Computer Skill Acquisition and Retention:

The Effects of Computer-aided Self-explanation

by

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Abstract

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This research presents an experimental study to determine to what extent computer skill learners can benefit from generating self-explanation with the aid of different computer-based visualization technologies. Self-explanation was stimulated with dynamic visualization (Screencast), static visualization (Screenshot), or verbal instructions only, and compared to a control group with no self-explanation instructions.

Sixty-two subjects were assigned to these four conditions for learning HTML fundamentals. Two quizzes were used to test learning outcomes. In comparison to the control condition, performance was best with dynamic visualization and static visualization. The self-explanation condition without visualization did not attain statistical significance in comparison to the control condition. The study did not detect statistical differences between the three methods of stimulating self-explanation, although the pattern of results was as predicted.

Qualitative data collected from a learning experience survey regarding the subjects' opinions about self-explanation prompts showed that subjects in different treatment groups gave similar responses about how they benefited from self-explanation prompts for learning HTML.

The qualitative data also revealed the learners' challenges to perform self-explanation activities, which can be used to improve the design of self-explanation implementation and future study.

Dedication

This dissertation is dedicated to my father, Wen-Tsung Chi,

my mother, He-Pi Chi,

my wife, Chien-Ying Yang,

my son, Lucas Chi,

and my daughter, Kaylee Chi.

Thank you for your love, support, and belief in me.

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Chapter 1: Introduction

1.1 Problem statement

Although there is a growing body of literature supporting the benefits of self-explanation for learning, it is still unclear to what extent learners can benefit from using computer technologies (e.g., a screenshot[1] application or a screencast[2] application) to help them generate self-explanations. Self-explanation (SE) is a constructive learning activity in which one explains something to oneself in an attempt to make sense of new information, either presented in a text or in some other medium (Chi, 2000). Self-explanation is generally accepted as an important, effective, and domain-general means to improve learning. Research has shown evidence that self-explanation benefits learning in many domains (such as programming, mathematics, reading, electrical engineering, and biology) and in different age range groups, from four-year-olds to adults (Ainsworth &Loizou, 2003; Calin-Jageman &Ratner, 2005; Graesser &McNamara, 2010; Johnson &Mayer, 2010; Pirolli &Recker, 1994; Rittle-Johnson, Saylor, &Swygert, 2008).

To learn skills in the programming domain, one needs to acquire both conceptual and procedural knowledge. For example, in the context of web programming, the document object model (DOM)[3] is an important concept that a programmer needs to manipulate HTML[4] elements, which can be used to create a procedure (the sequence of written code) for presenting

[1] A screenshot is an image taken by the computer user to record the visible items displayed on the monitor, television, or another visual output device ("Screenshot," 2013).
[2] A screencast is a digital movie in which the setting is partly or wholly a computer screen, and in which audio narration describes the on-screen action (Udell, 2005).
[3] DOM: Document Object Model--a platform- and language-neutral interface that will allow programs and scripts to dynamically access and update the content, structure and style of documents (retrieved from http://www.w3.org/DOM last accessed on November 18, 2016)
[4] HTML: Hyper Text Markup Language.

effects such as multiple animations. Learners develop their mental models (Johnson-Laird, 1983) to represent their cognition of web programming during learning. Chi (1997) found that the benefit of self-explanation occurs through the active construction and revision of a learner's mental model. Multimedia learning research has found that adding visualizations (e.g., pictures, line drawings, videos) to learning materials benefits learners by helping them develop their mental models (Richard E.Mayer, 2005). In the aforementioned programming case, the visualization process can be helpful for a learner to create a pictorial connection between the programming code and the executed results.

There are software technologies that can aid learners to generate self-explanation. For example, a screencasting application like Screencast-O-Matic[5] allows learners to record video and audio as they demonstrate their actions on a computer. This could produce a potential benefit because learners can self-explain what they learned in a more dynamic[6] manner by recording a video showing actions rather than just recording static text or images. Thus a web programmer, with the aid of a screencasting application, can explain how she creates animation effects[7] (dynamic presentations) on a web page. She can explain how the code works and demonstrate the animation on a real web page. This capability of showing dynamic outcomes could help a web programming learner explain computer code that is difficult to verbalize. Similarly, a screenshot application like the "Snipping Tool" in the Microsoft Windows 7/8 Operating System can capture static computer screenshots to aid learners to generate self-explanation with

[5] http://www.screencast-o-matic.com last accessed on November 18, 2016.
[6] A user can demonstrate his/her continuous actions on a computer such as writing computer code and executing it to see the outcomes.
[7] An example of animation effect is an image slider (or rotator) that is commonly seen on a website to show the rotation of images or pictures.

visualization. A limitation of a screenshot is that it does not have the capability to create a dynamic demonstration (e.g., showing an image-fading effect on a web page).

Generating self-explanation with the aid of computer technologies is likely to promote learning transfer and retention because it helps the learners to develop or revise their mental models, but it is also likely to demand more cognitive resources for the generative processing[8] and the use of computer technology. Thus, there is a need to examine whether it is worthwhile for a learner, when learning a task, to allocate more cognitive resources for generating self-explanations with computer-based visualization. Furthermore, it is necessary to determine whether the self-explanation effect generated by learners with the aid of computer-based visualization is superior to the self-explanation effect generated without the aid of computer-based visualization.

The different features of computer-based visualization technologies are likely to affect their capability of helping a learner to construct or revise his/her mental models in different learning contexts. It is unclear whether the fit of the learning tasks and the computer-based visualization technologies is an important factor to determine a learner's benefits of generating self-explanation with the aid of computer-based visualizations. To address this question, this research includes two common computer-based visualization technologies which have different features. One has the capability of creating dynamic visualizations and the other is limited to static images. The research also examines how these technologies differ with respect to two

[8] The processes of generating self-explanations.

types of learning tasks—(1) know-what learning tasks (to learn declarative knowledge[9]); (2) know-how learning tasks (to learn procedural knowledge[10]).

1.2 Purpose of the Study

The main purpose of this research is to determine to what extent computer skill learners can benefit from generating self-explanation with the aid of different computer-based visualization technologies and to examine whether the effect of self-explanation generated with the aid of computer-based visualization technologies is moderated by the type of learning tasks.

1.3 Research Questions

This study is designed to answer two primary questions:

1. To what extent can learners in the computer skill acquisition context benefit from generating self-explanation with the aid of two common computer-based visualization technologies: screencast and screenshot? Four conditions will be compared:
    - Learners do not generate self-explanation.
    - Learners generate self-explanation without the aid of computer-based visualization technologies.
    - Learners generate self-explanation with the aid of screenshot visualization.
    - Learners generate self-explanation with the aid of screencast visualization.
2. Does the type of learning task (Know-what vs. Know-how) interact with the computer-based visualization technologies with respect to generating self-explanation?

