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Expertise reversal effect in using explanatory notes for readers of Shakespearean text

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Abstract The reported study compared the instructional effectiveness of Modern English explanatory interpretations of Shakespearean play extracts integrated line by line into original Elizabethan English text, with a conventional unguided original text condition. Experiment 1 demonstrated that the explanatory notes group reported a lower cognitive load and performed better in a comprehension test than the control group when students had no prior knowledge of the text. In Experiment 2, a reverse effect occurred when the same material was presented to a group of Shakespearean experts. Experiment 3 replicated the results of Experiment 1 using a different Shakespearean play. The study demonstrated that the relative effectiveness of instructional conditions depended on learner levels of expertise. In accordance with the expertise reversal effect, the benefits of guided instruction reversed and became detrimental for learners with high prior knowledge levels. Retrospective verbal protocols indicated that the explanations were redundant for expert readers.

Keywords Cognitive load theory · Expertise reversal effect · Redundancy effect · Shakespearean texts · Explanatory notes

Introduction

The expertise reversal effect suggests that instructional methods and procedures that are beneficial for novices may become ineffective for more experienced learners (for a recent overview see Kalyuga 2007). This effect has been consistently replicated using materials in well-structured technical domains (e.g., Kalyuga et al. 2000, 2001; Reisslein et al. 2006). The aim of this study was to investigate whether the expertise reversal effect could be

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applied to a non-technical humanities-based domain such as complex literary text comprehension.

The study used the classical Shakespearean texts that are included in school curriculum across English speaking nations. Although these texts were written for performance, they are not always studied as such, and frequently the texts are read around the class whereby the focus is not dramatic but literary. The textual complexity of Shakespearean verse arises out of its Elizabethan English language, poetic composition, and allusions to religion and mythology. Shakespearean texts are usually filled with classical references and complex imagery communicated through a language that is different from Modern English. Comprehension of these texts is difficult due to many interactive elements of information that must be processed simultaneously in working memory.

Working memory is very limited in duration and capacity (Baddeley 1986). These limitations may cause comprehension problems while reading intrinsically complex texts. The sheer number of elements that readers are expected to combine together and process simultaneously can easily overwhelm working memory capacity and lead to cognitive overload. This is especially common when readers encounter unfamiliar terms and gaps in information or details in a text for which they do not have sufficient prior knowledge. Conventional modes of presenting Shakespearean texts are either minimal or require readers to consult disparate sources of information: footnotes, endnotes, and other supplementary literary sources. Traditional methods of learning such texts may impose high levels of unnecessary cognitive load due to learner cognitive activities involved in search for meaning. This extraneous cognitive load could be further exacerbated by split attention as students search through endnotes or refer to footnotes.

Effective construction of meaning requires linking new information with existing knowledge structures. In reading comprehension, explanatory notes can create a bridge between readers' prior knowledge and new concepts they may encounter in a text. For example, studies by Voss and Silfies (1996) found that expanding fictitious historical texts improved their comprehension as the textual expansion unpacked details that would otherwise have needed to be inferred based on readers' prior knowledge. Also, Britton and Gülgöz (1991) found that free recall was enhanced by rewriting text to minimize necessary inferences.

This study investigates the benefits of direct explanations that are integrated beneath each line of the original Shakespearean Elizabethan English text to reduce split attention. It was expected that the provision of explanations and textual simplifications (through the use of basic Modern English translations) would aid students' understanding. The integrated explanatory notes were compared with a traditional unguided text condition using learners with different levels of expertise in Shakespearean texts.

Instruction may not be beneficial for learning when it is either too easy or too difficult and not appropriately matched to levels of learner experience. Wittwer et al. (2008) studied instructional effects of experts' underestimation and overestimation of laypersons' knowledge relating to the use of computers and the internet. High-level knowledge explanations given by experts overwhelmed laypersons and resulted in low level of learning, whilst explanations that required low levels of knowledge did not benefit laypersons either.

In this paper, integrated explanations were expected to alleviate extraneous cognitive load for novices, although they could become redundant for more experienced readers. People with expertise in the area of Shakespearean literature usually spend many years of study evaluating various textual theories and criticisms. They have their own high level mental representations of the text meaning on literary, metaphorical, social, and historical

levels. As a result, subjecting these experts to reading integrated basic explanations and modern modifications of the text may in fact hinder rather than assist their comprehension. The redundancy effect (Chandler and Sweller 1991) usually occurs when sources of information that may be understood in isolation are integrated or presented to learners simultaneously, forcing them to process unnecessary information. Redundant information may have negative consequences for learning as it consumes cognitive resources that could otherwise be applied to enhance learning of essential information. The degree to which information is useful or redundant depends on levels of learner expertise. If learners are experienced enough to no longer need instructional guidance provided by examples, diagrams, or explanations, such instructional aids could become redundant and result in an expertise reversal effect (Kalyuga et al. 2003). Previous studies in technical domains have found that integrated direct instructional guidance could become redundant for more knowledgeable individuals. For example, experiments by Kalyuga et al. (1998) and Kalyuga et al. (2000) with technical trade apprentices found that integrated textual or auditory explanations that were provided simultaneously with visual diagrams were beneficial to beginning learners. However, after participants had undergone intensive training sessions, the explanations became redundant, and participants who received only the visual diagrams performed better.

Similarly, while integrated explanatory information may be beneficial for novice readers of Shakespearean texts, the same explanations could be highly inefficient for experts, especially when it is difficult to ignore this redundant information. As experts have already built a complex network of schematic structures that represent their unique understanding of a text, being reverted back to simplifications of that very text may generate a cognitive discrepancy with expert understanding. For example, it may force the experts to question the accuracy of their own interpretations or cause frustration for the lack of more sophisticated details within the explanatory notes, thus generating an extraneous cognitive load that may hinder performance.

Studies with science texts by McNamara et al. (1996) have shown that by providing students with elaborative information in addition to core reading material may enhance learning as long as the additional information offers explanations of details and makes explicit inferences missing from the original text. However, coherent textual elaborations in the high school biology course designed to assist comprehension were found to have adverse effects for more experienced learners. The authors suggested that the more incoherent a text is, the more it compels these learners to engage in deeper levels of processing to infer the meaning.

The experimental materials described in this paper were designed to reduce the amount of inferences required of readers by adding explanatory information to original Shakespearean texts. It is assumed that the perception of text coherence may depend on readers' levels of expertise in the domain. Text that may appear incoherent to novices may in fact be completely coherent for experts. When compared with reading less coherent texts, the elaborative textual information may aid the reading comprehension of novice learners by reducing their need to inference. The reversal in the benefits of such texts for experts might be interpreted from a cognitive load perspective as the consequence of a redundancy effect.

