The Effects of Self-Explanation and Reading Questions and Answers on Learning Computer Programming Language

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THE EFFECTS OF SELF-EXPLANATION AND READING QUESTIONS AND ANSWERS ON LEARNING COMPUTER PROGRAMMING LANGUAGE

By

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ABSTRACT

The current study explored the differential effects of two learning strategies, self-explanation and reading questions and answers, on students’ test performance in the computer programming language JavaScript. Students’ perceptions toward the two strategies as to their effectiveness in learning JavaScript was also explored by examining students’ preferred strategy and the reasons for their choice. An online interactive tutorial instruction that implemented worked-examples and multimedia learning principles was developed for this study. A total of 147 high school students (ages ranging from 14 to 17) who were taking a Computer Introduction course participated in this study. The course was offered in six periods and all periods were taught by one instructor, the current investigator. The six periods were randomly divided into two groups with three periods in each group. One group \((n = 78)\) started learning the first two of the five lessons in the tutorial with the self-explanation learning strategy while the other group \((n = 69)\) started the first two lessons with the reading questions and answers strategy. Then the two groups learned the next two lessons with the tutorial that swapped the two strategies, so they can experience the other learning strategy. Finally, the two groups went back to their original strategy to learn the 5th and last lesson in the tutorial. Students took an end-of-lesson test after each lesson and completed a questionnaire at the end of the final lesson regarding their perceptions toward the two learning strategies. Students’ prerequisite knowledge of XHTML and motivation to learn computer programming language were measured before taking the JavaScript tutorial lessons. The two learning strategies did not have differential effects on students’ test performance. However, students largely
expressed their preference toward the self-explanation learning strategy over the reading questions and answers strategy. Students considered self-explanation incurring much more work yet more effective with helping them learn JavaScript, supporting the notion that self-explanation generates germane cognitive load that directly contributes to learning. The seeming discrepancy in findings between students’ test performance and the reasoning for their choice on the preferred strategy was discussed in the areas of familiar versus new strategy, difficulty of learning materials, and experimental duration.
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# TABLE OF CONTENTS

ABSTRACT ......................................................................................................................... iii

ACKNOWLEDGEMENTS ..................................................................................................... v

LIST OF TABLES ................................................................................................................. xi

LIST OF FIGURES ............................................................................................................. xii

CHAPTER 1 ......................................................................................................................... 1

Learning Strategies Examined .......................................................................................... 4
  Self-explanation ................................................................................................................. 4
  Reading Questions and Answers .................................................................................... 8
Motivation as a Covariate ................................................................................................ 12
  Multimedia Learning Principles and Worked Examples ............................................ 15
Purpose of the Study ........................................................................................................ 18
Research Questions .......................................................................................................... 20
Significance of the Study ................................................................................................ 21
Definition of Terms ......................................................................................................... 22

CHAPTER 2 ......................................................................................................................... 25

Background ...................................................................................................................... 25
Self-explanation as a Learning Strategy .......................................................................... 30
  Effects of Self-explanation on Learning ........................................................................ 32
  Self-explanation Processes ............................................................................................... 33
  Self-explanation with Worked Examples ..................................................................... 38
  Self-explanation in Multimedia Learning .................................................................... 39
  Self-explanation as a Learning Strategy in General ..................................................... 40
Reading Questions and Answers as a Learning Strategy ............................................. 42
  Exploring the Learning Strategy of Question-Answer Relationship .......................... 44
LIST OF TABLES

Table 1  
2010-2011 School Accountability Summary Report of the Participating School .................................................66

Table 2  
Assignment of Student Groups .................................................. 68

Table 3  
Comparison between the tutorial versions of SE and Q&A ................. 91

Table 4  
Internal Consistency of Instruments ........................................... 97

Table 5  
Means and Adjusted Means of End-of-Lesson Tests by Two Groups ... 105

Table 6  
End-of-study Questionnaire Result Statistics of Both Groups ............ 107

Table 7  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 1 .........................................................109

Table 8  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 2 .........................................................110

Table 9  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 3 .........................................................111

Table 10  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 4 .........................................................112

Table 11  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 5 .........................................................113

Table 12  
The Elicited Themes and Sample Reasons of Students’ Preference for Item 6 .........................................................114

Table 13  
The Elicited Themes and Frequencies of Students’ Preference .................................................................115
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview of the instructional design in the format of a flowchart.</td>
</tr>
<tr>
<td>2</td>
<td>Login page of the Website of the tutorial.</td>
</tr>
<tr>
<td>3</td>
<td>Home page with topic list.</td>
</tr>
<tr>
<td>4</td>
<td>Details of lessons under each category.</td>
</tr>
<tr>
<td>5</td>
<td>An example of a lesson highlighted from the second topic. User can also choose to brush up XHTML knowledge by accessing this provided PowerPoint page with XHTML presentation. The pre-training principle is applied.</td>
</tr>
<tr>
<td>6</td>
<td>Lesson Learning Procedure.</td>
</tr>
<tr>
<td>7</td>
<td>After learner’s selection of a lesson, this page appears. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.</td>
</tr>
<tr>
<td>8</td>
<td>A full view of the second row of panels. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.</td>
</tr>
<tr>
<td>9</td>
<td>The Web page after the initial demo and Practice 1 page. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.</td>
</tr>
<tr>
<td>10</td>
<td>A full view of the second row: a window of self-explanation for the group doing self-explanation. There are the same number of questions in the guided self-explanation as that in the Q&amp;As illustrated in the next figure.</td>
</tr>
<tr>
<td>11</td>
<td>A full view of the second row: a window with Q&amp;As for the group that learns by reading Q&amp;As.</td>
</tr>
</tbody>
</table>
There are the same numbers of questions in Q&As as that in the guided self-explanation illustrated in the previous figure. .................................................................88

Figure 12  The group reading Q&As was given the option to take the test before time was up. .................................................................88

Figure 13  Learners encountered this Web page after completing a lesson and there was no test associated with the lesson. .................................................................89

Figure 14  Learners encountered this Web page after completing a lesson and if there was a test associated with the lesson. .................................................................90

Figure 15  End-of-Study Questionnaire, hosted on an Internet Website accessed by students after completing all five lessons.................................................................95

Figure 16  Process overview in the format of flowchart.................................................................98
CHAPTER 1

Introduction

Computer programming historically has had a notorious reputation of being difficult and frustrating to learn for novice learners (Ala-Mutka, 2004; Bonar & Soloway, 1989; Dijkstra, 1989; Garner, 2002; Kelleher & Pausch, 2005; Major, 2010; Milne & Rowe, 2002; Robins, Rountree, & Rountree, 2003) that Dijkstra (1989) calls it “a radical educational novelty.” It is estimated that around 40 to 50 percent of first year programming students either had a grade less than C (70%) or dropped out (Schuyler, 2011). Therefore, exploring effective instructional strategies is of primal interest among computer programming educators (Bucks, 2010; Goldenson, 1996; Kert & Kurt, 2012; May & Dhillon, 2009; Renumol, Janakiram, & Jayaprakash, 2010).

It is an intriguing undertaking at hand to help novice learners with learning JavaScript. Those learners are mostly Web design enthusiasts coming into the new realm of a computer scripting language that holds the promise to elevate their ability to create more advanced Web pages, but have not been exposed to any computer programming concepts. Those learners have not initially set out to conquer a computer programming subject. They are Web design students who have progressed to the point of learning to incorporate, or using the computer term, “embed” scripts into their Web pages to enhance the functionality of the Web pages. With scripts, Web pages can become dynamic such as displaying a ticking clock, and even interactive with the users such as greeting them.

Web page scripts can be written in a variety of scripting languages; among which, the most widely used is JavaScript. Scripting languages are only used for writing scripts,
not for stand-alone programs. Scripts have to be embedded into Web pages and executed alongside the Web pages being rendered. Therefore, the learners have already learned how to create Web pages before they would encounter the need for learning JavaScript. The supposed foundation of having learned Web design, along with the confidence it brings, nevertheless, could have given learners false promise that learning JavaScript is with the same ease as that of learning Web design. Quite the contrary, JavaScript presents a much higher degree of difficulty.

The introductory Web design course deals only with Extensible Hypertext Markup Language (XHTML) knowledge. It consists of tags and the rules on how the tags should work with the text content. An XHTML file can then be rendered as a Web page through a variety of browsers such as Google Chrome, Internet Explorer, Firefox, Opera, and Safari. The introductory Web design course comes across as generally learner-friendly to most students. The Web design learners’ experience in working on the basic Web design with only XHTML coding involved is an easy one. The learners’ expectation of the continued sense of instant gratification with learning JavaScript as they progress to that point is not realistic. Their comfort and pleasure in learning Web design is unfortunately interrupted by the suddenly surged intrinsic cognitive load resulted from learning JavaScript.

The difficulties that learning JavaScript incurs dwarf any of the difficulties that a learner might have encountered with learning XHTML. The Web enthusiasts tend to feel the overwhelming challenge of staying afloat with something they used to be very comfortable with while dealing with this “radical educational novelty” (Dijkstra, 1989). JavaScript does not remind students of any subjects that they have successfully learned in
their past, yet challenges the students with their capability and confidence in Web design that they felt that they had already succeeded.

In the current study, a computerized interactive tutorial was developed to help students learn JavaScript in order to help tackle the challenges that Web design students are frequently faced with. The tutorial was developed by taking advantage of a multimedia learning environment with the implementation of the multimedia learning principles and worked examples. Beyond these features in the tutorial, the study examined two learning strategies -- self-explanation and reading questions and answers -- to determine which of these strategies are more effective in learning JavaScript.

The tutorial was designed to accommodate teaching both in the traditional classrooms and in the increasingly prominent delivery platform of online or distance education (Palloff & Pratt, 1999, 2003, 2011). Web-based teaching provides an important route to successful learning in the online learning environment and in classrooms (Yip, 2004). The tutorial was hosted on a Website on the Internet that could be accessed from anywhere and at any time, therefore can be utilized by both classroom and online education.

Online or distance learning format is rapidly gaining momentum around the world. It can accommodate modern day learners’ educational needs without time or place constraints therefore is an attractive alternative to the traditional face-to-face education format for students with special needs such as working adults; or due to certain personality traits, those learners who prefer to learn in a virtual learning environment over a traditional classroom (Palloff & Pratt, 1999, 2003, 2011).
Teaching computer programming online has long become a reality yet there remain difficulties with students isolated without much contact with the instructor and even less with classmates (Domingue & Mulholland, 1997). There is the benefit of learner interaction with materials of a dynamic nature that modern day technology affords (Royuk, 2002). The current study provided the learner interaction with the target learning material through the online interactive tutorial to maximize the effect of learning.

The popularity of distance education necessitates integrated approaches to teaching programming language. The Internet brings useful tools for learning (J. Q. Anderson & Rainie, 2010), however, it is the instructional design, not the media, that mediates learning (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). With a computer and an Internet connection, a Website hosted tutorial like the one developed for the current study can be accessed from anywhere in the world. Teachers in both traditional classrooms and online learning setting can take advantage of such a computerized online tutorial. It is more advantageous to have an instructional design that can be delivered through both platforms and not limited to a specified venue.

**Learning Strategies Examined**

The current study explored the effects of two learning strategies, self-explanation and reading questions and answers, on students’ learning the computer programming language JavaScript.

**Self-explanation**

Self-explanation happens when learners explain concepts to themselves and verify their own understanding, which generates germane cognitive load and contributes
directly to learning (Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Sweller, 1994; Sweller, van Merrienboer, & Paas, 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005). Self-explanation studies have been extensively implemented on academic subjects such as physics (Fukaya, 2011; Nokes, Hausmann, VanLehn, & Gershman, 2011; van der Meij & de Jong, 2011) and mathematics (Durkin, 2011).

However, the studies examining self-explanation effects on learning computer programming language have been sporadic. There were only the series of studies with text learning of LISP (LISP stands for LISt Processing and is a family of computer programming languages) in the early to mid-90’s which demonstrated that students who had received explicit training in using the self-explanation strategies significantly outperformed the students who had not received explicit training (Bielaczyc, 1995; Bielaczyc & Pirolli, 1995; Pirolli & Bielaczyc, 1989; Pirolli & Recker, 1994; Recker & Pirolli, 1990), an experiment on the controlled self-explanations with learning the programming language Structured Query Language (SQL) (Yuasa, 1994), and recently one study regarding reflective self-explanations with learning the computer programming language JavaScript (Kwon & Jonassen, 2011). The positive results of self-explanation studies with the traditional academic subjects and its scarce studies with learning computer programming languages make self-explanation of particular interest for the current study to examine its effect on students’ learning of the computer programming language JavaScript.

Self-explanation is a domain-general constructive activity that directs learners’ attention to the learning materials while checking on their understanding (Roy & Chi,
2005) and its process has been evidenced as helping learners comprehend unfamiliar text (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara, O’Reilly, Best, & Ozuru, 2006). Using self-explanation strategy to learn computer programming concepts improved learning for students with both high and low prior knowledge (Kwon & Jonassen, 2011).

Other than the few studies described above, the effects of self-explanation on computer language learning have been seldom studied. The current study sought to fill that gap by replicating the previous self-explanation studies on computer programming language learning.

The process of self-explanation can be carried out in different formats such as thinking-aloud as the speaking format (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara et al., 2006), and typing the thoughts as the writing format (Muñoz, Magliano, Sheridan, & McNamara, 2006). Less-skilled readers are able to make more frequent bridging inferences with typing self-explanation text than with thinking aloud or speaking their self-explanation when they are dealing with science texts which are opposite to narrative texts like novels (Muñoz et al., 2006). That is, less skilled readers can benefit more from typing than speaking their self-explanations during their learning science text like JavaScript.

In the context of learning from worked examples, Renkl (1997) describes that learners use the self-explanation strategy to explain to themselves the example solution steps. Self-explanation engages learners to use their background knowledge to interpret the given instructional texts and examples (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Pirolli & Recker, 1994). If a certain step performed in the solution is not provided with
all the reasons, learners resort to explaining to themselves what is being learned from the worked examples. Good learners study solution structure of the examples while poor learners become hung up on the surface features of the examples (Chi et al., 1989). As early as kindergarten, children learned to exercise self-explanations by modeling after an expert’s answers to the questions which helped facilitate their encoding and acquiring a deeper effect of learning (Calin-Jageman & Ratner, 2005).

A self-explanation study had an assistance-giving-assistance-withholding procedure, namely assisting self-explanation prompts, that was found to promote high quality self-explanations; while open self-explanation prompts and no prompts were not as effective (Berthold, Eysink, & Renkl, 2009). Self-explanation techniques used alongside proper instructional support can improve transfer (Kalyuga, 2009). When combined with direct instruction, self-explanation becomes more effective and facilitates transfer well with persisting benefits over a delay (Rittle-Johnson, 2006).

Self-explanation is effective based on cognitive load theory (Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Kalyuga, Chandler, & Sweller, 1998; Paas, Renkl, & Sweller, 2003; Sweller, 1994; Sweller et al., 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005). A multimedia learning environment that properly implements cognitive learning principles can be effective (Fletcher & Tobias, 2005; Johnson & Mayer, 2010; Mayer, 2001, 2005a, 2008, 2009, 2011) because learners’ active construction of knowledge structure is what helps them benefit from multimedia over a single media (Schnotz & Bannert, 2003). Learners would not automatically learn by being in a multimedia environment (Kozma, 1994). By the same token, only if the learners doing self-explanation are actively engaged in the
knowledge construction and monitoring, do they benefit from such exercises (Crippen & Earl, 2004; Crippen & Earl, 2007; Schraw, Crippen, & Hartley, 2006; Sweller et al., 1998).

Findings of self-explanation studies informed the design of the current study in which direct instructions and appropriate instructional support were provided throughout the lessons. Students received direct instruction for self-explanation and were provided with clear examples to model after. Students were prompted to do self-explanation to answer the guiding questions. Moreover, after learners submitted their self-explanation answers, a popup window with suggested answers appeared as instructional support for the learners to verify their knowledge.

**Reading Questions and Answers**

Reading is a prevalent learning method across subjects, such as English and mathematics, and platforms, like textbooks and online tutorials. Conventionally, students have learned programming languages by reading lecture content from textbooks or electronic sources such as an Internet tutorial where students read the instructional materials on the monitor screen (Johansen, 2010; Quigley, 2010; Topley, 2010; Young, 2013).

Reading questions and answers helps students focus their attention (Raphael, 1982), and helps keep students on the right path of learning (McIntosh & Draper, 1995, 1996). An established learning strategy similar to reading questions and answers called question-answer relationship (QAR) focuses on understanding the relationship between questions and answers derived from the learning materials. The effects of learning of QAR have been widely evidenced to be positive (Benito, Foley, Lewis, & Prescott, 1993;
Kinniburgh & Shaw, 2009; McIntosh & Draper, 1995, 1996; Ouzts, 1998; Pappa & Tsaparlis, 2011; Raphael, 1982, 1986; Raphael & Au, 2005), providing support for the use of the variation of reading questions and answers. QAR instructional activities promote students’ ability to answer questions related to the text they are learning, and have shown significant potential in improving learning (Ouzts, 1998).

The question-answer relationship learning strategy applies to skilled adults (Ouzts & Palombo, 2005), young children (Beyersdorfer, 2003; Ezell, Hunsicker, & Quinque, 1996; Ezell, Kohler, Jarzynka, & Strain, 1992; Henry, 2008; Kelty, 1999; Lawrence, 2002; Raphael & Pearson, 1985; Raphael & Wonnacott, 1985; Soptelean, 2012), and older children in secondary education (McIntosh & Draper, 1995, 1996). “Sources of information” is what’s intended for students to identify through the implementation of question-answer relationship regardless their ages (Raphael, 1984; Raphael & Wonnacott, 1985). The learning strategy of question-answer relationship has also been shown to increase learners’ overall metacognitive awareness (Benito et al., 1993; McIntosh & Draper, 1995, 1996; Raphael, 1982), which guides students in the right direction of learning and therefore helps even students with learning disabilities improve their reading comprehension abilities (Gavelek & Raphael, 1982).

While studying questions and answers, students are taught to locate correct answers from the text in response to the questions (Raphael, 1982). Furthermore, the implementation of question-answer relationship strategy increases students’ abilities to read, model after the demonstrated format of answering questions, and learn the intended purpose of the text (McIntosh & Draper, 1995, 1996). This effect was shown in various studies of text reading. For example, the use of question-answer relationship for science
instruction enhanced students’ reading comprehension of science texts, and consequently, students’ test scores improved in both subjects of science and reading (Kinniburgh & Shaw, 2009). Students’ increased ability to identify the question-answer relationship even improved their mathematical reasoning skills and also expanded upon their existing strategies of successful test-taking (Mesmer & Hutchins, 2002).

Students with learning disabilities or behavior disorders often have difficulty understanding the means and ends relationships (Benevento, 2004). By applying the comprehension instruction framework of question-answer relationship (Raphael & Au, 2005), these students’ metacognitive awareness can be improved through practices (Gavelek & Raphael, 1982). In addition, question-answer relationship enhances students’ understanding of a word problem with a table or graphic that displays data, which involves a sophisticated multistep process and reasoning skills (Mesmer & Hutchins, 2002).

Four types of questions are categorized for students during the question-answer relationship instructional activity: right there, think and search, author and you, and on my own. They are questions that are literal questions using words directly from the text (right there), that require students to gather information from different parts of the text and integrate it into a meaningful answer (think and search), that require students to relate their own experience to the information in text (author and you) and that ask for students’ own background knowledge without reading the passage necessarily (on my own) (Mesmer & Hutchins, 2002). The question-answer relationship learning strategy provides similar effects as reading questions and answers.
Textbooks are one of the most predominant sources of knowledge. They are at least in part evaluated by their exercises and test questions. Pappa and Tsaparlis (2011) analyzed the questions of ten general chemistry textbooks and have the following findings: (a) thoughts-provoking open-type questions are scarce or missing, (b) most of the tests are for declarative knowledge and not procedural knowledge, (c) metacognitive questions are completely missing and (d) there is total lack of questions of relevant processes of the experiments (Pappa & Tsaparlis, 2011). Such findings informed paper textbooks as well as the current study with its electronic format to provide questions that are metacognitive, open-type, of relevant experimental processes, and provide more tests on procedural instead of declarative knowledge.

In summary, the selection of the two learning strategies was based on the following reasons: (a) both strategies contribute positively to student learning (Benito et al., 1993; Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Kinniburgh & Shaw, 2009; Ouzts & Palombo, 2005; Pappa & Tsaparlis, 2011; Raphael & Pearson, 1982; Roy & Chi, 2005; Sweller & Chandler, 1994; Sweller et al., 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005), (b) as reading has been used widely in computer programming language learning, comparing a self-explanation strategy with this seldom challenged conventional approach makes practical sense, and (c) a thorough literature search indicated that there has not been a study on the comparison of the learning strategies of self-explanation and reading questions and answers. Therefore, the current study explored the effects of learning of the two strategies by comparing students’ end-of-lesson test performances and their
perceptions of different aspects of learning supported by the two strategies after they experienced both treatments.

**Motivation as a Covariate**

Academic motivation has been evidenced to be important for learning (Chen & Pajares, 2010; Eccles & Wigfield, 2002; Usher & Pajares, 2009; Wigfield & Eccles, 2000; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006; Wigfield & Guthrie, 1997). Motivation is essential for students’ learning computer programming language especially because the learning of programming language imposes high intrinsic cognitive load (Garner, 2002) and therefore requires extensive practice (Law, Lee, & Yu, 2010). Based on the notion that motivation change is positively related to change in students’ achievement in the learning of computer programming languages (Su, 2008), various methods to promote motivation among students learning computer programming languages (Apiola & Tedre, 2012; Jiau, Chen, & Ssu, 2009) or Web development skills (Liu & Pedersen, 1998) were developed.

Serrano-Cámara, Paredes-Velasco, Alcover, and Velazquez-Iturbide (2003), for example, devised several learning tools that were aimed to promote students’ motivation which demonstrated the importance of motivation in learning computer programming concepts. Although their findings were mixed with unexpected amotivation issues, the positive portion of the results nonetheless shed light on the direction of future research on motivation improvement for promoting learning. An instruction design utilizing game-based assignments to increase students’ intrinsic value in learning computer language found that students were more motivated to complete tasks as compared to students who received traditional assignments (Jiau et al., 2009). Students who were instilled of utility
value by being informed how useful their Web design skills would be in personal and business aspects scored higher in quizzes and remained more interested after learning than the uninformed students (Fraughton, Sansone, Butner, & Zachary, 2011). Further, students’ motivation was improved with a sense of self-importance after being elevated to the role of hypermedia designers, not just learners to a computer application, which resulted in students’ better higher order thinking skills and design knowledge development (Liu & Pedersen, 1998). Along with the positive relationship of motivation change in the learning of computer programming languages (Su, 2008), the practice of providing timely assistance and motivational support should be deemed indispensable to help students improve and maintain intrinsic motivation in learning computer programming (Apiola & Tedre, 2012).

The current study included motivation variable as a covariate to increase precision of research findings. Included variables in the motivation constructs were self-efficacy, effort and persistence, and task value. Self-efficacy is how much a person believes in his/her own ability to complete tasks (Bandura, 1993, 1997, 2011; Chen & Pajares, 2010; Pajares, 1996; Schunk, 1991; Schunk & Pajares, 2002; Schunk & Zimmerman, 1997; Usher & Pajares, 2009; Zimmerman, 1989, 2000, 2008). Students’ computer programming language learning achievement can be increased if their self-efficacy is increased through a well facilitated e-learning setting (Askar & Davenport, 2009; Law et al., 2010).

Responsible learners exhibit high self-efficacy as well as high levels of effort and persistence during learning (Bandura, 1993; Zimmerman & Martinez-Pons, 1990). Not all students regulate themselves to invest effort even if they are generally aware of the
importance of effort and persistence in completing tasks (Hong, Sas, & Sas, 2006). Teaching students the importance of effort helps them improve their performance in problem solving and even persistence through academic difficulties (Li, 2013).

Task value is motivational inclination of students that the task (e.g., computer language learning) is important (attainment value), useful (utility value) or interesting and enjoyable (intrinsic value) (Eccles, 2005; Wigfield & Eccles, 1992). Tasks that are valued, especially those intrinsically valued, are related to high levels of learning and achievement (Greene, DeBacker, Ravindran, & Krows, 1999; Hong & Aqui, 2004). Low achievers, in general, value their school work less as compared to high achievers (Lepper, Corpus, & Iyengar, 2005). Students’ attainment value of a given task is influenced by three basic human needs: competence, autonomy, and relatedness (Connell & Wellborn, 1991). The attainment value of college computer programming students positively affected their achievement (Reitzes, 1986). Utility value is how useful a given task is to students, for example, studying computer programming languages is regarded as having high utility to aspiring programmers (Fraughton et al., 2011).

Interest directs students’ intrinsic value and predicts academic engagement and achievement (Eccles, Wigfield, & Schiefele, 1998; Wigfield et al., 2006). Whether students’ motivation is intrinsic or extrinsic makes a difference. Intrinsically motivated learners are interested in and enjoy the tasks. By contrast, extrinsically motivated learners engage in tasks with the goal of seeking rewards such as praise or high grades. High achievers tend to be more intrinsically motivated and seek challenges more so than low achievers (Eccles, 2005, 2007; Eccles & Wigfield, 2002; Eccles et al., 1998; Wigfield et al., 2006). The study of Visual Basic programming by Jiau et al. (2009), described above,
illustrated that such effort by instructional designers and classroom teachers can help students increase intrinsic value of the programming task. In general, studies of motivation in programming language learning have been sparse, warranting more investigation.

**Multimedia Learning Principles and Worked Examples**

The design of the tutorial of the current study followed the cognitive principles of multimedia learning while implementing an added instructional strategy of worked examples as the combination has been evidenced to be effective (Calhoun, 2013; Kapli, 2011). The cognitive principles of multimedia instructional design have been evidenced to be effective (Mayer, 2005a, 2005b, 2005c, 2005d, 2008, 2009, 2011). Worked examples, a built-in feature of the tutorial of the current study, have also demonstrated their effectiveness in many well-structured academic subjects including computer programming (R. K. Atkinson, Derry, Renkl, & Wortham, 2000; Garner, 2002; Murphy & Wolff, 2009). As these are important features of the tutorial developed for the current study, literatures on worked examples and multimedia learning principles are briefly described.

Using worked examples to teach during the early stage of learning yields superior effects compared to those of using conventional problem-solving in the areas of well-structured subjects like computer programming (R. K. Atkinson et al., 2000; Garner, 2002; Murphy & Wolff, 2009). Computer programming learning imposes a high intrinsic load while studying worked examples can help reduce extraneous load (Garner, 2002). The current study employed snippets of computer program codes for the worked examples (Crippen & Earl, 2004; Crippen & Earl, 2007; Hohn & Moraes, 1997; van
Merrienboer, 1990; van Merrienboer & Krammer, 1987) which were placed in each of the sample programs provided in the tutorial lessons.

Mayer (2004) proposes that fifty years of research provides consistent evidence against discovery learning type of problem-solving and in favor of guided instruction (Mayer, 2004). Worked examples reduce the overall time requirement to learn and to transfer and therefore facilitate both schema acquisition and rule automation (Cooper & Sweller, 1987). Several studies showed that learners ignored text description in favor of worked examples because of their more user friendly appeal (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Using worked examples in the current study for both groups affords the benefits suggested by previous studies.

Multimedia learning is defined as the construction process of the mental representation from words and pictures. The multimedia learning instruction guidelines are based on the cognitive load theory (Sweller, 1994) and other significant theories such as dual-coding theory (J. M. Clark & Paivio, 1991; Paivio, 1986). The augmentations can be from words to pictures or vice versa, and they lead to learners’ more intense cognitive processing of the learning materials (Fletcher & Tobias, 2005).

The multimedia principles suggest that words presented together with pictures can improve effect of learning from that of words alone with better retention and transfer (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Students performed 55 to 121 percent better in transfer tests of text plus graphics than those of text alone across ten comparisons (R. C. Clark & Mayer, 2003,
2008a, 2008b; Mayer, 1983; Mayer, Johnson, Shaw, & Sahiba, 2006). Students learn better with symbols and graphics than from symbols alone (Moreno & Mayer, 1999).