[9] Declarative knowledge refers to factual knowledge and information that a person knows (Bruning, 2004).
[10] Procedural knowledge is knowing how to perform certain activities (Bruning, 2004).

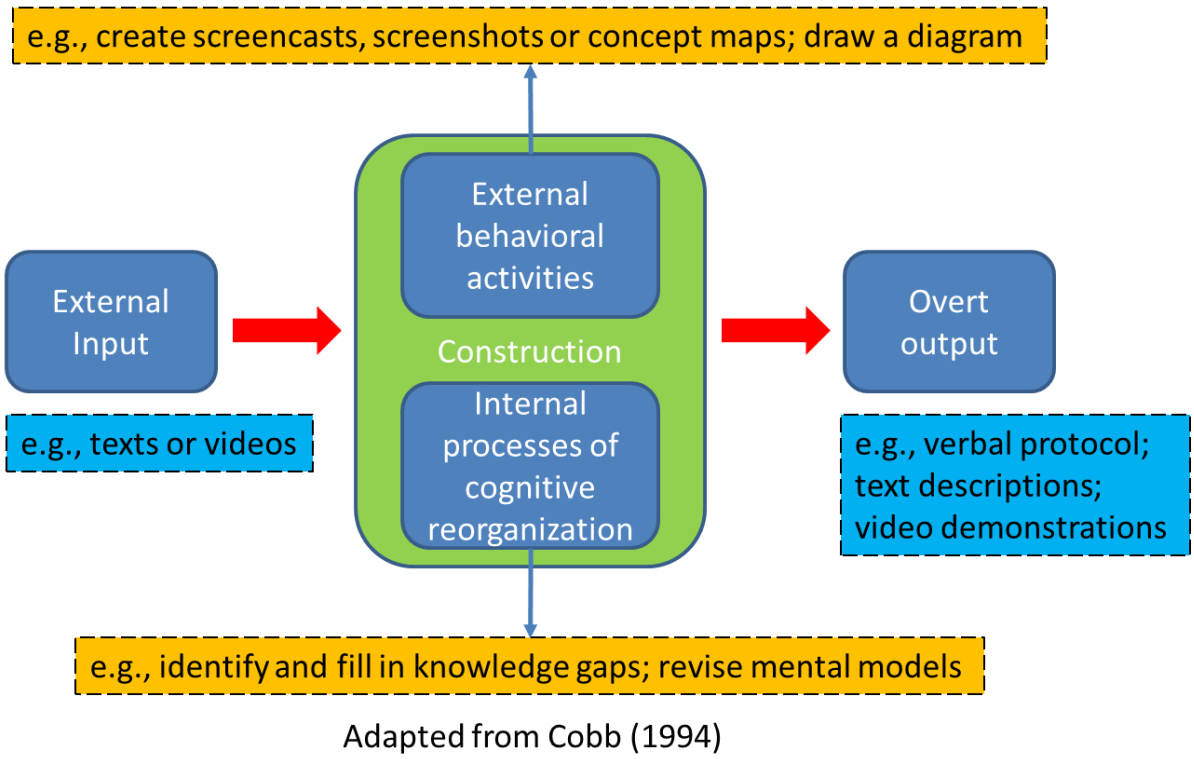
This dissertation is organized into five chapters. Chapter 1: Introduction, Chapter 2: Literature Review, Chapter 3: Research Methodology, Chapter 4: Discussion of Research Findings and Limitations, and Chapter 5: Implications and Conclusions.

Chapter 2: Literature Review

2.1 Self-explanation

For over twenty years, Chi and colleagues have been investigating a phenomenon known as self-explanation. Self-explanation (SE) is a constructive learning activity in which one explains something to oneself in an attempt to make sense of new information (Chi, 2000). It is necessary to understand that self-explanation is distinct from simply repeating the newly received information. Self-explanation involves the relating of concepts and procedures to examples or other concepts so it can help a learner generate new insight. The discovery of self-explanation as a learning strategy hinged on an assumption, which is that new knowledge cannot be readily and perfectly assimilated (or encoded) by the learner from direct instruction, either in the form of listening to an instructor's explanation, or in the form of reading a textbook. Instead, the acquisition of new knowledge requires learners to be actively involved in the *construction* of their own knowledge. As shown in Figure 1, active *construction* is a broad term denoting both the external behavioral aspects of learning (e.g., drawing a diagram, answering and asking questions, solving a problem) as well as the internal processes of cognitive reorganization (e.g., the construction and revision of one's mental models) (Cobb, 1994).

Figure 1: The mechanism of self-explanation



Adapted from Cobb (1994)

Self-explanation benefits learning in many domains, such as programming, mathematics, reading, electrical engineering, and biology; and in different age range groups, from four-year-olds to adults (Ainsworth &Loizou, 2003; Calin-Jageman &Ratner, 2005; Graesser &McNamara, 2010; Johnson &Mayer, 2010; Pirolli &Recker, 1994; Rittle-Johnson et al., 2008). The accumulation of evidence has shown that the self-explanation effect is not confined to only a few domains and has brought the insight that certain strategies or types of self-explanation are more beneficial than others. For example, it was found that successful self-explainers generate more self-explanations (Chi, Bassok, Lewis, Reimann, &Glaser, 1989). Further research indicated that the benefit of self-explanation is related to both the amount and the quality of self-explanation (Bielaczyc, Pirolli, &Brown, 1995; Chi, 1997; Chi, Leeuw, Chiu, &Lavancher, 1994). An in-depth analysis of previous studies of self-explanation showed that the benefit of

self-explanation is strongly related to the active construction and the revision of a learner's mental model (Chi, 1997). Ainsworth and Burcham (2007) also found that self-explanation was used not only to fill in missing information or knowledge gaps, but also to support knowledge revision and mental model repair.

Subsequent research tested whether subjects who were trained in self-explanation procedures performed better than those who were not trained. For example, McNamara (2004a) developed a self-explanation reading training program (SERT) and found that for a group of psychology undergraduate students studying science-based text passages, training significantly improved text-based comprehension during training compared to reading aloud alone. Following the success of the human one-to-one training program of SERT, a web-based training application called Interactive Strategy Training for Active Reading and Thinking (iSTART) was developed and shown to improve students' reading comprehension scores when compared to students who did not receive the iSTART training regardless of their level of prior knowledge (McNamara, 2004a; McNamara, O'Reilly, Best, &Ozuru, 2006). The research studies demonstrated that self-explanation could be taught and that subjects in the self-explanation groups generated a higher number of self-explanations and performed better on a variety of learning outcomes across multiple domains.