Previous studies in reading comprehension within a cognitive load framework by Yeung et al. (1998) and Yeung (1999) investigated the effect of integrated vocabulary definitions for expository literature using basic comprehension tests. It was expected that by placing definitions close to target words, the extraneous cognitive load resulting from spilt attention would be reduced. To test this assumption, cognitive load was measured using a subjective rating scale. The participant groups ranged from primary school students to

adults. A series of experiments demonstrated that less knowledgeable learners benefited from in-text definitions while a reverse effect was observed for more knowledgeable readers for whom the definitions were redundant.

Yeung et al. (1998) used basic-level primary texts and focused on a partial integration of singular definitions placed next to target words rather than on fully integrated coherent clauses. This paper investigates whether a similar effect could be observed using more complex texts. Furthermore, as the previous studies used students at different levels of expertise, this paper uses an elite group of experts to demonstrate an expertise reversal phenomenon. Additionally, while most studies in a cognitive load framework used subjective ratings scales to evaluate levels of cognitive load, this study also analyzed participants' retrospective verbal reports. It was expected that participants' self-reports would expand our understanding of cognitive mechanisms involved in redundancy and expertise reversal effects by recording actual accounts of thought processes in comprehension.

The materials used in this study were extracts of character speeches from Shakespearean plays. These are complex literary texts with high levels of element interactivity and associated intrinsic cognitive load. Based on cognitive load theory, it is possible to hypothesise that (a) explanatory notes in an integrated form would be beneficial to readers with little or no background knowledge of the selected Shakespearean plays as this format would facilitate comprehension by reducing split attention and extraneous cognitive load; (b) integrated explanatory notes would be redundant for more knowledgeable readers and interfere with their comprehension (an expertise reversal effect); and (c) the expertise reversal effect would be due to cognitive load factors as explanatory notes would engage experts in mental cross-checking of their understanding of the text with the offered explanations thus increasing extraneous cognitive load.

To test these hypotheses, three experiments were conducted. For each experiment, participants in a control group received an extract of original unaided Shakespearean verse and were encouraged to find out their own literary interpretation of this text. Participants in an experimental group were given a format where Modern English translation and explanatory information was embedded line by line beneath Shakespeare's Elizabethan English language. The learning materials were sufficiently complex to identify differences in comprehension between expert and novice learners.

Experiment 1

Experiment 1 was designed to determine whether explanatory information would assist low prior knowledge students in comprehending a complex literary text. The explanatory material used in this study was a simplified contemporary Modern English translation of an extract from Shakespeare's *Othello* which was integrated line by line directly beneath each line of Shakespeare's original Elizabethan English text (Fig. 1). It was assumed that the integrated textual additions would work on a lexical level by decoding difficult words and placing translations and explanations of metaphors and classical references in the fluid context of contemporary sentences rather than poetic verse. Cognitive load theory suggests that learning may be enhanced when two mutually referring sources of information are physically integrated to reduce the extraneous cognitive load due to split attention (Chandler and Sweller 1991, 1992; Tarmizi and Sweller 1988; Mayer 1997; Mayer and Moreno 1998). The experimental format was compared with a conventional format of unaided Shakespearean text (Fig. 2).

In the play Othello gives his wife Desdemona a special handkerchief as a token of his love.
Later, when Othello asks Desdemona for the handkerchief, Desdemona can't find it.
After that Othello hears a man bragging about how a lover gave him a handkerchief.
Then Othello sees that the handkerchief is the one that he originally gave to Desdemona.
Othello goes to see Desdemona…

DESDEMONA *in her bed asleep; enter* **OTHELLO** *with a light.*
OTHELLO:
It is the cause, it is the cause, my soul,
(Desdemona's adultery is the cause that drives me to punish her,)
Let me not name it to you, you chaste stars:
(but I dare not say the word 'adultery' in front of the pure stars:)
It is the cause, yet I'll not shed her blood,
(because of her sin I must punish her, but I won't draw her blood,)
Nor scar that whiter skin of hers than snow,
(or scar her skin that's whiter than snow,)
And smooth, as monumental alabaster;
(Her skin is as smooth as a fine white tombstone statue.)
Yet she must die, else she'll betray more men.
(Although she is beautiful I have to kill her, otherwise she will betray more men.)
Put out the light, and then put out the light:
(I'll put out the light, then I will put out Desdemona's light by killing her:)
If I quench thee, thou flaming minister,
I can again thy former light restore,
(If I put out this lantern light I can easily relight it)
Should I repent me;
(if I change my mind,)
but once put out thine,
(but once I take away your life Desdemona,)
Thou cunning pattern of excelling nature,
(you excellent model of beauty and deception,)
I know not where is that Promethean heat
That can thy light relume:
(I don't know where the divine spark is that could relight your life.)
when I have plucked the rose,
I cannot give it vital growth again,
(When I kill you it will be like having picked a rose,
when the stem is broken I can't make the flower grow again,)
It must needs wither;
(It will wither and die.)
I'll smell it on the tree, [Othello *Kisses her*]
(I can smell you, like a flower, still alive on the stem.)
A balmy breath, that doth almost persuade
Justice herself to break her sword: once more:
(Your sweet breath almost persuades me not to carry out justice by punishing you. I'll kiss you once more.)
Be thus, when thou art dead, and I will kill thee,
And love thee after: one more, and that's the last,
(After you are dead be as beautiful as you are now and I will love you after killing you.
I'll kiss you for the last time.)
So sweet was ne'er so fatal: I must weep,
(There has never been anyone so sweet as you who is so dangerous, your beauty is deceptive. It makes me cry,)
But they are cruel tears; this sorrow's heavenly,
(my tears are merciless, because they don't change my mind. The sadness I feel is love.)
It strikes when it does love: she wakes.
(It is an act of love to discipline those that we care for. Desdemona is waking up.)

Fig. 1 Explanatory notes integrated with Shakespeare's original text used in Experiment 1

In order to prompt readers to process both the Elizabethan English and the Modern English texts together throughout the extract without skipping any sections, the integrated format made it difficult for novices to immediately recognise that the two texts were

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Put out the light, and then put out the light:
If I quench thee, thou flaming minister,
I can again thy former light restore,
Should I repent me: but once put out thine,
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Be thus, when thou art dead, and I will kill thee,
And love thee after: one more, and that's the last,
So sweet was ne'er so fatal: I must weep,
But they are cruel tears; this sorrow's heavenly,
It strikes when it does love: she wakes.