Information from disparate sources causes a split-attention effect and imposes additional cognitive load with learners’ mental exertion to integrate the information (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). The physical and temporal integration of the information spares the learners of such exertion (Ayres & Sweller, 2005). The layout of the instructional design avoided the split-attention effect by displaying relevant information in neighboring panels. Further, as difficult materials cause high intrinsic cognitive load (Sweller, 1994), three multimedia principles are proposed to minimize cognitive overload; the segmenting principle recommends learner-controlled successive and bite-size segments with time allowed in-between segments, the pre-training principle suggests to provide learners with clear background information, and the modality principles proposes to fully utilize the auditory and visual channels (Ayres & Sweller, 2005; Low & Sweller, 2005; Mayer, 2005b, 2008, 2009, 2011; Moreno & Mayer, 2007).

Seductive details such as irrelevant imagery or music distract learners from comprehending the material (R. C. Clark & Mayer, 2003, 2008a) and depress meaningful learning (R. Garner, Gillingham, & White, 1989). The signaling principle posits that learners should be given prompts regarding what information to attend to and the organization of the information. The spatial and temporal contiguity principles advocate the physical integration or the simultaneous presentation of words and pictures, and can remove the effect of split-attention (Ayres & Sweller, 2005).
In summary, the instructional design of the present study adopted the segmenting principle with its topics arranged in the order of degrees of difficulty, and the pre-training principle by providing XHTML background knowledge (Mayer, 2005b, 2008, 2009, 2011; Moreno & Mayer, 2007). It followed the coherence principle to avoid seductive details by providing one solid pastel background color for each Web page, and the signaling principle by providing a prominent lecture panel that the learners were directed their attention to, and a clear organization of the topics arranged from beginning to advanced. Lastly, the tutorial applied the spatial and temporal continuity principles with neighboring panels which therefore provided a significant improvement from the traditional Web page display routine that can easily confuse a novice learner between the editing mode and the display mode.

**Purpose of the Study**

The difficulties that the Web design students experience from attempting to learn JavaScript can be alleviated by providing effective instructional materials. Based on the literatures on instructional principles reviewed above, an online interactive multimedia tutorial instruction that implemented a worked-example strategy was developed to reduce cognitive load and to improve learning of JavaScript.

This study explored the effects of the learning strategies of self-explanation and reading questions and answers in instructional materials that implemented a worked example learning strategy by teaching with snippets of computer program code (Hohn & Moraes, 1997; van Merrienboer, 1990; van Merrienboer & Krammer, 1987). The sample code associated with a topic that is selected by the learner from the lesson list on the home page had been written to demonstrate one programming concept at a time.
The design of this instruction afforded the learners to practice after seeing the sample code, first, typing exactly the same code as the sample code, in a window panel placed directly beneath the sample code window for the user’s reference. Both the sample code window, and the practice window that’s filled with the practice code by learners, had a “browser” window to its right, for the learners to display the corresponding Web page. Then, the display button for each of the “browser” window provided an opportunity for the learners to envision how the rendered Web page should look like. If the Web page was rendered as expected, it was a positive reinforcement of what the learner understood; otherwise the learner had to engage himself/herself when looking for the reason for the discrepancy.

When the learners felt their practicing was adequate, they were ready to go to the next page to practice again, but this time without a visual reference in the vicinity. The coding at this stage was still complimented by a browser window to the right in order for the learners to display the corresponding Web page of their “start from scratch” coding this time.

After this advanced stage of practice, the group of students using self-explanation would be prompted with questions that engaged them in the self-explanation activity with which they typed their self-explanations in the Web page and submitted. The reading questions and answers group was supplied with questions and answers that rehashed the knowledge that the students had just learned, but no prompts for self-explanation; meaning, the students in the reading questions and answers group only read but did not write down their thoughts.
The study examined the effects of the learning strategies of self-explanation and reading questions and answers in two ways: (a) by comparing the end-of-lesson test scores and (b) by comparing students’ perceptions of the learning activities of self-explanation and reading questions and answers. Although previous studies found positive effects of both self-explanation and reading questions and answers on learning, the current study is the first to explore differential effects of the two strategies in the JavaScript learning environment. Students’ background knowledge of XHTML and academic motivation to learn computer programming language were used as covariates in this study. To gather students’ perceptions of effectiveness of the two experimental strategies, two groups of students experienced both strategies, followed by tests provided at the end of each lesson. After students completed all five lessons, they filled out the end-of-study questionnaire regarding their perceptions toward the two learning strategies as to different aspects of support the strategies provided in learning (see detailed procedure in Chapter 3).

**Research Questions**

1. Was there a significant difference in student performance at the end-of-lesson test questions between the group that engaged in self-explanation activity and the group that read the provided questions and answers, during learning JavaScript in the tutorial? Student performance was rated using scores of the end-of-lesson test questions in the tutorial. The current study explored the differences in the effects of the two strategies as both had positive effects among previous studies.

2. Which learning strategy was superior for achieving a better understanding of JavaScript in students’ opinion? This question was examined using quantitative
and qualitative approaches. After reviewing both versions of the tutorial, students answered a questionnaire regarding their perceptions of the two versions. In addition, categories/themes were elicited from reasons provided by students. Then the categories and subcategories were tallied by the experimental conditions to quantify their perceptions. This information was used to examine what aspects of the two strategies were perceived as effective.

**Significance of the Study**

Learning JavaScript to enhance one’s Web design ability is a prominent milestone for one’s transformation into a sophisticated Web designer who can create Web pages abundant in functionality that mere XHTML coding cannot provide. Nevertheless, the sudden increase of the intrinsic cognitive load resulting from the learning of a computer programming language (Garner, 2002) that is a radical educational novelty (Dijkstra, 1989) has frustrated many Web designers who used to experience instant gratification of designing Web sites with the XHTML coding.

Online multimedia instructional design tutorials that implement a worked example strategy have been evidenced as effective (Calhoun, 2013; Kapli, 2011) and the built-in interactive feature could afford students an unlimited opportunity of practicing to their satisfaction while acquiring schema and encoding it to the long-term memory (Lee, 2008). However, the concept of learning by reading questions and answers that has long been used in learning computer programming languages has not yet been challenged. The specific interest of this study, utilizing a multimedia environment with the implementation of worked examples, lies in the added effect resulting from students’ utilizing self-explanation or reading questions and answers of the knowledge acquired
during learning. McNamara and Magliano (2004, 2009) propose that it is crucial to use reading strategies to comprehend unfamiliar text (McNamara, 2004; McNamara & Magliano, 2009). Even the intrinsically motivated learners should be guided with learning strategies; otherwise, they might not achieve the desired learning result because they do not necessarily have an adequate strategy repertoire (Renkl, 1997).

This current study is significant as the findings demonstrated the comparison of the effects of learning of self-explanations and reading questions and answers, both in test performance and in student perceptions, in a tutorial implementing a worked example strategy in a multimedia online environment.

Definition of Terms

**Modal model of memory**: A memory model that describes the human information processing system; how humans perceive and select information for further processing. The model is composed of sensory memory, working memory, and long-term memory (R. C. Atkinson & Shiffrin, 1968; Glanzer & Cunitz, 1966; Waugh & Norman, 1965).

**Cognitive Load Theory**: There are three different types of cognitive loads that learners encounter during learning, and each takes up some working memory capacity: intrinsic, germane, and extraneous cognitive load (Chandler & Sweller, 1991; Mousavi, Low, & Sweller, 1995; Paas et al., 2003; Sweller, 1988, 1989, 1994; Sweller & Chandler, 1994; Sweller et al., 1998; Tuovinen & Sweller, 1999; Jeroen J. G. van Merrienboer & Sweller, 2005).
**Traditional Problem-solving:** Conventional problem-solving employs a means-ends strategy which looks to show students how to reduce the differences between the goal state and the current problem state (Klahr, 1978, 1985; Klahr & Robinson, 1981).

**Worked examples:** Worked examples provide step by step guidance, and require radically less cognitive processing and working memory than conventional problem-solving (Greeno, 1980). In instructional designs, worked examples are typically composed of a problem, and then the steps to solve the problem, in order to demonstrate to the novice learners the way an expert would solve similar problems (R. C. Atkinson, Renkl, & Merrill, 2003; R. K. Atkinson et al., 2000). Worked examples offer detailed problem solutions to provide the learner with some structure for understanding how the solution was established without providing a script or algorithm (Crippen & Earl, 2004; Crippen & Earl, 2007). Worked examples have been largely considered to contribute tremendously to the improvement of learning compared to those of the conventional problem-solving.

**The multimedia principle:** The multimedia principle suggests that words presented together with pictures can improve effect of learning than that of words alone; resulting in better retention and transfer (Clark & Mayer, 2003; Mayer, 2001, 2005a, 2008, 2009, 2011; Moreno & Mayer, 2007).

**Self-explanation:** Self-explanation is the process that a reader pauses to evaluate his/her degree of understanding and attempt to improve it (Chi, 1996; Chi et al., 1989; Chi & VanLehn, 1991; McNamara, 2004; McNamara & Magliano, 2009). McNamara and Magliano (2004, 2009) define self-explanation as a cognitive process that learners
engage while reading text; readers explain their own understanding to themselves in the format of speaking or writing (McNamara, 2004; McNamara & Magliano, 2009).

**Reading questions and answers:** Reading questions and answers is the process that a reader reads a given set of questions and answers that relate to the learning material. A similar reading strategy, question-answer relationship that enlightens students to locate answers in the text, has proven its positive effect (Benito et al., 1993; Kinniburgh & Shaw, 2009; McIntosh & Draper, 1995, 1996; Ouzts, 1998; Pappa & Tsaparlis, 2011; Raphael, 1982, 1986; Raphael & Au, 2005), providing support for the effects of learning of its variation of reading questions and answers.
Background

Computer programming has long been considered very challenging by students to learn and for instructors to teach (Ala-Mutka, 2004; Kelleher & Pausch, 2005; Major, 2010). Researchers have agreed that mastering computer programming skills is difficult (Bonar & Soloway, 1989; Bucks, 2010). Novice computer programming learners experience various difficulties with basic program design and algorithmic complexity which lead to their admission of the fragility of novice knowledge (Robins, Rountree, & Rountree, 2003). Lacking the mental model of the execution process of a program in the computer memory makes learning computer programming less feasible for students (Milne & Rowe, 2002). The subject of computer programming language has the appearance of a radical educational novelty (Dijkstra, 1989) causing anxiety in students. That is, students are faced with something that does not remind them of any subject that they have successfully learned in their past. Students become disillusioned after they experience low levels of achievement in learning computer programming (Garner, 2002). It is estimated that 40 to 50 percent of first year computer programming students either performed below average with a grade less than C (70%) or withdrew from the class (Schuyler, 2011). Consequently, many students eventually resort to staying away from taking any more computer programming courses (Jenkins, 2002).
Computer educators have been exploring various instructional strategies that help make learning and teaching computer programming languages more conducive (Bucks, 2010; Goldenson, 1996; Kert & Kurt, 2012; May & Dhillon, 2009; Renumol, Janakiram, & Jayaprakash, 2010). For example, electronic performance support systems software was developed for undergraduate students’ learning programming languages (Kert & Kurt, 2012). Based on the progress of students’ learning reported by the software, the effects of the software during students’ learning process on students’ self-regulated learning were investigated. Students’ cognitive and metacognitive strategies of the experimental group were significantly superior to those of the control group that learned programming languages through traditional methods without the utilization of the software (Kert & Kurt, 2012). May and Dhillon (2009) postulate that to create robust and efficient computer programs, understanding the syntactic features of a programming language alone is not sufficient, suggesting that semiotics be used, in which syntaxes are delivered at both technical and human levels, to facilitate a deeper understanding in programming languages for students.

Although seldom studied in the context of programming language learning, self-explanation has been of particular interest for the current study among frequently implemented and studied teaching strategies. The learning strategy of self-explanation is the learners’ mental exercise of explaining concepts to themselves and checking their own understanding. It generates germane cognitive load and contributes directly to learning (Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Sweller, 1994; Sweller, van Merrienboer, & Paas, 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005).
In today’s digital age, online learning format has been rapidly gaining momentum as it accommodates modern day learners’ needs such as being able to take classes while living remotely from school or while working during regular school hours, or preferring to learn in a virtual learning environment over a traditional classroom (Palloff & Pratt, 1999, 2003, 2011). Online learners believe that high-quality learning can happen anywhere and anytime, not just in the traditional classrooms (Palloff & Pratt, 2003). Web-based teaching, in the online learning environment, is becoming an important route to successful learning (Yip, 2004). A computerized tutorial that is hosted on a Website on the Internet can be accessed from anywhere in the world as long as there is a computer and an Internet connection. Thus, these types of computerized online tutorials can be utilized by teachers in both the traditional classrooms and an online learning setting. An instructional design that can be delivered through both platforms would be more practical than those that are limited to their specified venues. It has been discussed that it is the instructional methods, not the medium, that mediate learning (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Thus, the design and development of an effective instructional material that accommodates both of the most common delivery platforms today is desirable.

In the current study, a computerized tutorial had been developed to improve students’ computer programming language learning experience. This tutorial was designed based on the cognitive principles of multimedia learning while employing worked examples as an added instructional strategy. The tutorial was hosted on a Website on the Internet to provide learners with access to learn from anywhere, at any time. Students using the tutorial could benefit from the instructional material that was
developed based on the cognitive principles of multimedia instructional design that have been evidenced to be effective (Mayer, 2005a, 2005b, 2005c, 2005d, 2008, 2009, 2011). Furthermore, worked examples, also having demonstrated their effectiveness in many well-structured academic subjects such as mathematics (Cooper & Sweller, 1987; Sweller, 1989; Sweller & Cooper, 1985; van Gog, Paas, & van Merrienboer, 2004, 2006; Zhang, 2001), science (Sweller, 1989), chemistry (Crippen & Earl, 2004; Crippen & Earl, 2007), physics (Richey & Nokes-Malach, 2013), engineering (Pollock, Chandler, & Sweller, 2002) and most pertinently, computer programming (Atkinson, Derry, Renkl, & Wortham, 2000; Garner, 2002; Murphy & Wolff, 2009), were included as a built-in feature of the tutorial of the current study.

Whereas the instructional design principles briefly mentioned above have been tested in numerous studies (Mayer, 2008, 2009, 2011), what has not been prominent in the computer language learning situations is that whether providing students with opportunities for self-explanation of their understanding of instruction is beneficial to student learning. Prevalently used methods in teaching subject matters using computer platform involve “reading” as students read the instructional materials on the monitor screen. Although self-explanation studies have been conducted widely with many traditional academic subjects such as mathematics (Durkin, 2011), chemistry (Crippen & Earl, 2004; Crippen & Earl, 2007; Hilsenbeck-Fajardo, 2010), physics (Fukaya, 2011; Nokes, Hausmann, VanLehn, & Gershman, 2011; van der Meij & de Jong, 2011), and statistics (Hall & Vance, 2010; Hsu, 2009; Leppink, Broers, Imbos, van der Vleuten, & Berger, 2012), there have been fewer studies examining effects of self-explanation on learning of a computer programming language.
In the early to mid-90s, there was a series of research studies conducted regarding individual and collaborative self-explanation strategies of instructional text while learning LISP programming languages (Bielaczyc, 1995; Bielaczyc & Pirolli, 1995; Pirolli & Bielaczyc, 1989; Pirolli & Recker, 1994; Recker & Pirolli, 1990), and another experiment on the controlled self-explanations with the acquisition of a programming language SQL (Yuasa, 1994). However, much time has elapsed since then and not until recently has there been only one study by Kwon and Jonassen (2011), regarding reflective self-explanations with the learning of a computer programming language JavaScript. The study concluded that the reflective self-explanation process helped students perform better in problem solving tasks (Kwon & Jonassen, 2011).

In the current study, two learning strategies were selected to examine their differential effects on student learning of computer programming languages: (a) self-explanation and (b) reading questions and answers. Self-explanation strategy is the main interest of the study, as reading strategy in computer language learning has been a conventional approach with textbooks or even online tutorial sources (Johansen, 2010; Quigley, 2010; Topley, 2010; Young, 2013). Literatures demonstrate that both strategies contribute to student learning (Benito, Foley, Lewis, & Prescott, 1993; Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Kinniburgh & Shaw, 2009; Ouzts & Palombo, 2005; Pappa & Tsaparlis, 2011; Raphael & Pearson, 1982; Roy & Chi, 2005; Sweller & Chandler, 1994; Sweller et al., 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005). Close examinations of the two learning strategies are followed. In regard to self-explanation, the effects and processes of self-explanation, worked examples and multimedia are examined. As far as learning by
reading questions and answers, its effects and similarity to the learning strategy of question-answer relationship are examined. Furthermore, the strategy of reading from a computer screen is compared to learning from textbooks. Finally, its wide applications throughout grades and adults are discussed.

**Self-explanation as a Learning Strategy**

Self-explanation is an effective learning strategy that generates germane cognitive load, and learners use it to help improve their understanding of concepts when learning (Crippen & Earl, 2004; Crippen & Earl, 2007; Sweller et al., 1998). Utilizing self-explanation strategy when learning computer programming concepts has improved learning effectiveness for students with both high and low prior knowledge (Kwon & Jonassen, 2011).

McNamara and Magliano (2004, 2006, 2009) define self-explanation as a cognitive process that learners engage in while reading text and suggest that the use of learning strategies, such as self-explanation, is imperative to comprehend unfamiliar text (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara, O’Reilly, Best, & Ozuru, 2006). In an experiment, for example, when college physics students exercised self-explanation by coming up with a rationale to interpret the solution steps of the examples in their textbooks, they learned more than those students who did not explain to themselves (Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

A learner’s reflection on what is being learned by recalling and contemplating the learned materials has been shown as one of the most crucial processes of learning (Davis, 2003). Dewey (1933) interprets reflection as “thinking with a goal.” Reflective thinking, as he suggests, is one of the most conscious ways of thinking. He postulates that
reflection is a process in which people re-examine their already acquired understanding of something, make connections among existing beliefs, and generate new beliefs (Dewey, 1933). Dillenbourg and Self (1992) call the process of reflection “a conversation of an individual with himself” and describe that it is like when in a conversation with a partner, one argues with himself or herself to either affirm, negate or seek out alternatives regarding the previously acquired thoughts (Dillenbourg & Self, 1992). These postulations allude to the belief that reflection plays a vital role in knowledge assimilation. Chung, Chung and Severance (1999) posit that reflection is a learner’s mental activity to plan and control learning, and through the explicit instruction of self-explanation strategies, students develop better understanding than those who received implicit instruction. Self-explanation represents the process of a constructive activity that is domain-general, and it ensures that learners attend to the learning materials while introspecting the evolving understanding (Roy & Chi, 2005). Research by Chi and her colleagues suggests that self-explanation can improve text comprehension to a deeper level (Chi et al., 1989; Chi, de Leeuw, Chiu, & La Vancher, 1994). With the utilizations of proper self-explanation techniques, readers are able to form a more consistent text level understanding (McNamara, 2009).

Self-explanation can occur spontaneously with human beings during the reading activity without formal training or being prompted. If people run into obstacles with comprehending the material at hand, they could well instinctively stop to explain to themselves what the content in question might in fact mean; when they are satisfied with the answer that they come up with, they then feel comfortable to resume the reading. Such self-explanation process is a natural activity that has an apparent purpose of
externalizing the comprehension of the text being read (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara et al., 2006). Chi (2000), after the initial view on self-explanation as the evaluation of understanding (Chi, 1996; Chi et al., 1989; Chi et al., 1994; Chi & VanLehn, 1991; McNamara, 2004; McNamara & Magliano, 2009), further modifies self-explanation as a dual process which is involved with not only the generation of inferences as previously posited, but also the repairing of the learner’s own mental model. It is postulated in this revised view that during the latter process, the learner becomes engaged in the self-explanation process if he or she perceives a discrepancy between what’s being conveyed and the learner’s original ‘naïve’ mental model (Chi, 2000).

**Effects of Self-explanation on Learning**

As the studies on the effects of self-explanation on computer language are sporadic, the current study was intended to replicate the research results of previous studies of self-explanation learning strategies with the instructional goal of teaching a computer programming language, JavaScript, in an online learning environment. Several studies that examined the effects of self-explanation on learning were reviewed. In an experimental study, for example, college physics students who exercised self-explanation by coming up with a rationale to interpret the solution steps of the examples in their textbooks learned more than those students who did not explain to themselves (Chi et al., 1989). Among some college students who were learning to solve mechanics problems by studying worked examples, students’ engagement in self-explanation had aided their understanding of the materials (Chi, 1996; Chi et al., 1989; Chi & VanLehn, 1991). The authors contend that self-explanation activity guided and assisted the accurate monitoring
of their own understanding and misunderstanding of the material. Further, Bielaczyc and her colleagues during the early to mid-90s demonstrate that students who had received explicit training in using the self-explanation strategies had significantly greater gains in knowledge than students who had not received explicit training in the self-explanation strategies in learning computer programming language (Bielaczyc, 1995; Bielaczyc & Pirolli, 1995; Pirolli & Bielaczyc, 1989; Pirolli & Recker, 1994; Recker & Pirolli, 1990). These findings indicate that the implementation of self-explanation improves students’ effect of learning and that the explicit training helps students identify and utilize self-explanation learning strategy successfully.

**Self-explanation Processes**

The process of self-explanation can be carried out in different formats.

**Thinking quietly to oneself.** Thinking quietly to oneself without calling attention from other people, even if they can be right next to the thinking person, is an invisible and silent way of going about the process, and possibly happens more often than other formats of self-explanation amongst humans’ daily lives. An ancient Chinese book, “The Great Learning” (http://en.wikipedia.org/wiki/Great_Learning, 2013), one of the “Four Books” of Confucianism, has the saying, “Extension of knowledge consists of the investigation of things” (English translations) (Muller, 2010). The idea is to think things through in order to understand them. In other words, a person would explain to himself or herself what meanings these things seemingly possess (http://baike.baidu.com/view/30135.htm, 2013). This teaching had resulted in a historically well known event in Ming Dynasty during which time, Wang Yang-Ming, an idealist Neo-Confucian philosopher, decided to sit quietly in front of some bamboos to
“investigate” for seven consecutive days and nights in order to understand bamboos. Not only did he fail to gain any more knowledge about bamboos than before he started, but he also fell ill and collapsed. It is not surprising that he became doubtful toward such method (Chan, 1972; http://en.wikipedia.org/wiki/Wang_Yangming, 2013). This might have been the first documented self-explanation in history with the format of thinking to oneself quietly, albeit not a successful event.

Scholars have inadvertently or supinely omitted such an undetectable format. For example, McNamara and her colleagues (2004, 2006, 2009) describe self-explanation as a cognitive process that learners engage in, either with the speaking or with the writing format, while reading text and explaining to themselves what the text means (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara et al., 2006). The self-explanation process that is carried out by thinking quietly to oneself, has ostensibly been left out. Even if thinking quietly to oneself could well have changed some individuals’ lives at some points of time in human history, it, as a form of self-explanation, is largely undocumented and generally off the radar of scholars.

**Thinking-aloud (the speaking format).** Oster (2001) proposes that thinking-aloud is a technique that requires students, while they are reading, to verbally describe their thoughts and strategies they employ to understand the material. This prompts metacognitive awareness to a learner who, through the thinking-aloud exercise, can improve his or her strategies for a better reading comprehension. Studies indicate that thinking-aloud significantly improves reading comprehension (Oster, 2001). In the aforementioned study in which college students learned to solve mechanics problems by studying worked examples, their self-explanations were implemented through several
thinking-aloud (talk-aloud) protocols and were then analyzed by the researchers (Chi, 1996; Chi et al., 1989; Chi & VanLehn, 1991). These thinking-aloud processes of self-explanation described above fits in the “speaking” format of self-explanation described by McNamara and her cohorts (McNamara, 2004, 2009; McNamara & Magliano, 2009; McNamara et al., 2006).

The practice of thinking-aloud makes it necessary for a learner to pause intermittently to reflect on his or her understanding of the text and verbally describe the reading strategies he or she is using. Therefore thinking-aloud helps guide learners with monitoring their grasp of materials and with employment of strategies necessary to facilitate learning (Baumann, Jones, & Seifert-Kessell, 1993). This finding coincides with the aspect of metacognitive awareness Oster (2001) proposes that thinking-aloud is able to promote for learners.

Both self-explanation and thinking-aloud can be composed of natural speeches and involve “talking to oneself.” However, experts differ in their opinions on self-explanation and thinking aloud. McNamara and Magliano (2009), for example, propose that self-explanation is considered capable of modifying the learner’s comprehension, while thinking-aloud by the learner only reflects his or her unaltered understanding processes. As a result, they suggest that the self-explanation process externalizes the process of comprehension for readers (McNamara & Magliano, 2009).

**Typing the thoughts (the writing format).** Poor readers do not initiate the self-explanation process as frequently as skilled readers do; and if poor readers are prompted to self-explain, the results generated are poor (Chi et al., 1994). For struggling readers either because they lack domain-specific knowledge or because their reading skills are
low, the introduction of reading strategy instruction can become very effective (Bereiter & Bird, 1985; McNamara, 2004, 2007; McNamara, O’Reilly, Rowe, Boonthum, & Levinstein, 2007; O’Reilly & McNamara, 2007). Self-explanation Reading Training (SERT; McNamara, 2004) is one of those instructional techniques that is aimed to improve the effect of learning. There are six reading strategies provided through SERT: comprehension monitoring, paraphrasing, elaboration, logic or common sense, predictions, and bridging (McNamara, 2009). Among those strategies, paraphrasing serves as a jump start and helps less skilled readers to begin a self-explanation process (McNamara et al., 2006), while bridging is the process of making inferences from separate sentences in the text to link the ideas together in order to integrate them into a coherent concept (Gernsbacher, 1997; Kintsch, 1988, 1998).

Narrative text, such as a novel, is different from science text that contains domain-specific content. Reading strategies therefore can have different levels of effectiveness when they are implemented through reading different types of text. For example, predictions, as one of the aforementioned six reading strategies, with which readers try to imagine what the content will be like next in the text, are more useful with reading narrative texts but are uncommon to be used with science texts (McNamara, 2009).

In a study that students were given both narrative text and science text to read with both thinking-aloud (the speaking format) and typing (the written format) protocols on reading strategies and took comprehension tests for each text, it was found that readers used more paraphrasing and bridging when they were thinking aloud with respect to narrative texts. On the other hand, when it came to science texts, less-skilled readers were
able to make more frequent bridging inferences when they were typing than when they were thinking aloud or speaking (Muñoz, Magliano, Sheridan, & McNamara, 2006). These important findings contributed to the understanding of computer-based tools that are used for assessment and intervention for reading. These findings are also very relevant with the student population that participates in the current study which was composed of, to a large extent, less-skilled readers. These participants can benefit more from typing, rather than speaking, their self-explanations with learning science texts such as the target learning goal of coding in the JavaScript language. These findings are particularly useful with today’s ubiquitous educational computer-based tools whereas students’ comprehension problems with textbook materials are predominant (Best, Floyd, & McNamara, 2008; McNamara, 2001).

In the automated version of SERT, named iSTART, there are animated agents that introduce, demonstrate, and help the learners practice how to use self-explanation while reading a science passage. A learner would explain to himself or herself by typing (using the written format) a self-explanation text. Based on a certain linguistic algorithm that has been used to design the program that can figure out the correctness of the learner’s answer, an animated agent would give feedback to such self-explanation text, in order that the learner can modify if the self-explanation text is not satisfactory. Empirical studies at both the college and high school levels have affirmatively indicated the effectiveness of iSTART for the improvement of both the understanding of text and the use of strategy (McNamara, 2009).

