Computers in the Schools

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t792303982

Reading Performances Between Novices and Experts in Different Media
Multitasking Environments

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Online Publication Date: 01 July 2009

To cite this Article Lin, Lin, Robertson, Tip and Lee, Jennifer(2009)'Reading Performances Between Novices and Experts in Different Media Multitasking Environments',Computers in the Schools,26:3,169 — 186

To link to this Article: DOI: 10.1080/07380560903095162
URL: http://dx.doi.org/10.1080/07380560903095162

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This experimental study investigated connections between subject expertise and multitasking ability among college students. One hundred thirty college students participated in the study. Participants were assessed on their subject expertise and reading tasks under three conditions: (a) reading only (silence condition), (b) reading with a video playing in the background (background multitasking condition), and (c) reading and watching video simultaneously (test multitasking condition). The data indicated that the participants performed best in the background condition; the experts scored better than the novices; experts performed better when the reading-comprehension questions were more difficult. Implications for teaching are discussed.

**KEYWORDS** multitasking, monotasking, dual task, novices, experts, new media and technologies

Multitasking is a human behavior that allows people to handle dual tasks simultaneously or with alternate multiple-task switches (Lee & Taatgen, 2002). With the rapid development and convergence of new media and technologies, including Internet hyperlinks, multimedia technologies, and mobile technologies, greater numbers of people are afforded opportunities for multitasking and are, to a degree, expected to multitask. Two studies by the Kaiser Family Foundation (Foehr, 2006; Roberts, Foehr, & Rideout, 2005)
reported that children and teens are multitasking and managing to pack increasing amounts of media content into the same amount of time each day—for instance, going online while watching TV. Terms such as digital natives, Net generations, Google generations (Oblinger & Oblinger, 2005; Prensky, 2001; Tabscott, 1998) were coined to refer to the younger generations who are fully immersed in new media and technologies and who use multiple technologies easily, interchangeably, and simultaneously. As a result, they often demonstrate more knowledge and skill with technologies than previous generations.

Yet, few connections have been made between people’s skills or knowledge levels and their ability to handle multiple tasks simultaneously. Even fewer studies have been done to examine the connections between multitasking and technology, or the significance of these connections for teaching and learning. Therefore, the purpose of this study was to unravel the mysteries between people’s knowledge and skill levels and their media multitasking abilities by comparing novices’ and experts’ reading skills in multitasking and monotasking conditions. It is hoped that the study will set a foundation to examine if people are more capable of media multitasking because of their immersion and familiarity with subject areas and media. Such an inquiry will provide insights for teaching and learning of the new generations of learners who will be immersed in the new media world.

PERSPECTIVES AND THEORETICAL FRAMEWORK

Relevant to this study are research in cognition, psychology, neuroscience, and new media and technologies. Concepts including novice and expert, learning and performance tasks, dual tasks, task switching, cognitive load, media impact, and technological extensions are discussed.

The common definition of learning is that it is a permanent change in behavior resulting from some intervention or practice (Atkinson, Atkinson, Smith, & Bem, 1993; Gagne & Medsker, 1996). In a learning task, one focuses on acquiring particular elements of knowledge or skills such as learning how to multiply. Once one has acquired basic knowledge or skills, one can start integrating his or her prior knowledge and skills. Perfecting one’s skill in solving problems based on one’s prior knowledge is an example of a performance task.

Parallel to the concepts of learning and performance tasks are the concepts of novice and expert. While a novice is considered a new learner, an expert has usually mastered the task with an in-depth level of knowledge. As such, an expert is considered a performer rather than a learner in the target area. Because of their deeper understanding of knowledge, experts are able to retrieve key aspects of their knowledge flexibly with little attentional
effort (Bransford, Brown, & Cocking, 1999). When people are familiar and proficient in performing tasks at hand, they can think ahead, notice multiple channels, and predict the next steps. This capability allows them to split their attention or pay attention to several things at once. To simplify discussions in this article, the terms *subject matter experts*, *performers*, and *participants with performance tasks* are used interchangeably; so are the terms *novices*, *learners*, and *participants in learning tasks*.