Fig. 2 Conventional format of original unaided Shakespearean text used in Experiment 1

different. It was expected that the stylistic distinctions between the two texts would not be instantly apparent to the novices so they would not know with certainty that the texts were in fact separate. Also, in both the experimental and conventional formats, the verse numbers commonly adjacent to each line were removed because they did not serve any function in this experiment and could unnecessary detract learners' attention from the text. It was hypothesised that the experimental group with the integrated explanatory notes would outperform the control group without access to any explanatory material.

Method

Participants

Twenty students from a Year 10 English class at a co-educational Sydney metropolitan high school participated in this study. Although these students were proficient readers, they had yet to develop proficiency in reading complex Shakespearean plays to understand the poetic meanings and sophisticated imagery of the language of these texts. Despite having had some exposure to a select few Shakespearean text types, none of the participating

students had any prior knowledge or understanding of the play or materials that were used in this experiment.

Materials and procedure

The materials used in this experiment were based on an extract from the Arden edition of Shakespeare's *Othello*. This text was selected for its popularity as one of the most frequently chosen Shakespearean texts by high school teachers (Batho 1998, p. 165). The extract from *Othello* that was used in this experiment was the famous speech by Othello (5.2.1-22) in which he deliberates over murdering his wife Desdemona. This speech occurs at the climax of the play and represents the greatest pivotal moment in the entire portrayal of the character of Othello. Due to the dramatic tension of the given situation in the play, the speech is full of metaphors, double meanings, and poetic allusions. The combination of these factors results in high levels of element interactivity, making this speech very difficult to understand for untrained readers of Shakespeare. To assist students in comprehending this text, the original Shakespearean verse was simplified into contemporary English. Archaic Elizabethan English words were translated into Modern English; metaphors were decoded into basic literal sentences; and a range of multiple meanings for poetic allusions (according to numerous academic editions) were simplified into one selected interpretation. This elaborative explanatory information was placed under each corresponding line of the original Shakespearean text.

To ensure correctness of all explanations and translations, and their correspondence with both traditional and script-based approaches to teaching Shakespeare in schools, the materials were checked by three Shakespearean experts. An expert from the School of English at the University of New South Wales checked for literal accuracy. The second expert from the School of Media, Film and Theatre at the same university checked for accuracy from a theoretical and theatrical point of view. The third expert from Sydney's Bell Shakespeare Company verified the practical accuracy of the verse as it would relate to the corresponding character. The first two experts also consulted the development of pre- and post-test items.

The experiment included a pre-test phase, an instructional phase, and a post-test phase.

The pre-test phase was used to determine the level of participants' prior knowledge related to the play. As a part of the pre-selection process (only novices had to participate in the experiment), potential participants were screened for their familiarity with the play. They were asked to complete a 9-point Likert type rating scale to indicate their perceived prior knowledge of *Othello* (1 indicated no knowledge of the play, and 9 indicated a very high-level knowledge of the play). According to previous studies, subjective measures of self-perceived knowledge levels correlate sufficiently highly with actual tests of knowledge (Mayer and Moreno 1998; Moreno and Mayer 2002). All pre-selected individuals rated their knowledge of *Othello* as absent or very low.

Following the ratings, a short 8 min pre-test was administered to the whole group of participants to test their general knowledge and understanding of the play. The pre-test consisted of 8 multiple choice items that covered factual knowledge such as quotes from the play (e.g., *What was Brabantio's warning to Othello?*), literary devices (e.g., the 'double-time' scheme), participants' understanding of themes and character relationships (e.g., Iago's opinion of women). Most questions required participants to demonstrate in-depth analytical understanding of the cause and effect of events and character interactions as a means of prioritising some of the foremost topics and issues presented by the play.

Based on the results of the pre-test scores (out of 8), participants were ranked and divided into two groups of 10 students (according to even and uneven rank positions) with equal average pre-test scores ($M = 2.20$, SD = 1.14 for the experimental group and $M = 2.20$, SD = 1.03 for the control group). Thus, neither group had a prior knowledge advantage.

The instructional phase occurred 1 h later on the same day. Participants in both groups were instructed to read their extract at least twice within the allocated time of 7 min. A prior pilot study indicated that this was ample time in which even the slowest of readers could read through the text at least twice. Repeated reading was also expected to increase students' retention of information (Barnett and Seefeldt 1989). Instructional materials in both conditions included a brief introductory summary to activate the appropriate schemas by placing the extract within the context of the dramatic plot.

The post-test phase: Immediately after completing the instructional phase, subjective ratings of perceived learning difficulty were collected using a 9-point Likert scale ranging from 1 (extremely easy) to 9 (extremely difficult). Subjective ratings of learning difficulty have been successfully used in many cognitive load studies (Chandler and Sweller 1996; Kalyuga et al. 1998; Paas and van Merriënboer 1993, 1994) as these scores correlate highly with more sophisticated direct measures of cognitive load.

Following the ratings, participants received a booklet containing 10 short-answer questions based on the extract. Students were directed to work through each question one by one and not to turn the page to the next question until instructed. This encouraged students to attempt all questions and gave them a sufficient and equal amount of time to respond. The questions were aimed at evaluating various levels of comprehension. The evidence of literal comprehension was obtained by asking readers to recognise appropriate meanings for words, recall the plot, and summarise the main idea of the text. Collecting the evidence of higher levels of comprehension required readers to interpret or infer meaning from the text by making logical conclusions, describing relationships, and detecting implied character traits (Strain 1976).

From a textual perspective McNamara et al. (1996), refer to two levels of comprehension related to the microstructure and the macrostructure of the text. The microstructure operates on a semantic level associated with vocabulary and the context of words in sentences. Comprehension of the macrostructure is based on the understanding of how larger sentence units relate to one another and to the reader's prior knowledge. From the perspective of cognitive load theory, it is possible to associate the comprehension of microstructure with relatively lower levels of element interactivity, while comprehending macrostructure may result in high levels of element interactivity, especially for novice readers. These varied levels of text difficulty were taken into account when designing a mix of questions with different levels of complexity to differentiate between tasks that required higher and lower levels of cognitive resources.