In the current study, students doing self-explanation were instructed to recall what they had learned, and answer the provided questions that were designed to guide them to
explain to themselves what they had learned. This process of typing up one’s thoughts by reflecting on what has been learned, fits in the “writing“ format of self-explanation described above (McNamara, 2001, 2004, 2009, 2007; McNamara & Magliano, 2009; McNamara et al., 2006; McNamara et al., 2007; Muñoz et al., 2006; O’Reilly & McNamara, 2007) that should benefit less-skilled learners more than the speaking format (thinking-aloud) does, with science texts like JavaScript used in Web pages (Muñoz et al., 2006).

**Self-explanation with Worked Examples**

Renkl (1997) describes self-explanation, in the context of learning from worked examples, as the strategy used by the learners when trying to explain the example solution steps to themselves. He suggests that successful learners dedicate more time on studying the examples and generate more task-related ideas during their thinking-aloud self-explanation process (Renkl, 1997). Learners use their background knowledge to interpret and explain the given instructional texts and examples (i.e., self-explanation) which yield declarative knowledge (Chi et al., 1989; Pirolli & Recker, 1994).

Nevertheless, the burden of explaining the solution steps is still on the learners if all of the reasons of a certain step performed in the solution are not provided. Self-explanation can be prompted by a learner’s mental awareness of a need to be able to describe what is being learned from the worked examples. Good learners make attempts to interpret the example solutions’ action parts and associate the action parts with the principles provided in the text. On the other hand, poor learners rely heavily on the “look” of the given examples. In other words, good learners, through self-explanations (i.e. interpreting action parts), study solution structure of the examples, while poor
learners fail to generate sufficient self-explanations therefore become hung up on the surface features of the examples (Chi et al., 1989). The effect can even be seen among learners of very young age such as the kindergarteners of one study; being able to exercise self-explanations by modeling after an expert’s answers to the questions helps the youngsters to facilitate encoding and therefore acquire a deeper effect of learning (Calin-Jageman & Ratner, 2005).

In a series of research studies, college students who have little or no previous experience in computer programming are set to learn about the particular concepts and maneuvers of recursion through a series of lessons in the LISP Tutor program. The students who perform better are much more capable of structuring self-explanations into goal-based types and contents of elaborations than could students whose performances are not as good (Pirolli & Recker, 1994).

**Self-explanation in Multimedia Learning**

Self-explanation has been addressed earlier in the context of cognitive load theory with abundant evidence supporting its effectiveness (Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Kalyuga, Chandler, & Sweller, 1998; Paas, Renkl, & Sweller, 2003; Sweller, 1994; Sweller et al., 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005). A multimedia learning environment had been adopted for the current study and could be potentially very effective.

While self-explanation was to be examined in this multimedia learning environment, we need to be mindful that learners would not automatically become knowledgeable by being passively exposed to the materials presented in a multimedia
learning environment (Kozma, 1994). The learner must actively construct a coherent knowledge structure in order to benefit from multimedia over a single media (Schnottz & Bannert, 2003). Only if the learners are exercising self-regulation, such as being actively engaged in the knowledge construction and monitoring, would they benefit from such learning environment (Crippen & Earl, 2004; Crippen & Earl, 2007; Schraw, Crippen, & Hartley, 2006; Sweller et al., 1998). Self-explanation, being part of the self-regulation, involves specific activity that encompasses generating inferences to “fill in the blanks,” assimilating information provided by the learning materials, and modifying previous faulty concepts (Chi, 2000; Roy & Chi, 2005).

**Self-explanation as a Learning Strategy in General**

Not all types of self-explanations are equally effective. To foster a better understanding, educators often make multiple representations to learners as a way of reaching out to learners with varied knowledge backgrounds. However, the high cognitive load imposed upon the learners through this common practice can result in a lowered effect of learning. An experimental study is conducted with the learning of probability theory in which multiple representational worked examples are used. An assistance-giving-assistance-withholding procedure, namely assisting self-explanation prompts, is found to be able to promote high quality self-explanations and therefore provide an experience of deeper learning. Open self-explanation prompts, or the control group with no prompts at all, on the other hand, result in a lesser effect of learning (Berthold, Eysink, & Renkl, 2009). Such findings have enlightened the current study to provide guiding questions for learners’ self-explanation activity; in addition, after learners had confirmed the submission of their self-explanation answers, the window of
suggested answers appeared for the learners to further verify their knowledge by comparing their answers with the suggested answers. These were the steps the current study took to ensure the provision of high quality self-explanations and the promotion of a deeper learning experience.

If learners have already sufficiently understood the learning material, a prompt that is at a less sophisticated level could force them to process redundant information (Gerjets, Scheiter, & Catrambone, 2006). This phenomenon is also evidenced in the proposed expertise reversal effect (Chi, Glaser, & Rees, 1982; Kalyuga, Ayres, Chandler, & Sweller, 2003; Kalyuga et al., 1998; Kalyuga, Chandler, & Sweller, 2000; Leppink et al., 2012; Reisslein, Atkinson, Seeing, & Reisslein, 2006). A study designed to address exploiting the advantages of multi-representational materials suggests that adaptive self-explaining prompts, which take learners’ expertise into consideration and guide the seasoned learners at their appropriate levels, promote learning more effectively (Yeh, Chen, Hung, & Hwang, 2010).

Self-explanation techniques accompanying appropriate instructional support may enhance learners’ abilities to transfer their knowledge and skills (Kalyuga, 2009). Self-explanation seems to be more effective when combined with direct instruction. Prompts to self-explanation facilitate transfer well under the condition of direct instruction, and these benefits persist over a delay (Rittle-Johnson, 2006). Such findings helped guide the design of the current study in which direct instructions and appropriate instructional support were provided throughout the tutorial lesson sessions. Students were prompted to do self-explanations with direct instruction and were provided with clear examples to
model after. It was expected that the transfer should be facilitated and have a lasting effect.

In summary, self-explanation can help learners reach a deeper understanding of the knowledge to be learned (Roy & Chi, 2005). From the point of view of cognitive load theory, self-explanation, although it incurs additional cognitive load, helps learners learn better, therefore is considered a germane cognitive load (Chandler & Sweller, 1991; Crippen & Earl, 2004; Crippen & Earl, 2007; Kalyuga, 2009; Sweller & Chandler, 1994; Sweller et al., 1998; van Merrienboer & Sluijsmans, 2009; van Merrienboer & Sweller, 2005). The self-explanation strategy therefore was selected for the current study to be implemented in the multimedia online tutorial environment that employed worked examples. The online tutorial environment and the worked examples were applied throughout the study regardless of which group.

**Reading Questions and Answers as a Learning Strategy**

Learning by reading question and answer sets derived from the target learning materials helps direct the attention of students to grasp the focal points (Raphael, 1982). Learning by reading questions and their corresponding answers also helps guide students to stay on the right path of learning (McIntosh & Draper, 1995, 1996). A similar and established learning strategy that focuses on understanding the relationship between questions and answers that are based on the learning materials is called Question-Answer Relationship (QAR). The effects of learning of QAR have been widely evidenced to be positive (Benito et al., 1993; Kinniburgh & Shaw, 2009; McIntosh & Draper, 1995, 1996; Ouzts, 1998; Pappa & Tsaparlis, 2011; Raphael, 1982, 1986; Raphael & Au, 2005).
The instructional activities of question-answer relationship are designed to promote students’ ability to answer questions based on the text they are reading, and has been shown to have significant potential in helping students improve learning effectiveness (Ouzts, 1998). The learning strategy of question-answer relationship has also been shown to increase learners’ overall metacognitive awareness (Benito et al., 1993; McIntosh & Draper, 1995, 1996; Raphael, 1982). The raised level of metacognitive awareness helps guide students in the right direction of learning and therefore helps improve the reading comprehension abilities even among the learning disabled (Gavelek & Raphael, 1982). While learning by reading questions and answers, students are enlightened to locate the relevant information from the text and then respond to the questions with the correct answers (Raphael, 1982). Furthermore, the utilization of the learning strategy of Question-Answer Relationship enhances the students’ abilities of reading, answering questions according to the demonstrated format, and learning in line with the intended purpose from the main text (McIntosh & Draper, 1995, 1996). The implementation of the learning strategy of question-answer relationship for science instruction has been shown to have an effect of increase in students’ reading comprehension of science texts, and as a result, students’ test scores were improved in both subjects of science and reading (Kinniburgh & Shaw, 2009). The increased ability of students to identify the Question-Answer Relationship even helps to improve their mathematical reasoning skills and also helps to expand upon their existing strategies of successful test-taking (Mesmer & Hutchins, 2002).

Among many challenges that educators are faced with today, one prominent challenge is to improve students’ reading comprehension, which is further heightened by
the increasingly diverse backgrounds of students who have entered the educational setting with very low reading comprehension capabilities. Efforts of closing the literacy gap are in dire need to be made and the learning strategy of question-answer relationship can provide a framework for comprehension instruction (Raphael & Au, 2005). Students with learning disabilities or behavior disorders often have difficulty comprehending the means and ends relationships (Benevento, 2004). The question-answer relationship framework can instill metacognitive awareness in learners through practices to benefit even those students who have learning disabilities or behavior disorders (Gavelek & Raphael, 1982).

Furthermore, the learning strategy of question-answer relationship helps students enhance their understanding of a word problem that is related to a table or graphic that displays data. This type of understanding involves a sophisticated multistep process and reasoning skills (Mesmer & Hutchins, 2002). The effectiveness of the learning method therefore provides reasons for the implementation of the selected learning strategy of reading questions and answers in the current study, in which the lecture content was composed of words and the resultant Web page was displayed graphically. That is, the learning strategy of reading questions and answers was expected to help promote the ability of students to draw the relationship between words and their corresponding graphics.

Exploring the Learning Strategy of Question-Answer Relationship

During the instructional activity of question-answer relationship, it is explained to students that they will encounter the four types of questions. First, “right there” questions: These are literal questions where the answers are right in the text; the questions often use
words directly from the text. Second, “think and search” questions: To answer this type of question, information needs to be gathered from different parts of the text to be integrated to form a meaningful answer. Third, “author and you” questions: Students are required to relate the information they gather from the text to their own experience; in other words, they must read the text thoroughly to be able to answer this type of question. Fourth, “on my own” questions: This type of question asks the students to answer with their own background knowledge without necessarily reading the passage (Mesmer & Hutchins, 2002).

**Learning by Reading Questions and Answers from Textbooks**

Reading textbooks has long been recognized as one of the most predominant human practices to obtain knowledge. To a certain degree, textbooks are evaluated by the exercises and test questions they provide at the end of chapters for the learners to practice and to examine the extent of their acquired knowledge. Pappa and Tsaparlis (2011) analyzed ten textbooks of general chemistry in order to study their questions that are included in the chapters on chemical bonding. The areas of concern include the forms of the questions such as if they are closed or open, and the type of knowledge being tested, such as declarative or procedural knowledge. Their findings are: (a) there are far more closed-type questions than open-type questions, while open-type questions are mostly in the format of short answer questions instead of the more thought-provoking type of questions such as an essay; (b) most of the tests are for declarative knowledge, not procedural knowledge; (c) metacognitive questions are completely missing from the textbook content; and (d) there is total lack of questions of relevant experimental processes (Pappa & Tsaparlis, 2011). Therefore, improvement apparently can be made,
either in paper textbooks or on Web pages, by providing more questions that are metacognitive, open-type, and of relevant experimental processes; and by providing more tests on procedural knowledge, instead of declarative knowledge.

**The Application of Question-Answer Relationship**

Raphael and Au (2005) propose that the learning strategy of question-answer relationship has the potential to enhance students’ reading comprehension and therefore improve their test taking results across grades and content areas; as a result, achieve the ultimate goal of closing all literacy gaps for all students utilizing this learning strategy (Raphael & Au, 2005).

A search through the literatures of question-answer relationship studies and its applications seemed to yield the observation that the learning strategy of question-answer relationship has been generally more appealing to a younger audience and therefore their researchers and practitioners such as elementary school children and their classroom teachers. For example, a study conducted by Raphael and Pearson (1985) in which sixth graders were trained to recognize question-answer relationship has shown results of the improvement of the sixth graders’ reading ability levels (Raphael & Pearson, 1985). In addition, two experimental studies to replicate the above results with fourth graders were also conducted and once the length of instruction was extended during the second experimental study, there were significant effects on better reading ability and higher quality of responses from the experimental group (Raphael & Wonnacott, 1985). There have been abundant additional studies that involved young subjects who were second graders (Henry, 2008), fourth and fifth graders (Beyersdorfer, 2003), fourth graders (Ezell, Hunsicker, & Quinque, 1996; Soptelean, 2012), third graders (Ezell, Kohler,
Jarzynka, & Strain, 1992), third and fourth graders (Lawrence, 2002), second graders (Kelty, 1999), along with many other examples of studies with young subjects, which seemed to support the notion that the majority of the participants of the application of the learning strategy of Question-Answer Relationship comprise the researchers and practitioners of learners of lower age groups.

Nevertheless, the Question-Answer Relationship learning strategy in theory and in practice does apply to both skilled adults and children, such as the graduate students in a children literature study (Ouzts & Palombo, 2005), the aforementioned younger children (Beyersdorfer, 2003; Ezell et al., 1996; Ezell et al., 1992; Henry, 2008; Kelty, 1999; Lawrence, 2002; Raphael & Pearson, 1985; Raphael & Wonnacott, 1985; Soptelean, 2012), and older children in the secondary education (McIntosh & Draper, 1995, 1996). The reason for the wide application is that “sources of information” are what have been intended for students in the classrooms to identify through teachers’ implementation of Question-Answer Relationship across all age groups (Raphael, 1984; Raphael & Wonnacott, 1985). In particular, the gap between students’ reading ability at the 12th grade of a certain ethnic group being only assessed at equaling the ability of 8th graders of another ethnic group has been stressed to be in dire need to close with the help of the learning strategy of question-answer relationship (Raphael & Au, 2005). In the current study, the participating students were of high school age with low abilities of reading comprehension (CCSD, 2011) and could benefit from the implementation of the similar learning strategy of reading questions and answers.

With these backgrounds the learning strategy of reading questions and answers was chosen as the other method for the current study. It was implemented in the same
multimedia online interactive tutorial environment that employed the same learning strategy of worked examples. A thorough literature search indicated that there had not been a study on the comparison of the learning strategies of self-explanation and reading questions and answers. The current study explored the effects of the two strategies by comparing students’ performance on end-of-lesson tests and their views on different aspects of learning supported by the two strategies after they experienced both treatments.

**Instructional Design Strategy:**

**Worked Examples versus Traditional Problem-solving**

Although worked examples was not the testing variable, because it was utilized in the design of the course materials as a main instructional strategy, this section is provided to discuss the role worked examples play in instructional designs and the effects of worked examples on learning versus traditional problem-solving approaches. These two approaches are compared in order to substantiate the choice of implementing a worked-example strategy in the instructional design in the current study.

**Traditional Problem-solving**

Conventional problem-solving employs a means-ends strategy which looks to show students how to reduce the differences between the goal state and the current problem state (Klahr, 1978, 1985; Klahr & Robinson, 1981). It is instinctive for individuals to adopt the means-ends strategy whenever they are faced with a novel situation, where they need to find a method to reach the goal state.

Studies show that children aged seven and above appear to be capable of applying means-ends strategies with the Tower of London problem (P. Anderson, Anserson, & Lajoie, 1996); children as young as four years of age are already competent in solving the
4-move Tower of Hanoi problem by using means-ends analysis (Klahr, 1985; Klahr & Robinson, 1981). By the time students reach the secondary school age, they are likely to be already well-versed in these means-ends strategies (Klahr, 1978). In other words, it appears that means-ends strategy becomes an instinctive nature for human beings quite early in life (Daum, Prinz, & Aschersleben, 2009).

Worked Examples

The purpose of utilizing an effective instructional design is to help learners acquire knowledge and skills effectively given the extremely limited available human working memory (van Gerven, Paas, van Merrienboer, Hendriks, & Schmidt, 2003). Studies have largely demonstrated that teaching by worked examples during the early stage of learning results in superior effects to those of teaching by conventional problem-solving in the areas of well-structured subjects, subjects such as mathematics (Cooper & Sweller, 1987; Sweller, 1989; Sweller & Cooper, 1985; van Gog et al., 2004, 2006; Zhang, 2001), science (Sweller, 1989), chemistry (Crippen & Earl, 2004; Crippen & Earl, 2007), physics (Richey & Nokes-Malach, 2013), Engineering (Pollock et al., 2002) and computer programming (Atkinson et al., 2000; Garner, 2002; Murphy & Wolff, 2009), were made a built-in feature of the tutorial of the current study.

When it comes to learning computer programming, which presents a high intrinsic load, studying worked examples may help reduce extraneous load (S. Garner, 2002). Worked examples can be in the format of snippets of computer program codes (Crippen & Earl, 2004; Crippen & Earl, 2007; Hohn & Moraes, 1997; van Merrienboer, 1990; van Merrienboer & Krammer, 1987); the current study employed snippets. In the online tutorial lessons, JavaScript code snippets were placed in each of the sample programs
provided. In contrast to the “black box” approach in which the computing process is not visible, the concrete computer model demonstrates the programming process by explicitly displaying the process to help learners acquire programming concepts (Mayer, 1981; van Merrienboer & Krammer, 1987). Based on the human working memory limitation and high intrinsic load associated with learning computer programming (Garner, 2002), a worked-example strategy was selected for instructional design approach for computer programming instruction in the current study. In the section below, the two approaches are compared.

**Worked Examples versus Traditional Problem-solving**

Novice problem solvers resort to means-ends strategies because of their lack of schema (Klahr, 1985). Unfortunately, problem-solving through a means-ends analysis contributes very little to learning because a means-ends analysis takes away learners’ attention from constructing a solution structure (Chi, Feltovich, & Glaser, 1981; Chi et al., 1982), imposes a heavier cognitive load (Sweller, 1989), and requires a large amount of mental effort (Kirschner, Sweller, & Clark, 2006), whereas worked examples lessen the demand for cognitive load and contribute to effective learning (Kirschner, Sweller, & Clark, 2006; Paas et al., 2003; Sweller, 1988, 1989, 1994; Sweller & Cooper, 1985).

**Quality and quantity issues.** The problem is two-fold in both quality and quantity. First, the learner’s attention is not directed to learning because of other activities such as trial and error (R. K. Atkinson et al., 2000), therefore the distractions cause lower quality of learning. Second, there is the burden of increased cognitive load; this extraneous cognitive load presents the quantity issue. As a result, the activity of problem-
solving interferes with knowledge acquisition and utilization, and ultimately depresses the effect of learning.

Worked examples, on the other hand, provide step-by-step guidance, and require radically less cognitive processing and working memory than conventional problem-solving (Greeno, 1980). In instructional designs, worked examples are typically composed of a problem, and then the steps to solve the problem, in order to demonstrate to novice learners the way an expert would solve similar problems (R. C. Atkinson et al., 2003; R. K. Atkinson et al., 2000). Worked examples offer detailed problem solutions to provide the learner with some structure for understanding how the solution was established without providing a script or algorithm (Crippen & Earl, 2004; Crippen & Earl, 2007).

Worked examples have been largely considered to contribute tremendously to the improvement of learning compared to those of the conventional problem-solving. Nevertheless, it is not just any worked examples; it is the effectively structured worked examples that are able to improve the learning results. The design of effectively structured worked examples takes aforementioned important factors, such as learners’ background knowledge, into consideration. The design of effectively structured worked examples has the purposes of reducing cognitive load while focusing attention on problem states and their associated moves, and then ultimately achieving high effects of learning (Ward & Sweller, 1990).

The usual worked examples in the textbooks tend to have a few examples right after the introduction and explanation of a theory or concept. For instance, after a physics equation of “distance = speed * time” is introduced and explained, there might be a few
examples calculating the distance between two locations demonstrated in order to familiarize students with the concept of using the average traveling speed to be multiplied by the time it takes to travel to arrive at the distance. However, the focus of the concept of learning by worked examples, in contrast to the usual textbook’s employment of worked examples, stresses the lengthened example phase. In other words, a sufficient number of examples, which is significantly higher than the usual number of textbook examples, are presented over an adequate period of time to learners before they are expected to solve like problems (R. C. Atkinson et al., 2003).

**Evidence of learning effectiveness of worked examples.** In a series of experiments of algebra learning, the use of worked examples as a substitute for problem-solving enables students to solve problems more rapidly with fewer errors (Sweller & Cooper, 1985). Learning with partly or completely worked examples is found to require less effort and lead to better transfer performance (Paas, 1992). The effect of worked examples is further manifested when students who learn algebra from worked examples outperform those in the control group after completing fewer practice problems with less assistance from the teacher (Carroll, 1994). A more recent study that utilizes worked examples in podcast videos to provide scaffolding experience for novice programming students has reported that students gain a better understanding and improve their performance as a result (Murphy & Wolff, 2009).

Experts are separated from novices by their ability to classify problems according to the structural aspects of problems (Chi et al., 1981; Chi et al., 1982; Silver, 1979). Novice learners, if presented with worked examples before solving problems during their learning process, are better able to focus their attention on problem structures than their
counterparts, and are less likely to be misled by the superficial features of the problems (R. K. Atkinson et al., 2000). Mayer (2004) concludes that based on fifty years of research; there is consistent evidence against discovery learning type of problem-solving and in favor of guided instruction (Mayer, 2004). The employment of worked examples facilitates the development of both schema acquisition and rule automation (Cooper & Sweller, 1987) by affording the opportunity to reduce the overall time requirement to learn and to transfer. Furthermore, worked examples usually come across as a more user-friendly alternative to learners. In multiple studies, learners were found to ignore text description in favor of worked examples because of the more interesting appeal of the latter (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Such phenomenon appears to be an indication of human tendency of gravitating toward the path of least resistance that worked examples offer. The choice of using worked examples in the design of instructional materials for both the groups in the current study afforded the benefits that were made known through previous studies.

**Instructional Design for Online and Classroom Learning and Teaching**

As the online education format is rapidly gaining momentum in today’s society (Palloff & Pratt, 1999, 2003, 2011), an ideal tutorial coming to mind is one that can be delivered to learners through both platforms - online or in classroom. Although online learning is growing, learning and teaching in the classroom will last for a while, necessitating integrated approaches to teaching programming language. The Internet brings useful tools for learning (J. Q. Anderson & Rainie, 2010). What is important, however, is that it is the instructional design, not the media, that mediates learning (Clark
The Need to Be Useful both in Classroom and Online

The online learning environment, or distance education, germinated from modern day technology, seems to have captured the attention of educators, learners, and administrators around the world. Online learning affords students the opportunity to achieve their academic goals without having to be physically present in class at a certain place at a certain time. Online learning provides an attractive alternative to the traditional face-to-face (f2f) education format for students with special needs (e.g., working adults). In addition, people of certain personality traits, even if they do not have those time and place constraints, might find the distance education format appeals to them more favorably than that of the traditional f2f (Palloff & Pratt, 1999, 2003, 2011).

As distance education has become an increasingly popular format in education, it is inevitable that teaching computer programming through the distance education format has long become a reality. The concern is that it is more difficult to teach computer programming in a distance education environment, where students are more isolated with limited contact with the instructor and possibly even less contact with their fellow students (Domingue & Mulholland, 1997). A study of learning conceptual mechanics shows that students in a microcomputer-based laboratory group who follow the interactive tutorial have a higher gain in understanding than that of students who follow cookbook laboratory procedures without any type of interaction. That better understanding elucidates the benefit of learner interaction with the materials of dynamic
nature that modern day technology readily provides (Royuk, 2002). It helps shed light on the necessity of the provision from the online tutorial to simulate learner interaction.

**The Multimedia Principles**

Multimedia principles are briefly discussed in this section, as they are used in the design of tutorial. In the current study, multimedia principles, along with the worked example learning strategy, had been incorporated as part of the design guidelines for the online tutorial with the intentions to duplicate the benefits proposed by previous studies.

Multimedia learning is defined as the construction process of the mental representation from words and pictures. Words are text that is either printed or spoken while pictures can be photos, drawings, animation, or video (Mayer, 2001, 2005d, 2009, 2011; Mayer, Griffith, Naftaly, & Rothman, 2008). The multimedia learning instruction guidelines are generated based on the Cognitive Load Theory (Sweller, 1994) and other significant theories derived from research results such as dual-coding theory (J. M. Clark & Paivio, 1991; Paivio, 1986).

The multimedia principles that provide the predominant multimedia learning instruction guidelines suggest that words presented together with pictures can improve effect of learning than that of words alone and it further results in better retention and transfer down the road (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Clark and Mayer (2003) illustrate a famous example: In order to explain how a bicycle pump works, learners can be shown some text alone, such as this statement, “As the rod is pulled out, air passes through the piston and fills the area between the piston and the outlet valve…” An alternative way to learn can be the same text accompanied by graphics showing the pump with the handle, rod, and
inlet valve and how air passes through the piston. Across ten of the comparisons of the above study, the correct percentage of students’ transfer tests of text plus graphics are between 55 percent to 121 percent better than those of text alone (R. C. Clark & Mayer, 2003, 2008a, 2008b; Mayer, Johnson, Shaw, & Sahiba, 2006). Other research study results conclude that students score much better on how radar works if they see an additional graphic representation (Mayer, 1983) and that students learn better on the subject of adding and subtracting signed numbers with symbols and graphics than from symbols alone (Moreno & Mayer, 1999). Those study results all speak to the effectiveness of the multimedia principle that students who learn from the combination of words and pictures outperform those who learn from words alone.

**Dual-Coding Theory Supports the Multimedia Principles**

Paivio’s dual-coding theory (1986, 1991) provides further theoretical basis for the instruction guidelines for multimedia learning. Dual-coding theory suggests that two complimentary cognitive subsystems exist; one is specialized to deal with human language like English, and the other is specialized for processing nonverbal objects, such as imagery. Paivio proposes that separate yet additive cognitive processes are evoked by the coding of words and pictures (J. M. Clark & Paivio, 1991; Paivio, 1986). The augmentations, either from words to pictures or vice versa, lead to learners’ more intense cognitive processing of the materials intended for them to learn (Fletcher & Tobias, 2005).

**The Split-Attention Principle**

The split-attention principle suggests that a split-attention effect would occur if the information being presented is from disparate sources. The separation of text and its
related graphics on two sides of a page in a book that causes readers to flip the page back and forth is one example. In order to understand the information, the learners have to hold some prior or the non-contiguous information in the working memory to integrate with its related information. As a result, an additional cognitive load is imposed on the working memory of learners due to their mental exertion to integrate the information (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007). Multiple studies had two groups receive identical text and illustration as their learning materials; one group received them in an integrated format, while the other group received them in a separated format. The results of those studies attest to the fact that the group receiving integrated text and illustration outperformed the other group (Mayer, 1989; Mayer, Steinhoff, Bower, & Mars, 1995; Moreno & Mayer, 1999).

Information of disparate sources causes the split-attention effect; therefore, integrating the information physically and temporally for presentation frees the learners from exerting the mental effort to integrate (Ayres & Sweller, 2005). The layout of the instructional design in the present study are a product of the observation and application of the split-attention principle, with the neighboring panels for sample and practice code, and the neighboring panels for XHTML code and its corresponding Web page display.

**The Segmenting, Pre-training, and Modality Principles Minimize Cognitive Overload**

There are materials that are very difficult for learners to learn. Assuming that there is no extraneous cognitive load, a course designer would be aiming at reducing the high intrinsic cognitive load (Sweller, 1994) of the instructional design for the learners. There are three multimedia principles proposed to minimize cognitive overload: the
segmenting, pre-training, and modality principles (Ayres & Sweller, 2005; Mayer, 2005b, 2008, 2009, 2011; Moreno & Mayer, 2007). The segmenting principle suggests that, instead of giving learners a continuous unit, successive and bite-size segments that are learner-controlled should be available with time allowed in between segments. The pre-training principle proposes that to reduce learners’ cognitive load, at the start of the learning, the names and characteristics of the learning components should be supplied to learners so they have clear background information. The modality principle recommends using a different channel to present the same information; for example, printed text can be transformed into spoken text, therefore freeing learners visually. Utilizing the modality principle in designing instruction helps expand the working memory capacity of a learner who might have exceeded the limit without fully utilizing both of the auditory and visual channels to receive information presentation (Low & Sweller, 2005; Mayer, 2005b).