There were studies focused on the optimal conditions under which self-explanation is found to have a beneficial learning impact. Previous research showed that the self-explanation effect is mostly found when using participants of at least an intermediate phase of skill acquisition. However, deBruin et al. (2007) found the self-explanation effect for learners who have little to no prior knowledge of the topic. Although there is inconsistency in the findings of several studies with respect to whether self-explaining benefits the low or high prior knowledge

learners more, one interpretation of the mixed results is that self-explanation can benefit both low and high prior knowledge learners for different reasons. For learners with high prior knowledge, the act of self-explaining allows them to repair their existing mental models and thus improve learning outcomes, whereas for learners with low prior knowledge, the act of self-explaining allows them to generate inferences to fill gaps of missing knowledge (Chi, 2000).

Other studies examined whether the format of the study material had an impact on learning from self-explanation. For example, Ainsworth and Loizou (2003) found that learners presented with diagrams generated significantly more self-explanations and showed greater learning outcomes than learners presented with the materials in a text-only format. Butcher (2006) found that simple diagrams led to more self-explanation inferences in college students studying the circulatory system when compared with students presented with text-only or complex diagrams.

Researchers have been studying the benefits of self-explanation for learning from different perspectives. However, it is still unclear to what extent learners can benefit from using computer technologies (e.g., word processor, screenshots, and screencasts) to help them generate self-explanations in the forms of different media (e.g., typing texts, typing texts with static images, or creating screencasts). This dissertation study is designed to provide data for a better understanding of the effect of self-explanation generated with computer-based visualizations in the learning context of computer skill acquisition.

2.2 Multimedia learning: Definition, Emphases, Relationship to Self-explanation

Mayer and Moreno (2003) define *multimedia learning* as learning from words and pictures and define *multimedia instruction* as presenting words and pictures that are intended to

foster learning. The words can be printed (e.g., on-screen text) or spoken (e.g., narration), while the pictures can be static (e.g., illustrations, graphs, charts, photos, maps) or dynamic (e.g., animation, video, or interactive illustrations) (R. E.Mayer &Moreno, 2003). Multimedia learning research has centered on the question of whether adding visualizations to words in instructional messages can improve student learning.

Advances in computer-based visualization technology have enabled the incorporation of sophisticated graphics in instruction, including animation, video, illustrations, and photos. Mayer defines an instructional visualization (or instructional picture or instructional graphic) as a visual-spatial representation intended to promote learning. Instructional visualizations can vary along several dimensions (Richard E.Mayer, 2011):

- Realism—pictures can vary from high realism (e.g., a photo or video) to low realism (e.g., a line drawing or an animated line drawing);
- Dynamism—pictures can be static (e.g., a drawing or photo) or dynamic (e.g., an animation or video);
- Interactivity—pictures can be interactive (e.g., a series of drawings that can be paced by the learner or an animation that can be stopped and started by the learner) or non-interactive (e.g., a drawing or continuous animation);
- Dimensionality—pictures can be presented in 2D or 3D form;
- Visual-spatial character—pictures can be visual representations (e.g., a drawing or photo of an object) or spatial representations (e.g., a chart or table or map);
- Delivery medium—pictures can be presented on a page or screen.

Many studies in the multimedia learning literature have been focused on pictures that are low in realism, non-interactive, visual, and two-dimensional; that can be either static or dynamic; and that can be delivered on a page or screen. In a review of multimedia learning research across thirteen experimental comparisons involving lessons on topics such as how brakes, pumps, or lighting works (Richard E.Mayer, 2011), people performed better on transfer tests when they learned from printed text and illustrations than from printed text alone (R. E.Mayer, 1989; R. E.Mayer, Bove, Bryman, Mars, &Tapangco, 1996; R. E.Mayer &Gallini, 1990; Moreno &Valdez, 2005) or from narration and animation than from narration alone (R. E.Mayer &Anderson, 1991, 1992, Moreno &Mayer, 1999, 2002). The median effect size (d) favoring words and pictures over words alone is 1.35, which is considered a large effect. These results show evidence that people learn better from words and pictures than from words alone.

Multimedia learning research emphasizes that adding visualizations to instructional materials can reduce learners' cognitive load and help them develop mental models so as to promote learning, whereas self-explanation research emphasizes that generating self-explanation is an active process of cognitive reorganization which helps learners not only to identify and fill in knowledge gaps, but also to construct and repair their mental models. In other words, multimedia learning focuses on designing the learning materials with the aid of visualizations to deliver new information to a learner, while self-explanation focuses on a learner's cognitive reorganization/reconstruction of the new information with prior knowledge. Both approaches aim to improve learning, but multimedia learning places more emphasis on constructing a better learning structure (environment) for learners, whereas self-explanation highlights the benefits of learners' active involvement in the construction of their own knowledge.

The self-explanation technique can be used by a person either overtly (e.g., output as verbal protocols) or covertly (e.g., self-explain in one's mind). Although in most self-explanation studies learners self-explain overtly because of the pragmatic reason to collect protocol data, one could self-explain and think covertly (Chi, 2000). The self-explanation technique can also be applied overtly in different forms other than verbal protocols. For example, one could self-explain new information by typing texts, drawing pictures/charts/mind maps or creating videos. Based on the reviews of multimedia learning and self-explanation research, one interesting question is raised:

- Does adding visualizations when self-explaining a concept or procedure enhance or hinder the effectiveness of self-explanation on promoting learning?

There is a lack of research addressing the above question. An example of learning web programming reveals why the above question is interesting in the learning context. In web programming, a client-side scripting language such as JavaScript is commonly used to deal with user interactions (e.g., alert messages and forms) between a user and a web browser to control the presentation of web contents (e.g., create animation effects). Assuming a student learns a new function of JavaScript to perform an animation effect on an object of a web document (web page), he/she could self-explain covertly how the JavaScript function works by thinking through what the code should be and imagining the result of execution, or he/she could self-explain overtly by adding visualizations (static or dynamic) to create the mental connection between the JavaScript code and the animation effect. This mental connection can be helpful for the learner to encode the new knowledge to his/her long term memory and produce deep learning.

As explained above, adding visualizations, an observable overt learning activity, can be integrated as a part of the self-explanation process. Generating self-explanations with the support of computer-aided visualization is likely to promote learning transfer and retention because it helps the learners to develop or revise their mental models, but it is also likely to require more cognitive resources for generative processing and the use of computer technology (Stull &Mayer, 2007). Thus, there is a need to examine whether it is worthwhile for a learner, when learning a task, to allocate more cognitive resources for generating self-explanations with computer-aided visualization. Furthermore, it is important to know whether the self-explanation effect generated by learners with computer-aided visualization is superior to the self-explanation effect generated without computer-aided visualization.

2.3 Computer-based visualization technologies: Features and Relationship to Self-explanation

This research studies whether adding visualizations can increase the effect of self-explanation. To minimize the cost of using technology to generate self-explanations (e.g., the demand of cognitive resources used to learn the technology), the selected computer-based visualization technologies in this study need to be easy to learn and use. The research focuses on two common computer-based visualization technologies: screencasts and screenshots. Table 1 shows the dimensions of the selected visualization technologies. The only difference between the two selected technologies is the dimension of dynamism. The features of each computer-based visualization technology and its relationship to self-explanation are described in the following sub-sections.