Microstructure test questions required the reader to refer to information from small segments of the verse (microstructure) in creating a corresponding textbase representation. For example, to answer the question *How does Othello describe Desdemona's skin*? the reader needed to refer to only two lines of the extract:

Nor scar that whiter skin of hers than snow,
And smooth, as monumental alabaster
(*Othello* 2:5:4-5)

In contrast, macrostructure test questions required readers to draw information from a series of sentences (macrostructure) to build an overall understanding of the text on a more

global scale by constructing a situation model. For example, *Describe as many indicators as you can of Othello's love for Desdemona from the passage you have just read.*

Two Shakespearean experts who advised on the development of the reading materials were consulted to ensure that the questions were valid. The experts also provided their opinions about probable and legitimately correct answers that could be expected in a response to each item. Though literary texts are highly subjective, correct answers were based directly on what could be inferred from the extract given to participants.

The same amount of time was allocated to answering each of seven microstructure questions (1.5 min) and each of three macrostructure questions (2.5 min). According to the scoring procedure, the total score for all microstructure questions was a maximum of 10 marks, and the total score for all macrostructure questions was a maximum of 12 marks. For example, a microstructure question was *What does Othello say he won't do to Desdemona?* This question involved two components of the correct answer: (1) Othello wouldn't shed or draw Desdemona's blood, and (2) Othello would not scar or cut Desdemona's skin. Each of these components were allocated one mark, with maximum two marks allocated to participants who mentioned both.

Results and discussion

The variables under analysis were self-ratings of prior knowledge, subjective ratings of mental load, and post-test text comprehension scores for microstructure and macrostructure questions (pre-test scores were equated when separating participants into groups). Means and standard deviations are displayed in Table 1.

One-way analyses of variance (ANOVA) indicated no differences between groups (the 0.05 level of significance is used throughout this article) for self-ratings of prior knowledge, $F(1,18) = 1.00$, MSE = .050, $P = .331$. For subjective ratings of difficulty, the explanatory notes group reported lower levels of cognitive load than the conventional text group, $F(1,18) = 9.82$, MSE = 1.47, $P < 0.01$, effect size (Cohen's f with .10, .25, and .40, corresponding to small, medium, and large effects, respectively) 0.70. The explanatory notes group outperformed the conventional text group for both microstructure test items, $F(1,18) = 8.19$, MSE = 3.23, $P < 0.01$, effect size 0.64 and macrostructure test items, $F(1,18) = 19.15$, MSE = 1.04, $P < 0.001$, effect size 0.98.

The results of this study were consistent with the predictions made according to cognitive load theory. Test performance differences favouring the integrated explanatory notes group were significant for both microstructure and macrostructure questions indicating that novices clearly benefited from the explanatory notes presented in an integrated format. These comprehension differences between groups may have been reflective of cognitive

Table 1 Mean and standard deviations for Experiment 1

	Maximum score	Explanatory notes group	Original text (control) group
Knowledge rating scale	9	1.10 (0.32)	1.00 (0.00)
Ratings of mental load	9	3.70 (1.06)	5.40 (1.35)
Scores for microstructure questions	10	5.50 (1.78)	3.20 (1.81)
Scores for macrostructure questions	12	5.40 (1.17)	3.40 (0.84)

Note Mental load ratings were made on 9-point scales (1 = extremely easy, 9 = extremely difficult)

load as indicated by the difficulty ratings. Since this study focused on novice learners, Experiment 2 was designed to investigate differences between the same instructional formats with participants who had high levels of prior knowledge in Shakespearean texts.

Experiment 2

Experiment 2 used exactly the same materials and procedures as Experiment 1 with a qualitatively different group of participants. The same extract from *Othello* (5:2:1-22) was presented to participants in its original form in a control group, and with integrated explanatory information in an experimental group. The experiment aimed to compare the learning effects of these two instructional conditions for experts with high proficiency in reading Shakespeare's works.

According to the expertise reversal effect, instructional material that is essential for a novice may become redundant for an expert and interfere with the expert's reliance on available knowledge base in long-term memory. It was hypothesised that experts reading integrated explanatory information would be inclined to check its interpretive accuracy against their own understanding of the passage. The distraction caused by these processes would result in an extraneous cognitive load. On the other hand, the experts exposed to the Shakespearean verse alone were expected to assimilate and interpret the material without distraction. In this experiment, retrospective verbal protocols were collected from participants in both groups at the completion of the post-test phase to investigate the involved cognitive processes more directly.

Method

Participants

A sample of 22 Shakespearean experts participated in this study. Participants were selected based on professional merit and represented a highly skilled group of professional actors, directors, teachers, and academics from a range of universities and dramatic organisations in Australia and the United Kingdom. Participants represented varied avenues of specialisations according to their knowledge of the works of Shakespeare ranging from textual to dramatic and from practical to theoretical. At the time of the experiment, all participants were involved in performing, teaching, or writing about Shakespeare's works. They had used the text of *Othello* in their work either just prior or at the time of the experiment. It was assumed that all participants were familiar with the extract used in this study. However, none of the participants had seen the experimental material prior to the study.

Materials and procedure

The procedure included the initial pre-testing and pre-selection phase followed by an instructional phase, a post-test phase, and, finally, by a reporting phase that involved the collection of retrospective verbal protocols. All participants were tested individually at their own workplace offices or dressing rooms.

Because the study of Shakespeare is a very broad area, in order to investigate the expertise reversal effect, experts selected for this experiment were required to have a

genuine expertise and specific understanding of the text of *Othello*. Therefore, as a part of the pre-selection process, potential participants were screened for their familiarity with the play. All pre-selected individuals self-rated their knowledge of *Othello* as high to very high. The pre-test was identical to that used in Experiment 1 and its results were used in allocating participants to two groups with equal average pre-test scores ($M = 7.36$, SD = .81 for both groups) to ensure equal levels of prior experience.

The instructional and post-test phases were identical to those used in Experiment 1. The post-test in this experiment was followed by retrospective verbal reports. At the beginning of this phase, participants were asked for their permission to be audio recorded. Then they were asked to give a verbal account of their thought processes in relation to the instructional material by verbally responding to the following questions: *What was going through your mind as you were reading the extract? What were you thinking about? How do you think you were making sense of the information?* Participants were free to respond openly with no time limits imposed.

Results and discussion

The variables under analysis were self-ratings of prior knowledge, subjective ratings of cognitive load, and post-test performance scores for microstructure and macrostructure questions measuring text comprehension (pre-test scores were equated when separating participants into groups). Means and standard deviations are displayed in Table 2.