The instructional design of the present study applied both the segmenting principle with its topics arranged in the order of degrees of difficulty, and the pre-training principle by providing XHTML background knowledge (Mayer, 2005b, 2008, 2009, 2011; Moreno & Mayer, 2007). The modality principle is one of the cognitive principles of multimedia learning that suggests that by fully utilizing the auditory and visual channels to present information, the learners’ working memory can be effectively expanded. For example, an illustration can be accompanied by onscreen text explanation (as the instructional design in the current study had it), or by spoken text that has the same words but are auditory, in order to take advantage of both channels. The latter provides better effect of learning for the learners (Mousavi et al., 1995). From the split-
attention principle point of view, instead of trying to physically integrate words and imagery together which will nonetheless burden the visual channel concurrently, learning can be better facilitated by presenting written text in auditory mode (Low & Sweller, 2005).

The Coherence, Signaling, Spatial and Temporal Contiguity Principles

Furthermore, for minimizing extraneous cognitive overload, the coherence, signaling, spatial contiguity, and the temporal contiguity principles (Mayer, 2005c, 2008, 2009, 2011; Moreno & Mayer, 2007) were applied to the design of the instruction of the present study.

Some course designers, in an effort to make learning materials more appealing, are tempted to insert colorful illustrations or background music to “spice things up.” However, the imagery and music are irrelevant to the targeted learning objectives. Therefore, this interesting information is called seductive details. The opposite of enhancing effect of learning as desired, seductive details in reality distract learners from focusing on learning the essential information. Although supplying emotional interest, seductive details do not provide cognitive interest and furthermore deprive learners of the enjoyment of comprehending the material (R. C. Clark & Mayer, 2003, 2008a) and frequently depress meaningful learning (R. Garner, Gillingham, & White, 1989). The coherence principle, against “seductive details,” advises the coherent presentation of relevant materials. Following the coherence principle, the design of the instruction of the current study avoided seductive details. For example, consistently throughout the Web pages in the Website, the instructional design had one solid pastel color for background color of each Web page, demonstrating the observation of the coherence principle.
The signaling principle proposes that if learners are given prompts regarding what information to attend to and the organization of the information, learning can be improved. The tutorial of the current study had a clear organization of the topics arranged from easy to advanced, and the prominent lecture panel where the learner’s attention was directed to. Therefore, the design of instruction was consistent with the signaling principle.

The split-attention effect (Ayres & Sweller, 2005) can be removed following the spatial and temporal contiguity principles which advocate the physical integration of words and pictures, or the simultaneous presentation of words and pictures. The spatial and temporal continuity principles were applied in the instructional design in multiple ways that sample and practice code, and XHTML code and its corresponding Web page display, existed side by side, and could be displayed the same time with a press of the display button. It was a significant improvement from the traditional Web design learning. The traditional way of learning Web design can be confusing to a novice learner who has to juggle between the editing mode (e.g., in notepad) and the display mode (e.g., an Internet Explore displayed Web page). It is a common sight that a novice Web design student attempts, though to no avail, to change wording in the Web page displayed through a Web browser due to the separation between the editing and the display modes.

**The Relationship between Motivation and Achievement in Computer Language Learning**

Academic motivation has a significant impact on students’ learning at school (Chen & Pajares, 2010; Eccles & Wigfield, 2002; Usher & Pajares, 2009; Wigfield & Eccles, 2000; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006; Wigfield &
Guthrie, 1997). To develop good computer programming language skills which require much practice, students have to be adequately motivated (Law, Lee, & Yu, 2010). Motivation is such an important factor for learning computer programming concept that a research study was conducted to evaluate the effects of several learning tools that were designed to promote students’ motivation in learning computer programming (Serrano-Cámara, Paredes-Velasco, Alcover, & Velazquez-Iturbide, 2013). Rowell and Hong (2013) recommend that to promote students’ academic motivation for learning, or to prevent declines in their motivation, timely interventions from school personnel, individually or in small group settings, are necessary and can be effective.

Some computer programming language instruction designers seek the utilization of game-based assignments to increase students’ motivation to complete tasks (Jiau, Chen, & Ssu, 2009). Others suggest providing students learning to write computer program with timely help and emotional support so they do not adopt extrinsic sources of motivation (Apiola & Tedre, 2012). All such efforts to promote motivation among students are based on the notion that motivation change is positively related to students’ achievement change in the learning of computer programming languages (Su, 2008). In the close proximity of examining motivation in computer learning, a couple of other studies are worth noting. One study showed students’ motivation enhancement by being tasked with the hypermedia designer’s role, not just learning to use the hypermedia computer application, and as a result, students’ higher order thinking skills and design knowledge development were better supported (Liu & Pedersen, 1998). The other study reported that intrinsic motivation had the mediating role for the behavioral transfer of 430 computer users of Web 2.0 applications from knowledge seeking to knowledge.
contributing (Yan & Davison, 2013). These studies showed the positive effect of motivation in computer learning, albeit motivation was not used as a covariate in these studies for examining instructional approaches to increasing student learning in computer programming language.

In the current study, motivation was included as covariate in the examination of effects of self-explanation and question-and-answer strategies on the learning computer program language and was answered by students in a modified version of Self-Assessment Questionnaire (SAQ) (Hong, O'Neil, & Feldon, 2005; O'Neil, Sugrue, Abedi, Baker, & Golan, 1992). The motivation constructs measured for this study included self-efficacy, effort and persistence, and task value. In the sections that follow, those motivation constructs and their relationships with achievement of computer language learning are briefly reviewed.

Students who are responsible for their own learning are motivated to direct their own learning processes (e.g., Zimmerman, 1989, 2000). They demonstrate high self-efficacy, invest effort, and demonstrate persistence when they encounter difficult tasks (e.g., Wolters, 2003; Zimmerman, 2000). Further they view learning tasks as useful (utility value), important (attainment value), and interesting (intrinsic value) (Eccles, 2005, 2007; Eccles & Wigfield, 2002; Eccles, Wigfield, & Schiefele, 1998; Wigfield, 1994; Wigfield & Eccles, 2000; Wigfield et al., 2006; Wigfield & Guthrie, 1997).

Connell and Wellborn (1991) suggested three basic human needs that affected students’ attainment value of the task given: competence, autonomy, and relatedness (Connell & Wellborn, 1991). Students who want to become engineers, mastering mathematics and science courses have high utility value; otherwise, the value of doing
the work to succeed in these courses was too low to motivate their effort (Eccles, 2009). There is strong evidence that interests and intrinsic value can predict academic engagement and therefore achievement (Eccles et al., 1998; Wigfield et al., 2006).

Findings of studies in the programming language area demonstrate the motivation effects on learning and achievement. For example, to motivate adult programming students to learn the Visual Basic programming language, a game-based instruction was developed for the experimental group, compared to the traditional teaching of the control group. Students of the computer game-based group outperformed significantly the traditional group in motivation and programming ability, likely because the experimental instruction had appealed to the intrinsic value of the students (Jiau et al., 2009). In another study, students who received information on how their skills could be applied personally or in business before starting to learn HTML scored higher in quizzes during learning and expressed greater post-lesson interest (Fraughton, Sansone, Butner, & Zachary, 2011), indicating that utility value instilled in students helped motivate students to obtain higher achievement. It was recommended that when designing a user interface, there should be provision for user motivation so the computer programmers were not lacking of social support while often working in solitude (Selker, 2005).

Self-efficacy is the confidence a person has in him/herself to possess the ability to accomplish tasks (Bandura, 1993, 1997, 2011; Chen & Pajares, 2010; Pajares, 1996; Schunk, 1991; Schunk & Pajares, 2002; Schunk & Zimmerman, 1997; Usher & Pajares, 2009; Zimmerman, 1989, 2000, 2008). Studies suggested that a well-facilitated e-learning setting can help increase self-efficacy and therefore improve students’ computer
programming language learning achievement (Askar & Davenport, 2009; Law et al., 2010).

Responsible learners not only report high self-efficacy but also display high levels of effort and persistence during learning (Bandura, 1993; Zimmerman & Martinez-Pons, 1990).

Students are often aware that making an effort and being persistent in completing tasks is an important part of schooling. However, even those students who are aware of the need to make more effort do not necessarily regulate themselves to put forth the effort (Hong, Sas, & Sas, 2006). On the other hand, students who value tasks, for example, tests, will likely expend more effort, resulting in high test scores (Wise & DeMars, 2005). Effort regulation and persistence are positively related to academic performance (Obach, 2003; Volet, 1997). Further, importance of persistence was also demonstrated in international studies, as persistence predicted national differences in math and science achievement more so than did content knowledge (Boe, May, & Boruch, 2002). When the importance of effort in achievement was taught to students, in addition to the strategy instruction to solve problems, students performed significantly better in the areas of problem solving, persistence through academic difficulties, effective use of problem solving strategy and effort beliefs toward problem solving (Li, 2013).

As these findings demonstrate, motivation and achievement have a strong relationship. Thus, motivation was used in this study to increase the precision of the research findings.
CHAPTER 3

Methodology

The current study was intended to examine if there was a significant difference in student performance between the two learning strategies, self-explanation and reading questions and answers, on students’ learning of JavaScript, the most widely used scripting language in Web design. The instruction was designed by utilizing the learning strategy of worked examples, and the cognitive principles of multimedia learning including the spatial and temporal contiguity principles, the coherence principle, the redundancy principle, and the image and personalization principles. This experimental research had two comparison groups. The design principles and worked examples were constant to both groups; that is, they were applied to both groups.

The experimental variable was learning practice; Group 1 was given opportunities to self-explain learned materials for the first two lessons and the fifth lesson (henceforth, the SE group), whereas Group 2 read the questions and answers (Q&As) of learned materials for these lessons (henceforth, the Q&A group). For lessons 3 and 4, it was the other way around. The instructional materials were in a format of a tutorial that was hosted on a Website on the Internet. Students could access from anywhere as long as there was a computer and the Internet access, although for the current study, the access was limited only from a classroom to control the place variable. The current study explored the differences of the two learning strategies in their effects on test performance; further, students’ opinions as to which learning strategy helped them learn JavaScript better were examined through both quantitative and qualitative approaches.
Participants and Setting

Participants were students at a high school in the Clark County School District in the state of Nevada.

Table 1 shows student demographics and summary of school characteristics (CCSD, 2011). As can be seen in Table 1, this school has high rates of student transiency, dropout and truancy, and low rates of attendance and graduation, compared to the average rates of the school district. The participants for the current study consisted of students of diverse ethnic background with the vast majority of students being Hispanic. The age distribution of most participating students ranged from 14 to 17 years of age, while a few others (at the time there were four) were 18 years of age or older.

Table 1

2010-2011 School Accountability Summary Report of the Participating School

<table>
<thead>
<tr>
<th>Demographics and Student Information</th>
<th>School</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>64.7%</td>
<td>42.1%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>17.0%</td>
<td>12.4%</td>
</tr>
<tr>
<td>IEP (Students with Disabilities)</td>
<td>15.9%</td>
<td>10.2%</td>
</tr>
<tr>
<td>LEP (Students with Limited English Proficiency)</td>
<td>24.8%</td>
<td>23.0%</td>
</tr>
<tr>
<td>FRL (Students Qualifying for Free/Reduced)</td>
<td>66.0%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Average Daily Attendance</td>
<td>90.6%</td>
<td>94.8%</td>
</tr>
</tbody>
</table>

Graduation/Dropout Information: Class of 2010

<table>
<thead>
<tr>
<th></th>
<th>School</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduation Rate</td>
<td>42.9%</td>
<td>68.1%</td>
</tr>
<tr>
<td>Dropout Rate</td>
<td>8.2%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Transiency Rate</td>
<td>40.7%</td>
<td>30.7%</td>
</tr>
</tbody>
</table>
Students who were taking the introductory computer classes were the initial subjects. These classes were offered to all class standing, from freshmen to seniors. Students were randomly assigned to two experimental groups, the SE group and the Q&A group, with three classes in each group. Earlier during this computer course, the knowledge of beginning Web development was introduced to the students. Therefore, students had varying degrees of prerequisite knowledge of coding Web pages in XHTML but had little to no previous computer programming experience. They were informed of such research during the semester and given the option to participate. To encourage participation, the volunteers earned nominal credit, which was an additional five percent of their total earned grade, toward their semester grade. The students who chose not to participate, or did not complete the participation after signing up for it because of their absences or submitting blank responses, were given an alternative computer project to complete in order to earn the additional five percent of their grade.

One hundred forty seven students consented to participate in the study. There were six periods a day. The first 3 periods and the last 3 periods were labeled Group 1 and Group 2, respectively. Table 2 presents the number of students in each group by gender.
Table 2

Assignment of Student Groups

<table>
<thead>
<tr>
<th>Student groups</th>
<th>Group 1 (n = 78)</th>
<th>Group 2 (n = 69)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periods 1, 2, 3</td>
<td>Periods 4, 5, 7</td>
</tr>
<tr>
<td>Male</td>
<td>46</td>
<td>37</td>
</tr>
<tr>
<td>Female</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

Materials

An online multimedia tutorial on the introductory topics of a Web scripting language, JavaScript, was developed for novice students. Two different versions of this tutorial were created for the two comparison groups of this study. This online tutorial required the users to log on with a given username and password that were assigned beforehand and stored in the database, in order to ensure the following aspects: a) only eligible users were accessing the tutorial; b) any individual user would receive appropriate training materials intended for the specific group he or she belonged to; and c) the learner activities (self-explanation narrations and test taking) were recorded through the server with time stamps.

The online interactive multimedia tutorial implemented a worked-example instructional strategy for both comparison groups. For the group that was learning through the self-explanation strategy, students answered the guiding questions in the format of self-explanation by typing their answers. For the group that was learning through reading questions and answers, students only read the given set of questions and
answers. The JavaScript topics delivered in both formats had been written by the author with reference to several widely adopted textbooks and information online to ensure the contents were accurate and up to date (Johansen, 2010; Quigley, 2010; Topley, 2010; Young, 2013). This online interactive multimedia tutorial was hosted on a Website that could be accessed through the Internet with any browser. No special software was needed, and learners did not need to know any programming languages or computer applications to utilize this tutorial. All a learner needed in order to access either version of this tutorial was a computer and the Internet access, along with a username and password.

Both versions of the instructional design applied the Dick and Carey systems approach model (Dick, Carey, & Carey, 2005) and Mayer’s multimedia learning principles (Clark & Mayer, 2003; Dick et al., 2005; Kalyuga, Chandler, & Sweller, 1999; Leahy, Chandler, & Sweller, 2003; Mousavi, Low, & Sweller, 1995). For the organization of instructional materials, Reigeluth’s elaboration theory was applied (Reigeluth, 1987, 1992, 1999; Reigeluth & Curtis, 1987). Elaboration theory suggests sequencing of the learning materials according to their complexity, from simple to complex, in order to provide a meaningful context that allows the integration of subsequent ideas. A desirable instructional design should provide a sequence of instruction that is aimed at cultivating meaning-making and motivation for the learner, and allow the learner’s own decision making on scope and sequence during the learning process (Reigeluth, 1987, 1992, 1999; Reigeluth & Curtis, 1987).

In the present study, the instructional material had a list of various JavaScript topics that were arranged from the most basic concept of the positioning of the JavaScript code into an XHTML file, to increasingly more complex JavaScript programming
concepts such as the maneuvers of object instantiation. Such design was based on the aforementioned notion that the general sequencing pattern should be from simple to complex; furthermore, on the notion that the sequencing in an instructional design affects the stability of cognitive structures and consequently retention and transfer (Ausubel, 1963). This interactive multimedia tutorial, in both versions for the two comparison groups, was designed to have students progress from the basic through the complex concepts in order to build a stable cognitive structure with the ability to transfer.

**Instructional Design Framework**

The Dick and Carey systems approach (Dick et al., 2005) views instruction-related components such as the instructor, learners, materials, activities, and environments as a whole, instead of a sum of isolated parts. Following the components of the model, the instructional design was developed in the phases below:

**Phase 1: Identify instructional goal.** Students needed to acquire the knowledge and skills of writing JavaScript code when developing Web pages, after they had at least the basic knowledge of building Web pages with XHTML.

**Phase 2: Analyze the instructional goal.** Students were able to recognize the need for JavaScript coding and to initiate their own effort to write correct and functioning JavaScript code independently when designing Web pages.

**Phase 3: Analyze learners and contexts.** Students had little to no previous knowledge of JavaScript or other programming languages. Students were mostly of a low socioeconomic status in an inner city turnaround high school. Students had been taught basic computer knowledge and skills including building Web pages with XHTML and would be able to use them to further their skills in Web development.

Phase 5: Develop assessment instruments. Knowledge and skills of JavaScript that students had acquired from the instruction were assessed by pretest and posttest. Tests were consisted of short coding questions (e.g., write code for a popup window that asks a user to input his/her name).

Phase 6: Develop instructional strategy. The worked examples that make efficient use of working memory and the cognitive principles of multimedia learning that take into consideration learners’ characteristics and cognitive needs were employed for both versions of the instruction. Groups 1 and 2 were given opportunities to experience self-explanation and Q&As at different times to evaluate treatment effect on student learning.

Phase 7: Develop and select instruction. An online multimedia tutorial was developed based on the instructional strategies described (see examples of screenshots below).

Phase 8: Design and conduct formative evaluation of instruction. After testing the tutorial by the researcher, three faculty members of a college who had been teaching computer programming were asked to examine this tutorial. In addition, a faculty member who has instructional design background was consulted for screen design and instructional design principles. Their feedback was utilized for improving the quality of the tutorial. For example, the layout of the lesson page used to be one row of two window panels side by side, with the sample code inside the left panel, while the right panel was acting as a browser to display the Web page on click. The original idea was for the
learners to study the sample code, and change it inside of the panel to see how the
corresponding display would become. It was suggested that one additional row of two
window panels was to be inserted below the row, with the code panel empty, so learners
could practice by typing the exact same code in the empty window panel beneath while
looking at the sample code. This suggestion reflected a practical application of the spatial
contiguity principle. It was also suggested and adopted that in order for the learners to
practice further, and independently, an additional row of the same two window panels of
code and display was to appear at the top of the next page, after they have become
familiar with the coding knowledge with the practice provided on the previous page.
Other suggestions incorporated include the clarification and refinement of the
instructional wording, and the overall improved look with the fittest fonts and sizes.

*Field testing.* A pilot study had been conducted as part of formative evaluation of
the material at another high school within the same school district, with two freshman
classes during the spring semester of the year 2011. One class was randomly chosen as
the group that implemented the self-explanation learning strategy only, with 28
participants, and the other class as the group that read questions and answers only, with
20 participants. They followed the procedure described to access the Website where the
tutorial was hosted. Due to the class time constraint, students were asked to work on only
the first two lessons. The participating students filled out a survey form afterwards
regarding the study they took part in. The pilot study survey questions are in Appendix A.
The answers of the pilot survey questions were tallied and displayed in Appendix B.
The author’s observations during the field testing, combined with the suggestions made in the survey by students who participated in the pilot study, and verbal interviews with three students, have led to the following understanding:

1. Students generally needed more time for each lesson than originally specified.
2. The existence of a timer gave students tremendous pressure. The timer could be either eliminated, or the allotted time could be significantly increased to relieve students’ anxiety. It was decided that the allotted time was to be increased to 30 minutes each lesson.
3. The free hosting site appeared to be handling 20 simultaneous logons without any problem. When there were 28 students trying to log on at the same time, five of them were met with an “exceeding capacity” warning. However, after they tried again, all five students were able to log on and stay on for the rest of the time. This problem seemed to be short-lived and therefore did not create a major concern. The investigator continued to keep a close eye on any possible problems to resolve the issues promptly.
4. An explicit verbal explanation about the flow of this tutorial, or a visual aid like the flow chart shown in Figure 1, which was not devised at the time of the pilot study, can give students a much better idea of what to expect, therefore reduce the anxiety of taking the tutorial.

**Phase 9: Revise instruction.** The feedback received as a result of the test runs was incorporated in order to enhance the clarity of meaning and therefore the easiness of understanding the instructions for students throughout the process of learning. For
example, in addition to the aforementioned layout changes, after field testing, the time allotted for learning the lessons was increased.

**Phase 10: Design and conduct summative evaluation.** The instruction was evaluated through a questionnaire by students participating in the current study. The findings of the current study will provide further information for tutorial revision for future use.

*Flowchart of the Instruction*

Figure 1 provides an overview of the instructional design in the format of a flowchart. The instructional design is structured into five Web pages as shown for each lesson of a JavaScript topic. Learners of both groups see exactly the same pages 1, 2, 3, and 5 while page 4 is different for the two comparison groups. A learner logs on through page 1, selects a lesson of interest on page 2, studies and practices that particular lesson on page 3, and practices further on the upper part of page 4. The only difference appears at the lower part of page 4. A student in the Q&A group would read questions and answers for that selected lesson, whereas a student of the SE group would answer guiding questions for the self-explanation activity and submit those answers corresponding to those guiding questions. Then the learners encounter the exact same content again on page 5, in which students of both groups will take the exact same test questions and submit their answers to the server which are to be retrieved for reviewing.
Students in both groups received a URL of the Website where this multimedia interactive online tutorial was hosted. From the instructor, each participant was provided with a username and password that were unique, and they identified which group in the database, Group 1 or Group 2, this individual belonged to. A learner would sign in with the URL and logon information given.

Figure 2 illustrates the logon page when students enter the correct URL to access this tutorial. In this case, a student with username “test1” has entered his username and password. After clicking the Login button, if the login information is correct, the user “test1” will be taken to the next Web page, as shown in Figures 3, 4, and 5. This page presents a list of JavaScript topic categories arranged according to their levels of
difficulty, from basic to advance. Notice the learner is greeted with his login username, with the instructor’s picture next to the greeting words, as if the learner has been greeted by the instructor personally.

Figure 2. Login page of the Website of the tutorial.

Figure 3 is the first page learners see after the login page and is called the tutorial’s home page. A list of categorized JavaScript topics are arranged according to their levels of difficulty, from basic to advanced. Notice the instructor greets the user by
his or her “username,” which is an application of the multimedia personalization principle to promote the effect of learning (Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2005b, 2008, 2009, 2011; Mayer, Fennell, Farmer, & Campbell, 2004; Moreno & Mayer, 2007). The home page was the same for both groups. Students chose from exactly the same list of topics and had the same opportunity of brushing up their XHTML knowledge since they might have been rusty with their background knowledge by not being in practice with it for a while.

Figure 3. Home page with topic list.

Figure 4 illustrates that each category of the topics had a drop-down menu that lists lessons numbered according to the level of difficulty. The learner highlights a lesson, and then clicks the “Go” button to the right to select it to learn in the next pages.
Figure 4. Details of lessons under each category.

Figure 5. An example of a lesson highlighted from the second topic. User can also choose to brush up XHTML knowledge by accessing this provided PowerPoint page with XHTML presentation. The pre-training principle is applied.
Figure 5 shows another example of a lesson highlighted to be selected. If the users found their XHTML knowledge to be rusty, they could also take advantage of the links provided, below the list of topics, to brush up their XHTML knowledge.

Figure 6 illustrates the lesson learning procedure for these two groups. For the first two lessons, students in Group 1 were linked to the lessons with the SE treatment, whereas Group 2 with the Q&A treatment. Then for the next two lessons, the students were assigned to the instruction sites that presented swapped instructional methods. For lessons 3 and 4, students in Group 1 learned with the Q&A method while Group 2 students learned with the SE method. Finally, students returned to their initially designated learning methods for lesson 5, the last lesson for this study. In other words, Group 1 students learned lessons 1, 2 and 5 and Group 2 students learned lessons 3 and 4 with the SE method; Group 1 students learned lessons 3 and 4 and Group 2 students learned lessons 1, 2 and 5 with the Q&A method.

<table>
<thead>
<tr>
<th>Group</th>
<th>Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Self-explanation</td>
</tr>
<tr>
<td>2</td>
<td>Q&amp;A</td>
</tr>
</tbody>
</table>

*Figure 6. Lesson Learning Procedure*
Same for both of the groups, the guidelines provided by the multimedia principles were implemented to construct the Website environment of the online tutorial in which worked examples were employed as an instructional strategy. The difference in treatments with the two groups was the order of applying experimental instructional strategies, self-explanation or reading questions and answers. In other words, for each lesson, while students of one group were engaged in the self-explanation learning activity, students of the other group immersed themselves in the activity of reading questions and answers. The end-of-lesson test performances were used to determine the differential effects of the two experimental strategies.

The tutorial was originally designed for a learner to select any JavaScript topic to learn, such as a lesson titled “An XHTML file without JavaScript.” The learner goes under the category of “Basic Concepts and Syntaxes” and finds the lesson from the drop down menu, “An XHTML file without JavaScript,” highlights it, then clicks the “Go” button to the right and the learner will be taken to the next page, as Figure 7 shows. Learners cannot move to an advanced level without completing the lessons leading up to that level. Nevertheless, for the current study, learners were instructed that they were to limit the learning to the first five lessons and they were to follow the exact order to learn from lesson 1 to lesson 5 with the pre-designated learning method for each lesson as shown in Figure 6.

Figure 7 presents the first page of the currently selected lesson. In the first row of window panels underneath the instructor’s lecture, there are two panels side by side. The left window panel, under the title of “Demo Code of an XHTML file without JavaScript,”
has the example code for that lesson, as worked examples can be in the format of snippets of computer program code (Crippen & Earl, 2004; Crippen & Earl, 2007; Hohn & Moraes, 1997; van Merrienboer, 1990; van Merrienboer & Krammer, 1987). The learner was expected to read the code first, envision how the rendered Web page should look like, and then click the “display” button above the right window, with the title, “How the Demo code looks on Web page” to render the corresponding Web page of the sample code. This process of the anticipated learner behavior of self-explanation, if does exist, is very helpful for the learners’ understanding (Crippen & Earl, 2004; Crippen & Earl, 2007).
Figure 7. After learner’s selection of a lesson, this page appears. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.

Timer

Click if ready for the next practice

Instructor is “teaching” this specific lesson

Figure 8 shows a full view of the second row of panels. At the second row, there is a left window for practice 1 with the title, “Practice 1: Type the above demo code in this panel.” The learners were to type the exact demo code as that in the window above, into this panel, with the advantage of being able to conveniently see the example code, hence incur no additional cognitive load according to the spatial and temporal contiguity principles of multimedia learning at this level of learning (Mayer, 2005b). The learners can then display it in the right window panel under the title, “How Practice 1 code looks on Web page.” There is an expectation of self-explanation from the learners, possibly more so than when the learners are learning from the demo code, as the learners now get
to type the demo code on their own. Nevertheless, the learners were supposed to follow the demo code exactly without creation or modification. It is intended for the learners to emulate the process of coding from scratch during the learning process by typing exactly as the demo code shows. Therefore, learners were discouraged from copying the demo code and pasting it into the Practice 1 window panel. Furthermore, students were informed that the test they would take after each lesson required their own ability to write code so they should cultivate it during practice.

Figure 8. A full view of the second row of panels. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.

When the learners were satisfied that they had had enough practice, they could click the button, “Ready to write your own code? Go to Practice 2” and be taken to the next Web page, as shown by Figure 9.
Figure 9. The Web page after the initial demo and Practice 1 page. The spatial and temporal contiguity principles are applied between the code window panel and the display window panel.