Table 1: The dimensions of the selected visualization technologies

Dimension of visualization	Screenshot	Screencast
Realism	High	High
Dynamism	***Static***	***Dynamic***
Interactivity	Non-interactive	Non-interactive
Dimensionality	2D	2D
Visual-spatial character	Visual/spatial	Visual/spatial
Delivery medium	Computer screen	Computer screen

2.3.1 Screencasting technology

The term "screencast" was coined by Udell (2005). A screencast is a screen capture of the actions on a user's computer screen with or without real time audio narration. Screencasts are usually produced and output in various video formats and can be post-processed to enhance video quality such as trimming unnecessary parts and adding transition effects. Compared to common video tutorials, screencasts tend to be shorter and are easily produced by a single person on a computer with screencasting software and an audio recording device (Chen &Rabb, 2009). Recent products like Screencast-O-Matic and Screenr[11] are free web-based screencasting tools by which users can easily record screencasts and download them or share them on internet sites such as YouTube[12]. Proprietary products like Camtasia Studio[13] support more compact, cross-

[11] http://www.screenr.com last accessed on September 28, 2015 (retired on November 12, 2015).
[12] http://www.youtube.com.
[13] http://www.techsmith.com/camtasia.html last accessed on November 18, 2016.

platform file formats suitable for web-based delivery such as Adobe Flash[14], and have more sophisticated editing features allowing changes in sequence, mouse movement, and audio.

Screencasts have been used in various contexts including information literacy instruction, specialized library database instruction[15], common reference queries and distance learning[16]. A natural application of this technology is the creation of web-based lectures demonstrating and explaining, step-by-step, the process of using software[17].

In addition to recognizing individuals' benefits of consuming (watching) screencasts in different learning domains, this study is designed to provide data for a better understanding of possible benefits of producing screencasts as a part of self-explanation processes in the context of computer skill acquisition. When producing a screencast, the creator needs to organize different pieces of information in his/her mind and output them as dynamic screen motion with verbal descriptions. From a self-explanation standpoint, creating screencasts can be seen as learners' external behavioral aspects of learning, which is one of the two active processes of knowledge construction (Cobb, 1994). This external learning activity is likely to influence learners' internal processes of cognitive reorganization (the construction or revision of one's mental models) (Cobb, 1994).

2.3.2 Screenshot technology

According to Wikipedia[18], a screenshot (or screen dump, screen capture [or screen-cap], screengrab ([or screen grab], or print screen) is an image taken by the computer user to record

[14] http://www.adobe.com/products/flash.html last accessed on November 18, 2016.
[15] http://library.ncu.edu/wl_template.aspx?parent_id=272#Quick last accessed on April 2, 2014.
[16] http://www.lynda.com last accessed on November 18, 2016.
[17] http://sub.watchmecode.net/ last accessed on November 18, 2016.
[18] http://en.wikipedia.org/wiki/Screencast last accessed on November 18, 2016.

visible items displayed on the monitor, television, or another visual output device. Usually this is a digital image using the (host) operating system or software running on the computer, but it can also be a capture made by a camera or a device intercepting the video output of the display (such as a DVR). That latent image converted and saved to an image file such as to JPEG[19] or PNG[20] format is also called a screenshot.

Computer screenshots can be used to demonstrate any visual part on a computer monitor. They are often used for complementing word communication (printed or spoken words). For example, the instructions of using a spreadsheet application may include many screenshots with text descriptions. One can also use screenshots to communicate with other people about a particular software problem that he or she is having on a computer. Compared to screencasts, screenshots are used in similar contexts, but the difference is they do not have the capability of making dynamic presentations. For example, when demonstrating an image slider[21] on a web page, screenshots cannot perfectly show the image-fading effect between the image rotations, while screencasts can capture the dynamic motion of the image slider.

Similar to screencast creation, creating screenshots can be integrated into self-explanation processes. For example, a web programming learner can create some screenshots with text descriptions to self-explain how the code generates the image-fading effect in an image slider on a web page. A simple comparison of the two selected computer-based visualization technologies is shown in Table 2.

[19] Joint Photographic Experts Group, pronounced as jay-peg, a commonly used method of irreversible compression for digital images.
[20] Portable Network Graphics, a raster graphics file format that supports lossless data compression.
[21] An image slider (or rotator) is commonly seen on a website to show the rotation of images or pictures.

Table 2: Comparison of the selected computer-based visualization technologies

	Computer-based visualization	
	Screencast	Screenshot
Self-explanation output	Screencasts with spoken-word description.	Screenshots with either printed-word or spoken-word description.
Main features	A user can capture his/her activities on a computer with verbal narration such as explaining how to use a spreadsheet application or showing the programming code and its executed results.	A user can capture static images to show any visible part on a computer screen.
Capability of creating dynamic visualization	Yes	No
Common applications	Information literacy instruction; software tutorials; distance learning.	Software tutorials; computer-user manuals; trouble shooting communication.

2.3.3 Computer-based visualizations and learning tasks

One of the purposes of this research is to determine whether self-explanation with computer-based visualizations increases a learner's performance more than self-explanation without computer-based visualizations. The study was designed to discover whether learners who used computer-based visualization technology to self-explain performed better than those who did not.

The design of this research is based on the assumption that self-explanation, an active constructive learning activity, can either identify a learner's knowledge gap or revise his/her mental models. However, the different features of computer-based visualization technologies are likely to support a learner to construct or revise his/her mental models differently in various learning contexts. For example, in the case of learning web programming, if learners want to

self-explain what the web client-server model is, those who generate their self-explanations with the aid of screencast visualizations may not perform significantly better than those who generate their self-explanations with the aid of screenshot visualizations because both visualization technologies have the capability to create the know-what explanation (used to acquire declarative knowledge), although in different ways. Learners with screencasts can generate the explanation by including dynamic visual presentation with spoken-word descriptions while learners with screenshots can generate the explanation by including static images with printed-word descriptions. However, in another case of learning web programming, if learners want to create the know-how explanation (used to acquire procedural knowledge) of how the code generates an image-fading effect from normal to transparent in three seconds on an image slider, the learners who generate their self-explanations with the aid of screencast visualizations are likely to perform better than those who generate their self-explanations with the aid of screenshot visualizations because the screencast explanation has the capability to demonstrate the dynamic motion of the image slider on a web page, while the screenshot explanation cannot do the same thing. The capability of demonstrating the dynamic web page presentation is likely to influence a web-programming learner's mental model, which in turn affects that person's learning outcomes.

