, textbook selection, cognitive load theory, textbook cost, community college, instructional design cost, basic accounting education

Introduction

An important discovery of recent learning theory research, generally referred to as cognitive load theory, or CLT, has been the identification of universal cognitive constraints, and that an instructional method improves or degrades learning within these constraints (Kalyuga, 2009; Schnotz and Kurschner, 2007; Sweller, 1988; Sweller, van Merrienboer and Paas, 1998). In this author's view, important implications of these results can be overshadowed by sheer technological dazzle of Internet applications as well as the permutations of Internet media possibilities, often referred to as hypermedia. While implementation of well-designed multi-media applications and hypermedia can be productive and useful, research also shows that overuse or incorrect use can be dysfunctional (Chang & Ley, 2006; Eveland and Dunwoody 2001; Kalyuga, 2009). Further, improvident electronic media use may be encouraged by celebrated icons such as Bill Gates (ex-CEO of Microsoft) and Jack Welch (ex-CEO of General Electric) with a real interest in education but who promote the use of Internet technology itself as an inherent educational benefit, without careful evaluation of learning outcomes and cost constraints.

The focus of this case study is the improvement of online student learning outcomes (efficiency and achievement) by taking advantage of contemporary research results in a way that is easiest for instructors and that will not add to infrastructure or operating costs, and can reduce student costs. Possible secondary benefits may be the reduction in counter-productive use of Internet tools or more effective application of the tools. Progress toward these objectives can be accomplished by applying CLT research to what continues to be the content lynchpin in most online classes: the textbook (and instructor-developed material). The textbook, printed or digital, remains as the central instructional and reference tool in the distance learning environment, although most learners in online courses prefer a printed text or printed materials (Chang &Ley 2006; Precel, Eshet-Alkalai, & Alberton, 2009) and hypermedia can reduce learning compared to traditional print medium (Eveland & Dunwoody, 2001).

Evolution of Contemporary Learning Theory: A Brief Review

In the twentieth century, the first well known theorist is generally considered to be Lev Vygotsky, who is best known for theories about the convergence of thought and language, the zone of proximal development and the concept of scaffolding. Interestingly, both of the last two ideas remain today as elements in the application of cognitive learning theory. The zone of proximal development refers to a range of optimal learning with upper and lower boundaries that are a function of learner expertise and content difficulty. Scaffolding refers to the method of reducing instructional guidance as a learner progresses through material.

In the 1940's and 50's the work of B.F. Skinner created the behaviorist school of learning. Behaviorism is a focus on stimulus-response in a controlled environment, a key element of which is rapid reinforcement of desired behavior. An important educational development resulting from these ideas was the creation of programmed learning, which was incorporated into numerous textbooks. Information is presented in small steps called frames, and each frame includes a question. Immediate feedback is provided in an adjacent area to the frame, which the student uncovers. Agreement between the uncovered answer and the correct answer, which occurs in most cases, provides reinforcement. Incorrect answers are redirected back to the beginning of the process or other frames. The elements of small steps, immediate feedback, self-paced nature, and feelings of motivational reinforcement are effective and appear today as elements of cognitive learning theory. However, programmed learning itself encountered difficulties in application; as well, using a programmed learning text for reference or review was often difficult, and the system fell out of favor.

In 1956 two independent events created lasting effects on instructional training. The first was the development by Benjamin Bloom of what became known as Bloom's taxonomy. Bloom identified six hierarchical levels of knowledge (cognitive taxonomy), simple to advanced. This ultimately led to a second taxonomy for educators known as a taxonomy for learning. In general, the taxonomies probably became most useful as a framework of metacognitive processes for more motivated learners. The second, and currently more influential event, was the publication by George Miller of "The magic number seven plus or minus two: some limits on our capacity to process information" (Miller, 1956). This work showed that, with possible rare exceptions, human cognitive processing of new discrete elements of information is severely limited to the range of about seven simultaneous elements. This range later became known as a "chunk" and a foundation component in both concept and application of cognitive load theory.