Psychologists, neuroscientists, and information scientists have studied aspects of multitasking such as dual tasking, task switching, and sequential actions (Baddeley, Chincotta, & Adlam, 2001; Burgess, Veithc, de Lacy Costello, & Shallice, 2000; Monsell & Driver, 2000; Sohn & Carlson, 2000; Spink, Ozmutlu, & Ozmutlu, 2002; Spink & Park, 2005). In general, these studies have revealed that people show severe interference when even very simple tasks are performed at the same time, if both tasks require selecting and producing action. Some researchers have suggested that multitaskers do not retain as much of what they learn as they would when focused (Just et al., 2001; Rubinstein, Meyer, & Evans, 2001). Some believe that switching between tasks wastes precious time because the brain is compelled to restart and refocus (Meyer & Kieras, 1997). Each time one has this alternation there is a period in which one will make no progress on either task. The result is that it takes longer to finish any one chore, and that one does not do it nearly as well as one would had one given it one’s full attention (Meyer & Kieras, 1997).

Poldrack and Foerde (2007) found that people had a harder time learning new things when their brains were distracted by another activity. The Functional Magnetic Resonance Imagings (fMRIs) used by researchers showed that when people learned without distraction, an area of the brain known as the hippocampus was involved. This part of the brain is critical to the processing and storing of information. But when people learned the task while multitasking, the hippocampus was not engaged; instead, an area called the striatum was activated. Results show that learning while distracted or multitasking alters the brain’s learning processes and changes the way people learn (Poldrack & Foerde, 2007).

Foerde, Knowlton, and Poldrack (2006) found that learning new things is dependent on working memory where habit learning is not as sensitive to working memory. Cognitive load plays an important role in both hindering performance as well as enhancing experience (Ang, Zaphiris, & Mahmood, 2007). Some tasks such as learning new skills may require high cognitive loads, while other tasks familiar and automatic may require lower cognitive loads. Generally, high cognitive loads result in low-task capacities. People learning to drive seldom do anything else because they need all the brain participation they can get for the driving (Just, Keller, & Cynkar, 2008). Tasks, however, can be transferred from high cognitive loads to low cognitive loads by repetition (Ang, Zaphiris, & Mahmood, 2007). One explanation could be
that repetitive practice stimulates activity in the striatum resulting in habit learning and lower cognitive loads. The level of required focus changes with experience. According to Just, Keller, and Cynkar (2008), the brain rewires itself to do the routine tasks involved in driving over time; for instance, when our eyes see a red light, our foot hits the brake, with no conscious thought involved. Scientists call this phenomenon “automaticity” (Just et al., 2008). It enables us to do one thing while focusing on something else. In other words, learning to do one task automatically helps us to multitask. If cognitive loads can be shifted from high to low as the research suggests, teachers and learners might be able to take advantage of a close connection between habit learning practices, performance or expertise levels, and multitasking capacities.

New media and literacy scholars have devoted much time and attention to the changes and impacts that new media and technologies have brought to the younger generations (Gee, 2003; Gibson, Aldrich, & Prensky, 2007; Prensky, 2001, 2006; Tapscott, 1998). Prensky, for example, suggested that there are cognitive differences between digital natives (the younger generations who grow up surrounded by digital technologies) and digital immigrants (the adult generations; Prensky, 2001). According to Prensky, the digital native generation is comfortable with multitasking and is comfortable with random (vs. step-by-step) and parallel (vs. linear) access to information. McLuhan (2002) reminded us that media is an extension of the human being. According to McLuhan, each media adds itself on to what we already are, creating both “amputations and extensions” to our senses and bodies, shaping them into a new technical form (p. 42). McLuhan stated that “by continuously embracing technologies, we relate ourselves to them as servomechanisms” (p. 235). It is this dependency and linkage to technology that makes it an integral part of our lives.

Stated by Hembrooke and Gay (2003), “the ubiquity, pervasiveness and mobility of new technologies encourage a simultaneity of activities that goes beyond anything our culture has heretofore ever known. Indeed, the ability to engage in multiple tasks concurrently seems to be the very essence or core motivation for the development of such technologies” (p. 1). Luciana, Conklin, Hooper, and Yarger (2005) found that the brain’s ability to effectively self-organize competing information remains in the developmental process until 16 or 17 years of age. Perhaps the digital generation has developed multitasking prowess beyond that of its parents.