Therefore, it is proposed that the learning task is an important factor in determining a learner's benefits from generating self-explanation with the aid of computer-based visualizations. The main difference between the two selected computer-based visualization technologies is the capability of creating dynamic visualizations, so in order to answer the research questions, this dissertation includes two types of learning tasks: 1) declarative knowledge (know-what) types, in

which dynamic visualization is not important; 2) procedural knowledge (know-how) types, in which dynamic visualization is important.

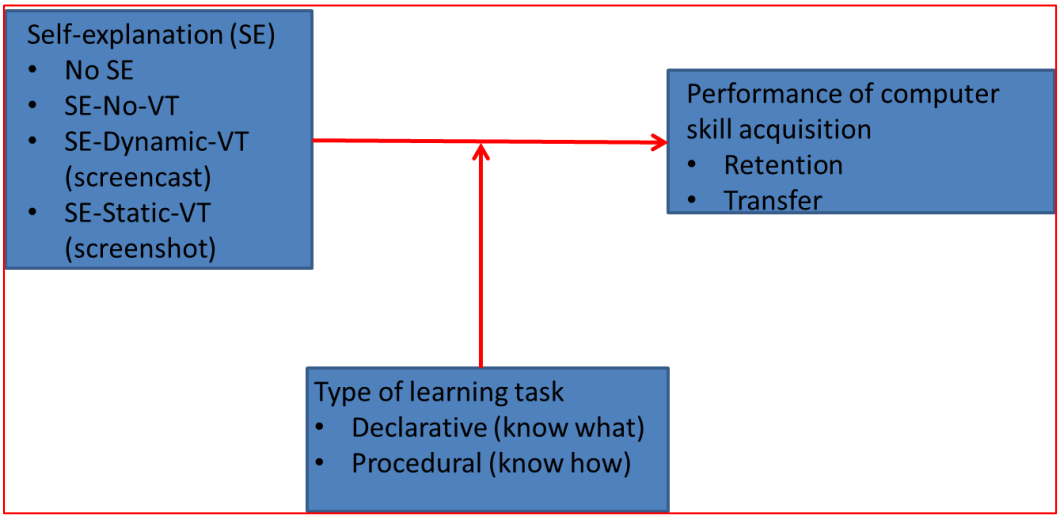
Chapter 3: Research Methodology

The purposes of this study are 1) to uncover to what extent computer skill learners can benefit from generating self-explanation with the aid of different computer-based visualization technologies and 2) to examine whether the effect of self-explanation generated with the aid of the computer-based visualization technologies is moderated by the type of learning task. A lab experimental design was used to collect data. The study recruited research subjects to complete two different types of learning tasks in order to learn some new computer skills. Each participant was randomly assigned to one of four groups, each of which had different treatment conditions. This chapter includes the conceptual model that guided the research, the research questions, and descriptions of the research design, the data sources, the analysis of the data, and the limitations of the study.

3.1 Conceptual Model

The conceptual model shown in Figure 2 reflects that learning strategy (self-explanation) with or without the aid of two different visualization technologies (VT) – screencasts and snapshots – affects one's performance of computer skill acquisition (in terms of knowledge transfer and retention). The model also indicates that the intervention of self-explanation interacts with the type of learning task (declarative or procedural knowledge) with respect to learner's performance of computer skill acquisition.

Figure 2: Conceptual model



3.2 Research Questions and Hypotheses

The main research questions and hypotheses are based on the discussion in the "Literature Review" and are described below.

1. To what extent can learners in the computer skill acquisition context benefit from generating self-explanation (SE) with or without the aid of two common computer-based visualization technologies: screencasts and screenshots?

   As discussed in Chapter 1 (p.4), four conditions were compared in this study: 1) Learners do not generate self-explanation (NOSE), 2) Learners generate self-explanation without the aid of computer-based visualization technologies (NVSE), 3) Learners generate self-explanation with the aid of screenshot visualization (SSSE), and 4) Learners generate self-explanation with the aid of screencast visualization (SCSE).

Hypothesis 1 (H1): For learners engaged in acquiring a computer skill, those in a group with any type of self-explanation treatment perform better in the knowledge transfer and retention tests than those in the group without a self-explanation treatment:

Previous research in self-explanation has shown evidence that generating self-explanations is likely to promote learning transfer and retention because it helps the learners to develop or revise their mental models. Thus, the self-explanation effects were hypothesized as follows:

H1A: SCSE group performs better than NOSE group

H1B: SSSE group performs better than NOSE group

H1C: NVSE group performs better than NOSE group.

Hypothesis 2 (H2): For learners engaged in acquiring a computer skill, differences in performance (knowledge transfer and retention tests) will exist based upon the approach of generating self-explanation in an expected order, from the best performed SCSE group, follow by the SSSE group, to the NVSE group:

As explained in Chapter 2 (p.12), adding visualizations, an observable overt learning activity, can be integrated as a part of the self-explanation process. Based on the potential advantage of adding visualization to the self-explanation process, this research hypothesized that the self-explanation effect generated by learners with computer-aided visualization is superior to the self-explanation effect generated without computer-aided visualization.

In addition, as stated in Chapter 2 (p.17), learners with screencasts can generate the explanation by including dynamic visual presentation with spoken-word descriptions, while learners with screenshots can generate the explanation by including static images with either spoken-word or printed-word descriptions. The capability of screencast-explanation to demonstrate the dynamic motion on a web page, such as animations or image sliders—contrasted with the screenshot-explanation, which cannot do the same thing--is more likely to help a web-programming learner to create a better mental model, which in turn affects that person's learning outcomes. Thus, the expected order of the self-explanation effects was hypothesized as follows:

H2A: SCSE group performs better than NVSE group

H2B: SSSE group performs better than NVSE group

H2C: SCSE group performs better than SSSE group.

2. Does the type of learning task (Know-what vs. Know-how) interact with the computer-based visualization technologies with respect to generating self-explanation?

As discussed in Chapter 2 (p.18), the learning task could be an important factor in determining a learner's benefits from generating self-explanation with the aid of computer-based visualizations. The main difference between the two selected computer-based visualization technologies is the capability of creating dynamic visualizations, which better supports a computer skill learner to explain and demonstrate his/her continuous actions on a computer such as writing computer code and executing it to see the outcomes. This visual and dynamic capability is predicted to benefit learners more in tasks that involve procedural knowledge than those that involve only declarative

knowledge, because procedures involve more action. Thus, Hypothesis 3 was developed as follows:

Hypothesis 3 (H3): For learners engaged in acquiring computer skills, the effects of self-explanation (no aid of computer-based visualization, with the aid of screencasts, and with the aid of screenshots) will be stronger in the expected order— the SCSE, SSSE, NVSE groups—when the learners acquire **know-how (procedural knowledge)** than when they acquire **know-what (declarative knowledge)**. Thus, an interaction is predicted between *type of learning* task (procedural vs. declarative) and type *of self-explanation* support.