On the next Web page, shown in Figure 10, the first row of window panels looks similar to the window panels of the first row in the previous page. The difference is that this time, learners were at their liberty to create their own code. This is instructed by the words from the instructor, “Practice now by typing … (specific instruction for that particular lesson). Come up with your own code to see how the corresponding Web page is displayed.” In addition, above the left panel of the first row is the wording, “Practice 2: Type your own ….” At this time, learners were guided to type their own code from scratch according to their learning of the sample code of the previous page, and then again render the Web page in the right window panel conveniently according to the spatial and temporal contiguity principles of multimedia learning (Mayer, 2005b).
Both groups saw a window in the second row on this page but the window was of different purposes for the two groups. For the group doing self-explanation, the instruction above the window, as Figure 10 shows, was: “In this lesson, I will have you ‘explain’ what you have learned. Explaining to yourself helps you remember and understand what you have learned.” Inside the window, there were a few guiding questions for that lesson to help students reflect on what they had just learned through reading the lecture content, studying the worked example program code snippets, and practicing hands-on with the coding of a Web page. When students encountered these types of questions for the first time, there was a pair of sample question and answer provided for their reference as to how they should word their answers.
An example of a question was: “Why is that by looking at an XHTML file’s full name (name and extension, such as ‘Webpage.htm’), we cannot tell if there is JavaScript code embedded in it?” A sample answer would be: “An XHTML file does not change its file name or extension with or without embedding JavaScript code. As a result, we have no way to tell if there is JavaScript code embedded in the file or not by looking at its file name and extension.”

Before students typed their explanations, a prompt appeared, “Your explanation will be graded.” This was designed to prevent students from simply submitting their explanation without making an effort to explain correctly. Students would type their answer under each of the several questions on the lesson’s Web page and click a button to submit the typed answers. They were then asked if they were sure about their submission. After the confirmation of the desire to submit, students were prompted with their typed answers, and were asked if they wanted to change any of their answers with which they got an opportunity to make modifications. Once students had further confirmed that they wanted to submit the final answers, or if the time specified for that lesson had run out, a popup window with the pairs of question and its suggested answer would appear for them to compare with their own answers. The “OK” button that comes with the set of suggested answers will have to be clicked before students could move on to the next page of test questions.

Students’ self-explanation answers were to be retrieved from the server for reviewing. Because typing takes more time than reading, students in the group doing self-explanation were given an additional two minutes per item. Although the investigator found that approximately an average of one extra minute was needed for typing, two
minutes were allocated because there were many ELL students. The time taken to read
the suggested answers was not counted against the allotted time for learning and self-
explaining. This was to ensure that the learners took the time necessary to read through
the suggested answers to correct or affirm their understanding expressed in their answers
to the guiding questions for the self-explanation activity.

On the other hand, students in group reading Q&As saw the window with
questions and answers as Figure 11 shows. The title above the second row window was,
“Please read the following Q&As carefully to help clarify the concepts you have learned
in this lesson.” Students were directed to read the given sets of questions and answers that
rehashed the previous teaching and practice of that lesson. The questions were the exact
same guiding questions the group using the self-explanation strategy received, and the
full answers displayed immediately beneath those guiding questions were exactly the
same as those suggested answers given to the self-explanation group in the popup
window. Then, they were taken to the test page either at the end of the timer’s counting
down of the allotted time, or they could click the button “I am ready to take test” before
the time was up, as Figure 12 shows.
Figure 11. A full view of the second row: a window with Q&As for the group that learns by reading Q&As. There are the same numbers of questions in Q&As as that in the guided self-explanation illustrated in the previous figure.

Figure 12. The group reading Q&As was given the option to take the test before time was up.
Both of the groups would then encounter the same testing page with the same test question(s). For the lessons that are not associated with a test, there was the page that explained that there was no test and linked them back to the home page where there was the list of topics for the learners to continue selecting and learning about, as shown by Figure 13. If there was an associated test with the lesson, then the user was taken to the test page, as shown by Figure 14. Once a learner had completed a lesson, that lesson became unavailable for that learner to be selected from the topic list on the home page.

*Figure 13.* Learners encountered this Web page after completing a lesson and there was no test associated with the lesson.
Figure 14. Learners encountered this Web page after completing a lesson and if there was a test associated with the lesson.

Table 3 is the comparison summary of the two versions of the tutorial which implements a worked example strategy and the design principles of the multimedia learning, with the employment of either self-explanation or reading questions and answers.
Table 3

Comparison between the tutorial versions of SE and Q&A

<table>
<thead>
<tr>
<th></th>
<th>Self-explanation</th>
<th>Reading Q&amp;As</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production format</td>
<td>Online multimedia tutorial</td>
<td>Online multimedia tutorial</td>
</tr>
<tr>
<td>Equipment or software required for delivery</td>
<td>Computer and Internet access only</td>
<td>Computer and Internet access only</td>
</tr>
<tr>
<td>Treatment variable</td>
<td>Self-explanation</td>
<td>Q&amp;As</td>
</tr>
<tr>
<td>Interactive</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hands on Practicing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Accessing time or frequency constraints</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Learning at learner's own pace</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time limit within lessons</td>
<td>Abundant time allotted for lessons</td>
<td>Abundant time allotted for lessons</td>
</tr>
</tbody>
</table>
Measures

XHTML Pretest

Prior to introducing students to the online tutorial, an XHTML test was administered to students to evaluate their background knowledge of Web design. There were a total of nine questions either in the multiple-choice or the fill-in-the-blank format. In order to incorporate JavaScript code into a Web page, only a basic understanding of the XHTML knowledge was required and the test reflected such requirement. Examples of questions included “What is the extension of an XHTML file?” and “The operation system automatically attaches ‘.txt’ to a file generated in Notepad when that file is being saved. How do we ensure that the XHTML file has an extension ‘.htm’ or ‘.html’?” See Appendix C for the full test.

Motivation Questionnaire

A 23-item questionnaire was also used to assess students’ motivation levels in self-efficacy, effort expenditure, task value (attainment, utility, and intrinsic value), and distractor items. A modified version of the Self-Assessment Questionnaire (SAQ) was utilized. Items in this questionnaire were modified to accommodate the current study (i.e., computer language) from a well-established instrument on motivation and metacognition (see Hong, O'Neil, & Feldon, 2005 and O'Neil, Sugrue, Abedi, Baker, & Golan, 1992 for the history of instrument development and validation results). Examples of items included: “I can master computer programming skills” (self-efficacy, 4 items); “I concentrate fully when I work on any computer programming task” (effort, 4 items); “It is important for me to do well in this class” (attainment value, 4 items); “The concept
taught in this class is useful for me to learn” (utility value, 4 items); “I like this class because computer language interests me” (intrinsic value, 4 items); “I cannot concentrate when I work on computer programming” (distractor, 3 items). See Appendix D for the full questionnaire.

End-of-lesson Tests

The tests at the end of the lessons in the online tutorial were developed to assess the level of a student’s acquired topical, procedural knowledge. The following example is the end-of-lesson test of Lesson 3:

Create an XHTML file that writes the following text in both XHTML and JavaScript coding.

(1) Using the XHTML coding, write the text to the Web page: This text is written using XHTML.

(2) Using the JavaScript coding, write the text to the Web page: This text is written using JavaScript (Note: Using XHTML to achieve the same result will NOT earn you credit. JavaScript must be used.)

For this test, students needed to be able to create an XHTML file and write the same text through XHMTL code and JavaScript code. See Appendix E for the full test.

Students’ answers were rated on the following 5-point grading scale: (1) Little to no correctness, (2) Slightly correct, (3) Half-way correct, (4) Mostly correct, and (5) Completely correct. The Cronbach’s alpha (α) for internal consistency was .76 which is within the acceptable range for internal consistency or reliability (Nunnaly, 1978; Tuckman, 1999).
End-of-study Questionnaire

This questionnaire was developed for participating students who had completed all five lessons and gone through both versions of the tutorial. The items in the questionnaire were tailored to inquire students’ perceptions about the learning effectiveness and their preference toward the instructional material focusing on the self-explanation or reading Q&As in learning JavaScript language. Students made a selection between self-explanation or reading Q&As and supplied the reason for the choice. A link was provided on the high school’s network to connect students to the Website hosting the survey. For example, period 4 students were taken to the following Website to enter their answers where they saw the title: “Period 4: JavaScript Tutorial Learning Survey” (see Figure 15).
Figure 15. End-of-Study Questionnaire, hosted on an Internet Website accessed by students after completing all five lessons.

The following are the six items of the questionnaire in which (a) is self-explanation and (b) is reading Q&As:

1. Which method of learning, (a) or (b), helped you understand JavaScript concepts better? Explain why.

2. Which method of learning, (a) or (b), helped you understand better the importance of utilizing JavaScript for Web development? Explain why.
3. After which exercise, (a) or (b), did you think that you could write your own JavaScript code? Explain why.

4. Which method of learning, (a) or (b), helped you visualize better what a given piece of JavaScript code will do in your Web page? Explain why.

5. Which method of learning, (a) or (b), helped you understand better the importance of the correctness of writing the JavaScript code? Explain why.

6. Which method of learning, (a) or (b), helped you learn JavaScript better? Explain why.

Cronbach’s alpha (Cronbach, 1947, 1951, 1971; Cronbach & Shavelson, 2004) was computed for scores from the following instruments: Pretest of XHTML background knowledge, the students’ motivation questionnaire, the end-of-lesson tests on the five lessons of the study, and the end-of-study questionnaire on preference of one of the two learning methods (either SE or Q&A). The Cronbach’s alphas for the motivation questionnaire and the end-of-study questionnaire were computed based on their adjusted sample size due to the missing answers as a result of the absences of the participants. The estimated reliability for each category is shown in Table 4.
Table 4

*Internal Consistency of Instruments*

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (XHTML background knowledge)</td>
<td>.85</td>
</tr>
<tr>
<td>Motivation Questionnaire</td>
<td>.90&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>End-of-lesson Tests (on five lessons with settled scores)</td>
<td>.76</td>
</tr>
<tr>
<td>Preference of learning methods (SE or Q&amp;A)</td>
<td>.73&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

$N = 137.$
<sup>a</sup>$n = 134.$  <sup>b</sup>$n = 133.$

**Procedure**

Study procedure, group assignment and lesson procedure, and data analysis procedure are presented in this section.

**Study Procedure**

Figure 16 shows the flowchart of the study process. Students first made a decision if they needed to brush up their XHTML knowledge before they started learning lessons on JavaScript. For each lesson, students read the tutorial lecture, studied the worked example JavaScript code snippets, did the hands-on practices in coding in JavaScript, and then were taken to the proper Web page to engage in either the activity of self-explanation or reading questions and answers. After learning that lesson, students were led to the end-of-lesson test page to take the test. Once students had completed all five lessons, they took the end of study questionnaire regarding their preference of either of the learning methods, SE or Q&A.
Figure 16. Process overview in the format of flowchart.

**Group Assignment and Lesson Procedure**

Students of six classes that had learned beginning Web development were randomly assigned into two groups with three classes in Group 1 and the other three classes in Group 2. Each participant received a URL and a unique username and password to access the Website where the tutorial was hosted. After the first two lessons, the two groups of students switched methods for the next two lessons. For lesson 5, the two groups would return to their original learning strategy designation.

This form of group assignment was utilized to afford students the experience of both types of experimental conditions. This format allowed for the collection of perception data (research question 2). The rationale for the second swap was that lessons 1 and 2 were easier than lessons 3 and 4. Therefore, after the first swap, the group that used to read questions and answers had to start doing self-explanations and might
experience higher intensity of self-explanation with lessons 3 and 4 than the first group’s self-explanation with lessons 1 and 2. The second swap for lesson 5 would balance the experience for the two groups. Although students were made aware that they were participating in a study, they were not informed about either the self-explanation learning strategy or the reading questions and answers activity being specifically the treatment condition.

The study was conducted during regular school hours. There were 50 minutes in each period. Students of each period of all six periods met daily, Monday through Friday, during the week. A period was devoted for one lesson. The lesson selected for the period was clearly conveyed to students in three different formats: (a) it was in a printed daily lesson plan posted on a regular spot of the classroom wall, (b) it was hand-written on the white board in the front of the classroom under the “Class Objectives,” and (c) it was verbally announced by the instructor. Students were instructed to practice typing the code from scratch and discouraged from copying and pasting, as writing their own code is the ultimate goal of the tutorial. Furthermore, students were advised to follow the designed sequence of learning within each lesson in order to receive the most benefit of the theories based design.

Students were allowed to go back and forth between the page that has the demonstration and the first practice, and the page that has the second practice and either the Q&A or the self-explanation, depending on the learning path they were on, as these two pairs are presented in one Web page, respectively for each group. As described earlier, students could not go back to a previous lesson once a lesson was completed. The test questions at the end of lessons were the same for students of both of the two
comparison groups. As Figure 1 illustrates, contents on the Web pages 1, 2, 3 and 5 of the tutorial are exactly identical for both groups; the only difference appears at the lower part of the Web page 4 of the tutorial.

After students had completed all five lessons, they were directed to find a provided link on the high school’s network to reach the Website hosting the end-of-study questionnaire, which measured the learner preference of the two learning strategies, self-explanation and reading Q&As, and reasons for the choice.

**Data Collection**

To conduct a study in a high school within the Clark County School District (CCSD), a research protocol was submitted and approved by the University of Nevada Las Vegas (UNLV) Institutional Review Board (Appendix F) and by CCSD’s Department of Research and School Improvement (Appendix G). An authorization letter signed by an administrator of the school site where the study is conducted was also obtained (Appendix H). Before the study was conducted with the students at the high school site, the Youth Assent form, the Parent Permission form, and the Informed Consent form for students 18 or older were distributed, and signed forms were returned to a teacher who distributed the forms (see Appendix I, J, K).

Data were collected on an XHTML test, a refresher, and a motivation questionnaire, from both groups prior to the tutorial lesson sessions starting. During the tutorial sessions, the answers to the test questions were collected from both groups. The data from the self-explanation answers to the guiding questions for the self-explanation group were collected as well. The final test on JavaScript and responses to the end-of-study questionnaire were collected after the tutorial lesson sessions.
Data Analysis

Both quantitative and qualitative methods were employed with this research to measure the effect that self-explanation learner activity has on learning a computer programming language by the learners of Web development who had little to none previous programming experiences.

Quantitative data analysis. Two analyses of covariance were conducted with a between-subject factor (group) and two covariates (XHTML test scores and motivation scores). Practical significance ($\eta^2$) was reported, along with statistical significance for each statistical test. Before testing research hypotheses, data was screened and statistical assumptions were tested. For end-of-lesson test scores, skewness of lessons 1, 2 and 5, and of lessons 3 and 4 were smaller than $|1|$, approximating normal distribution. Individual z-scores were all smaller than $|3|$, thus no subjects were removed. Homogeneity of variance/covariance assumption was met, $p = .709$, for end-of-lesson test scores of lessons 1, 2 and 5. For lessons 3 and 4, although the probability level for the test of homogeneity of variance/covariance assumption was .032, the slight departure from the homogeneity assumption would not pose the robustness of the hypothesis testing as the group sizes were similar and the data approximated normal distribution. The assumption for the homogeneity of regression coefficient was met, with $p$ values ranging from .34 to .82 for two dependent variables for the two experimental groups. Students’ preference choice between SE and Q&A were counted for each item and frequency differences were examined with chi-square tests.
**Qualitative data analysis.** Students’ narrative responses to the six questionnaire items were analyzed for each participant to elicit categories using the following procedure:

(a) Listing and compiling: Participants’ responses were transcribed and compiled into a computer file.

(b) Category elicitation: 1) each response was judged and tentatively labeled, and 2) tentative labels were inspected to determine if there were common categories that can be elected.

(c) Mapping: 1) all participants’ responses were mapped onto the tentative categories; 2) categories were inspected for further revisions, and 3) after the categories were established, each participant’s responses were re-evaluated to map them onto the proper categories.

(d) Elicitation of higher-order categories: Categories were inspected again to elicit the main, over-arching categories within each questionnaire item.

After the listing and compiling processes were completed by the investigator, two coders independently conducted category elicitation and mapping for each student’s responses. Marshall and Rossman (2006) describe a similar procedure (Marshall & Rossman, 2006) and it has been used in previous studies on qualitative data (e.g. Hong, Sas, & Sas, 2006)(Hong, Sas, & Sas, 2006). The results from the two coders were very similar in category elicitation. One coder had elicited 11 major categories and the other had elicited 10 throughout the six items, themes mostly overlapping across items. After a thorough comparison between the two coders’ elicitations, it was determined that the categories elicited by the two coders were mostly overlapping except a category elicited
by one coder encompassed the other coder’s two categories. Through further discussions, the two coders had reached the agreement of having two separate themes of "It affords (allows/forces) me to take the initiative to learn and express my knowledge" and "I get to learn and practice on my own/challenge myself." The coders had further discussed and agreed on having two additional categories of "Just because" and "Obscure, incorrect, or irrelevant" to include those responses that don't fit into the major categories. Intercoder agreement on theme elicitation was 92.3%, indicating an acceptable rate (Lombard, Snyder-Duch, & Bracken, 2002; Neuendorf, 2002). Then students’ individual responses were remapped. For each theme elicited, students’ reasons for their preferences between SE and Q&A methods were counted and the counts were compared with chi-square test.
CHAPTER 4

Results

The current study examined the effects of two learning strategies, self-explanation and reading questions and answers, on students’ learning of the JavaScript programming language. Results are organized for each research question.

Research Question 1

Was there a significant difference in student performance at the end-of-lesson test questions between the group that engaged in self-explanation activity and the group that read the provided questions and answers, during learning JavaScript in the tutorial? This question was tested by analyzing students’ performance on answering the end-of-lesson test questions in the tutorial. Two analyses of covariance (ANCOVA) have been performed.

Analyses of covariance. The first ANCOVA was performed with the mean end-of-lesson test scores of lessons 1, 2 and 5 as the dependent variable, and with two covariates, mean XHTML pretest score and mean motivation score, both of which were obtained before students started learning the five lessons. The group (self-explanation vs. Q&As) was the independent variable. The second ANCOVA was similar to the first one, except the dependent variable, now the mean of end-of-lesson test scores of lessons 3 and 4. For this test, the student compositions for the two groups were swapped (see Chapter 3).

The means and the standard deviations and adjusted means and standard errors for students’ end-of-lesson tests scores are presented in Table 5.
Table 5

*Means and Adjusted Means of End-of-Lesson Tests by Two Groups*

<table>
<thead>
<tr>
<th></th>
<th>The Self-explanation Group</th>
<th>The Q&amp;A Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>Adjusted M (SE)</td>
</tr>
<tr>
<td>Lessons 1, 2, 5</td>
<td>2.30 (1.24)</td>
<td>2.31 (0.13)</td>
</tr>
<tr>
<td>Lessons 3, 4</td>
<td>2.28 (1.32)</td>
<td>2.28 (0.17)</td>
</tr>
<tr>
<td></td>
<td>n = 78 (self-explanation)</td>
<td>n = 69 (Q&amp;A)</td>
</tr>
</tbody>
</table>

There was no statistically significant difference in the adjusted means of end-of-lesson test scores for lessons 1, 2 and 5 between the two groups, $F(1, 143) = .940, p = .334, \eta^2_p = .007$. Likewise, the adjusted means of end-of-lesson test scores for lessons 3 and 4 were not statistically significantly different between the two groups, $F(1, 143) = .105, p = .746, \eta^2_p = .001$.

**Research Question 2**

Which learning strategy was superior for achieving a better understanding of JavaScript in students’ opinion? This question was tested by the responses from the students to the end-of-study questionnaire about their perceptions after they had the exposure to both versions of the tutorial.
There were six items in the questionnaire representing different aspects of learning. Each item asked students to select their preferred method of learning, either self-explanation (SE) activity or reading questions and answers (Q&A). Under each question, an area was provided for students to write their rationale for the preference choice. Students’ choices were tallied and tabulated by the perspective groups (see Table 6).
Table 6

*End-of-study Questionnaire Result Statistics of Both Groups*

<table>
<thead>
<tr>
<th>End of Study Questionnaire Items</th>
<th>Group 1</th>
<th></th>
<th>Group 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SE</td>
<td>QA</td>
<td>χ²</td>
<td>SE</td>
</tr>
<tr>
<td></td>
<td>count</td>
<td>%</td>
<td>count</td>
<td>%</td>
</tr>
<tr>
<td>1. Which method of learning helped you understand JavaScript concepts better?</td>
<td>44</td>
<td>58</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td>2. Which method of learning helped you understand better the importance of utilizing JavaScript for Web development?</td>
<td>44</td>
<td>58</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td>3. After which exercise did you think that you could write your own JavaScript code?</td>
<td>41</td>
<td>54</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>4. Which method of learning helped you visualize better what a given piece of JavaScript code will do in your Web page?</td>
<td>43</td>
<td>57</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>5. Which method of learning helped you understand better the importance of the correctness of writing the JavaScript code?</td>
<td>43</td>
<td>57</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>6. Which method of learning helped you learn JavaScript better?</td>
<td>49</td>
<td>64</td>
<td>27</td>
<td>36</td>
</tr>
</tbody>
</table>

<sup>*</sup><i>p < .02</i>

<sup>ns</sup> = not significant
As the chi-square statistics in Table 6 indicate, only Item 6 (“Which method of learning helped you learn JavaScript better?”) demonstrated a statistical significance, \( p < .02 \), in Group 1, with a higher frequency showing for SE. When both groups’ frequency data were used to test the differences, again only Item 6 was significantly different, \( p < .05 \). In all items (except for Item 2 of Group 2), students had tendency of preferring SE more than Q&A.

With each questionnaire item, students were asked to provide their rationale for their preference in the comment area. These comments were organized to elicit themes. Under each item, a table listed the themes elicited with their corresponding sample student responses under the categories of SE and Q&A preferences. All comments submitted by participating students (not all students submitted their comments) for the 6 questionnaire items were transcribed and compiled into a computer file as Appendix L details. There were 575 student comments out of the possible 1008 comment areas provided so the commenting rate was at 57.04%.

**Item 1:** “Which method helped you understand JavaScript concepts better?” Fifty eight percent of the Group 1 students, who had started learning the first two lessons with the self-explanation method, chose SE, while the rest 42% chose the reading Q&As. Group 2 students, who had started learning the first two lessons with the reading Q&As method, also preferred SE over Q&A at 55% to 45%. See sample responses in Table 7.
Table 7

*The Elicited Themes and Sample Reasons of Students’ Preference for Item 1*

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>None)</td>
</tr>
<tr>
<td>It helps me think</td>
<td>“To think about it”; “It made me think harder about the information from the lessons”; “It made me have to understand it enough to be able to explain it” (and 3 additional answers).</td>
</tr>
<tr>
<td>It provides more information</td>
<td>“Because it explains more of JavaScript.”</td>
</tr>
<tr>
<td>Doing nothing/easier than typing</td>
<td>None)</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>“I say self-explanation because it is way easier to follow along than to just read Q&amp;As”; “I understand better,” (and 5 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>“The way it helped me understand is because the example and display examples help me then I try” (and 1 more).</td>
</tr>
<tr>
<td>It affords (allows/forces me to take the initiative to learn and express my knowledge)</td>
<td>“…you can explain it on how you learned it”; “… because being able to learn on our own by answering questions let us understand the concepts more comfortably”; “It made me have to understand it enough to be able to explain it” (and 1 more).</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>“It helped me remember some of the JavaScript concept by using self-explanation.” (and 2 more).</td>
</tr>
<tr>
<td>I get to learn and practice on my own / challenge myself</td>
<td>“…because being able to learn on our own by answering questions let us understand the concepts more comfortably”; “It made me have to understand it enough to be able to explain it” (and 9 more).</td>
</tr>
<tr>
<td>New, interesting, less stressful</td>
<td>None)</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>“I was getting my question answered by the prompted answers”; “Self-explanation because when information was given, I could read it and know what I am doing.”</td>
</tr>
<tr>
<td>“Just because”</td>
<td>“It was better”; “It’s better than Q&amp;As”; “I always learn better like that”; “Self-explanation works best for me” (and 2 more).</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>“Self-explanation is a domain general constructive activity” (Author notes: Such explanation was not provided to students therefore is deemed irrelevant to reason of preference) (and 11 more).</td>
</tr>
</tbody>
</table>


**Item 2:** “Which method of learning helped you understand better the importance of utilizing JavaScript for Web development?” Students in Group 1 preferred SE over Q&A at 58% to 42%; students in Group 2 preferred Q&A over SE at 52% to 48%. See sample responses in Table 8.

### Table 8

**The Elicited Themes and Sample Reasons of Students’ Preference for Item 2**

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>None)</td>
</tr>
<tr>
<td></td>
<td>“Q&amp;As because it had the answer there for you already”; “Because when it asked me questions, it reminded me of what the topic was about and what to do” (and 16 more).</td>
</tr>
<tr>
<td>It helps me think</td>
<td>“If I explain it to myself in my own words, I will learn faster” (and 5 more).</td>
</tr>
<tr>
<td></td>
<td>“I can read and think better.”</td>
</tr>
<tr>
<td>It provides more information</td>
<td>“Because I had more of an idea of what JavaScript is” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>“Because it gave lessons and how-tos on how to do it, and why it was important.”</td>
</tr>
<tr>
<td>Doing nothing / no typing</td>
<td>None)</td>
</tr>
<tr>
<td></td>
<td>None)</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>“If I read the method, I think I can get it myself instead of Q&amp;As”; “I understand better with my own explanation” (and 6 more).</td>
</tr>
<tr>
<td></td>
<td>“Because it shows us questions and answers so it’s easier to understand” (and 4 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>“Self-explanation gave more coherent examples and it helped to see it already written out.”</td>
</tr>
<tr>
<td></td>
<td>None)</td>
</tr>
<tr>
<td>Taking the initiative to learn and express my knowledge</td>
<td>“If I explain it to myself in my own words, I will learn faster” (and 2 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>None)</td>
</tr>
<tr>
<td></td>
<td>“Because when it asked me questions, it reminded me of what the topic was about and what to do.”</td>
</tr>
<tr>
<td>I get to learn and practice on my own / challenge myself</td>
<td>“If I explain it to myself in my own words, I will learn faster”; “Well, I pick self-explanation, because it helps you learn by doing it yourself”; “SE is better to understand yourself because like that you know JavaScript better to help with the Web page”; “I understand better with my own explanation” (and 6 more).</td>
</tr>
<tr>
<td></td>
<td>None)</td>
</tr>
<tr>
<td>New, interesting, less stressful</td>
<td>“Because it interested me and it made me want to keep on doing it”; “It was something new.”</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>“When the suggested answers came up, it showed me that if I would have used something else, I would not get the same result.”</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>“Just because”</td>
<td>“I think self-explanation is better” (and 9 more).</td>
</tr>
<tr>
<td></td>
<td>“It helps me understand better”; “I learn better this way”; “Cause its Q&amp;As”; “I dunno, just did seem to help me better” (and 7 more).</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>“Don’t know what that means” (and 9 more).</td>
</tr>
<tr>
<td></td>
<td>“Because Self-explanation is easier to learn from. While Q&amp;A expects you to know the answers.” (Author notes: This explanation does not make sense as the selection was QA preference.)</td>
</tr>
</tbody>
</table>
Item 3: “After which exercise did you think that you could write your own JavaScript code?” Group 1 students preferred SE over Q&A at 54% to 46%; students in Group 2 preferred SE over Q&A at 57% to 43%. See sample responses in Table 9.