Constructivist learning theory, a theoretical framework for the later development of a pedagogy called active learning, primarily views an instructor as an enabler or helper providing minimal guidance, rather than a source of information and control, while emphasizing learner control and "learning by doing". Examples of active learning elements are group and class discussions, learner-controlled discovery, students teaching other students, social context, and motivation. Today, active learning remains as an element of instructional design but is no longer a primary instructional approach because empirical research results never fully validated the theory, and because later cognitive empirical research demonstrated that constructivist-based teaching could in fact be very inefficient for novice learners (Kirschner, Sweller, & Clark, 2006; Mayer, 2004). Nevertheless, elements of active learning such as learning by doing (problem solving), the social and motivational aspects of learning, and to some extent learning styles, are still considered to be valid parts of the contemporary learning theory framework.

This brings us to cognitive load theory (CLT), which is now generally accepted as the predominant learning theory. The genesis of CLT occurred in the late 1970's when John Sweller (1982) at the University of New South Wales began examining the widely-used approach of using problem-solving as an instructional method and discovered that the means-end procedure usually required was demanding and highly inefficient. This subsequently led to numerous experiments that provided initial empirical results validating cognitive load theory (Sweller & Chandler, 1991). The fact that CLT and related princples derived from CLT have been empirically demonstrated and that these can lead directly to prescriptive instructional design methods has resulted in its wide acceptance and ongoing evaluation. CLT application, although comprising new ideas, also retains important elements of prior work such as feedback, chunking, and zone of proximal development; as well, it is not inconsistent with the application of other elements such as the social nature of learning and the effects of learner control in the learning process.

CLT in a Nutshell

CLT describes cognitive architecture as consisting of two kinds of memory that are necessary in order for explicit learning to occur: working memory and long-term memory. Working memory is a short-term memory that acquires sensory input and temporarily stores, manipulates, and analyzes information. Working memory retains only about 5-9 small elements (chunks) of information simultaneously for short periods of time. Long-term memory retains seemingly unlimited amounts of information for long periods of time and can be accessed by working memory, although long-term memory cannot perform the functions of working memory. Learning is an alteration of long-term memory. If there is no change in long-term memory, nothing has been learned. From an instructional design viewpoint, this learning results in an increase in some kind of expertise.

According to CLT, working memory creates a change in long-term memory by constructing what is called a schema, which is a combined group of individual elements that working memory synthesizes, treats as a single element, and with repeated review becomes long-term memory. As a person acquires new related information and integrates the new information, the existing schema grows and retained understanding deepens; however, the now larger schema is still treated as single element by working memory. The great advantage of this is that by recalling a large schema that is treated as a single element, working memory can accommodate a complex issue containing many interacting elements that individually would far exceed working memory capacity.

The cental CLT construct that relates to instructional design is cognitive load. Cognitive load refers to the mental effort that a learning or analytical task places upon working memory. A student's ability to comprehend material or perform a task depends upon the cognitive load imposed and mental effort exerted. Reseach has resulted in defining three types of cognitive load.

1. Intrinsic load: Intrinsic load is the inherent difficulty of a task relative to a student's level of expertise existing in long-term memory (Sweller & Chandler, 1994). If intrinsic load is too high (many elements interacting and/or too little expertise) or too low (few elements and/or excessive expertise), learning is impeded.

2. Extraneous load: Extraneous load is the unnecessary load created by incorrect design, application, and content of learning material, which force working memory to deal with distracting elements (Sweller & Chandler, 1994).

3. Germane load: Germane load is the working memory resource needed to create schema from individual elements for long-term memory acquistion (Sweller, 1998; van Merrienboer, 1997). Germane load is essential to learning because it both creates and automates the use of schema, but it is a use of working memory resources.

Together intrinsic, extraneous, and germane load are additive and should never exceed working memory limits. Therefore, to maximize efficiency and understanding the two CLT instructional options are optimizing intrinsic load relative to the learner (Kalyuga, Chandler, & Sweller,1998; McNamara, Kintsch, Songer, & Kintsch, 1996) while minimizing extraneous load.