3.3 Research Design

In order to observe the effects of computer-aided self-explanation, an experimental study was conducted to test the research hypotheses. As shown in Table 3, the study recruited subjects to participate in a laboratory experiment in which participants were asked to complete two different types of learning tasks (*know-how* and *know-what*) in order to learn HTML fundamentals. Each participant was randomly assigned to one of four groups in which learners were given either one of the three treatments or no treatment. The research subjects, the development of learning materials, the description of the experimental procedural, and the collection and analysis of data are described in following sub-sections.

Table 3: Research design

Learning Task Series (LTS)	Group 1: NOSE	Group 2: NVSE	Group 3: SSSE	Group 4: SCSE
LTS 1 (know-what tasks)	No SE activities (control group)	SE without the aid of computer-based visualization technologies	SE with the aid of screenshot visualization	SE with the aid of screencast visualization
LTS 2 (know-how tasks)				

3.3.1 Research Subjects

The target research subjects are college students having no or limited prior knowledge of web programming (e.g., HTML). As shown in Table 4, sixty-two research subjects were recruited from private colleges in the Southwest US. To motivate students to participate in the dissertation study, a gift card with cash value of $15 was given to participants when they completed the experiment.

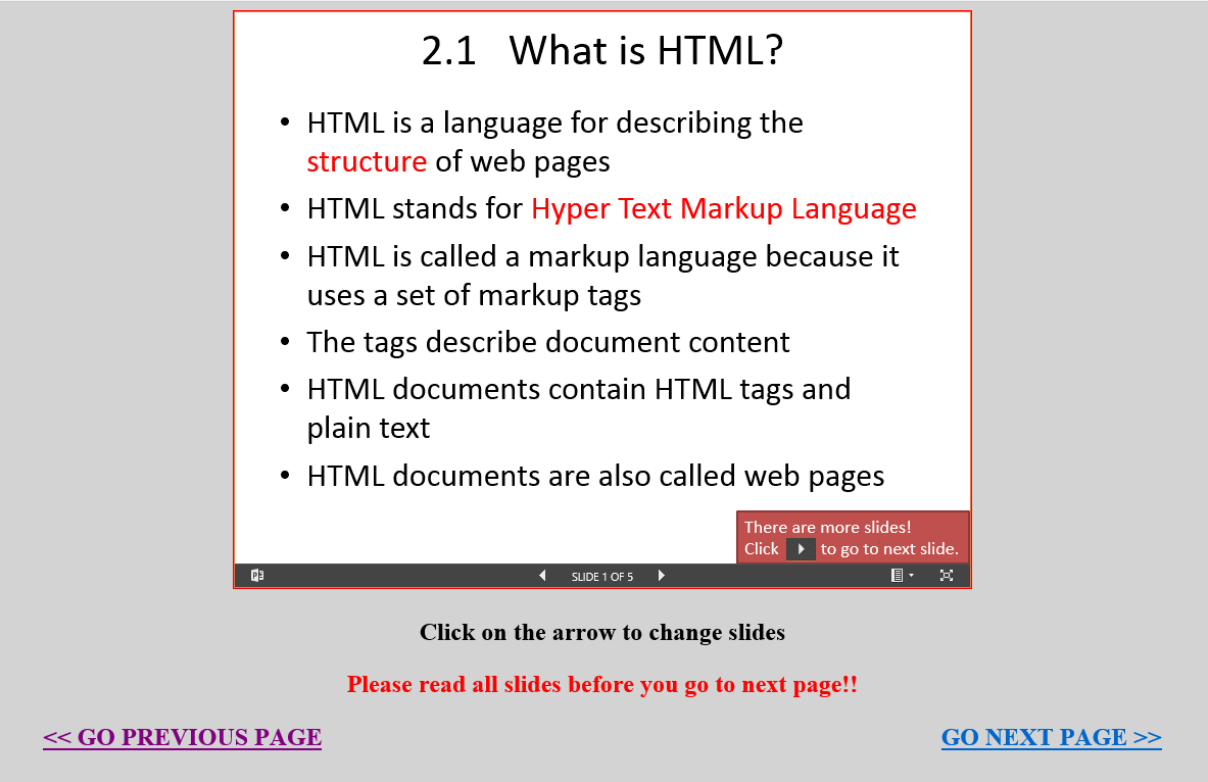
Table 4: Research subjects

Group	Year in undergraduate program				Gender	
	1st Year	2nd Year	3rd Year	4th Year	Male	Female
NOSE	7	1	4	3	6	9
NVSE	4	6	2	4	7	9
SSSE	7	2	2	4	2	13
SCSE	12	2	2	0	6	10
Subtotal	**30**	**11**	**10**	**11**	**21**	**41**

3.3.2 Development of Learning Materials

The learning tasks for this study were set in the context of web programming and specifically to learn Hyper Text Markup Language (HTML), the main markup language for creating web pages and other information that can be displayed in a web browser. Each participant was given two series of learning tasks: one for know-what (declarative knowledge) and the other for know-how (procedural knowledge). Each series of learning-tasks included several learning sections. The learning materials for the assigned learning sections were presented to research subjects on web pages. As shown in Figure 3, the subjects used "GO NEXT PAGE" and "GO PREVIOUS PAGE" links to navigate the web wages for their learning tasks. There were four versions of learning materials, one for each of the four groups of subjects, who either learned HTML fundamentals without self-explanation prompts or learned HTML fundamentals with one of three versions of self-explanation prompts. Each version of learning materials included two series of learning tasks as each subject was required to complete both series of self-taught learning tasks. A pilot study was conducted at a public college in the Southwest US to refine the learning materials and the experimental procedure before any experimental session was scheduled. Based on the pilot study, some descriptions in the learning materials were clarified and the experimental procedure was streamlined to reduce the session time. Examples of the learning materials are shown in Appendix A.