Table 9
The Elicited Themes and Sample Reasons of Students’ Preference for Item 3

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“It’s way much easier for me to do because it’s done for you already”; “Q&amp;As helped me write my own JavaScript code because it gave me review to what was coming towards me and gave me the understanding of what it was possibly going to ask me” (and 36 more).</td>
</tr>
<tr>
<td>It helps me think</td>
<td>“It just got me to think, then it was easier” (and 4 more).</td>
</tr>
<tr>
<td></td>
<td>“Q&amp;A gets me to think then understand”; “If I read it to myself &amp; then re-read it &amp; translate it in a way that I will understand &amp; then think about it, I will get it.”</td>
</tr>
<tr>
<td>It provides more information</td>
<td>“It gives you more information” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>“It showed me the right way to insert things to it.”</td>
</tr>
<tr>
<td>Doing nothing/easier than typing</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“It’s way much easier for me to do because it’s done for you already.”</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>“If I read it to myself &amp; then re-read it &amp; translate it in a way that I will understand &amp; then think about it, I will get it” (and 5 more).</td>
</tr>
<tr>
<td></td>
<td>“Q&amp;A helped me understand it more” (and 4 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>“How students study and use examples in learning”; “Self-explanation because it had examples.”</td>
</tr>
<tr>
<td></td>
<td>“Because it shows me examples which help me understand the exercise”; “Because it gives you like an example of how to do it.”</td>
</tr>
<tr>
<td>It affords (allows/forces) me to take the initiative to learn and express my knowledge</td>
<td>“Doing it yourself is better than just reading”; “if I read it to myself &amp; then re-read it &amp; translate it in a way that I will understand &amp; then think about it, I will get it” (and 3 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>“...you could type the code till you remember it without looking at it” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>“Because it helps some steps we forgot.”</td>
</tr>
<tr>
<td>I get to learn and practice on my own/challenge myself</td>
<td>“Doing it yourself is better than just reading”; “Would start understanding try it on my own” (and 10 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>New, interesting, less stressful</td>
<td>(None)</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>“Because it gave me a recap on what is needed to complete.”</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>“Just because”</td>
<td>“Self-explanation is better” (and 3 more).</td>
</tr>
<tr>
<td></td>
<td>“Yes since I learned better with Q&amp;As.”</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>“May be not” (and 11 more).</td>
</tr>
<tr>
<td></td>
<td>“Well not really because, I really didn’t know how to do it” (and 3 more).</td>
</tr>
</tbody>
</table>
**Item 4:** “Which method of learning helped you visualize better what a given piece of JavaScript code will do in your Web page?” Students in Group 1 preferred SE over Q&A at 57% to 43%; Group 2 students preferred SE over Q&A at 55% to 45%. See sample responses in Table 10.

Table 10

*The Elicited Themes and Sample Reasons of Students’ Preference for Item 4*

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>Q&amp;A</td>
</tr>
<tr>
<td>It shows me what to do exactly</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“Gives me the correct code” (and 9 more).</td>
</tr>
<tr>
<td>It helps me think</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“Because it showed more things to me and by answering the question it made me think twice about it.”</td>
</tr>
<tr>
<td>It provides more information</td>
<td>“Self-explanation shows me more than just Q&amp;A” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>“More information”; “Because it showed more things to me and by answering the question it made me think twice about it.”</td>
</tr>
<tr>
<td>Doing nothing/easier than typing</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“Because someone gives questions and in those questions will be codes.”</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>“Because I feel like it explained it good, to the point where I really understood it” (and 6 more).</td>
</tr>
<tr>
<td></td>
<td>“Easier” (and 4 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>“The example given helped a lot” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>It affords (allows/forces) me to take the initiative to learn and express my knowledge</td>
<td>For everyone it would be easier because if put in your own words it's easier for you”; “I was able to show what it would do myself” (and 3 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>“I was able to remember them”; “It makes you memorize stuff”; “…help me understand the correct way so when I do it on my own one day, I would remember the correct everything.”</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>I get to learn and practice on my own / challenge myself</td>
<td>“I would've read it myself and try to get it the JavaScript code” (and 9 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>New, interesting, less stressful</td>
<td>(None)</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>(None)</td>
</tr>
<tr>
<td>“Just because”</td>
<td>“Because the answer shows how it's supposed to be.”</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>“This way I understand it better” (and 5 more).</td>
</tr>
<tr>
<td></td>
<td>“I visualize it better”; “It’s better for me”; “I really don’t have a reason” (and 2 more).</td>
</tr>
</tbody>
</table>

Author notes: No video was shown.
**Item 5**: “Which method of learning helped you understand better the importance of the correctness of writing the JavaScript code?” Group 1 students preferred SE over Q&A at 57% to 43%; Group 2 students preferred SE over Q&A at 57% to 43%. See sample responses in Table 11.

Table 11

The Elicited Themes and Sample Reasons of Students’ Preference for Item 5

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>SE: (None)</td>
</tr>
<tr>
<td>It helps me think</td>
<td>SE: “Helped me figure out how to get the codes of JavaScript right/correct”, “It made me understand it more to have to explain it” (and 2 more).</td>
</tr>
<tr>
<td>It provides more information</td>
<td>SE: “Because if you make a mistake then it shows it” (and 1 more).</td>
</tr>
<tr>
<td>Doing nothing/no typing</td>
<td>SE: (None)</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>SE: “Because it was laid out clear on what you have to do”; “Because it gives a better understanding”; “Easier to understand”; “Because self-explanation helps me understand it a little bit more”; “I understand this better with explanation” (and 3 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>SE: “Because you can see what incorrect coding will do to your Web page.”</td>
</tr>
<tr>
<td>It affords (allows/forces) me to take the initiative to learn and express my knowledge</td>
<td>SE: “For everyone it would be easier because if put in your own words it's easier for you”; “It shows what you need and then you have to do it” (and 3 more).</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>SE: (None)</td>
</tr>
<tr>
<td>I get to learn and practice on my own / challenge myself</td>
<td>SE: “For everyone it would be easier because if put in your own words it's easier for you” (and 9 more).</td>
</tr>
<tr>
<td>New, interesting, less stressful</td>
<td>SE: (None)</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>SE: “If you wrote it wrong then you'd think it's right but it's really wrong”; “Because it will show it while going over it”; “Because if you make a mistake then it shows it.”</td>
</tr>
<tr>
<td>“Just because”</td>
<td>SE: “Because it was self-explanation” (and 3 more).</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>SE: “This style made it hard” (and 9 more).</td>
</tr>
</tbody>
</table>
**Item 6:** “Which method of learning helped you learn JavaScript better?” Students in Group 1 preferred SE over Q&A at 64% to 36%; students in Group 2 preferred SE over Q&A at 52% to 47%. See sample responses in Table 12.

Table 12  
*The Elicited Themes and Sample Reasons of Students’ Preference for Item 6*

<table>
<thead>
<tr>
<th>Elicited Theme</th>
<th>Sample Student Reasons for Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“I think to myself”; “It got me to think harder” (and 3 more).</td>
</tr>
<tr>
<td>It helps me think</td>
<td>“I think to myself.”</td>
</tr>
<tr>
<td>It provides more information</td>
<td>“It explains more specifically” (and 1 more).</td>
</tr>
<tr>
<td></td>
<td>“Gives more info”; “…because it not only helped me review but gave me useful information, that could enable me get a full understanding”; “More detail was explained”; “Because there were more details.”</td>
</tr>
<tr>
<td>Doing nothing/no typing</td>
<td>(None)</td>
</tr>
<tr>
<td></td>
<td>“I only need to read….to understand the concepts.”</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>“…easier to understand”; “I can tell from my own wording that I understand more”; “Made me comprehend the material better”; “It’s a lot easier to understand …”; “Self-explanation is more helpful to understand” (and 2 more).</td>
</tr>
<tr>
<td></td>
<td>“I say both but Q&amp;As helps me understand it”; “It explains better”; “I only need to read the Q&amp;As to understand the concepts” (and 4 more).</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>“Self-explanation clearly gave me examples”; “It helped me learn better by giving examples…” (and 2 more).</td>
</tr>
<tr>
<td></td>
<td>(None)</td>
</tr>
<tr>
<td>Taking the initiative to learn &amp; express knowledge</td>
<td>“I think both helped, but self-explanation helped more by practice” (and 1 more).</td>
</tr>
<tr>
<td>Helps remember better</td>
<td>“I remember better by explaining to myself.” (and 1 more).</td>
</tr>
<tr>
<td>I get to learn and practice on my own / challenge myself</td>
<td>“…because if put in your own words it’s easier for you”; “I can tell from my own wording that I understand more”; “I can explain to myself what’s going on”; “It gave me the code to study and type on my own” (and 9 more).</td>
</tr>
<tr>
<td>“…less stressful”</td>
<td>“…all I can say it was less stressful.” (and 1 more).</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>“Because it explains it like an adult/professional would”; “Because after you type, it tells you and explains it to you.” (and 3 more).</td>
</tr>
<tr>
<td>“Just because”</td>
<td>“…teaching me the best way to use JavaScript”; “Because it just helps you understand a lot more than Q&amp;As” (and 4 more).</td>
</tr>
<tr>
<td>Oblique, incorrect or irrelevant</td>
<td>“Am not sure which one may help me learn the JavaScript” (and 12 more)</td>
</tr>
<tr>
<td></td>
<td>“It helped me to interact.” (Author notes: There is no interaction with Q&amp;As.)</td>
</tr>
</tbody>
</table>
Due to the similarity of the themes elicited from student responses throughout the six questionnaire items, the themes were combined to count frequencies and to perform chi-square tests to determine the differences between SE and Q&A preferences (see Table 13).

Table 13
The Elicited Themes and Frequencies of Students’ Preference

<table>
<thead>
<tr>
<th>Themes</th>
<th>SE</th>
<th>Q&amp;A</th>
<th>(\chi^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>It shows me what to do exactly</td>
<td>0</td>
<td>140</td>
<td>140***</td>
</tr>
<tr>
<td>It helps me think</td>
<td>26</td>
<td>8</td>
<td>9.53**</td>
</tr>
<tr>
<td>It provides more information</td>
<td>11</td>
<td>10</td>
<td>0.05ns</td>
</tr>
<tr>
<td>I don’t have to do anything/Easier than typing</td>
<td>0</td>
<td>5</td>
<td>5.00*</td>
</tr>
<tr>
<td>It is easier to understand</td>
<td>43</td>
<td>45</td>
<td>0.05ns</td>
</tr>
<tr>
<td>I learn better with examples</td>
<td>10</td>
<td>4</td>
<td>2.57ns</td>
</tr>
<tr>
<td>It affords (allows/forces) me to take the initiative to learn and express my knowledge</td>
<td>24</td>
<td>0</td>
<td>24***</td>
</tr>
<tr>
<td>It helps me remember better</td>
<td>10</td>
<td>4</td>
<td>2.57ns</td>
</tr>
<tr>
<td>I get to learn and practice on my own/challenge myself</td>
<td>66</td>
<td>0</td>
<td>66.00***</td>
</tr>
<tr>
<td>It’s new/interesting/less stressful to me</td>
<td>3</td>
<td>0</td>
<td>3.00ns</td>
</tr>
<tr>
<td>The prompted answers enlighten me</td>
<td>10</td>
<td>0</td>
<td>10.00**</td>
</tr>
<tr>
<td>“Just because”</td>
<td>36</td>
<td>30</td>
<td>0.55ns</td>
</tr>
<tr>
<td>Obscure, incorrect or irrelevant</td>
<td>70</td>
<td>15</td>
<td>35.58***</td>
</tr>
</tbody>
</table>

* \(p < .05\)
** \(p < .01\)
*** \(p < .001\)

ns = not significant
Several themes of student reasons for preference demonstrated statistically significant differences between SE and Q&A. Those themes that demonstrated higher frequencies in SE as compared to Q&A included: “It affords (allows/forces) me to take the initiative to learn and express my knowledge”; “I get to learn and practice on my own/challenge myself”; “The prompted answers enlighten me”; and “Obscure, incorrect or irrelevant.” Those themes that demonstrated higher frequencies in Q&A as compared to SE included: “It shows me what to do exactly”; “I don’t have to do anything / Easier than typing”. The following categories of student reasons for preference did not demonstrate statistical significant: “It provides more information”; “It is easier to understand”; “I learn better with examples”; “It helps me remember better”; “It’s new/interesting/less stressful to me”; and “Just because.”
CHAPTER 5

Discussion

Both learning strategies of self-explanation and reading questions and answers have been evidenced to have positive effects on learning (Durkin, 2011; Fukaya, 2011; Kinniburgh & Shaw, 2009; Kwon & Jonassen, 2011; Leppink, Broers, Imbos, van der Vleuten, & Berger, 2012; McIntosh & Draper, 1995, 1996; Pappa & Tsaparlis, 2011; Raphael & Au, 2005). However, the two strategies have not been compared in any study in any subject domain. This study is the first to compare their effects on test performance, specifically on learning the computer programming language JavaScript. To strengthen the understanding of their effects, students’ preferences for either strategy and the reasons for their choice in learning JavaScript were examined. Furthermore, the current study, along with the study by Kwon and Jonassen (2011), filled the research gap after nearly two decades by examining the effectiveness of self-explanation strategy in learning a computer programming language.

Differential Effects of Two Learning Strategies on Computer Language Learning

Self-explanation has demonstrated its effects on student learning in previous studies of computer language learning (Bielaczyc, 1995; Bielaczyc & Pirolli, 1995; Kwon & Jonassen, 2011; Pirolli & Bielaczyc, 1989; Pirolli & Recker, 1994; Recker & Pirolli, 1990; Yuasa, 1994). On the other hand, reading questions and answers, although it has wide application (Benito, Foley, Lewis, & Prescott, 1993; Kinniburgh & Shaw, 2009; McIntosh & Draper, 1995, 1996; Ouzts, 1998; Pappa & Tsaparlis, 2011; Raphael,
1982, 1986; Raphael & Au, 2005), has no studies focusing on computer programming language learning.

In the current study, self-explanation activities and reading questions and answers activities did not make a difference in students’ performances at the end of each lesson. However, the questionnaire data collected at the end of the study revealed that students from both groups expressed their favorable impressions toward self-explanation over the familiar reading method with the reasons they offered. Although not all students’ choices of preferences were accompanied by comments, the comments entered have provided good information on what students were interested in and what and why one learning strategy might have worked for them better than the other. The eleven major themes that were elicited from these reasons, frequencies of the elicited themes, and sample reasons of students’ preferences will be discussed. The findings regarding student preferences were of interest especially because of the nonsignificant difference in test performance between the two strategy groups.

Elicited Themes

The themes elicited were indicative of students’ attitude toward learning.

Excluding the reasons that were “just because” or “obscure, incorrect or irrelevant,” and only considering the reasons with more than zero count for either self-explanation or reading strategy, the reasons among students’ preference for self-explanation seemed to be more evenly distributed than those for the preference for reading questions and answers. Of nine themes with 203 counts of reasons for the preference of self-explanation, the largest count was 66 for one reason (“I get to learn and practice on my own/challenge myself”). As to reading questions and answers strategy, of the seven
themes elicited, there were 140 counts toward only one reason (“It shows me what to do exactly”).

Students who selected the reading questions and answers method as their preference appeared to have quite a consensus about preferring to be showed what to do. On the other hand, the combined most and second most cited themes for the self-explanation preference demonstrated statistically significant differences and accounted for over 40% of the counts. These two themes for the self-explanation preference showing their popularity among students’ beliefs were, “I get to learn and practice on my own/challenge myself,” and “It affords (allows/forces) me to take the initiative to learn and express my knowledge.” It seemed that students liked the challenges brought forth by the self-explanation method, appreciated the opportunity to take charge of their own learning, wanted to be in control of the learning process, and were happy to give their input during learning. These themes of the preference for self-explanation indicated that students enjoyed actively participating in learning and meeting challenges.

As one theme revealed, the self-explanation method had appealed to some students because it was new, interesting or less stressful. It was new to the students because they had never heard of such learning strategy before the present study according to their verbal and written comments. There likely was a certain novelty effect from a new method, and therefore students found it interesting. Since the “less stressful” comment was not elaborated, it was not clear why the commenting student felt that way other than the conjecture that the appearance of reading questions and answers caused higher anxiety in the individual. Nevertheless, no students considered it a new experience
to read questions and answers, further attesting to the notion that students had previous exposures to the reading questions and answers method.

The two themes, “The prompted answers enlighten me” and “It helps me think,” appeared to be supportive of the surmise that students would rather think about how to answer the questions on their own before verifying with the prompted answers, while still drawing upon the knowledge provided. Students seemed to enjoy knowing that they had understood it correctly by reading the prompted answers after some delay, instead of being spoon fed with immediate questions and answers.

On the other hand, the themes that demonstrated higher frequencies of preference in reading questions and answers with statistical significance also revealed what might have appealed to students. For example, students candidly expressed their feelings as to the pleasure of “not having to do anything” or similarly, “easier than typing,” because typing was required by the self-explanation method but not by reading questions and answers.

The theme of “not having to do anything/easier than typing,” along with the aforementioned most predominant reason of students’ preference for the reading questions and answers method: “It shows me what to do exactly,” disclosed that some students relied on being closely guided with their learning, instead of taking the initiative to learn. These most vocalized reasons might have somewhat reflected the intense academic and emotional needs of the participating students.

The reasons for preference that did not demonstrate statistical significance between the two strategies were: “It provides more information”; “It is easier to understand”; “I learn better with examples”; “It helps me remember better”; “It’s
new/interesting/less stressful to me”; and “Just because.” These themes on reasons were not as relevant as other themes that showed significant difference between the two strategies possibly on the grounds that students of both preferences shared several similar opinions regarding each questionnaire item for their own choice. For example, “It is easier to understand” was shown in 43 and 45 times respectively for the self-explanation and reading strategy. One student described himself as a “Q&A type of person”, because the reading questions and answers method was easier to understand for him, while the self-explanation method was easier to understand for another student whose preference was self-explanation, “I understand better with my own explanation.”

“It provides more information” was expressed 11 and 10 times respectively for the self-explanation and reading strategy. The tutorial information provided through both methods was ultimately identical. It appeared that students considered their preferred method as the one that provided them with more information because that method had a better appeal to their learner characteristics than the other method did.

The examples of “I learn better with examples” and “It helps me remember better,” selected by students of both preferences as their reasons, offered a further indication that they shared these same opinions toward their respective preferred learning methods. The examples provided to students through both methods were the same; however, students attributed the reason for their preference to those same examples by citing “I learn better with examples.” Similarly, some students considered their preferred method more helpful for memorizing the materials while students preferring the other method deemed their choice more helpful instead. Both of the examples attest to the
contention that students’ preferred method had a better appeal to their learner characteristics than the other method.

In conclusion, students’ reasons for their choice of preference—easier to understand, more informative, more helpful with memorization, easier to learn with examples—spoke to the phenomenon that either one of the two methods could appeal to certain types of learner characteristics but with different understandings of how the processing of information through each strategy will help them learn. An understanding of the learner characteristics of the target audience could become very helpful with the instructional designs at hand. Tailoring the instructional designs to accommodate the learner characteristics can help maximize students’ learning, especially those students who struggle with learning; however, teachers and instructional designers should strive to search and use well-evidenced, effective learning and instructional strategies in developing instructional materials.

Another phenomenon worth noting is the extraordinarily high numbers of the “just because” and “obscure, incorrect or irrelevant” types of reasons for choosing the self-explanation and reading questions and answers. These high numbers were probably caused by the low academic standing and behavior issues of the participating students. The limitations stemmed from some of the participating students’ low reading comprehension might have caused to a certain extent confusion and hindered appropriate understanding for the strategies and their ability to reason (Schumm, Vaughn, Klingner, & Haager, 1992; Skinner, 1994).
**Student Choices between the Two Strategies**

Students’ choices of preference collected from the end-of-study questionnaire showed that students in both groups expressed their preference toward the self-explanation method. In general, there were higher percentage of students that preferred self-explanation within the group that started learning the first two lessons with the self-explanation method than those students who started learning with the reading questions and answers method. However, only students within the group that started learning with the self-explanation method made a statistically significant difference with Item 6 showing a higher frequency for self-explanation over reading questions and answers. It appeared that the participating students might have somewhat been thrown off by the wording of each item that was intended to solicit students’ differential responses based on various aspects of the learning objectives. The item wording may have presented more difficulty for students with lower academic standing to decipher (Schumm et al., 1992; Skinner, 1994). The conclusive question of Item 6, “Which method of learning helped you learn JavaScript better?” was perhaps easier for students to understand, thus making a choice decision more certainly, while being unsure about the delicate differences presented in other questions regarding different aspects of learning. It appeared that students decisively expressed their feeling that self-explanation helped them learn JavaScript better but were unable to determine if self-explanation was helping them in every aspect of learning such as helping them remember better.

**Exposures and preferences.** Students in the group that started learning with the self-explanation method showed a higher percentage difference between their preference for self-explanation and reading questions and answers compared with students of the
other group. A logical conjecture is that the early exposure to a designated learning method might have had created a favorable first impression. When students were later exposed to the other method which, even if became their preferred method, the degree of preference for the later-introduced method seemingly was reduced compared to that of students who had encountered it as their first learning method. Students might have been more receptive and impressionable at the beginning of the study; that is, the first introduced method was what the students might have become comfortable with. This whole situation was compounded by the fact that students already had previous exposure to the method of reading questions and answers and were most likely receptive of the concept and procedure. The sequence of instruction/learning strategies should be examined further to understand its effects on learning.

Some observed phenomena supported the conjecture that students had created a comfort zone with their first encountered learning method. For example, a usual verbal comment by students in the group that started learning with the reading questions and answers method, after they switched to self-explanation with their lessons 3 and 4, was how much more work the latter involved. They cited that they needed to think about what they had to answer and physically typed it up, compared to the previous hands-off approach to merely reading questions and answers. Similarly, students who first learned the lessons with the self-explanation method then switched to reading questions and answers expressed how they were surprised, “There is nothing to do but just read what is given.” The instructor was asked frequently if there really was nothing they had to do before taking the end-of-lesson test, even if “reading” is a learning activity.
These findings appeared to coincide with the previous findings that there existed a relationship between exposures and preferences and that exposures could change preferences even among children of preschool age (Cox & Cox, 2002; Martindale, Moore, & West, 1988; Schuckert & McDonald, 1968; Wiedl, 1975).

Furthermore, these comments were reflective of the students’ perception of the comparative workload of the two learning methods. Of great interest is that even if students perceived self-explanation as requiring much more work than reading questions and answers, they largely regarded self-explanation as a better method that helped them learn JavaScript. Regardless students’ previous or even constant exposure to the familiar reading method and the recognized heavier workload of self-explanation, students found that self-explanation resonate well with their learning. This has provided further support for the concept of germane cognitive load proposed by the cognitive load theory. As previous studies suggested, self-explanation generates cognitive load which directly contributes to learning therefore the load is considered germane (Crippen & Earl, 2004; Crippen & Earl, 2007; DeLeeuw & Mayer, 2008; Sweller, van Merrienboer, & Paas, 1998). Students’ choice of self-explanation as the better method for learning JavaScript while alleging that it imposed heavier work load had acknowledged the connection between self-explanation and its imposed cognitive load. The endorsement from students helped substantiate the notion that the cognitive load generated by self-explanation was germane and therefore more helpful for students’ learning JavaScript.

**No Group Difference in Test Performance**

Several suppositions on the lack of evidence of significant group differences in students’ end-of-lesson tests are proposed.
**Familiar versus new strategies.** The reading strategy used in the present study to contrast with self-explanation had a wide and consistent application with success in various subject matters (Benito et al., 1993; Kinniburgh & Shaw, 2009; McIntosh & Draper, 1995, 1996; Mesmer & Hutchins, 2002; Ouzts, 1998; Pappa & Tsaparlis, 2011; Raphael, 1982, 1986; Raphael & Au, 2005). The participating students had experience with the reading strategy, as compared to the unfamiliar concept and procedure of the self-explanation strategy that was introduced to students for the first time. Further, both groups received the same questions during the treatment period (i.e. self-explanation vs. reading questions and answers) which came after students had finished the lecture content and completed hands-on practice. The group that read questions and answers was shown the answers instantaneously alongside the questions and just needed to read passively, whereas the self-explanation group had to think about how to answer the questions and type up the answers in their own words before they were given the same answers through a popup window. The self-explanation questions guided students’ effort to formulate answers for them, although this effort was not related to test scores in this study.

There were both verbal and written comments from students during the experimental period indicating that they had not heard of the term of self-explanation before taking part in this study, supporting the notion that students had little to no exposure to self-explanation as to the reading strategy at the time the study was conducted. Thus, even if self-explanation might have helped students learn JavaScript better, the familiarity of reading might have been part of the reason that students were able to take advantage of it more readily, and therefore resulting in no difference in test performance. Learning by reading questions and answers listed on a Web page, although
not identical, is nonetheless a very comparable experience to reading printed questions and answers in a paper textbook. In other words, learning by reading from computer screen or paper does not make a significant difference in students’ reading comprehension (Tillman, 1995), supporting the contention that it is the instructional design, not the media, that mediates learning (R. C. Clark & Mayer, 2003, 2008; R. E. Clark, Yates, Early, & Moulton, 2010; Mayer, 2005a, 2005d, 2008, 2009, 2011; Moreno & Mayer, 2007).

**Difficult learning materials.** The subject of computer programming language not only has the appearance of a radical educational novelty (Dijkstra, 1989) but also is widely recognized as imposing high levels of intrinsic cognitive load on novice learners (Garner, 2002). The questions were open-type, not multiple choice items, or those that require one correct answer (Pappa & Tsaparlis, 2011). For instance, for a question that asked the learners why one cannot tell if there is JavaScript code being embedded in a Web file, there was no direct answer that learners could quote straight from the text. This item, as well as others, is a “think and search” question that learners acquire an understanding by reading through the text and formulate an answer in their own words. Based on the learners’ background knowledge of XHTML (they learned prior to participating in the current study and this tutorial included it to remediate and strengthen their understanding before JavaScript was taught) and the new information provided in the tutorial lesson, the learners were expected to derive an answer. Thus, the high level of difficulty of the target learning material as well as the open-type test items might have reduced the discriminating ability of the end-of-lesson tests.
Short experimental period. With the short experimental duration of several 50-minute class periods spanning a week, it was a challenging mission for students to master the new learning strategy of self-explanation. With a longer experimental period, students could have acquired new knowledge and skills to utilize the self-explanation approach that might have helped them learn and perform better on the tests. Research with different experimental periods may shed more light on the proper length of time required for students to learn a new learning strategy such as self-explanation.

Conclusions

The current study was the first to examine if there was difference in the effects of the two learning strategies of self-explanation and reading questions and answers on students’ learning JavaScript. The current findings contributed to the educational knowledge base and to classroom and online teaching practice with the understanding of students’ preference for self-explanation learning strategy. Students regarded it as interesting, challenging, and most importantly, affording their active participation in learning. On the other hand, some students preferred reading questions and answers over self-explanation because they benefitted more from the method that appealed better to them. Such understanding of learner characteristics will help forge future design and development of instructional materials that utilize research findings on effective teaching and learning strategies in general as well as adapt to local needs such as learner characteristics. More studies on the strategy of self-explanation with computer programming language learning in adequate lengths of experimental periods are warranted to help further ascertain the potential effect that self-explanation can offer in traditional academic subjects as well as in computer programming.
Limitations and Future Research

Positive effects of the self-explanation learning strategy have been evidenced in many academic subjects such as mathematics (Durkin, 2011), physics (Fukaya, 2011; Nokes, Hausmann, VanLehn, & Gershman, 2011), chemistry (Crippen & Earl, 2007; Hilsenbeck-Fajardo, 2010), and statistics (Hall & Vance, 2010; Leppink et al., 2012), and in a few instances of computer programming language learning studies such as those conducted by Kwon and Jonassen (2011) and Bielaczyc and her colleagues (1989 - 1995). Nonetheless, the self-explanation approach is a more difficult and novel strategy to master within the relatively short experimental period of the current study than reading questions and answers, a familiar method to students. A longer experimental period might have demonstrated different findings, warranting more studies.

The knowledge being tested in the XHTML pre-test was declarative, which might have made the pre-test a less effective covariate when the knowledge being tested in the end-of-lesson test questions was procedural. Improvement of the pre-test questions such as adding questions that examine students’ procedural knowledge could increase the effectiveness of the covariate.

The design for students to experience both learning strategies might need refinement. It started students with one strategy to learn the beginning two lessons, then switched them to the other strategy for the next two lessons, then returned them to the original strategy. An example of a modified design for a balanced learning experience could be an addition of a fourth stage of learning by going through the other strategy one more time, such as Group 1 experiencing SE → Q&A → SE → Q&A instead of the conducted procedure of SE → Q&A → SE, along with balancing the level of difficulty in
learning materials that student will experience in the four learning phases. Furthermore, adding a control group that experienced neither self-explanation nor reading questions and answers could have clarified the difference between either treatment versus no treatment. As a result of those design limitations, even though students had expressed a preference for self-explanation, it would be difficult to recommend self-explanation without reservations.