One way ANOVA indicated no differences between groups for self-ratings of prior knowledge, $F(1,20) = .071$, MSE = 0.64, $P = .792$. The explanatory notes group reported significantly higher levels of cognitive load than the conventional text group, $F(1,20) = 50.16$, MSE = 2.55, $P < 0.001$, effect size (Cohen's *f*) 1.51. The explanatory notes group scored significantly lower than the conventional text group for simple test questions, $F(1,20) = 15.16$, MSE = 2.03, $P < 0.001$, effect size 0.83, and macrostructure test questions, $F(1,20) = 47.64$, MSE = 2.48, $P < 0.001$, effect size 1.47.

Because expertise is continuously expandable, potential for learning in ill-structured domains is not constrained even when studying familiar texts. Whilst maintaining accord with textual context, experts may arrive at novel text connections or imaginative representations. For instance, a director may have a new idea for staging, or an actor may display an alternative reaction. However, the results of this experiment showed that experts' performance was adversely affected by explanatory notes presented in an integrated format. Post-test results clearly favoured the conventional group, and difficulty ratings indicated that performance differences between groups were related to levels of cognitive load.

Table 2 Means and standard deviations for Experiment 2

	Maximum score	Explanatory notes group	Original text (control) group
Knowledge rating scale	9	8.36 (0.81)	8.27 (0.79)
Ratings of mental load	9	6.55 (2.09)	1.73 (1.01)
Scores for microstructure questions	10	6.00 (1.34)	8.36 (1.50)
Scores for macrostructure questions	12	4.91 (1.87)	9.55 (1.21)

Note Mental load ratings were made on 9-point scales (1 = extremely easy, 9 = extremely difficult)

Retrospective verbal reports also indicated cognitive processing differences between the two groups. Common responses produced by participants in the conventional group reflected their prior knowledge elaboration processes and included text analysis strategies, imagination, and associations with prior experiences. All 11 participants in this group used text analysis strategies such as decoding metaphors, imagery and symbolism, for example, "*…I'm looking here at what the issue is, and then looking at the lines in terms of how they carry the issue forward*" (control group participant #12); "*…the first level is simply understanding the words, the sentences. The second level would be understanding the kind of the imagery patterns created by the colour scheme, the nature scheme*" (control group participant #14). Six participants in this group mentioned using strategies related to imagination or visualisation, for example: "*I imagine Othello speaking this monologue*" (control group participant #21). Six participants also made associative references to performances they had seen or to other related texts, for example, "*I was actually remembering having seen the recent Stratford performance, so it's partly an act of recollection in the context of performance or performances I've seen*" (control group participant #17).

Responses in this group were also very detailed and showed clear application of metacognitive analysis, for example, "*First of all, trying to make sense of the vocabulary and the grammar and the structure and understanding the imagery. So basic sense. Secondly, trying to keep up with the verse. So trying to see what Shakespeare's is doing with the rhythms of it, and how that affects the meaning and how that might indicate character state of mind and so forth. Thirdly, trying to reason through the intention of the character in the scene. So relate it back to the play and to my knowledge of the play and contextualise it and see what the character wants. And fourthly and finally, imagining it played out on stage. So trying to see how it might be staged, see how an actor might approach it. Imagine what an actor is physically doing at that time, particularly connected to Desdemona on the bed, and then I suppose assimilate all that at once really*" (control group participant #2).

Overall, comments made by participants in the conventional group suggested cognitive activities essential for furthering their understanding of the Shakespearean text. Conversely, responses in the explanatory notes group were indicative of extraneous cognitive activities. Participants in this group frequently referred to the explanatory notes as distracting, difficult to read, and frustrating. Preoccupied with these issues they were deterred from reflecting directly on the contents of the original text. Also, a common theme throughout experts' responses to the explanatory notes was textual cross-checking. This involved evaluating the accuracy and validity of the integrated explanatory information against their own understanding.

Seven (out of 11) participants in this group mentioned explicitly comparing or cross-checking the information in the explanatory notes with their understanding of the original text., for example, "*I just compared it [the explanatory notes] with what my opinions were.*" (explanatory notes group participant #1); "*I would read a line and then when I read the kind of contemporary English I was sort of in a way checking back against how it interpreted the Shakespearean language/to sort of see if it was a valid reading of the archaic language*" (explanatory notes group participant #8); "*My immediate response is, 'is that the interpretation that I would offer? Is that my reading of that line?' So I'm kind of hesitating taking a view on the version of the line that is being offered to me. So again that takes me away from the text. So I'm actually sort of thinking about that issue as I'm going into reading the next line*" (explanatory notes group participant #9). The latter response

demonstrates that the crosschecking process occupies the reader's cognitive resources and limits the attention devoted to each subsequent line.

These comments support the notion that redundant information does indeed lead to crosschecking, which is believed to cause the expertise reversal effect. Furthermore, seven participants mentioned that they either lost their reading flow or were interrupted by the explanatory notes, for example, "*I probably know this speech just about best of all probably by heart and so the glosses [explanatory notes] were interrupting the flow of my reading*" (explanatory notes group participant #7); "*…it interrupted the text and it interrupted my expectation/it interrupted my understanding of it*" (explanatory notes group participant #8). Five participants expressed experiencing difficulty reading as a result of the explanatory notes, for example, "*I just found them [the explanatory notes] quite hard to read*" (explanatory notes group participant #3). Two participants noted that they had opinions that conflicted with the information presented by the explanatory notes, for example, "*This is my own opinions conflicting with what's there which slows me down right. 'So sweet was ne'er so fatal'. I hesitate there because you gloss it with dignity, but/I read it as a stupid cliche*" (explanatory notes group participant #1).

Additionally, two participants stated that the explanatory notes were restrictive to the full scope of the original text's meaning, for example, "*I often find these explanations not satisfying, unsatisfying, because they give you one thing,/What's brilliant about Shakespeare is he's open to so many interpretations*" (explanatory notes group participant #3). Only one participant found that the explanatory notes contributed to his understanding, "*I never looked at a Shakespearean speech and really read it through with someone else's words before and I found that interesting and found it was well translated. I guess that helped me again see the logic of the thought process of Othello/Suddenly, I guess I never thought of it before, when she wakes he doesn't just rush into the act…*" (explanatory notes group participant #2)

In general, most participants in the explanatory notes group repeatedly verbalised concerns over extraneous activities mainly associated with the coordination of redundant and essential information. These participants also reported higher ratings of cognitive load. Together with post-test scores favouring the conventional group, these results indicated that the redundant explanations were detrimental to expert performance. When compared to the results of Experiment 1 in which explanatory information was beneficial to novices (the explanatory notes group scored higher in the post-test and reported lower cognitive load), the results of Experiment 2 indicated a direct reversal in the effectiveness of the explanatory notes format consistent with the expertise reversal effect. To provide further evidence for the effect, a follow-up experiment was designed with different participants and textual materials.