PURPOSE OF THE STUDY, HYPOTHESES, AND RESEARCH QUESTIONS

This study was conducted under the background of rapid new media and technology development. The purpose was twofold: first, to examine to what extent different multitasking conditions might influence people’s task
performances; second, to examine to what extent people's familiarity and expertise with their subject matter areas might affect their multitasking abilities.

It was hypothesized in this study that people perform better in their expertise areas than in their novice areas in multitasking conditions. An evidence of this hypothesis could be seen in driving. Typically a beginner can only focus on one task at a time, such as looking straight at the road ahead. Over time as the driver gains more experience and expertise, he or she can carry on a conversation, turn on and listen to the radio, and change music CDs while driving, usually with considerable confidence and ease.

A college setting was chosen to examine the possible connections mentioned. Reading comprehension was decided as the task to perform. Undergraduate and graduate students were invited to participate in the study. Participants were tested on their reading comprehension skills in three subject matter areas: history, politics, and science. The following were the research questions: Does multitasking affect people's reading comprehension skills? How? Can people multitask better when they read materials of which they have more knowledge? That is, can people who are subject matter experts multitask better than those who are subject matter novices? Why or why not?

EDUCATIONAL OR SCIENTIFIC IMPORTANCE OF THE STUDY

Students are often more advanced in technologies than their teachers, and the social and practical implications of multimedia layering or technological multitasking may differ between generations. The use of technologies such as remote control units, cell phones, iPods, game controller devices, digital recording and imaging devices occurs at progressively earlier ages as the younger generations appropriate conventions much earlier than adults, largely due to their sense of play and free time to investigate these functions. Control conventions overlap, and children learn at an early age what functions are held in common and those that are unique. Their expertise levels in new media and technology may have a great impact on their ability to learn and to manipulate different learning environments.

If we are to understand what technological multitasking environments do to our students, and what they may mean to our students, we must compare student outcomes in a variety of settings. Our essential goal, therefore, is to design the learning environment in a way that improves the student's ability to focus, read, understand, and learn.

METHOD

Materials and Instruments

A total of two sets of readings, equivalent in content areas and in difficulty levels, were created for the experiment. Each set included one article
in history, one in politics, and one in science. Six multiple-choice questions were developed for each article, of which, two questions were basic-knowledge-level questions, two were intermediate-level comprehension questions, and two were in-depth, analysis-level questions based on Bloom’s Taxonomy (Bloom & Krathwohl, 1956). The highest score a participant could receive from a set of readings was 18 (with 1 credit for each correct answer).

Knowledge level questions sought information that was easily located or recalled from the reading. For instance, we asked, “Who was the main subject of the reading?” or “What is the main location described in the reading?” to be sure that the participants were paying a basic level of attention. Comprehension level questions required participants to understand the meaning of the article to summarize its key concepts. For instance, we asked, “Which of the following best describes what the reading is about?” or “What is the strongest supporting statement made by the author?” to solicit information regarding whether they truly understood what the article was saying. Analysis-level questions required participants to assess and synthesize the reading, build a structure from diverse elements, and create a new meaning or structure. For instance, we asked, “Given what you read, which of the following statements is true?” or “What is the most probable take-away message the author wants you to have?” to measure whether they had integrated what they read with previous knowledge and could consider future directions. Responses to these questions allowed us to see the depth of reading comprehension of the participants and the impact of different media multitasking conditions.

A total of two videos (one 16-minute television sitcom and one 16-minute news broadcast) were also developed with six multiple choice questions for each, following a similar test design strategy as those used for reading comprehension questions for the articles. The 16-minute sitcom was an episode from “Family Ties” (TV series 1982–1989), while the news broadcast was an in-depth report on drunk driving. The content of the videos was not related to the selected reading materials. The selection of the videos was intended to imitate a natural multitasking environment, where students would watch TV while doing homework. The multiple-choice questions followed immediately after each article or video (when the video was played). For the purpose of this article, the participants’ video scores were not calculated or included in the quantitative data analysis, although they were collected and used as a manipulation check between background and test multitasking conditions. Only the participants’ reading comprehension scores were used to examine their levels of performance in multitasking and multitasking conditions. Doing so allowed researchers to focus on comparing the same skills exhibited by the participants.
Participants