Many participating students of the current study were academically challenged. The large counts of the “obscure, incorrect or irrelevant” theme shown in both groups of students who preferred respective strategy might have been one of the reasons for the nonsignificant test performance. The current findings warrant the need for continued research on the topic of self-explanation, especially in difficult subject matters or with participants that are academically challenged. The comparison of self-explanation and other strategies is also new territory worthy of further exploration.

To help tackle the difficulties students were faced with learning the computer programming language JavaScript, the current study developed an interactive online tutorial that utilized a multimedia learning environment with the implementation of a worked examples strategy to help students learn. An online tutorial has potential to be used for online or classroom teaching. Tutoring is regarded as the “gold standard” of instructions in computer programming (Brooks, Schraw, & Crippen, 2005). The performance-related feedback generated from a computer, if followed well with the multimedia learning instruction guidelines such as the spatial and temporal contiguity principles (R. C. Clark & Mayer, 2003, 2008; Mayer, 2001, 2005a, 2008, 2009, 2011;
Mayer, DeLeeuw, & Ayres, 2007), will keep learners interested and result in efficient instruction no less than human tutors.

An appropriately designed computer-based or Web-based learning environment can simulate the effect of tutoring. Computers outperform human tutors with their effortlessly exuding endless patience (Lee, 2008). Modern technology has rendered learners the possibility to achieve an interactive effect between human and machine, like the interactions between human tutors and learners without time, place, or even people constraints in a computer-based learning environment (Royuk, 2002), as people began to treat computers as their learning partners (Reeves & Nass, 1996).

To further take learner characteristics into consideration, the pre-training principle that helps prime learners before a formal study and the signaling principle that assists in orienting the learners throughout the study (Mayer, 2001, 2005a, 2005b, 2005c, 2008, 2009, 2011) will be fully utilized. Such application will help maximize the understanding of the effect of self-explanation learning strategy even with difficult subject matters or academically challenged learners.
APPENDIX A: JAVASCRIPT TUTORIAL SURVEY

1. Regarding the duration given for each lesson:

   (i) the first lesson: **An XHTML file without JavaScript**
       
       How much time was given for this lesson? _____ minutes ,
       Is the duration _____ too short  ____ too long  ____ just right
       (circle your choice)
       
       Your suggested duration _____ minutes
       
   (ii) the second lesson: **Embedding JavaScript tags into XHTML and writing comments**
       
       How much time was given for this lesson? _____ minutes ,
       Is the duration _____ too short  ____ too long  ____ just right
       (circle your choice)
       
       Your suggested duration _____ minutes
       
   (iii) The test that covers lessons 1 and 2: (____ minutes)
       
       How much time was given for this lesson? _____ minutes ,
       Is the duration _____ too short  ____ too long  ____ just right
       (circle your choice)
       
       Your suggested duration _____ minutes
2. What problem(s) have you encountered when going through this tutorial? What would you suggest to fix them? (Use back if you have more to write)

Problem & suggested solution 1:

Problem & suggested solution 2:

3. What else would you like to suggest in order to improve this tutorial? (Use back if you have more to write)
APPENDIX B: JAVASCRIPT TUTORIAL SURVEY TALLY

(1) Experimental Group

Duration Time adequacy deemed by students:

<table>
<thead>
<tr>
<th>Duration Time deemed</th>
<th>First lesson (5 min)</th>
<th>Second Lesson (7 min)</th>
<th>Test (5 min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just right</td>
<td>10</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Too short</td>
<td>16</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Too long</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>No answer</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

(2) Control Group

Duration Time adequacy deemed by students:

<table>
<thead>
<tr>
<th>Duration Time deemed</th>
<th>First lesson (5 min)</th>
<th>Second Lesson (7 min)</th>
<th>Test (5 min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just right</td>
<td>7</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Too short</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Too long</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>No answer</td>
<td>7</td>
<td>10</td>
<td>13</td>
</tr>
</tbody>
</table>
APPENDIX C: XHTML PRE-TEST

1. (10 points) What application has our class used to create an XHTML file? (Circle the correct answer)
   a. Dreamweaver
   b. Word
   c. Excel
   d. PowerPoint
   e. Notepad

2. (10 points) What is the extension of an XHTML file?
   a. .htm or .html
   b. .doc
   c. .txt
   d. .ppt
   e. .xls

3. (10 points) The operation system automatically attaches “.txt” to a file generated in Notepad when that file is being saved. How do we ensure that the XHTML file has an extension “.htm” or “.html”? (Say the file name is Example.htm)
   a. In the field of “File name”, enter Example.htm
      In the field of “Save as type”, select All Files (*.*)
   b. In the field of “File name”, enter “Example.htm” (note the double quotations around the full file name)
      In the field of “Save as type”, either of the two selections is fine
c. Both a and b are correct

d. Neither a or b is correct

4. (10 points) What is the XHTML tag for comment?
   <![CDATA[Here goes the comment -->]]>

5. (10 points) What is the XHTML tag for paragraph? `<p>The paragraph</p>`

6. (10 points) What is the XHTML tag to make the surrounded text **bold**?
   `<b>Surrounded text</b>`

7. (10 points) What is the XHTML tag to make the surrounded text *underlined*?
   `<u>Surrounded text</u>`

8. (10 points) What is the XHTML tag to make the surrounded text *slanted*
   `<i>Surrounded text</i>`

9. (10 points) Among the 6 heading tags, `<h1>`, `<h2>`, ..., `<h6>`, which one yields the largest size?
   a. `<h1>`
   b. `<h2>`
   c. `<h3>`
   d. `<h4>`
   e. `<h5>`
f.  <h6>

10. (20 points) What are the basic tags an XHTML file has?

   Suggested answer:

   <html>
   <head>
   </head>
   <body>
   </body>
   </html>
APPENDIX D: SELF-ASSESSMENT QUESTIONNAIRE: FORM PRE*

* The Self-Assessment Questionnaire (Hong, 2001, 2004) is not to be copied or reproduced in any form without the written permission of the author.

**Directions:** The following items ask your views about computer programming. Some of them are related to computer programming in general, others are about the JavaScript course you are currently taking. Read each item and indicate how you **generally think** by circling 1, 2, 3, or 4. There are no right or wrong answers. Do not spend too much time on any one statement. (1 = Almost never, 2 = Sometimes, 3 = Often, 4 = Almost always)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Almost never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It is important for me to do well in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I concentrate fully when I work on any computer programming tasks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>The course material in this class is useful for me to learn.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Considering the difficulty of computer programming, I expect to do well in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I am interested in the content of this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I cannot concentrate when I work on computer programming.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Getting a good grade in this class is a very important thing for me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>I put forth my best effort when I learn any computer programming language.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>The content taught in this class is useful for me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>I can master computer programming skills.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>I like this class because computer language interests me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>I think I will receive a low grade in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Understanding the content of this class is important to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>I work hard to do well on all computer programming tasks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>This class provides useful sources of knowledge about computer programming.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>I think I will receive a good grade in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>I enjoy learning the content covered in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>I cannot understand programming concepts.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>It is important for me to learn the course material in this class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>As far as computer programing goes, I keep working even if it is difficult.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21</td>
<td>The programming language I am learning in this class is useful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>I can understand programming concepts.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23</td>
<td>Computer programming is interesting to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Your Name: ________________________________
### APPENDIX E: END-OF-LESSON TEST

<table>
<thead>
<tr>
<th><strong>Self-Explanation</strong></th>
<th><strong>Q &amp; As</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In this lesson, I will have you explain what you have learned. Explaining to yourself helps you remember and understand what you have learned.</td>
<td>Please read the following Q&amp;As carefully to help clarify the concepts you have learned in this lesson.</td>
</tr>
<tr>
<td>Example question: Can an XHTML file be displayed correctly if there is no JavaScript code embedded in the file?</td>
<td>Question 1: Can an XHTML file be displayed correctly if there is no JavaScript code embedded in the file?</td>
</tr>
<tr>
<td>Your answer: Yes. An XHTML file can be displayed correctly if there is no JavaScript code embedded in the file. So far I have only learned to work with XHTML files that do not have embedded JavaScript code and they are displayed correctly.</td>
<td>Answer: Yes. An XHTML file can be displayed correctly if there is no JavaScript code embedded in the file. So far you have only learned to work with XHTML files that do not have embedded JavaScript code and they are displayed correctly.</td>
</tr>
<tr>
<td>Now answer the following questions:</td>
<td>Question 2: Why is that by looking at an XHTML file's full name (name and extension, such as &quot;Webpage.htm&quot;), we cannot tell if there is JavaScript code embedded in it?</td>
</tr>
<tr>
<td>Question 1: Why is that by looking at an XHTML file's full name (name and extension, such as &quot;Webpage.htm&quot;), we cannot tell if there is JavaScript code embedded in it?</td>
<td>Answer: Because the full file name does not change regardless if there is JavaScript code embedded or not.</td>
</tr>
<tr>
<td>(Suggested answer: Because the full file name does not change regardless if there is JavaScript code embedded or not.)</td>
<td>Answer: Because the full file name does not change regardless if there is JavaScript code embedded or not.</td>
</tr>
</tbody>
</table>

Notes on the suggested answers: After students submit their self-explanation answers, a window pops up, with the title in the top blue bar, “Suggested Answer(s)” and each SE question...
and its suggested answer.

Question 2: Explain what type of file extension an XHTML file has if there is JavaScript code embedded in it?

(Suggested answer: An XHTML file still has the .htm or .html extension as before the JavaScript is embedded.)

Question 3: Explain what type of file extension an XHTML file has if there is JavaScript code embedded in it?

Answer: An XHTML file still has the .htm or .html extension as before the JavaScript is embedded.
In the box below, create an XHTML file that fits the following descriptions by using all proper tags you have learned:

1. The blue title bar of your XHTML Web page has the title: **This is where the title is.**

2. Your Web page looks like this (you can copy and paste the following content to save time):

   This is the content of my Web page. There are two paragraphs. I know how to separate words into multiple paragraphs by using a certain tag that I have learned for a while.

   This is my second paragraph of my two paragraphs. Simply hitting the return key on my keyboard to create spaces between lines in the Notepad does not make the paragraphs separate on a Web page. I have to use the correct tag to accomplish the paragraph effect.

<table>
<thead>
<tr>
<th><strong>Question 1:</strong> Recalling what we have learned with XHTML, and now with XHTML. Why is commenting necessary in the Web design?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Suggested answer: It helps keep a record of the time and programmer(s), what work has been done, and any related thoughts, such as a revolutionary idea to accomplish certain Web effect.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Question 2:</strong> Why is commenting in JavaScript different from commenting in an XHTML file? Can you give some examples?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Suggested answer: JavaScript is a programming language embedded in XHTML while XHTML is a markup language. They each have different syntax rules. So they way they comment are different. For example, in JavaScript, I can use /* This is a comment */; while in XHTML, I use &lt;!-- This is a comment --&gt;)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Question 1:</strong> Recalling what we have learned with XHTML, and now with XHTML. Why is commenting necessary in the Web design?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer: It helps keep a record of the time and programmer(s), what work has been done, and any related thoughts, such as a revolutionary idea to accomplish certain Web effect.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Question 2:</strong> Why is commenting in JavaScript different from commenting in an XHTML file? Can you give some examples?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer: JavaScript is a programming language embedded in XHTML while XHTML is a markup language. They each have different syntax rules. So they way they comment are different. For example, in JavaScript, I can use /* This is a comment */; while in XHTML, I use &lt;!-- This is a comment --&gt;)</td>
</tr>
</tbody>
</table>
In the box below, create an XHTML file that includes all JavaScript possible comment formats. Choose a suitable comment format for each of the following items:
1. the name of your school
2. description of this tutorial and this particular Web page
3. today's date
4. Which factor matters the most when you select a college? Examples such as reputation, distance from home, tuition or specialized sport(s). And then explain why that factor is important to you.

Note: Using plain XHTML to achieve the same result will NOT earn your credit. JavaScript must be used.

Table:  
<table>
<thead>
<tr>
<th>Lesson 3</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1: How do we write plain text to a Web page in an XHTML file?</strong>&lt;br&gt;(Suggested answer: Just type the text as is, how it will be displayed on a Web page, without formatting tags such as <code>&lt;b&gt;</code> to make it bold or <code>&lt;i&gt;</code> to make it Italic.)</td>
<td><strong>Question 1: How do we write plain text to a Web page in an XHTML file?</strong>&lt;br&gt;(Suggested answer: Just type the text as is, how it will be displayed on a Web page, without formatting tags such as <code>&lt;b&gt;</code> to make it bold or <code>&lt;i&gt;</code> to make it Italic.)</td>
</tr>
<tr>
<td><strong>Question 2: How do we write plain text to a Web page in JavaScript?</strong>&lt;br&gt;(Suggested answer: In JavaScript, <code>document.write(&quot;This plain text will be displayed to a Web page.\&quot;)</code> is used to write text between the quotation marks to a Web page.)</td>
<td><strong>Question 2: How do we write plain text to a Web page in JavaScript?</strong>&lt;br&gt;(Suggested answer: In JavaScript, <code>document.write(&quot;This plain text will be displayed to a Web page.\&quot;)</code> is used to write text between the quotation marks to a Web page.)</td>
</tr>
</tbody>
</table>

In the box below, create an XHTML file that writes the following text in both XHTML and JavaScript coding.

1. Using the XHTML coding, write the text to the Web page: This text is written using XHTML
2. Using the JavaScript coding, write the text to the Web page: This text is written using JavaScript (Note: Using XHTML to achieve the same result will NOT earn your credit. JavaScript must be used.)

Table:  
<table>
<thead>
<tr>
<th>Lesson 3</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1: How do we format text on a Web page by using XHTML code?</strong>&lt;br&gt;(Suggested answer: Surround the text with formatting tags. For example, <code>&lt;u&gt;Text to be formatted as bold.&lt;/u&gt;</code>)</td>
<td><strong>Question 1: How do we format text on a Web page by using XHTML code?</strong>&lt;br&gt;(Suggested answer: Surround the text with formatting tags. For example, <code>&lt;u&gt;Text to be formatted as underlined.&lt;/u&gt;</code>)</td>
</tr>
<tr>
<td><strong>Question 1: How do we format text on a Web page by using JavaScript code?</strong></td>
<td><strong>Question 1: How do we format text on a Web page by using JavaScript code?</strong></td>
</tr>
</tbody>
</table>
| Lesson 4 | Question 2: How do we format text on a Web page by using JavaScript code?  
(Suggested answer: Surround the text with formatting tags exactly as how it's done in XHTML coding, between the double quotations in the JavaScript document.write statement. For example, `document.write("<u>Text to be formatted as underlined.</u>");`) | Question 2: How do we format text on a Web page by using JavaScript code?  
Answer: Surround the text with formatting tags exactly as how it's done in XHTML coding, between the double quotations in the JavaScript document.write statement. For example, `document.write("<u>Text to be formatted as underlined.</u>");` |
|---|---|---|
| Test | In the box below, create an XHTML file that includes both of the following items: (The blank can be any function of a pair of formatting tags of your choice. For example, bold or italicized)  
(1) Using the XHTML coding, write the text to the Web page: This text is ______ by using XHTML.  
(2) Using the JavaScript coding, write the text to the Web page: This text is _____ by using JavaScript (Note: Using XHTML to achieve the same result will NOT earn your credit. JavaScript must be used.) |  |
| Lesson 5 | Question 1: How do you declare a variable?  
Suggested answer: For example, if the name of the variable is "aVariable", then the statement to declare the variable is the following:  
`var aVariable;` | Question 1: How do you declare a variable?  
Answer: For example, if the name of the variable is "aVariable", then the statement to declare the variable is the following:  
`var aVariable;` |
| Lesson 5 | Question 2: How do you assign a value to a variable?  
Suggested answer: For example, a variable "thisVariable" can be assigned a value, "aValue", by using the statement  
`thisVariable="aValue";` | Question 2: How do you assign a string value to a variable?  
Answer: For example, a variable “thisVariable” can be assigned a string value, “A string”, by using the statement  
`thisVariable="A string";` |
| Lesson 5 | Question 3: How do you write the value of a variable to the Web page  
Suggested answer: For example, a variable is called "aVariable", to write out its value to the Web page, use the statement: | Question 3: What symbol do you use to concatenate strings?  
Demonstrate an example.  
Answer: Symbol is the + sign. For example, `theCompleteString = stringA + stringB + stringC` |
| Test | In the box below, create an XHTML file that includes the JavaScript code that
|      | (1) declares three string variables,
|      | (2) one string variable is the concatenation of the other two string variables, and
<table>
<thead>
<tr>
<th></th>
<th>(3) write out the three strings onto the Web page.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>document.write(aVariable);</td>
</tr>
</tbody>
</table>
APPENDIX F: UNIVERSITY OF NEVADA, LAS VEGAS IRB APPROVAL

Social/Behavioral IRB – Expedited Review Approval Notice

NOTICE TO ALL RESEARCHERS:
Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation, suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: February 18, 2012
TO: Dr. Eunsook Hong, Educational Psychology
FROM: Office of Research Integrity - Human Subjects
RE: Notification of IRB Action
Protocol Title: The Effect of Self Explanation on Learning Computer Programming Language
Protocol #: 1201-4034
Expiration Date: February 17, 2013

This memorandum is notification that the project referenced above has been reviewed and approved by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46 and UNLV Human Research Policies and Procedures.

The protocol is approved for a period of one year and expires February 17, 2013. If the above referenced project has not been completed by this date you must request renewal by submitting a Continuing Review Request form 90 days before the expiration date.

PLEASE NOTE:
Upon approval, the research team is responsible for conducting the research as stated in the protocol most recently reviewed and approved by the IRB, which shall include using the most recently submitted Informed Consent/Assent forms and recruitment materials. The official versions of these forms are indicated by a footer which contains approval and expiration dates.

Should there be any change to the protocol, it will be necessary to submit a Modification Form through ORI - Human Subjects. No changes may be made to the existing protocol until modifications have been approved by the IRB. Modified versions of protocol materials must be used upon review and approval. Unanticipated problems, deviations to protocols, and adverse events must be reported to the ORI - HS within 10 days of occurrence.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

Office of Research Integrity - Human Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805
March 6, 2019

Nancy Lee
7492 Grassy Field C1,
Las Vegas, NV 89114

Dear Nancy,

The Research Review Committee of the Clark County School District has received your request entitled:
The Effect of Self-Exploration on Learning Computer Programming Language. We are pleased to inform you that your proposed protocol has been approved with the following provisions:

1. Participation is voluntary and can be withdrawn at any time.
2. Provide a letter of acceptance from principals who agree to be involved with the study.

This research protocol is approved for a period of two years from the approval date. The expiration of this protocol is March 6, 2019. If any of the human subjects described in the referenced protocol will be used beyond the expiration date, you must provide a letter requesting an extension to the protocol prior to the date of expiration. The letter must indicate whether there will be any modifications to the original protocol. If there is any change to the protocol, it will be necessary to request additional approval for such change(s) in writing to the Research Review Committee.

Please provide a copy of your research findings to this office upon completion. We look forward to the results. If you have any questions or require assistance please do not hesitate to contact Brett Campbell at 888-7792 or email us at Research@CCSD.NV.gov.

Sincerely,

John N. Carpenter, Ph.D.
Coordinator, CIV
Chair, Research Review Committee

cc:
- Brett Campbell
  - Nelly Roberts - SUPPORT
  - Eric Johnson - SPONSOR
  - Paolo Minotto
  - Research Review Committee

March Office: 5445 W. Sahara Avenue, Las Vegas, Nevada 89146. Telephone (702) 709-3000

147
APPENDIX H: FACILITY AUTHORIZATION LETTER

Western High School

Letter of Acknowledgement of a Research Project at a CCSD Facility

Office of Research Integrity – Human Subjects
University of Nevada, Las Vegas
4505 S. Maryland Parkway, Box 45447
Las Vegas, NV 89154-4473

*Subject:* Letter of Acknowledgement of a Research Project at a CCSD Facility

*Dear ORI – Human Subjects:*

This letter will acknowledge that I have reviewed a request by Ms. Nancy Lee to conduct a research project entitled, "Efficacy Study of JavaScript Learning Methods," at Western High School.

When the research project has received approval from the UNLV Institutional Review Board and the Department of Research of the Clark County School District, and upon presentation of the approved letter to me by the approved researcher, as site administrator for Western High School, I agree to allow access for the approved research project.

If we have any concerns or need additional information, the project researcher will be contacted or we will contact the UNLV Office of Research Integrity – Human Subjects at 845-2784.

Sincerely,

[Signature]

[Signature]

[Signature]

[Date]

[Signature]

[Signature]

[Signature]

[Date]

[Signature]

[Signature]

[Date]
APPENDIX I: YOUTH ASSENT FORM

UNLV
UNIVERSITY OF NEVADA-LAS VEGAS

ASSENT TO PARTICIPATE IN RESEARCH

TITLE OF STUDY: The Effect of Self Explanation on Learning Computer Programming Language

1. I am your Computer teacher Ms. Nancy Lee at Western High School.

2. We are asking you to take part in a research study because we are trying to learn ways we can help students learn computer language better.

3. If you agree to be in this study, we will collect and analyze your class assessment data. Your grades in this course or other information such as attendance or test scores will not be used in the research.

4. Although there are risks involved in research studies, we do not expect risks in this research.

5. If you agree to let us use your assessment data, then you might help us learn if the methods used in the tutorial promote learning in students.

6. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say “yes” you can still decide not to do this.

7. If you agree, your name will not be attached to the database; only group information will be reported. A 5% bonus credit will be given for the data allowed in this study. You can earn an alternative equivalent credit by working on a project agreed upon beforehand by you and me. If you don’t want to be in this study, you don’t have to participate. You will still learn JavaScript, but if you decided not to participate, your information will not be included in the study. Remember, being in this study is up to you and no one will be upset if you don’t want to participate. If you decide that you don’t want to participate in the study, it will not affect how I, or the school treats you.

8. You can ask any questions that you have about the study. If you have a question later that you didn’t think of now, you can email me at nleel@interact.com.net or ask me during our daily class meetings. If I have not answered your questions or you do not feel comfortable talking to me about your question, you or your parent can call the UNLV Office of Research Integrity – Human Subjects at 702-895-2794 or toll free at 877-895-2794.

9. Signing your name at the bottom means that you agree to be in this study. You and your parents will be given a copy of this form after you have signed it.

_____________________________    ____________________________
Signature of Participant                        Date

Participant Name (Please Print)

Approved by the UNLV IRB Protocol 1302-4014
Received: 01-16-12  Approved: 09-18-12  Expiration: 09-17-13

149
APPENDIX J: PARENT PERMISSION FORM

TITLE OF STUDY: The Effect of Self Explanation on Learning Computer Programming Language
Nevada Las Vegas for 3 years after completion of the study. After the storage time the information gathered will be shredded.

Contact Information
If you have any questions or concerns about the study, you may contact Ms. Nancy Lee at nieel@interact.cscd.net (702 799-4080) or Dr. Eunsook Hong at eunsook.hong@unlv.edu (702 895-3346). For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794 or toll free at 877-895-2794 or via email at IRB@unlv.edu.

Voluntary Participation
Your child’s participation in this study is voluntary. Your child may refuse to participate in this study even if you agree. If you decide that your child cannot participate in the study, it will not affect how the teacher or the school treats them. You are encouraged to ask questions about this study at any time during the research study.

Participant Consent:
I have read the above information and agree that my child may participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

__________________________________________  __________________________
Signature of Parent                                       Date

__________________________________________
Parent Name (Please Print)

Approved by the UNLV IRB Protocol 1303-4654
Received: 02-16-12  Approved: 02-19-12  Expiration: 02-17-13
APPENDIX K: INFORMED CONSENT FORM

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

STUDENT INFORMED CONSENT
Department of Educational Research, Cognition, & Development

TITLE OF STUDY: The Effect of Self-Explanation on Learning Computer Programming Language

INVESTIGATOR(S): Dr. Eunsook Hong, Nancy Lee

CONTACT PHONE NUMBER: Dr. Eunsook Hong (702) 895-3246, Nancy Lee (702) 799-4080

Purpose of the Study:
You are invited to participate in a research study. The purpose of this study is to learn the effect of self-explanation on learning computer programming language.

Participants:
You are being asked to participate in the study because you are in the Computer Applications course and have acquired basic Web design knowledge to be advanced to learn JavaScript.

Procedures:
If you volunteer to participate in this study, your class assessment data will be collected and analyzed.

Benefits of Participation:
Your participation may help us learn if the methods used in the tutorial promote learning in students.

Risks of Participation:
There are risks involved in all research studies. However, we do not expect risks in this research.

Cost/Compensation:
There will not be financial cost to you to participate in this study. A 3% bonus credit will be given for the data allowed in this study. Students can earn an alternative equivalent credit by working on a project agreed upon beforehand by both the student and the instructor.

Confidentiality:
All information gathered in this study will be kept confidential. No reference will be made in written or oral materials that could link you to this study. The information collected in this research study will be analyzed and reported in group form only. Your information will not be reported on an individual basis or tied to you or your name in any way. By agreeing to have your information included in this study, your grade will not be affected either positively or negatively. All records will be stored in a locked facility at the University of Nevada Las Vegas for 3 years after completion of the study. After the storage time the information gathered will be shredded.