Case Study Background and Environment

This case study evolved from the author's incremental application of CLT to his online and classroom Web-enhanced introductory accounting courses at the community college level. Experience with creating supplementary materials and making course design changes ultimately led to the development of a basic accounting text incorporating CLT features and structured writing methodology (Mostyn, 2007). CLT methods encompassed both printed text and online reinforcement. Data in the form of student evaluations are presented in this case study, with suggestions for implementing this approach in other courses and for possible more rigorous empirical evaluation.

Because of the Internet's unmatched accessibility, convenience, and quick access to immense resources, online course offerings and enhancements are growing rapidly at all educational levels. By Fall of 2007 nearly 22% of all students enrolled in degree-granting post-secondary schools were enrolled in at least one online course. However, the enrollment distribution is not uniform; although community colleges – associates degree institutions - teach about 37% of the college student body, more than one-half of the total online enrollment is at associate's degree institutions. (Allen & Seaman 2008). Yet, despite its advantages, online course delivery intrinsically creates a higher cognitive load, particularly for novice learners, and often high attrition. (Clark, R. 2003; Eveland and Dunwoody 2001; Kalyuga, 2009 pp.49-50,149-161; Stefano & LeFevre, 2007; Tyler-Smith, 2007) and therefore requires mitigating instructional strategies. In the author's view, this is a particularly critical issue for community colleges, which encompass a very wide range of student academic preparation, abilities, and economic and cultural diversity while also comprising a large proportion of the post-secondary population.

The challenges, not surprisingly, are availability and cost. From an institutional viewpoint, most college budgets are severely strained, and either incurring one-time departmental instructional design costs or adding to recurring Web maintenance overhead costs in any form is problematic. Therefore, the numerous schools for which additional enrollment does not result in excess funds available for development or for installation of adaptive systems that include online delivery such as developed by NCAT (National Center for Academic Transformation: http://www.center.rpi.edu/whoweare.html) and which do not want to become online correspondence schools driven by economies of scale, there may be severely diminished resources for new development as maintenance needs must be met first. Probably for most instructors the default strategy then becomes the selection of materials available primarily from textbook publishers. These decisions are likely to result in a further shifting of new instructional design and delivery costs to the students and an increased dependence on publishers.

Of course, we are all aware of the long-term trend in textbook prices and the burden this places on many students. This author at various times has been told by working students that they have had to limit courses primarily because of textbook costs or that they could not keep up because of limits on text availability in the library. The suggestions that follow result from the author's instructional design attempts to improve learning outcomes by reducing extraneous load and optimizing intrinsic load, not incurring additional organizational cost, and reducing student textbook and materials costs. This is done by focusing on the textbook and key instructor-developed materials.

The Expertise Reversal Effect in Adaptive Design

Fully adaptive instruction, meaning adapting instructional methods to accommodate individual learner needs for all learners, has been a longstanding, highly elusive, goal of educators. Clearly, complete success is made highly unlikely by three obstacles: correctly identifying learner needs, finding methods that demonstrably meet those needs, and providing financial resources to carry all this out. As well, learner needs that mediate instructional methods are not strictly academic, such as personal goals, motivation, family, work, financial, and health issues, and so on are variable and generally not identifiable. However, one of the later findings in CLT research makes it clear that educators can create a valuable adaptive benefit in the domain that is within their control. Research results called the "expertise reversal effect" (Kalyuga *et al.*) show that contrary to intuitive assumptions, more explanations are not always better or at worst neutral. For any given level of expository detail, the level of working memory load reverses with a learner's difference in level of expertise. For example, very detailed explanation or extensive repetition increases cognitive load and decreases learning efficiency for higher-expertise students, while it decreases load and increases efficiency for low-expertise students ("Expertise" generally refers to the level of knowledge, meaning schema, that a learner has developed for a particular task. Among students in this author's basic accounting classes, expertise differences could result from students' high school classes (some took bookkeeping), work experience, personal study, motivation, working memory processing speed and capacity, or learning disability, among other things.). Also, overloading working memory with unneeded guidance may reduce motivation (Schnotz & Kurschner (2007).