Figure 3: Learning materials on a web page



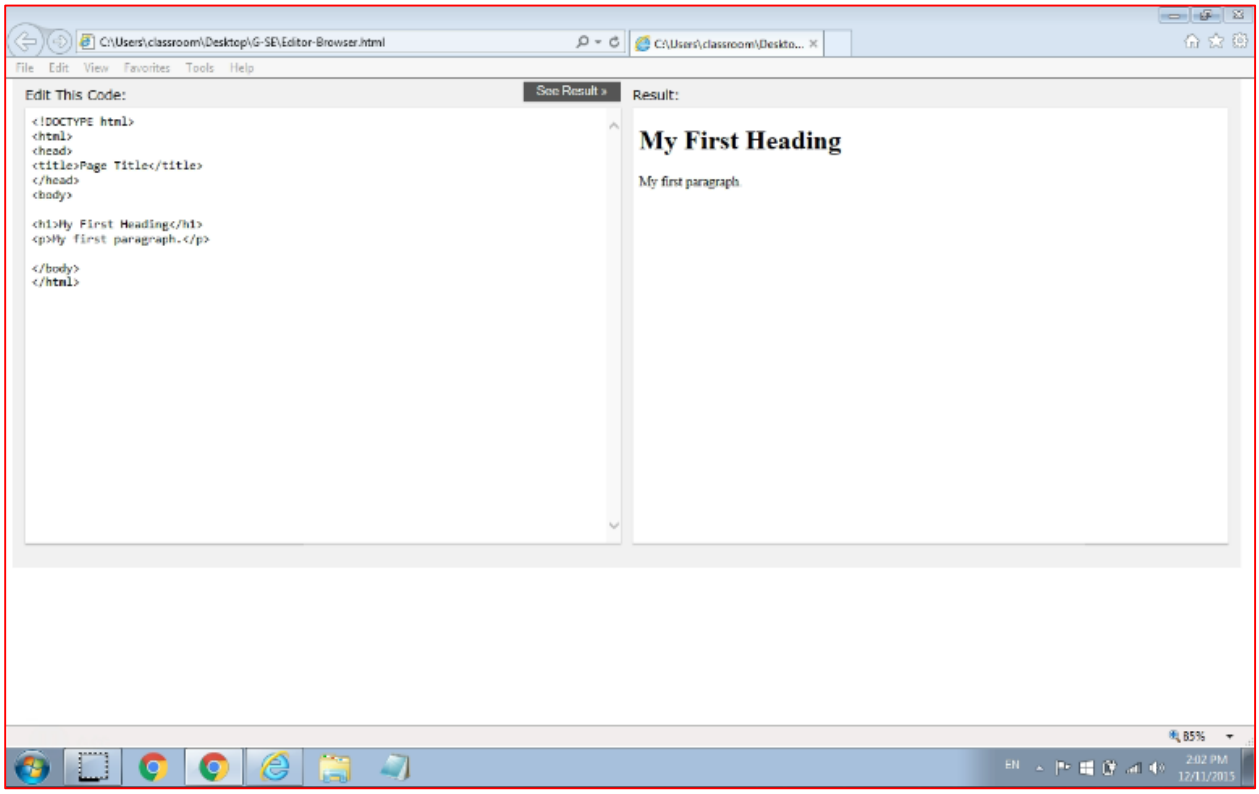
3.3.3 Experimental Set-up and Procedure

3.3.3.1 Experimental Set-up

The experiment was conducted in a laboratory. One computer running Windows 7 operating system and two 19-inch monitors were set up for the experiment. On the left monitor, a web browser and HTML editor were embedded in a web page. This setting allowed a subject to write HTML code and instantly see how the code was displayed on a web page, as shown in Figure 4. On the right monitor, the learning materials were presented on web pages with navigation links as shown in Figure 3. The learning materials were created in the format of Microsoft PowerPoint slides that were stored on the cloud service, Microsoft OneDrive, and embedded in web pages, so the Internet connection was required for all experimental sessions.

Depending on the experimental group, all required software applications such as Screen-O-Matic, Snipping Tool and Notepad were pinned to the task bar for easy access.

Figure 4: Embedded web browser and HTML editor



3.3.3.2 Experimental Procedure

Table 5 summarizes the experimental procedure. The experimenter made an appointment with each participant to confirm the experimental schedule and set up the lab before the appointment. Each participant was scheduled for a two-hour appointment to complete the experiment. After the participant checked in and signed the consent form, the experimenter explained the experimental procedure and the computer set-up. When participants were ready to start the experiment, they started with the Welcome page and then proceeded to a pre-training section in which the participants learned what a web browser and a HTML editor are and how

they can be used together to learn HTML fundamentals. In addition to the aforementioned pre-training, the participants in SSSE and SCSE groups were also trained to use either Snipping Tool (a screenshot application) or Screencast-O-Matic (a screencast application) respectively.

Table 5: Experimental Procedure

Steps
The participant check-in and sign the consent form
Pre-training section • The participants in all groups ▪ Learned what a web browser and a HTML editor are ▪ Trained to use the embedded virtual browser and HTML editor for learning HTML fundamentals • The participants in SSSE group ▪ Trained to use Snipping Tool (a screenshot application) • The participants in SCSE group ▪ Trained to use Screencast-O-Matic (a screencast application)
Section 1: Introduction Section 2: HTML Tags and Elements
Self-explanation task #1 (NVSE, SSSE, SCSE groups) Review task #1 (NOSE group)
Section 3: HTML Attributes, Headings and Paragraphs
Self-explanation task #2 (NVSE, SSSE, SCSE groups) Review task #2 (NOSE group)
Section 4: HTML Line Break and Formatting Tags
Self-explanation task #3 (NVSE, SSSE, SCSE groups) Review task #3 (NOSE group)
Section 5: HTML Lists and Links
Self-explanation task #4 (NVSE, SSSE, SCSE groups) Review task #4 (NOSE group)
Assessment: Quiz #1
Section 6: How to create HTML Headings, Paragraphs and Links step by step
Self-explanation task #5 (NVSE, SSSE, SCSE groups) Review task #5 (NOSE group)
Assessment: Quiz #2
Learning experience survey
Reward the participant and sign him/her off
Debrief and dismiss the participant

After the participants completed the pre-training section, they proceeded to the Introduction section, which briefly introduced all sections in the learning materials and described the learning objectives. The primary training for HTML fundamentals was from Section 2 to Section 6. Except for the NOSE group, which had five review tasks prompted during the training sections, the other three groups had five self-explanation tasks prompted during the training sections. Each of these three groups performed the self-explanation tasks with the aid of different computer visualization tool or without the aid of any computer visualization tool. From Section 2 to Section 5, the subjects learned the Know-what knowledge about HTML such as what HTML Elements, Attributes, and Paragraphs are, while they learned the Know-how knowledge in Section 6, which focused on how to create HTML Headings, Paragraphs and Links step by step. After the participants completed the Section 5 and self-explanation Task #4 (review Task #4 in NOSE group), they proceeded to the first learning assessment (Quiz_1), which consisted of fifteen multiple-choice questions.

The participants continued to learn in Section 6 in which they were required to follow the instructions and create HTML Headings, Paragraphs and Links step by step. After completing the self-explanation task #5 (the review Task #5 in NOSE group), the participants were prompted to complete the second learning assessment, Try It Yourself (Quiz_2), in which they were given a HTML code template and asked to write HTML code to display a HTML page shown in the instructions. When completing the second learning assessment, the participants were directed to fill out a learning experience survey. Lastly, the participants were compensated with a $15 gift card, debriefed, and dismissed.

3.3.4 Data Collection

Data collected for this dissertation included the following parts:

- Two quizzes were given to test participants' learning transfer and retention during the experimental sessions.
- A learning experience survey which included questions about the participants' background information, prior knowledge and their learning experience during the learning sessions.