Participant Initials ______

Approved by the UNLV IRB, Protocol 1301-4031
Received: 07-16-11 Approved: 07-18-12 Expiration: 07-17-13

1 of 2
## Questionnaire Answers and Reasons

(A=Answer, 1= Self-explanation; 0= Q&As)

<table>
<thead>
<tr>
<th>ID</th>
<th>P</th>
<th>item 1 Reason</th>
<th>item 2 Reason</th>
<th>item 3 Reason</th>
<th>item 4 Reason</th>
<th>item 5 Reason</th>
<th>item 6 Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Because I understand better when someone is telling me what to do.</td>
<td>Because I like the answers given to me.</td>
<td>Because I had already known what to do.</td>
<td>Because someone gives questions and in those questions will be codes.</td>
<td>Because it will show it while going over it.</td>
<td>Because questions help me better.</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>Helps me think more</td>
<td>I can read and think better</td>
<td>I could eliminate answers</td>
<td>I visualize it better</td>
<td>I can ask for help when I need it</td>
<td>I think to myself</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>The way it helped me understand is because the example and display examples help me then I try.</td>
<td>It was something new.</td>
<td>None of the methods because I don't know how.</td>
<td>Because it was very little to understand the correctness.</td>
<td></td>
<td>Because you could copy and paste your</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Self-explanation because I have no clue what Q&amp;As</td>
<td>Don't know what that means</td>
<td>I don't think that I can write a JavaScript with this but I can try.</td>
<td></td>
<td></td>
<td>Am not sure which one. May help me learn the JavaScript</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>Q&amp;As helped reiterate what I already learned and tested me on the depth of my JavaScript knowledge</td>
<td>Self-explanation gave more coherent examples and it helped to see it already written out</td>
<td>Q&amp;As tested me on the paramount information and after doing these I felt comfortable in writing JavaScript codes</td>
<td>Self-explanation actually gave me a visual of how JavaScript code would look in the Web page.</td>
<td>When I copied everything the first screen read I noticed that the slightest mistake can dramatically alter the code</td>
<td>Although self-explanation was extremely helpful the Q&amp;As made me reassured that I knew how to write JavaScript code. The Q&amp;A's tested my immediate wit.</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>It gives more information to understand.</td>
<td>So you can see if you got it wrong.</td>
<td>based on what I missed, I am able to have the right answers.</td>
<td>More information.</td>
<td>Helps you understand more the lesson.</td>
<td>Gives more info.</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>0</td>
<td>I like things to be done before I do them</td>
<td>1</td>
<td>So I can know what I will be doing.</td>
<td>0</td>
<td>It's way much easier for me to do because it's done for you already.</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
<td>It was telling me more details.</td>
<td>0</td>
<td>I understand it better</td>
<td>1</td>
<td>Doing it yourself is better than just reading</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>1</td>
<td>Self-explanation is a domain general constructive activity</td>
<td>1</td>
<td>detected by asking students to speak aloud as they study and counting.</td>
<td>1</td>
<td>how students study and use examples in learning.</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>1</td>
<td>Because it helps me get a better explanation on how to do it</td>
<td>1</td>
<td>If I read the method I think I can get it myself instead of Q&amp;As</td>
<td>0</td>
<td>Because it shows me examples which helps me understand the exercise</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>0</td>
<td>Well I think what helped me was the QAs.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>0</td>
<td>Helps me think more</td>
<td>0</td>
<td>I can read and think better</td>
<td>0</td>
<td>I could eliminate answers</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>1</td>
<td>Because it's easier to understand</td>
<td>1</td>
<td>Because it told me better on how to develop my Web page</td>
<td>1</td>
<td>Because it gave me a recap on what is needed to complete</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>0</td>
<td>Because that helped me understand what they were asking and what they were meaning.</td>
<td>1</td>
<td>Because Web development is hard for me and with self-explanation helps me understand it a lot.</td>
<td>0</td>
<td>Because it gives you like an example of how to do it.</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>1</td>
<td>Because you understand it better</td>
<td>1</td>
<td>you understand better</td>
<td>1</td>
<td>because it's self-explanatory</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>1</td>
<td>Because the way I learn is very unique. I learn by looking at examples, not the other way around.</td>
<td>0</td>
<td>Because it gave lessons and how-to's on how to do it, and why it was important</td>
<td>1</td>
<td>Because everything flows much better with the Self-explanation</td>
</tr>
<tr>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>0</td>
<td>Well if I do it and it shows me how to really do it, it helps me understand something.</td>
<td>1</td>
<td>It showed me the difference of a regular Web page and a JavaScript one.</td>
<td>0</td>
<td>It showed me the right way to insert things to it.</td>
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<tr>
<td>27</td>
<td>1</td>
<td>0</td>
<td>Because it explain you the answer and question</td>
<td>1</td>
<td>Well, I pick self-explanation, because it helps you learn by doing it yourself.</td>
<td>0</td>
<td>Well not really because, I really didn't know how to do it.</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>1</td>
<td>Self-explanation helps me understand JavaScript concepts better because Q&amp;A I don't know answers to.</td>
<td>0</td>
<td>Because Self-explanation is easier to learn from. While Q&amp;A expects you to know the answers.</td>
<td>1</td>
<td>Because you can see what JavaScript will do to your Web page when displayed</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>1</td>
<td>Because it was self-explanatory.</td>
<td>0</td>
<td>Because the question and answer was helpful.</td>
<td>1</td>
<td>Because it made it look easier.</td>
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<tr>
<td>30</td>
<td>1</td>
<td>0</td>
<td>Cause well I understand it better :) It helped me understand it</td>
<td>1</td>
<td>Well it gives me a better understanding</td>
<td>0</td>
<td>It is necessary</td>
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<td>31</td>
<td>1</td>
<td>1</td>
<td>Tell me what I needed to know</td>
<td>0</td>
<td>Tell what should learn</td>
<td>0</td>
<td>Tell you everything what you need for JavaScript</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>1</td>
<td>Because, it gives me a better explanation on how to do it</td>
<td>1</td>
<td>If I explain it to myself in my own words, I will learn faster</td>
<td>1</td>
<td>If I read it to myself &amp; then re-read it &amp; translate it in a way that I will understand &amp; then think about it, I will get it.</td>
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<tr>
<td>33</td>
<td>1</td>
<td>0</td>
<td>None of these methods helped me but the Q&amp;As method helped me a little.</td>
<td>1</td>
<td>None, I still don't know how to write JavaScript code.</td>
<td>1</td>
<td>None of these methods.</td>
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<tr>
<td>34</td>
<td>1</td>
<td>0</td>
<td>There is more information.</td>
<td>0</td>
<td>Because it helps some steps we forgot</td>
<td>0</td>
<td>0</td>
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<tr>
<td>35</td>
<td>1</td>
<td>0</td>
<td>Well I think what helped me was the Q&amp;As because when I don't know the answer, it shows and I learn it.</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
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<tr>
<td>36</td>
<td>1</td>
<td>0</td>
<td>Some people can't remember the material and therefore cannot answer questions (Some answer for all).</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>37</td>
<td>1</td>
<td>1</td>
<td>I can't really describe it, it's like I know how to work with it. At least I believe so.</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>38</td>
<td>2</td>
<td>1</td>
<td>Self-explanation, was a better method of learning and understanding JavaScript because being able to learn on our own by answering questions lets us understand the concepts more comfortably.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>39</td>
<td>2</td>
<td>0</td>
<td>Questions and answers were better because it ask you what have you learned or what code to use</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>40</td>
<td>2</td>
<td>0</td>
<td>This is easier because you can get exact information with the right question.</td>
<td>same as # 1</td>
<td>same as # 1 and # 2</td>
<td>same as # 1, # 2 and # 3</td>
<td>same as # 1, # 2, # 3, # 4 and # 5</td>
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<tr>
<td>42</td>
<td>2</td>
<td>1</td>
<td>I say self-explanation because it is way easier to follow along than to just read Q&amp;As</td>
<td>0</td>
<td>Q&amp;A because I read more clearly in what to do</td>
<td>1</td>
<td>Self-explanation because it had examples.</td>
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<tr>
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<tr>
<td>44</td>
<td>2</td>
<td>1</td>
<td>It makes it change</td>
<td>1</td>
<td>maybe not</td>
<td>1</td>
<td></td>
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<tr>
<td>45</td>
<td>2</td>
<td>0</td>
<td>It was better for me because I am a question and answer type of person</td>
<td>x</td>
<td>I would have to say neither of those helped.</td>
<td>0</td>
<td>It was more direct.</td>
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<tr>
<td>46</td>
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<td>0</td>
<td>If I didn't understand it, I got some more detail.</td>
<td>0</td>
<td>The Q&amp;As explained a little more detail than I could do myself.</td>
<td>0</td>
<td>I knew more about it than if I explained it myself.</td>
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<tr>
<td>47</td>
<td>2</td>
<td>0</td>
<td>Reading questions and then reading the answer helps me the most because it's logical</td>
<td>0</td>
<td>Reading the question then the answer is better</td>
<td>1</td>
<td>Self-explanation gave me more answers.</td>
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<tr>
<td>48</td>
<td>2</td>
<td>1</td>
<td>It was easier.</td>
<td>0</td>
<td>It helped me learn the codes.</td>
<td>0</td>
<td>It helped me a lot.</td>
</tr>
<tr>
<td>49</td>
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<td>1</td>
<td>Because it explains more of JavaScript</td>
<td>0</td>
<td>Because shows us questions and answers so it's easier to understand</td>
<td>1</td>
<td>Because JavaScript is easier with self-explanation</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>1</td>
<td>It showed me the differences between them.</td>
<td>1</td>
<td>It took me a while but I'd say lesson 4.</td>
<td>1</td>
<td>I was able to remember them.</td>
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<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>56</td>
<td>2</td>
<td>1</td>
<td>I always learn better like that</td>
<td>0</td>
<td>Learning on my own is the best way.</td>
<td>0</td>
<td></td>
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<tr>
<td>57</td>
<td>2</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>58</td>
<td>2</td>
<td>0</td>
<td>because you would be able to understand why that's the answer</td>
<td>0</td>
<td>same thing it would be easier to understand why the answer it is</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>2</td>
<td>0</td>
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</tr>
</tbody>
</table>

None of the above. I could have learned JavaScript better with a JavaScript for dummies book.

More detail was explained.

Self-explanation is better

They both did but I think the self-explanation was better.

Both because it would have question and answer then I could want to do it on my own and get it right.
<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
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</tr>
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<tr>
<td>60</td>
<td>2</td>
<td>1</td>
<td>Self-explanation works best for me</td>
<td>1</td>
<td>Self-explanation works best for me</td>
<td>1</td>
<td>Self-explanation works best for me</td>
<td>1</td>
<td>Self-explanation works best for me</td>
</tr>
<tr>
<td>62</td>
<td>2</td>
<td>1</td>
<td>Because its more based on how you understand it</td>
<td>1</td>
<td>Because they asked you a question first</td>
<td>1</td>
<td>Because it would be based on what was learned and I could try it.</td>
<td>1</td>
<td>Because it was a lot easier</td>
</tr>
<tr>
<td>64</td>
<td>2</td>
<td>1</td>
<td>Because it's more based on how you understand it</td>
<td>1</td>
<td>Because they asked you a question first</td>
<td>1</td>
<td>Because it would be based on what was learned and I could try it.</td>
<td>0</td>
<td>Easier to understand</td>
</tr>
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<td>3</td>
<td>1</td>
<td>Because it's more based on how you understand it</td>
<td>1</td>
<td>Because they asked you a question first</td>
<td>1</td>
<td>Because it would be based on what was learned and I could try it.</td>
<td>1</td>
<td>Because it was a lot easier</td>
</tr>
<tr>
<td>68</td>
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<td>Because it's more based on how you understand it</td>
<td>1</td>
<td>Because they asked you a question first</td>
<td>1</td>
<td>Because it would be based on what was learned and I could try it.</td>
<td>1</td>
<td>Because it was a lot easier</td>
</tr>
<tr>
<td>69</td>
<td>3</td>
<td>1</td>
<td>Because it's more based on how you understand it</td>
<td>1</td>
<td>Because they asked you a question first</td>
<td>1</td>
<td>Because it would be based on what was learned and I could try it.</td>
<td>1</td>
<td>Because it was a lot easier</td>
</tr>
<tr>
<td>70</td>
<td>3</td>
<td>0</td>
<td>It was easier for me than typing the answers</td>
<td>0</td>
<td>The questions made sense to me.</td>
<td>0</td>
<td>They display it better.</td>
<td>0</td>
<td>Overall, I liked this method better.</td>
</tr>
<tr>
<td>71</td>
<td>3</td>
<td>1</td>
<td>I understand better</td>
<td>1</td>
<td>Because I got to try it before then doing work</td>
<td>1</td>
<td>It let me try first and challenge myself</td>
<td>1</td>
<td>I understand JavaScript better now!</td>
</tr>
<tr>
<td>72</td>
<td>3</td>
<td>0</td>
<td>It was easier for me than typing the answers</td>
<td>0</td>
<td>The questions made sense to me.</td>
<td>0</td>
<td>They display it better.</td>
<td>0</td>
<td>Overall, I liked this method better.</td>
</tr>
<tr>
<td>75</td>
<td>3</td>
<td>1</td>
<td>I read the questions and answers in a way I understand. It's a bit different from the Q&amp;As for it helps too but sometimes I don't understand.</td>
<td>1</td>
<td>It gives you ways to do it and also helps you.</td>
<td>1</td>
<td>It gives you more information.</td>
<td>0</td>
<td>Overall, I liked this method better.</td>
</tr>
<tr>
<td>77</td>
<td>3</td>
<td>1</td>
<td>I read the questions and answers in a way I understand. It's a bit different from the Q&amp;As for it helps too but sometimes I don't understand.</td>
<td>1</td>
<td>The reason you give help but it's best I put it in my own words.</td>
<td>0</td>
<td>I see the questions and answers and the thing to put in JavaScript.</td>
<td>0</td>
<td>Overall, I liked this method better.</td>
</tr>
<tr>
<td>78</td>
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<td>1</td>
<td>You see what it's talking about</td>
<td>1</td>
<td>Something you can see what it talking about.</td>
<td>0</td>
<td>Because in the next Q it sometimes shows the code</td>
<td>1</td>
<td>Mine for I can tell from my own wording that I understand more.</td>
</tr>
<tr>
<td>79</td>
<td>3</td>
<td>1</td>
<td>Self-explanation helped me understand JavaScript</td>
<td>0</td>
<td>Q&amp;As because it talks about utilizing.</td>
<td>0</td>
<td>A because it told me what to do</td>
<td>1</td>
<td>Some script can be written</td>
</tr>
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<td>80</td>
<td>3</td>
<td>1</td>
<td>Self-explanation helped me understand JavaScript</td>
<td>0</td>
<td>Q&amp;As because it talks about utilizing.</td>
<td>0</td>
<td>A because it told me what to do</td>
<td>1</td>
<td>Some script can be written</td>
</tr>
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<td>You see what it is detailing about.</td>
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<td>Something you can see talking in explaining about.</td>
<td>1</td>
<td>Some script can be written</td>
<td>1</td>
<td>A because it gives a better understanding</td>
</tr>
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<td>82</td>
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<td>1</td>
<td>Something you can see talking in explaining about.</td>
<td>1</td>
<td>Some script can be written</td>
<td>1</td>
<td>A because it gives a better understanding</td>
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<td>You see what it is detailing about.</td>
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<td>Something you can see talking in explaining about.</td>
<td>1</td>
<td>Some script can be written</td>
<td>1</td>
<td>A because it gives a better understanding</td>
</tr>
</tbody>
</table>

**Overall:** I liked this method better.
It was better for me to read what I need to be doing that to have it self-explained. Because self-explanation works better for me, it's like I am telling myself what I already know. It gave me an idea of what I needed to do. Because the questions already gave me an explanation of what I needed to do.

Because self-explanation works better for me, it's like I am telling myself what I already know. It gave me an idea of what I needed to do. Because the questions already gave me an explanation of what I needed to do.

Because self-explanation works better for me, it's like I am telling myself what I already know. It gave me an idea of what I needed to do. Because the questions already gave me an explanation of what I needed to do.
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<td>115</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
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</tr>
<tr>
<td>116</td>
<td>4</td>
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<tr>
<td>117</td>
<td>4</td>
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<tr>
<td>118</td>
<td>4</td>
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</tr>
<tr>
<td>120</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>JavaScript</td>
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<td>---</td>
</tr>
<tr>
<td>121</td>
<td>4</td>
<td>0</td>
<td>a, because it was more easy</td>
<td>0</td>
<td>Neither, they were both difficult</td>
<td>1</td>
</tr>
<tr>
<td>122</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>123</td>
<td>4</td>
<td>1</td>
<td>Because when I asked a question I wasn't getting my question answered.</td>
<td>1</td>
<td>Don't want to explain why.</td>
<td>1</td>
</tr>
<tr>
<td>124</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>125</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>126</td>
<td>4</td>
<td>1</td>
<td>It made me think harder about the information from the lessons.</td>
<td>1</td>
<td>When the suggested answers came up, it showed me that if I would have used something else, I would not get the same result.</td>
<td>1</td>
</tr>
<tr>
<td>127</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>128</td>
<td>4</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>129</td>
<td>4</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>130</td>
<td>4</td>
<td>1</td>
<td>Neither, I like visuals</td>
<td>1</td>
<td>Neither helped</td>
<td>1</td>
</tr>
<tr>
<td>131</td>
<td>4</td>
<td>1</td>
<td>I don't really care what to say</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>132</td>
<td>4</td>
<td>1</td>
<td>It helped me remember some of the JavaScript concept by using self-explanation</td>
<td>1</td>
<td>Both because when you were explaining I didn't understand until I saw the question and answer.</td>
<td>0</td>
</tr>
<tr>
<td>133</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>133</td>
<td>4</td>
<td>0</td>
<td>Cause it's just questions and answers</td>
<td>0</td>
<td>Cause it's Q&amp;As</td>
<td>1</td>
</tr>
<tr>
<td>-----</td>
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<td>---------------------------------------</td>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>136</td>
<td>5</td>
<td>0</td>
<td>I liked Q&amp;A because it is easier than all the codes.</td>
<td>0</td>
<td>It showed it full on and made much more sense to me.</td>
<td>1</td>
</tr>
<tr>
<td>137</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>5</td>
<td>0</td>
<td>I know how to learn by reading it.</td>
<td>0</td>
<td>It helps me understand better.</td>
<td>0</td>
</tr>
<tr>
<td>139</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>5</td>
<td>1</td>
<td>Self-explanation because learned better like that</td>
<td>0</td>
<td>Q&amp;As because it had the answer there for you already.</td>
<td>0</td>
</tr>
<tr>
<td>141</td>
<td>5</td>
<td>1</td>
<td>Because I can understand a lot better</td>
<td>0</td>
<td>Because it is easier to understand</td>
<td>1</td>
</tr>
<tr>
<td>142</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>143</td>
<td>5</td>
<td>1</td>
<td></td>
<td>0</td>
<td>1</td>
<td>Because what it said write your own, it seems right of self-explanation</td>
</tr>
<tr>
<td>145</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>146</td>
<td>5</td>
<td>1</td>
<td>because I can learn and understand better.</td>
<td>0</td>
<td>because is more easy</td>
<td>1</td>
</tr>
<tr>
<td>147</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>5</td>
<td>1</td>
<td>Because that's what</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>149</td>
<td>5</td>
<td>0</td>
<td>Since it describes JavaScript better than self-explanation</td>
<td>0</td>
<td>It made you understand better.</td>
<td>0</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>151</td>
<td>5</td>
<td>1</td>
<td>I learned the JavaScript codes by myself and I figured out how to do it in the JavaScript codes.</td>
<td>1</td>
<td>My self-explanation helped me better understand the importance of utilizing JavaScript for Web development.</td>
<td>0</td>
</tr>
<tr>
<td>153</td>
<td>5</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>154</td>
<td>5</td>
<td>0</td>
<td>it was easier</td>
<td>0</td>
<td>it was easier</td>
<td>0</td>
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<td>-----</td>
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<td>155</td>
<td>5</td>
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<td>156</td>
<td>5</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>158</td>
<td>5</td>
<td>1</td>
<td>It made me have to understand it enough to be able to explain it.</td>
<td>0</td>
<td>I could just use the proper codes to answer the question easily.</td>
<td>0</td>
</tr>
<tr>
<td>159</td>
<td>5</td>
<td>0</td>
<td>It was easier to understand</td>
<td>0</td>
<td>It helps me answer the question faster,</td>
<td>1</td>
</tr>
<tr>
<td>160</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>161</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>162</td>
<td>5</td>
<td>0</td>
<td>Because even if I didn't know the right answer, the right answer was provided.</td>
<td>0</td>
<td>Most of the questions were questions I had myself.</td>
<td>0</td>
</tr>
<tr>
<td>163</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>164</td>
<td>5</td>
<td>1</td>
<td>I believe that's better because it lets you express your knowledge.</td>
<td>0</td>
<td>Q&amp;As because I know what's being asked, and I won't forget to include anything like in self-explanation.</td>
<td>1</td>
</tr>
<tr>
<td>165</td>
<td>5</td>
<td>0</td>
<td>I understand better this way</td>
<td>0</td>
<td>I learn better this way</td>
<td>0</td>
</tr>
<tr>
<td>168</td>
<td>5</td>
<td>1</td>
<td>Because I don't understand JavaScript at all. I don't think the two top answers will be right.</td>
<td>1</td>
<td>I don't know the importance of JavaScript.</td>
<td>1</td>
</tr>
<tr>
<td>169</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>170</td>
<td>7</td>
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</tr>
<tr>
<td>176</td>
<td>7</td>
<td>1</td>
<td>Because if I explain it to myself it helps me understand it better.</td>
<td>0</td>
<td>Because I kept looking back at it at the question then answering it.</td>
<td>1</td>
</tr>
<tr>
<td>178</td>
<td>7</td>
<td>1</td>
<td>If I check it and explain it well, to myself then I understand it better.</td>
<td>0</td>
<td>Keep checking back and forth and I got it.</td>
<td>1</td>
</tr>
<tr>
<td>179</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>7</td>
<td>1</td>
<td>Self-explanation because you can explain it on how you learned it.</td>
<td>0</td>
<td>Because when it asked me questions it reminded me of what the topic was about and what to do.</td>
<td>1</td>
</tr>
<tr>
<td>181</td>
<td>7</td>
<td>0</td>
<td>It's easier just to follow directions &amp; have common questions answered.</td>
<td>0</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>182</td>
<td>7</td>
<td>1</td>
<td>I understand it better.</td>
<td>0</td>
<td>It shows me.</td>
<td>1</td>
</tr>
<tr>
<td>184</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>185</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>186</td>
<td>7</td>
<td>0</td>
<td>Because I will be able to study the questions and the answers.</td>
<td>1</td>
<td>Because I will be able to ask myself how it helped me.</td>
<td>1</td>
</tr>
<tr>
<td>187</td>
<td>7</td>
<td>0</td>
<td>Because it shows me how to do it.</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>188</td>
<td>7</td>
<td>0</td>
<td>helps me remember more.</td>
<td>0</td>
<td>helps me remember more.</td>
<td>0</td>
</tr>
<tr>
<td>189</td>
<td>7</td>
<td>0</td>
<td>Because I can read the question and try to answer then I check if I got it right.</td>
<td>0</td>
<td>Because it explain how to use it in an easy way.</td>
<td>1</td>
</tr>
<tr>
<td>190</td>
<td>7</td>
<td>0</td>
<td>Because it helps you understand what's going on.</td>
<td>0</td>
<td>Because there is a lot of information to cover.</td>
<td>1</td>
</tr>
<tr>
<td>191</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>7</td>
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<td>195</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>7</td>
<td>1 Because I could ask questions.</td>
<td>0 Because I could understand it.</td>
<td>0 Because I could understand it.</td>
<td>1 Because she could tell me how to do it.</td>
<td>0 Because I can read it and answer it.</td>
</tr>
<tr>
<td>197</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>198</td>
<td>7</td>
<td>1 Self-explanation because when information was given, I could read it and know what I am doing.</td>
<td>1 I will be able to ask myself for help.</td>
<td>1 I visualize what's going on.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>199</td>
<td>7</td>
<td>1 Because I could ask questions.</td>
<td>0 Because I could understand it.</td>
<td>0 Because I could understand it.</td>
<td>1 Because she could tell me how to do it.</td>
<td>0 Because I can read it and answer it.</td>
</tr>
<tr>
<td>200</td>
<td>7</td>
<td>1 Cause when people explain it to me, I got it down way better.</td>
<td>0 I dunno, just did seem to help me better.</td>
<td>1 Really, never. I never thought that I would be able to write my own code, but now I can.</td>
<td>0 I really don't have a reason.</td>
<td>1 Both helped me really the same.</td>
</tr>
<tr>
<td>201</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>202</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>204</td>
<td>7</td>
<td>1 because I learn better with explanation</td>
<td>1 I understand better with my own explanation</td>
<td>1 I understand better with explanation</td>
<td>1 This way I understand it better.</td>
<td>1 I understand this better with explanation.</td>
</tr>
</tbody>
</table>

---

Because I could ask questions.
Because I could understand it.
Because she could tell me how to do it.
Because I can read it and answer it.
Because I could read it and understand it.
Self-explanation because when information was given, I could read it and know what I am doing.
I will be able to ask myself for help.
I visualize what's going on.
Because she could tell me how to do it.
Because I can read it and answer it.
Both answers helped me out a lot.
Because I learn better with explanation.
I understand better with my own explanation.
This way I understand it better.
I understand this better with explanation.
Explanation is more helpful to understand.
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Tillman, G. (1995). Will Implementing Reading Computer Assisted Instruction Compared to Traditional Reading Instruction Produce More Effective Comprehension at the Elementary School Level?


CURRICULUM VITAE

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Las Vegas, NV 89131
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Email: nancylee999@gmail.com

EDUCATIONAL HISTORY

2013  (Anticipated) Ph.D. Learning & Technology, University of Nevada Las Vegas.
        Advisor: Dr. Eunsook Hong.

1987  M.S., Civil/Structural Engineering, University of California, Los Angeles

1986  B.S., Civil/Structural Engineering, National Taiwan University, Taipei, Taiwan

Illustrated Computer Courses Taken:

2010  Cisco Academy Certified Instructor, Internetworking Discovery, IT Essentials

2005  Artificial Intelligence, Computer Science, UNLV

2000  Microsoft Certified System Engineer: Southern California Institute of Technology

2000  Visual Basic: Southern California Institute of Technology

2000  Windows2000: Southern California Institute of Technology

1999  AutoCAD: Irvine Valley College

1991  C++ & Advanced Data Structures (Pascal): El Camino College

CERTIFICATIONS

2010  Cisco Academy Certified Instructor (Internetworking Discovery, IT Essentials)

2005  MCSD.NET (Microsoft Certified Solution Developer, MCAD.net + VB. NET
        Web + .NET solution architecture)
2005  MCAD .NET (Microsoft Certified Application Developer, VB. NET windows, SQL, XML)


2000  MCP (Microsoft Certified Professional)

2001  A+ Computer Technician (2 certificates: Hardware, Software)

1996  CBEST (California Basic Educational Skills Test Certificate)

LICENSES

Professional Civil Engineer, California, Certificate No. C 50979, since 1993

EIT, California, Certificate No. XEO74567, since 1991

Nevada State Licensed Teacher, No. 83122, since 2008

ILLUSTRATED HONORS AND AWARDS

First Place National Treatise Contest Winner, 1979

First Place Mathematics Competition Winner, 1978

First Place Speed Reading Contest Winner, 1975

First Place Speech Contest Winner, 1973

PROFESSIONAL HISTORY

Teaching Experience

2008 – present  Computer Science Instructor
Advanced Technologies Academy
2002 – 2008
Computer Science Instructor, College of Southern Nevada

2000 – 2002
Instructor at the following organizations: Computer Learning Centers, ITT Technical Institute, Computer Education Institute, US Technical Institute. Taught Java, C++, Visual Basic, SQL, HTML, XHTML, JavaScript, MCSE, Networking, A+, etc.

1996 - 1999
Instructor, Irvine First Baptist Church Chinese School, CA
Taught Chinese reading and writing to Chinese immigrants’ children and community residents interested in learning Chinese language and culture.

Professional Engineer Experience

1987 – 2000
12 years of Engineer/Project Management experience:
STARDYNE Corporation, Bechtel Corporation, Northridge Earthquake Retrofitting Project, High Point Inc., KTI Corporation, Madison Industries

Bechtel Corporation: Added new features to the Bechtel in house program BSAP. Individually developed Bechtel Continuous Improvement Award-winning Structural & Plant Design Departments interface program. Designed spread footings, sleepers, caissons, retaining walls, supports for conduits, heat exchangers, pumps, etc.

STARDYNE Corporation: Enhanced STARDYNE finite element analysis program by adding improved graphics, solid modeling & increased plotting speed; individually developed STARDYNE’s new product AutoCAD interface. Languages used: FORTRAN, C, and C++
PUBLICATIONS


PRESENTATIONS


Lee, N. (2005). *Your Best practices When it Comes to Distance Education*. Session Chair for Nevada Online Education Consortium Annual Conference.


**JOURNAL ARTICLE REVIEWER**

The Online Journal of Distance Learning Administration
Editorial Board
Spring 2010 - Volume 13 Issue 1

American Educational Research Association Division C: Learning and Instruction
Section 5: Learning Environments
Theme: “Education Research in the Public Interest”
September 2005

Section 7: Technology Research
Theme: “The World of Educational Quality”
September 2006

**BOOK REVIEWER**

*Go! XHTML*
Published by Prentice Hall
2005 – 2006

**GRANT APPLICATION REVIEWER**

Minority Science and Engineering Improvement Program (MSEIP)
Awarded by U.S. Department of Education
June 2008

**COMMITTEES SERVED**

Sabbatical Leave Committee, College of Southern Nevada, 2003 – 2008. Participated in meetings and provided suggestions that were incorporated into the sabbatical leave application form and instructions to improve their ease and clarity. Evaluated and
recommended the award of sabbatical leaves to faculty members.

Search Committee for IT Web Designer, College of Southern Nevada, 2004

Academic Standards Committee, College of Southern Nevada, 2005. Read and commented on all program reviews, making recommendations regarding new programs and substantive changes to existing programs, and dealing with other issues sent to us by faculty, administration, other committees, or the Senate. Sample issues: Grade “D” transferability and the replacement of Math course requirements for A.S. degrees.

Search Committee Certificate, College of Southern Nevada, 2006 – 2008

COMMUNITY VOLUNTEER

Conducted pro bono program evaluation and wrote proposal for the Nevada Treatment Center's form consolidation and computerization project to enable central management of client data, in cooperation with UNLV's Center for Urban Partnerships. Consulted and recommended students to NTC. Oct. 2004 - Feb. 2005