One hundred and thirty-seven undergraduate and graduate students in a major research university participated in the experiments. Most participants (126 out of 137) were undergraduates who were College of Education majors. Most of them planned to be K–12 teachers after they graduate. At the time when they participated in this experiment, they were taking the survey level course “Computers in the Classroom,” in the fall semester of 2008. They were interested in new media and technologies such as various Web 2.0 technologies, but were not familiar with their potential classroom applications. The 11 graduate participants majored in learning technologies and were interested in design and research issues in new media and technologies. The contents of the articles in the experiments, however, were not related to technologies; instead, they focused on history, politics, and science, because we intended to examine to what extent different multitasking conditions might influence people’s reading performance and to what extent people’s expertise with their subject matter areas might affect their multitasking abilities.

Seven undergraduate participants’ scores were excluded from the data after z-values associated with the participants’ scores were charted. Their z scores showed a lack of participation as they did not attempt to answer most of the questions. Data analysis, therefore, was based on 130 (instead of 137) participants. Of the 130 participants, 74 were juniors, 24 were sophomores, 21 were seniors, and 11 were graduate students. One hundred seventeen (90%) were female, while 12 were male (one did not indicate gender). The participants’ ages ranged from 19 to 53, averaging 23.9 years old. Over 80% of the participants were below 30 years old.

Data Collection: Expert and Novice Groups

The participants were asked to rate their familiarity and enjoyment of each of the three topics—history, politics, and science—separately to determine their familiarity, knowledge, and skill levels with regard to each of the three subject matters. This was measured using the following three sets of four questions, each answered using a 7-point Likert scale ranging from “none whatsoever” to “extremely high”:

- What is your interest in history/politics/science? (intentional)
- How much do you know about history/politics/science? (cognitive)
- What is the amount of work you do in history/politics/science? (behavioral)
- To what extent do you enjoy reading about topics related to history/politics/science? (affective)
The questions were developed based on the ABC (Affective, Behavioral, and Cognition) model (Rosenberg, Hoveland, McGuire, Abelson, & Brehm, 1960). According to Rosenberg et al. (1960), a person’s knowledge orientation consists of three different (albeit interrelated) components: the affective (i.e., how a person feels), the behavioral (i.e., what a person does), and the cognitive (i.e., what a person knows). The ABC approach has spawned a long list of research investigations through 5 decades, either validating the model (Bagozzi, 1978) or using it to evaluate other models (Jarvis & Petty, 1996). The simplicity and elegance of the ABC model have made it a useful tool to measure people’s knowledge orientation and its connection with upstream (causal factors) and downstream (caused factors) constructs. This model provided a reliable way to determine the participants’ expertise in the three subject areas of the reading materials.

The scores for these four questions were combined to indicate the range of novice (a lowest possible score of 4) versus expert (maximum score of 28) orientation of the individual on each of the three topic areas. All of the expertise scores (three for each participant) were used to find the mean and standard deviation (SD) of the entire set of 390 data points (130 participants in 3 subject areas). Each score was then turned into a $z$-value based upon its relationship to that common mean and SD. These $z$-values were charted to find the natural break points between a low-score set, a medium-score set, and a high-score set.

The natural breaking lines at .7 SDs above and below the mean were found, and thus those scores below $-0.7$ SDs were tagged as “Novice Group,” those above $0.7$ SDs were tagged as “Expert Group,” and those in between as “Intermediate Group.” These tags were recorded as each participant’s separate expertise in each subject was labeled as Novice, Expert, or Intermediate in history, politics, and science respectively. With this procedure a participant could be a novice in one subject while an expert or intermediate in other subjects: The identification was done at the level of the participant-subject combination.

As a result, roughly 1/4 of our participant-subject data points were in the novice group, 1/4 were in the expert group, and 1/2 were in the intermediate group (as shown in Figure 1—the emergence of three subject groups: novice, intermediate, and expert).