<u>Suggestion</u>

Use a text that is written to a level consistent with course objectives, but with a level of learner control that helps students move to a less condensed explanatory level, based on their expertise at identifiable points. This is most useful at points of critical knowledge or difficult comprehension. For example, in the author's basic accounting classes an understanding of adjusting entries is a challenge for many students early in the class and is a common point where students begin to fall behind. The reading material presents the topic at a typically condensed level with accompanying worked examples.

However, immediately following explanations and examples for each adjustment type, students are asked if they would like more explanation and practice, which they can access immediately with a few page turns. They are referred to another section where both content is segmented into smaller elements and explanations are simpler and more incremental, with a corresponding level of practice. Students can later return to the more condensed presentation. In effect, this addresses both the expertise reversal effect (more elaborative and incremental explanations) and reducing the intrinsic load of the material (more segmented design and later returning to the more condensed design). A student survey showed that 59% found the additional explanation and reinforcement either very or highly useful (see Appendix II for student survey results), not unexpected for a heterogeneous basic community college class, in which the majority of students do not speak English as their first language.

Notice that this is not programmed learning; students are not forced into content based on performance outcomes, and they can return to the enhanced material at any time, for example, after working problems (with solutions). However, learner control is also limited because the content is specific and progress is guided. If you feel that students should have more objective guidance, integrated periodic cumulative tests with solutions and text reinforcement location references based on specific topic outcomes can be included. Again, consistent with the expertise reversal effect, this is optional. Thirty-nine percent of students indicated that the feature was either very useful or highly useful. Finally, guidance at the beginning of a goal or section to read or skip based on past performance or interest is also useful.

Probably it will be difficult to locate a text containing all these elements. Established pedagogy and development costs are reasons, as well as the resulting printing cost for a larger book. Unfortunately, textbooks also often strive to maintain chapters of approximately equal length with inadequate attention to the inherent difficulty of a chapter or to the importance of earlier chapters as foundation content. What to do? Option 1: Use whatever text that you find is most acceptable. Option 2 (more ambitious): Find the least expensive text that provides the desired content and quality of exposition (see below) written to the normative course level. Identify what you believe are key locations for reinforcement, and then create the reinforcement that consists of a more detailed exposition level with practice. To incorporate the material into the course, place directions for use of the material as closely as possible in the syllabus to the related text assignment so that they can be easily identified at the appropriate point. An online syllabus could contain direct links to the content.

For physically integrating material with a textbook, explore alternatives for a low cost custom publishing service that will integrate content, and order low cost material, such as shrink wrapped pages for three ring binders. Another option is to use tutorial and practice software/Web resources. Keep in mind that these generally do not include much exposition, vary in quality, and often involve either a separate direct cost or a hidden cost as part of a higher textbook price. The greater the number of steps required to access the content and the greater its complexity and number of options, the greater the cognitve load.

Minimizing Extraneous Load

Since extraneous load on working memory is the unnecessary load caused by instructional design, a change in design elements that create this load presents a good opportunity to increase learning efficiency. For example, making design changes to reduce the expertise reversal effect as discussed above is a reduction in extraneous load. There are numerous other opportunities to reduce extraneous load. Some additional suggestions follow.

Writing structure

At one time or another most of us have seen a text that contains the "wall of words"; that is, continuous text with few paragraph breaks and no illustrations. This is a perfect example of what works only for advanced learners with substantial expertise. It is certainly not appropriate for novice learners.

Suggestion

Ideally, a text should follow the chunking principle. A single element of the instructional content should limit the related sub-elements, procedures, concepts, or steps in working memory to less than nine items before a new clearly identified element is introduced. If there are interacting elements within a complex concept, probably 4 to 5 would be a better limit. Any commentary, note, or "item of interest" will be an element. Visual elements add to working memory load. Therefore, be cautious about adjacent content that is intended to add interest, references, complex designs, and even illustrations. They are all elements that add to working memory within a particular topic.