Experiment 3

Experiment 3 was designed to replicate the findings of Experiment 1 by using different instructional materials. According to cognitive load theory, extraneous cognitive load can be reduced by physically integrating mutually referring sources of information. Experiment 1 found that an explanatory notes format was beneficial to novices. The aim of Experiment 3 was to determine whether this effect could be generalised to different textual materials and another group of novices. Additionally, this experiment offered an insight into novices' cognitive processes through retrospective verbal protocols that could be compared with experts' verbal reports in Experiment 2.

Method

Participants

Twenty Year 10 students from an English class at a co-educational Sydney metropolitan high school participated in this study. The students had sufficient levels of general reading ability, but had yet to develop reading skills for complex literary texts. None of the students had previously undertaken any in-depth study of Shakespeare's *Romeo and Juliet*, though, due to the popularity of this particular play, most students were basically familiar with the story and had seen Baz Luhrmann's (Luhrmann and Martinelli 1996) contemporary cinematic adaptation of the text.

Materials and procedure

The reading materials for this experiment followed the same design formats as those in Experiments 1 and 2. An extract of a well known monologue by Juliet (3:2:1-31) from Shakespeare's *Romeo and Juliet* was used. Like *Othello*, *Romeo and Juliet* is one of the most popular texts selected by teachers due to its themes of youthful love to which teenagers often relate (Batho 1998). The selected extract presents some complex themes and metaphors that may be inaccessible to readers with little prior knowledge about the play without additional explanations.

All the explanatory information was placed in parenthesis and closely integrated line by line with the original verse to eliminate split attention and to minimise the possibility of reading the two styles of text separately from each other. The majority of the explanatory information was adapted from footnotes and endnotes of multiple editions of the play. As no single academic edition of a Shakespearean play contains notations for every line of verse, some additional references were used from a modern English text (Durband 2001). The material was preceded by a short introductory summary of the play to help readers activate the appropriate schemas by placing the extract within the context of the dramatic plot. The summary and the accuracy of all explanatory information, as well as all test questions (and legitimately correct answers) were cross-checked by two Shakespearean experts who had previously consulted the development of experimental materials for the *Othello* passage.

The same experimental procedure as that in Experiment 2 was used in this experiment. It included the pre-test, instruction, post-test, and reporting phases. The first three phases were conducted simultaneously with both groups. The reporting phase was conducted by interviewing participants individually immediately after the post-test phase.

In the pre-test phase, all participants were first asked to rate their perceived prior knowledge of *Romeo and Juliet* on a nine-point scale (from no knowledge to a very high knowledge level). All individuals selected for the study self rated their knowledge of the play as absent or very low. The pre-test was structurally similar to that used in the previous experiments and consisted of 8 multiple choice items. Participants were divided into two groups of 10 with equal pre-test score averages ($M = 2.40$, $SD = 1.27$ for the experimental group and $M = 2.40$, $SD = 1.84$ for the control group).

In the instructional phase, 7 min were allocated to reading the material (an ample amount of time for a novice to read the text at least twice, according to a pilot probe). After the allocated reading time expired, participants rated their perceived difficulty of the reading materials for understanding on a scale from 1 to 9.

A short-answer booklet consisting of twelve microstructure and macrostructure questions was used to test students' understanding of the instructional material. As in previous experiments, the same amount of time was allowed for participants to answer each of nine microstructure questions (1.5 min) and each of three macrostructure questions (2.5 min). According to the scoring procedure, a maximum score of 13 could be allocated for correct answers to all microstructure questions, and a maximum score of 16 could be allocated for correct answers to all macrostructure questions. The post-test was followed by the reporting phase that was similar to that used in Experiment 2. Although no time caps were placed on participants' reports, only randomly selected five participants from each group were interviewed due to class time constraints.

Results and discussion

The variables under analysis were self-ratings of prior knowledge, subjective ratings of cognitive load, and post-test performance scores for microstructure and macrostructure questions measuring text comprehension (pre-test scores were equated when separating participants into groups). Means and standard deviations are displayed in Table 3.

One way ANOVA indicated no differences between groups for self-ratings of prior knowledge, $F(1,18) = .16$, MSE = .33, $P = .696$. The conventional text group reported significantly higher levels of cognitive load than the explanatory notes group, $F(1,18) = 16.81$, MSE = 2.01, $P < .001$, effect size (Cohen's f) 0.92. The explanatory notes group scored significantly higher than the conventional text group for microstructure test questions, $F(1,18) = 7.30$, MSE = 2.47, $P < .05$, effect size 0.60, and macrostructure test questions, $F(1,18) = 5.88$, MSE = 2.76, $P < .05$, effect size 0.54. Thus, post-test performance results favoured the explanatory notes group, and this superiority was achieved with lower levels of cognitive load.

Participants' retrospective verbal protocols indicated distinct differences in cognitive processes between participants who studied different instructional formats. The majority of participants in the explanatory notes group reported that the explanations were helpful. All five interviewed participants in this group mentioned that the explanatory notes helped their understanding of the text, for example, "*…it helped me because it put things into my own words…*" (explanatory notes group participant #1). The responses in the explanatory notes group were in line with the group's lower ratings of mental load suggesting that participants in this group experienced a lower level of cognitive load.

Common responses of the interviewed participants from the conventional group were in correspondence with their higher cognitive load ratings. Three participants expressed a lack of understanding of the Shakespearean verse as a result of reading the conventional

Table 3 Means and standard deviations for Experiment 3

	Maximum score	Explanatory notes group	Original text (control) group
Knowledge rating scale	9	1.20 (0.42)	1.30 (0.68)
Ratings of mental load	9	3.70 (1.25)	6.30 (1.57)
Scores for microstructure questions	13	4.80 (1.81)	2.90 (1.29)
Scores for macrostructure questions	16	3.80 (2.15)	2.00 (0.94)

Note Mental load ratings were made on 9-point scales (1 = extremely easy, 9 = extremely difficult)

text format, for example, "*I kind of like went back and just looked at over the information, but I don't know, I didn't really understand it*" (control group participant #10). Two participants tried to use their prior knowledge of a screen adaptation of the text, for example, "*Well I usually um pictured it in the um movie and, yeah I was just thinking about how most characters were portrayed in their different positions, and that's about it*" (control group participant #6).