Participants’ reading comprehension scores in three conditions: silence, background multitasking, and test multitasking conditions: Each participant was placed in two of the three conditions (with one condition at a time for 16 minutes): (a) reading only, with no video (the silence or monotasking condition); (b) reading with a video playing in the background (the video background multitasking condition); and (c) reading with a video playing and being told that he or she would be scored for the answers to the questions on the video when the reading test was complete (the video test multitasking condition). As a result, every participant read all six articles
(three articles in each condition) and completed 36 reading comprehension multiple choice questions. Additionally, every participant watched at least one video and completed six multiple-choice questions based on the video. Some participants watched both videos and completed a total of 12 questions on the two videos. The reading articles, videos, and multitasking conditions were alternated so that no particular article, subject, video content, or condition was favored due to its order or sequence of appearances. The total time for the data collection with each participant was 50 minutes to 1 hour, varying only due to administrative processes.

Table 1, Layout and Sequence of the Experiments (see appendix), displays the sequence and layout of the experiments, the number of participants in each setting, and the numbers of videos used.

Manipulation check on background multitasking condition and test multitasking condition: Toward the end of each experiment, every participant was asked to record the percentage of attention paid to the reading materials and questions and the percentage of attention paid to the video that was playing (assuming that one paid 100% attention to the experiment). While self-reports of attention percentage may not be as reliable as test data, we looked at the difference in self-reported attention paid to the video under

FIGURE 1 The emergence of 3 subject expertise groups: novice, intermediate, and expert.
the background multitasking condition as opposed to the test multitasking condition, expecting that attention paid in the test condition would be higher.

A chi-square analysis showed a statistical difference in the reported attention paid on the videos as compared to what would have been received had the pattern been random. As expected, participants reported less attention paid to the video when watching videos under the video background condition (25.43%) than when watching under the test condition (38.24%). In addition, a chi-square analysis showed a significant difference in the pattern of wrong, blank, and correct answers received on the videos as compared to what would have been received had the pattern been random. Participants scored fewer correct answers (311) under the background video condition than under the test video condition (397) on the videos. In addition, when watching under the test condition, participants had fewer blank answers (10) or wrong answers (193) than when watching under the background condition (26 blank and 233 wrong answers) on videos. This indicated that the background versus test video manipulations worked as expected, and that we can rely on background/test video multitasking condition comparisons.

After the participants’ reading comprehension scores were calculated, data of correct, wrong, and blank answers were analyzed using SPSS (Version 16.0). Participants’ scores were analyzed from the angles of subject areas, question difficulty levels, the participants’ expertise levels, and the multitasking conditions.

RESULTS

Reading Comprehension Scores by Novice, Intermediate, and Expert Groups Under the Three Conditions

Figure 2 compares the participants’ average scores of all the subject areas under the three different conditions: silence (monotasking) condition,
background multitasking condition, and test multitasking condition. One can observe from the data and figure that the average scores of the participants in the intermediate group were almost identical to the average scores of all the participants in all three conditions. In addition, among the three conditions, the participants performed best in the background condition, second in the silence condition, and third in the test multitasking condition, except that the expert group scored almost equally in the silence condition and in the background condition. Finally, although the 3 groups exhibited similar patterns under the three conditions, with performance best in the background multitasking, second in the silence condition, and third in the test multitasking condition, the expert group performed better than the novice group did in each of the three conditions separately and as a whole. The lowest percentage average score of the experts (73.1% in the test multitasking condition) was the same as the highest percent average score of the novices (73.1% in background condition). We confirmed that the correct scores for the expert and novice groups differed statistically by using a Mann-Whitney ranking procedure (Novice group: $N = 107$, Median = .75, Mean = .69, Mean Rank = 92.62, Sum of Ranks = 9,910.50; Expert group: $N = 95$, Median = .75, Mean = .755, Mean Rank = 111.50, Sum of Ranks = 10,592.50; $U = 4,132.5$; $p < .05$ two tailed).
Comparison Between Novices and Experts in Reading Comprehension Levels Under the Three Conditions

Did experts and novices perform differently when addressing questions of different difficulty levels? Table 2 provides an overview of the numbers of questions asked from each of the 3 expertise groups by question difficulty level and under each of the three conditions.