For his own materials, this author chose to apply a system that is called structured writing, which not only applies the chunking principle, but also designs format according to a predefined taxonomy of content types. Finally, look for a substantial amount of white space. Here is an example from the author's materials: The introduction to the perpetual inventory method is a major topic. This is broken down into seven separate sections that consists of overview, cost of goods sold calculation, transactions for buyers, transactions for sellers, shipping and sales tax, a comparison table of journal entries, and ending inventory. The largest section contains eight sub-elements, the smallest, three. Every sub-element is clearly labeled for the reader, and no sub-element contains more than 6 items, including related diagrams.

So, the general rule is to look for element limits (chunking), simplicity, and segmentation by the use of white space. Another point to keep in mind is that design format matters most for beginners when element interactivity is high. Design is much less important when the content is simple. (Sweller, 2002). As a consequence, it is best to focus your review on essential foundation or complex content.

An interesting result of this type of design is that the text will look unusually simple; any feeling of “academic density” disappears. However, the page count increases. Some students at first are intimidated by the page count and the author has learned to advise students at the beginning of class that the reading will be easy and not to worry about the number of pages. Results from the student questionnaire confirmed the utility of this writing approach. Ease of use received the highest rating in all categories. Ninety-five percent of responses indicated that the text materials were either clear or very clear. This appears to at least support the structured writing approach, again considering that the majority of students did not speak English as a first language. Looking for these features when reviewing textbooks appears to be time well spent. Alternatively, creating your own materials and physically incorporating them with existing text materials as discussed above will probably produce even better results.

Illustrations and Diagrams

As a general rule, but depending on the nature of the content, illustrations are better than text for reducing cognitive load. This applies to objects (compare describing a simple object like a circle to showing one), processes, and procedure steps that can be shown in a table (step 1, step 2, etc.). However, there are load effects that need to be considered.

Suggestion

Consider the following issues when reviewing heavily-illustrated texts: If the related written content and the illustration are both required, i.e. they cannot be fully understood independently, the text should be placed adjacent to the illustration. If this is not done, extraneous load is created because mental effort is required to search for and then integrate the two elements. Empirical results demonstrate that least load is created and learning outcomes are best when key explanatory text is integrated within the diagram itself. (Mayer, Steinhoff, Bower, & Mars,1995). However, this should be evaluated carefully, because if the illustration or text can be understood independently, integrating the text into the illustration creates redundancy and increases the reader’s extraneous load (Chandler & Sweller, 1991). Finally, very simple and limited icon cues such as dots, stars, etc. may facilitate review. Again, this is not something that needs to be reviewed for every single topic within a textbook. Initially concentrating on key or complex topics gives the best bang for the buck.

Worked Examples

Cognitive load theory studies have repeatedly demonstrated that worked examples are a highly effective method of instructional design, improve learning outcomes, and reduce the significant load on working memory that is created by only assigning problems for practice. Therefore, for highly structured content such as the author’s basic accounting class, worked examples will be a clear benefit when used before problems are assigned (Moreno, 2006). Furthermore, the use of worked examples is particularly beneficial for novice learners and does not show an expertise-reversal effect for faster learners (Halabi, Tuovinen, & Farley, 2005).

Suggestion

Given this data, it makes sense to look for ample utilization of worked examples. In the author’s experience, many textbook designs incorporate worked examples into the content when presenting new topics, and perhaps at the end of chapters. Therefore it should be possible to obtain a text that includes this feature. However, usually a single worked example per concept or task is not sufficient. An instructor can clearly make a difference in learning outcomes by creating multiple worked examples for key concepts or tasks that students can access before attempting to complete problems. An effective way to do this is by utilizing the “completion problem effect” (van Merrienboer, Shuurman, deCroock, & Pass, 2002). This method acts as a bridge between worked examples and problem assignments. The method is simply to begin with a fully-explained example and then over a series of several similar examples require the learner to complete increasingly large elements of the problem (“fading”) which may also increase motivation as well as reduce cognitive load. A caution with worked examples: the utility of worked examples decreases sharply if the inherent complexity of an example creates an excessive intrinsic load on working memory. In this case, the example should be broken down into key component elements.