In summary, Experiment 3 expanded the findings of Experiment 1 by using new material with a different group of novices. The significance of these findings is clear when compared with the results from experts in Experiment 2 in which the explanatory notes group indicated a higher level of cognitive load, scored lower on post-test results, and generated verbal comments that were reflective of increased extraneous activities. On the other hand, the post-test results and verbal reports by experts in the conventional group showed evidence of enhanced learning and reduced extraneous activities. When viewed in light of results of Experiments 1 and 3, the results of Experiment 2 provide evidence of an expertise reversal effect in literature learning. Integrated textual explanations that are beneficial for novices become redundant for experts and interfere with their understanding and performance.

General discussion

According to cognitive load theory, duration and capacity limitations of working memory may greatly impact the amount of information a reader can process at any given time. Shakespearean texts were chosen for the experiments reported in this paper due to their intellectual complexity and high levels of intrinsic load that can easily overwhelm working memory. The sophisticated Elizabethan English language and classical references of Shakespearean texts make them intrinsically too difficult for novice readers to understand on their own. Therefore, explanatory notes in modern English were developed to guide readers and facilitate their understanding. Because conventional formats with separated instructional aids (such as glossaries and footnotes) may result in additional cognitive load due to split attention, this study used an integrated experimental presentation format for the original Shakespearean and the modern explanatory texts.

The experiments were designed to investigate the effectiveness of the integrated explanatory notes for readers with various levels of expertise. According to the expertise reversal effect (Kalyuga et al. 2003; Kalyuga 2005, 2007), instructional designs that are beneficial for novices may become redundant and have adverse effects for more experienced individuals, especially when the experts find it impossible to ignore redundant information. It was therefore expected that integrated explanatory information could be beneficial for novices but redundant and distracting for experts.

Experiment 1 presented an extract from *Othello* to novice Grade 10 students who had no prior knowledge of the text. The results demonstrated that the integrated explanatory condition group reported a lower cognitive load and performed better in a comprehension test than the control group. In Experiment 2, the same material was presented to a group of Shakespearean experts, and a reverse effect occurred: the control group outperformed the experimental group. The test performance and difficulty rating data along with retrospective verbal protocols indicated that the explanations were redundant for these readers, thus demonstrating an expertise reversal effect in the literary comprehension area. Experiment 3 replicated the results of Experiment 1 using a different text, an extract from *Romeo & Juliet*, with a group of Grade 10 high school novice-level students. Cognitive

load ratings, test performance scores, and retrospective protocols indicated advantages of integrated explanatory notes.

Collectively, the results of the experiments provide a strong support for managing cognitive load conditions through the use of different instructional formats for individuals with different levels of expertise. According to cognitive load theory, it can be speculated that for novices, learning is more efficient when students are not required to engage in unguided search processes, such as searching through endnotes and glossaries, or using elimination or trial-and-error techniques to decipher portions of Shakespearean text. Instead when dealing with intrinsically difficult materials such as Shakespearean texts, students should engage in activities that are directly related to schema construction. This study demonstrated that novices greatly benefited from guided instruction in the form of explanatory notes for complex Shakespearean verse.

On the other hand, experts who already have a well structured domain specific knowledge base do not require explanatory information in their area of expertise. According to cognitive load theory, processing such redundant information may add unnecessary (extraneous) cognitive load and detract cognitive resources from further learning, thus resulting in a redundancy effect. Experiment 2 with experts demonstrated that explanatory information could become redundant.

In this study, in addition to traditional ratings of mental load and test performance scores, analyses of retrospective verbal protocols were used to support a cognitive load explanation of the expertise reversal effect. Experts' reports demonstrated attempts to assimilate redundant information into their available knowledge structures by analysing the legitimacy of the explanatory notes and comparing them with their own understanding. Studies by Spiro and Jehng (1990) have shown that exposure to different perspectives encourages cognitive flexibility by allowing individuals to create broader perceptions. With the exception of one comment made by a single participant, the verbal reports indicated that this was not the case for the explanatory notes in this study as they were designed to be a basic foundation for novices and did not offer avenues for expanding experts' understanding. From an expert's viewpoint, the notes would have been perceived as 'oversimplifications' resulting from 'reductive bias' (Spiro et al. 1991). According to the expertise reversal effect, exposure to simplified explanatory notes may have been cognitively constraining for complex understanding. This view is also in line with Spiro et al's. (1991) suggestion that instruction that is effective for introductory learning may inhibit the progress of experienced learners in ill-structured domains.

Furthermore, as the explanatory notes were presented to participants in an integrated form, it was impossible for experts to ignore them and they could not avoid allocating their cognitive resources to dealing with the unnecessary distraction. The expert participants in this study commonly referred to the explanatory notes format as frustrating, distracting, and difficult to read. This group also scored lower on reading comprehension tests than experts in the control group who were presented with a conventional format of original Shakespearean verse. Similar results were also obtained by Yeung et al. (1998) and Yeung (1999) who demonstrated that integrated vocabulary definitions benefited only low-level knowledge students. The results of this study are also consistent with findings by Wittwer et al. (2008) who found that instruction was ineffective when it was based on either an overestimation or underestimation of levels of learner prior knowledge.

The reported experiments extend the redundancy and expertise reversal effects to the area of literary reading comprehension. These findings also challenge the traditional ways in which Shakespeare is taught. Contrary to convention, this study has clearly demonstrated that novices require fully guided explanatory instruction when first introduced to

Shakespearean texts. Even though dual-language texts with original Shakespeare on one page and modern English translations opposite have been published before (e.g., Durband 2001), these translations are not as comprehensive and coherent as explanations. They may not offer sufficient levels of instructional guidance and their separate-page format may create spilt attention situations. This paper suggested using integrated explanatory notes with novice learners.

However, as learners progress in their understanding, an integrated format could become less effective. Though intermediate knowledge students still need some guidance, they are also likely to experience the redundancy effect. Learner-controlled instructional presentations with optional integrated formats (e.g., using hypertext in e-learning environments) could be cognitively optimal for these learners. With such presentations, learners could elect to view integrated explanations when and if they are required. However, success of such instruction would depend on learners' accurate evaluations of their own understanding, as Shakespeare may be understood on a literal level without realisation of figurative meaning. In such cases, on-screen pop-up questions could be included to encourage deeper comprehension. The investigation of e-learning programs in Shakespearean comprehension that allow self-regulated learning is an area for future research.