Figure 3 compares percentage scores that novices and experts exhibited in knowledge-level questions, comprehension-level questions, and analysis-level questions separately.

The data showed that (a) with knowledge-level questions, experts’ performances were parallel to novices’. Both groups did best in the background multitasking condition, second in silence, and third in the test multitasking condition; (b) with comprehension-level questions, experts exhibited very different patterns from novices. Experts did best in silence, second in test, and third in background conditions. Novices still did best in background, second in silence, and third in test conditions. Interestingly, novices’ average scores in background and silence conditions were also higher than experts’ average scores in both background and test conditions; (c) with analysis-level questions, experts did extremely well in all conditions while novices performed poorly in the test multitasking condition. In fact, the experts did better on analysis questions than on comprehension questions under the background condition, and did equally well on analysis questions as on comprehension questions under the test condition.

It appeared that the novices performed more consistently than experts in three conditions. In general, the novices performed best in the background multitasking condition, second in the silence condition, and third in the test multitasking condition, although the pattern started to change when the reading comprehension questions became increasingly difficult. As shown

<table>
<thead>
<tr>
<th>Expertise groups</th>
<th>Question difficulty levels</th>
<th>Silence</th>
<th>Background</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>Knowledge-level</td>
<td>100</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Comprehension-level</td>
<td>100</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Analysis-level</td>
<td>100</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Knowledge-level</td>
<td>184</td>
<td>286</td>
<td>282</td>
</tr>
<tr>
<td></td>
<td>Comprehension-level</td>
<td>184</td>
<td>286</td>
<td>282</td>
</tr>
<tr>
<td></td>
<td>Analysis-level</td>
<td>184</td>
<td>286</td>
<td>282</td>
</tr>
<tr>
<td>Novice</td>
<td>Knowledge-level</td>
<td>106</td>
<td>144</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>Comprehension-level</td>
<td>106</td>
<td>144</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>Analysis-level</td>
<td>106</td>
<td>144</td>
<td>178</td>
</tr>
</tbody>
</table>
in Figure 3, the novices did almost equally well, and a little better in the silence condition than in the background condition when they worked with analysis-level questions.

In comparison, the experts exhibited different behavior patterns from those of novices. Although it can be said that the experts also performed best in the background multitasking condition as shown in their performance on the knowledge-level and analysis-level questions, the experts seemed to be affected the opposite way from that of the novices in different multitasking conditions. For instance, the experts received lower average scores than novices did in the comprehension-level questions under the background condition. Additionally, the experts performed better with analysis questions than they did with comprehension-level questions in the background multitasking condition. When the question difficulty levels rose, the experts seemed to perform better in the multitasking condition.

**DISCUSSION**

As expected, the overall reading comprehension scores of students who were novices were significantly lower than those students who were experts in the given subject areas.

We expected that this difference would be less substantial in the silence condition since novices performed best in supportive and comforting environments (Hackman, 1992). The silence condition, without directly considering its comfort or demand nature, carries the least amount of external stimulation and distraction. Our findings indicated that the opposite may
have been true. We found that all the participants, especially the novices, did best in the background multitasking condition. In fact, the performance gap between novices and experts was closest in the background condition, with the expert’s percentage average score of 76.9% compared to the novice’s percentage average score of 73.1%. If it is true that novices perform best in environments that are supportive and comforting (Hackman, 1992), did the video background provide such a comfortable environment for students to study and comprehend what they were reading? Is it possible that the silence and test conditions were more intense than the background condition? Is it possible that the novices in fact had more control and flexibility in the background condition, which provided them the comfort and support that they needed?

In contrast, the experts seemed to need more challenges in order to perform better. This was evidenced by their performance on the analysis-level questions in both the background and test multitasking conditions. With analysis-level questions in the background and test multitasking conditions, the average percentage scores of the experts (73.6% and 65.7%, respectively) were much better than those of the novices (57.6% and 50%, respectively). However, the gap between the average percentage scores of the experts and novices in the silence condition was not as distant (65% for experts compared to 58.5% for novices). In addition, the experts did not seem to fluctuate as much as novices did when conditions changed.