Another possibility is to present a series of problems related to the content with a solution immediately adjacent to each problem. Solved problems can function as worked problems, providing that the solution is complete and comprehensible. Solved problems with solutions in a different location may also function as worked examples, however cognitive load increases as the learner spends time searching for the solutions.

The worked example effect should be addressed not only within the context of textbook selection but also but also by taking advantage of the power offered by software and Internet tools. In his work, this author found that the development of accompanying algorithmic Web-based practice/graded tests was very productive for content delivery, not just assessment. While viewing individual practice test questions, students could always click to create a screen that immediately presented both the question and solution - hence, a worked example – and then click back to the problem to solve with new data, repeating as necessary. Students could then "fade" this procedure so that solutions were available only at the end of the practice test, and then retake (answer-until-correct) the missed questions. This, in effect, presents an extended series of worked examples with the learner controlling the extent of use, followed by problems with solutions. Ninety-two percent of students rated these online practice tests as "very or highly useful" for learning the course content. Some publishers are now offering system-graded algorithmic homework problems with practice problems that offer cues and answers along the way. These can function in a similar manner as above and be quite useful, although they will be broader and not as focused as designs that provide stand-alone questions with solutions; homework problems tend to be longer and a composite of concepts. Whichever your preference, it is important to ensure the comprehensiveness and clarity of the solutions. Explanations that are too condensed will not function effectively as worked examples for novice learners. Finally, Web-based tools tend to be easier to use than downloadable software because of compatibility issues, and also because Web-based tools are generally accessible from any location, whereas downloaded software is not.

Feedback

Most instructors appreciate the importance of practice and homework without needing to read research studies. What may not be quite so widely appreciated is the importance of feedback from practice. As discussed above, problem assignments ideally follow worked examples; however, problem assignments should provide feedback in the form of solutions. Students who practice with feedback perform better and have a more positive attitude toward the content than students who practice without feedback (Martin, Klein, & Sullivan, 2007).

Suggestion

When reviewing a textbook for adoption, evaluate the quantity and quality of explanations and solutions provided. This includes the solutions for system-graded homework features. Are only the solutions shown, with little accompanying explanation? For novice learners feedback should contain not only the answer, but also a procedural explanation of the problem solution ("rich" feedback). This type of feedback is statistically significantly more efficient for low-expertise learners than minimal feedback and does not create an expertise reversal effect (Halabi, 2006).

This data also creates some interesting questions regarding possible research for course design. What is the importance of assigning grades to homework compared to all feedback, or scaffolding feedback? In the author's basic classes only a few key homework problems were graded, all others were used for instruction and discussion, but not assessment, and detailed solutions were readily accessible to students. (Assessment was primarily weekly online quizzes, tests, and a project.). This design has not resulted in any identifiable difference in final grades or learning outcomes in higher-level transfer classes.

Learning Style

Individual learning style is a paradigm developed by constructivist theory that essentially argues that learning primarily depends upon relating to personal experience and following personal preferences, and should not be closely guided. Although there is significant lack of consensus concerning learning styles, this author decided to try story-telling as one element of early content. A three-part adventure that contained the same technical content as in the standard presentation was included. At the beginning of each story segment, the technical content was briefly outlined and students were informed that the story could be skipped and standard presentation of the same content followed on a specified page.

Nevertheless, 41% of the students reported that the stories were either very or highly useful, a surprising result even for basic classes.

Conclusion

Because textbooks remain the central source of content information for online classes, instructors should try to apply the research results of contemporary learning theory, primarily cognitive load theory, as an important part of making their book selections and in developing their own course content. This approach creates a great opportunity to improve learning outcomes while containing institutional and student costs. This case study provides one example.

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Appendix I: Methods Summary (and an example of text and tables in structured writing design)

Providing Content That Adapts to the Expertise Reversal Effect

Overview

The expertise reversal effect refers to the effect of exposition density on cognitive load. The effect is a function of the level of a learner's schema development and the level of explanatory detail. The load reverses as schema develops.