Levels of instructional support during learners' transition from novice to expert states should progressively decrease. Renkl and Atkinson (2003) as well as Renkl et al. (2004) demonstrated the effectiveness of gradual fading of instructional guidance in worked examples in technical areas. Similar techniques could be potentially used in literary domains. For the fading technique to be effective, it must be introduced at the right time when learners have acquired sufficient schemas to be able to gradually solve problems on their own. When levels of learner prior knowledge are not known in advance or when required levels of fading need to be determined, suitable assessment methods are needed to diagnose levels of learner expertise in real time in order to appropriately tailor instructional formats.

Future research needs to investigate how to make efficient and accurate assessment of learners' prior knowledge in literature domain that can evaluate depth of understanding of themes and character analysis, as well as contextual understanding of how cultural, religious and political environments have influenced a text's composition and an author's intended interpretation of the text. Rapid assessment methods have been recently investigated in technical domains (Kalyuga 2006; Kalyuga and Sweller 2004). Unlike most technical domains, the meaning of literature is often subjective and involves many variables. Therefore, assessing such knowledge may never be quite as 'rapid' as tests applicable to technical areas, however, efficient specific measures of expertise need to be devised and applied in this domain.

Shakespearean texts are usually filled with classical references and complex imagery communicated through a language that is different from Modern English. As long as Shakespeare maintains cultural significance in literature and a compulsory place in school curriculum, students will continue to struggle with the disparity of the language. This paper provided evidence for the benefits of teaching Shakespeare according to principles of human cognition and cognitive load theory.

References

Baddeley, A. D. (1986). *Working memory*. New York: Oxford University Press.

Barnett, J. E., & Seefeldt, R. W. (1989). Repeated reading and recall. *Journal of Reading Behaviour, 21*, 351–361.

Batho, R. (1998). Shakespeare in secondary schools. *Educational Review, 50*(2), 163–172.
Britton, B. K., & Gülgöz, S. (1991). Using Kintsch's computational model to improve instructional text: Effects of repairing inference calls on recall and cognitive structures. *Journal of Educational Psychology, 83*(3), 329–345.
Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction, 8*, 293–332.
Chandler, P., & Sweller, J. (1992). The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology, 62*, 233–246.
Chandler, P., & Sweller, J. (1996). Cognitive load while learning to use a computer program. *Applied Cognitive Psychology, 10*, 1–20.
Durband, A. (2001). *Shakespeare made easy: Romeo and Juliet*. Cheltenham, England: Stanley Thornes.
Kalyuga, S. (2005). Prior knowledge principle. In R. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 325–337). New York: Cambridge University Press.
Kalyuga, S. (2006). *Instructing and testing advanced learners: A cognitive load approach*. New York: Nova Science.
Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review, 19*, 509–539.
Kalyuga, S., & Sweller, J. (2004). Measuring knowledge to optimize cognitive load factors during instruction. *Journal of Educational Psychology, 96*, 558–568.
Kalyuga, S., Chandler, P., & Sweller, J. (1998). Levels of expertise and instructional design. *Human Factors, 40*, 1–17.
Kalyuga, S., Chandler, P., & Sweller, J. (2000). Incorporating learner experience into the design of multimedia instruction. *Journal of Educational Psychology, 92*, 126–136.
Kalyuga, S., Chandler, P., & Sweller, J. (2001). Learner experience and efficiency of instructional guidance. *Educational Psychology, 21*, 5–23.
Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). Expertise reversal effect. *Educational Psychologist, 38*, 23–31.
Luhrmann, B. (Producer/Director), & Martinelli, G. (Producer). (1996). *Romeo+Juliet* [Motion picture]. United States: Twentieth Century Fox Film Corps.
Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist, 32*, 1–19.
Mayer, R., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual-processing systems in working memory. *Journal of Educational Psychology, 90*, 312–320.
McNamara, D., Kintsch, E., Songer, N. B., & Kintsch, W. (1996). Are good texts always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction, 14*, 1–43.
Moreno, R., & Mayer, R. E. (2002). Verbal redundancy in multimedia learning: When reading helps listening. *Journal of Educational Psychology, 94*, 156–163.
Paas, F., & van Merriënboer, J. J. G. (1993). The efficiency of instructional conditions: An approach to combine mental-effort and performance measures. *Human Factors, 35*, 737–743.
Paas, F., & van Merriënboer, J. J. G. (1994). Variability of worked examples and transfer of geometrical problem-solving skills: A cognitive-load approach. *Journal of Educational Psychology, 86*, 122–133.
Reisslein, J., Atkinson, R. K., Seeling, P., & Reisslein, M. (2006). Encountering the expertise reversal effect with a computer-based environment on electrical circuit analysis. *Learning and Instruction, 16*, 92–103.
Renkl, A., & Atkinson, R. K. (2003). Structuring the transition from example study to problem solving in cognitive skills acquisition: A cognitive load perspective. *Educational Psychologist, 38*, 15–22.
Renkl, A., Atkinson, R. K., & Groβe, C. S. (2004). How fading worked solution steps works—a cognitive load perspective. *Instructional Science, 32*, 59–82.
Spiro, R. J., & Jehng, J. (1990). Cognitive flexibility, random access instruction, and hypertext: Theory and technology for the nonlinear and multi-dimensional traversal of complex subject matter. In D. Nix & F. J. Spiro (Eds.), *The "handy" project. New directions in multimedia instruction* (p. 201). Hillsdale. NJ: Lawrence Erlbaum.
Spiro, R. J., Feltovich, P., Jacobson, M., & Coulson, R. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in Ill-structured domains. *Educational Technology, 2*, 4–33. (May).
Strain, L. B. (1976). *Accountability in reading instruction*. Columbus, Ohio: Charles Merrill.
Tarmizi, R., & Sweller, J. (1988). Guidance during mathematical problem solving. *Journal of Educational Psychology, 80*, 424–436.

Voss, J., & Silfies, L. N. (1996). Learning from history text: The interaction of knowledge and comprehension skill with text structure. *Cognition and Instruction, 14*, 45–68.

Wittwer, J., Nückles, M., & Renkl, A. (2008). Is underestimation less detrimental than overestimation? The impact of experts' beliefs about a layperson's knowledge on question asking and learning. *Instructional Science, 36*, 27–52.

Yeung, A. S. (1999). Cognitive load and learner expertise: Split attention and redundancy effects in reading comprehension tasks with vocabulary definitions. *Journal of Experimental Education, 67*, 197–221.

Yeung, A. S., Jin, P., & Sweller, J. (1998). Cognitive load and learner expertise: Split attention and redundancy effects in reading with explanatory notes. *Contemporary Educational Psychology, 23*, 1–21.