Perhaps when novices are given less stressful situations, they tend to do better, and fail when placed under hard or severe circumstances. When experts are given less stressful situations, they tend to slack off and not perform well, but they rise to the occasion when they are placed under hard and demanding situations. These results also supported to a degree that experts are able to retrieve information with less attentional effort and that they are more capable of splitting attention or paying attention to several things at once (Bransford, Brown, & Cocking, 1999). That is, experts experience less cognitive load than novices do in multitasking conditions.

The literature suggested that multitasking interferes with learning or performance (Just et al., 2001; Meyer & Kieras, 1997; Poldrack & Foerde, 2007). Our study confirmed that suggestion in that all the participants performed worst in the test multitasking condition. However, the participants did not perform best in the silence condition; instead, they did best in the background multitasking condition. Therefore, we suspect that it is necessary to further examine the control, self-regulation, and comfort that people have in the process of multitasking and learning. It is possible that people perform better in an environment when they have more control and flexibility, and are more comfortable and confident. The media multitasking, therefore, becomes part of the individual comfort and control for learning and performance. The best instructional strategy is, perhaps, to scaffold learning.
TABLE 3  Reading Comprehension Performances by Subjects Under Each Condition Between Experts and Novices

<table>
<thead>
<tr>
<th>Average scores (%)</th>
<th>Silence</th>
<th>Background</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>74.3%</td>
<td>75.4%</td>
<td>68.3%</td>
</tr>
<tr>
<td>Experts (all subjects)</td>
<td>77.0%</td>
<td>76.9%</td>
<td>73.1%</td>
</tr>
<tr>
<td>Experts (science)</td>
<td>74.4%</td>
<td>75.0%</td>
<td>65.9%</td>
</tr>
<tr>
<td>Experts (history)</td>
<td>81.8%</td>
<td>78.6%</td>
<td>73.0%</td>
</tr>
<tr>
<td>Experts (politics)</td>
<td>72.2%</td>
<td>75.4%</td>
<td>80.8%</td>
</tr>
<tr>
<td>Novices (all subjects)</td>
<td>71.1%</td>
<td>73.1%</td>
<td>64.4%</td>
</tr>
<tr>
<td>Novices (science)</td>
<td>65.0%</td>
<td>73.7%</td>
<td>58.0%</td>
</tr>
<tr>
<td>Novices (history)</td>
<td>64.1%</td>
<td>66.7%</td>
<td>64.5%</td>
</tr>
<tr>
<td>Novices (politics)</td>
<td>76.1%</td>
<td>75.7%</td>
<td>67.8%</td>
</tr>
</tbody>
</table>

environments and provide a variety of resources that challenge the learner at the appropriate level (Kelly, 2008).

LIMITATIONS AND FURTHER STUDIES

Although the general pattern indicates that the participants performed best in the background multitasking condition, second in the silence condition, and third in the test multitasking condition, and that experts outperformed novices, there were some inconsistencies among the different subject areas. For instance, for the politics articles, experts performed best in the test multitasking condition (with an average score of 80.8%), second in the background condition (with an average score of 75.4%), and third in the silence condition (with an average score of 72.2%). This pattern is different from the general pattern. Table 3 provides further detail of the average scores of the participants in different subject areas and under different conditions.

We suspect that this may be because of the nature of the articles selected (e.g., politics) and the timing of the experiment (i.e., Fall 2008) that was held before the presidential election took place. We believe that it is necessary to conduct further studies to compare performance in different subject areas.

Another limitation was the fact that most of our participants were pre-service female teachers. Future studies should include a more balanced gender representation and people of other ages and professions.

CONCLUSION

This study extended our understanding of multitasking and learning by looking at the differences between reading comprehension scores in monotasking versus multitasking conditions, and by considering the subject
matter expertise levels of the participants: whether subject experts perform better in multitasking environments than subject novices do. Our data indicate that experts not only performed better than novices in all conditions separately, but also performed equally well in the test multitasking condition (their worst condition) as novices did in the background multitasking condition (their best condition). These findings will hopefully help inform instructors and instructional designers on how to best adjust the environment (monotasking or multitasking) to meet the students’ levels of mastery of the learning topics for improved student learning motivation and outcomes.

REFERENCES