Principles

- Develop low intrinsic load supplementary material for low-schema learners that is targeted to the difficult, interactive course content and key foundation content.
- Allow learner control to access the supplementary material as needed.

Procedure

Step	Action		Example
1	Select a suitable textbook for course objectives.		Select a principles of accounting textbook at a quality standard level of exposition, practice, and review.
2	Create low intrinsic load material targeted to difficult, interactive, and foundation course content.		For the 5 key adjusting entries create expanded step-by-step content for each of the five types (with practice).
3	Incorporate material as follows:		
	IF you …	**THEN…**	
	do not physically integrate supplementary content into text	place directions for (optional) use in syllabus next to the related assignment, including page references.	Learner reads standard content on first adjustment type and may refer back to supplementary content at key points *if needed*, OR learner can first read supplementary content.
	physically integrate supplementary content and page references into text,	use a low cost custom publishing service. Delivering three hole shrink-wrapped pages for three ring binders further reduces student cost.	Learner reads standard content on first adjustment type and may refer back to supplementary content *if needed* by using integrated page references at key points, OR learner can first read supplementary content.
	want greater learner control,	learner decides if review is necessary based on reading and practice.	Learner studies prepaid expense adjustments, does not fully understand; therefore, uses supplementary material reference. Learner skips other enhanced content
	want more objective guidance/control,	integrate cumulative self-tests with feedback into content. Feedback includes references to supplementary material by key topic.	Learner completes test on all adjusting and closing entries types and sees low scores on accrual entry and depreciation type adjustments. Uses review references provided.
4	Evaluate tutorial software/Web resource to ensure that it reduces cognitive load for both high and low-schema students, or is appropriately targeted.		

Other Techniques for Minimizing Extraneous Load

Overview

Extraneous load is the unnecessary cognitive load created by poor instructional design. For example, the expertise reversal effect can result in a mismatch between student expertise and the level of detail of expository content. The following material summarizes five other important elements for minimizing load. These are:

1. Writing structure,
2. Illustrations and diagrams,
3. Worked example effect,.
4. Feedback from practice,
5. Learning styles

Summary

Element	Principles
Writing Structure	● Structure matters most for low-schema learners. ● Carefully identify topics and non-text elements. ● Apply the chunking rule at all levels (topics/sub-topics/elements). ● Include ample white space. ● Expect page count to be greater than non-structured writing.
Illustrations and Diagrams (Including tables)	● Use illustrations and diagrams whenever possible to explain concepts, principles, and procedures unless text can be better and more quickly understood without an illustration or diagram. ● If the illustration requires explanatory text, the text should be integrated into the illustration. ● Do not create redundancy if either text or illustration is adequate.
Worked Examples	● Utilize multiple worked examples, each focused on key points. ● Worked examples are especially useful for novice learners and do not create an expertise reversal effect for more advanced learners. ● The more concepts or procedures in an example, the greater the intrinsic load created. ● Worked examples can be integrated with online practice problems, according to how solutions are presented. This can include a “fading” procedure.
Feedback from practice	● Practice should follow worked examples ● Students who practice with feedback perform better and have more positive attitudes than students who practice without feedback. This should be considered for both non-graded and graded assignments. ● “Rich” (fully explanatory) feedback is especially important for novice and low schema learners.
Learning Styles	● Although there is a lack of empirical consensus about learning styles, course design that addresses a different learning style may prove useful. (Examples are including story-telling in text and integrating small group practice with lecture.)

Appendix II: Student Survey Summary

Response size: 124 (8 classes)

	Not necessary for me	Somewhat useful	Very useful	Highly useful and I reviewed them more than once
The extra reinforcement for additional help and practice were:	8%	33%	40%	19%
How useful are the online practice quizzes in *learning* the material?	4%	4%	19%	73%
How useful were the stories to you?	24%	35%	31%	10%
How useful were the book's cumulative tests for you?	27%	34%	25%	14%
	Confusing and unclear	Somewhat understandable	Clear and generally understandable	Very clear and understandable; easy to follow
What is the overall clarity of the book?	--	5%	43%	52%

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