As shown in Appendix C, there were four versions of learning experience survey because each group either performed the self-explanation tasks with different conditions or did not perform the self-explanation tasks.

The dependent variables were the learning outcomes: the test scores of Quiz_1 and Quiz_2. The first quiz consisted of fifteen multiple-choice questions that were used to test the subjects' retention about the subject matter, HTML fundamentals. Each correct answer was worth one point and the maximum score for Quiz_1 was fifteen points. The second quiz was designed to test how well the subjects apply what they learned in the learning sessions to create a simple web page (knowledge transfer). The quiz required the subjects to write HTML code to display a web page shown in the instructions and save the code as an HTML file. The HTML code was graded in fifteen parts, each of which consisted of HTML elements or attributes. The researchers used a strict grading rule in the study, which meant the subjects must write each part of the code completely correct; no partial credit was given. Each part of the HTML code was worth one point and the maximum score for Quiz_2 was also fifteen points. Appendix D shows grading rubric which includes the scoring key (correct HTML code for Quiz_2) and grading

criteria. The standard scoring key and strict grading criteria minimized subjective human judgements, so multiple graders were not used to grade Quiz_2.

3.3.5 Data Analysis

Data analysis includes two parts: quantitative data and qualitative data. One-way ANOVAs and t-tests were used in quantitative analyses. Content analysis was carried out in qualitative analysis to code subjects' responses on their learning experience surveys, particularly from the three SE groups. The results are shown in the following sections.

3.3.5.1 Quantitative Data

Table 6 shows the descriptive statistics for each group on the two quizzes.

Table 6: Descriptive statistics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Quiz_1	SCSE	16	13.81	1.167	.292	13.19	14.43	12	15
	SSSE	15	14.07	1.223	.316	13.39	14.74	12	15
	NVSE	16	13.69	1.662	.416	12.80	14.57	8	15
	NOSE	15	13.60	1.183	.306	12.94	14.26	11	15
	Total	62	13.79	1.307	.166	13.46	14.12	8	15
Quiz_2	SCSE	16	12.81	1.721	.430	11.90	13.73	10	15
	SSSE	15	12.40	2.947	.761	10.77	14.03	6	15
	NVSE	16	11.56	3.502	.875	9.70	13.43	3	15
	NOSE	15	10.13	1.846	.477	9.11	11.16	7	13
	Total	62	11.74	2.752	.349	11.04	12.44	3	15

Two one-way ANOVAs were used as preliminary tests on Quiz_1 and Quiz_2 as shown in Table 7. The ANOVA for Quiz_1 did not attain statistical significance, F (3, 58) = .352, p = .788, perhaps because performance was near the maximum possible, limiting the sensitivity of Quiz_1 for this population[22]. No further statistical tests were performed with Quiz_1. The ANOVA for Quiz_2 did attain statistical significance, F (3, 58) = 3.119, p = .033.

Table 7: ANOVA

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Quiz_1	Between Groups	1.866	3	.622	.352	.788
	Within Groups	102.408	58	1.766		
	Total	104.274	61			
Quiz_2	Between Groups	64.163	3	21.388	3.119	.033
	Within Groups	397.708	58	6.857		
	Total	461.871	61			

[22] The percentage of the participants who scored 14 or 15 on Quiz_1 is 69% in contrast to 34% on Quiz_2.

The hypotheses were tested with t-tests on the Quiz_2 scores using appropriate pair-wise comparisons. In comparison to the control condition as shown in Table 8, performance was better with dynamic visualization ($d = 1.50$, $t = 4.17$, $p < .001$) and static visualization ($d = .92$, $t = 2.52$, $p = .019$). The self-explanation condition without visualization ($d = .51$, $t = 1.43$, $p = .165$) did not attain statistical significance in comparison to the control condition. Thus, Hypotheses 1A and 1B were supported, though Hypothesis 1C was not.

The three self-explanation conditions did not differ significantly from each other with any pairwise comparison, although the order was predicted as shown in Figure 5. None of the second set of hypotheses was supported.

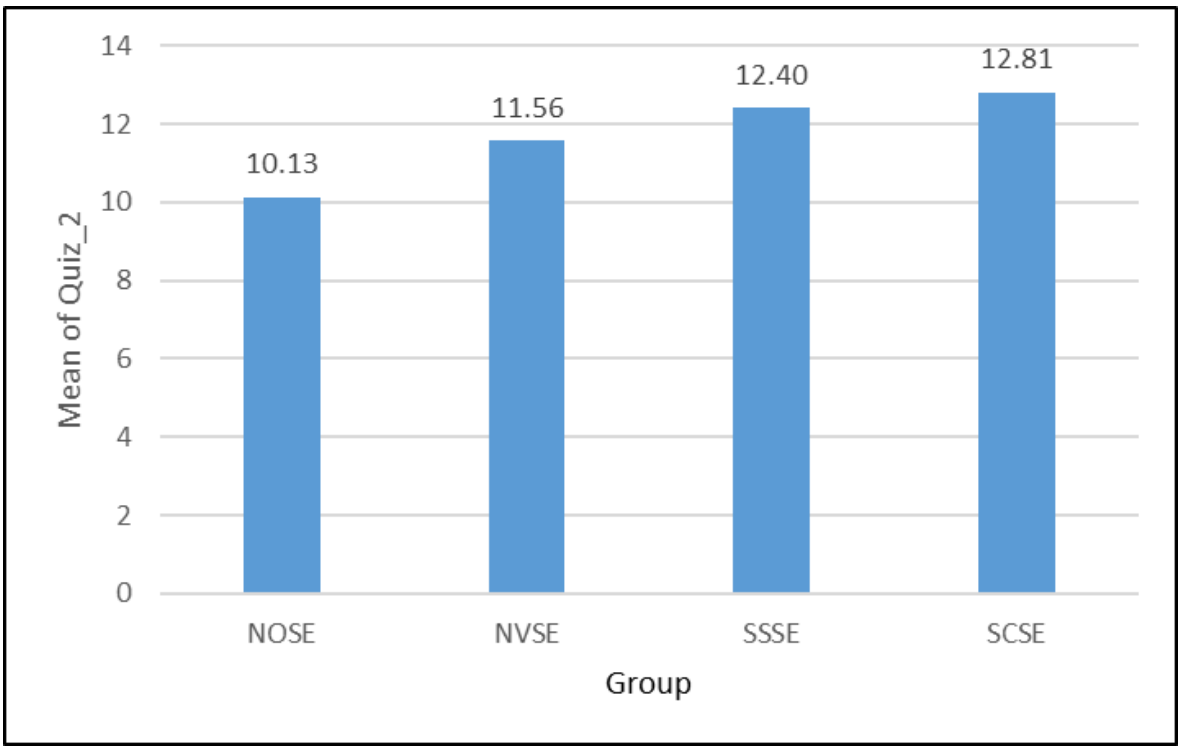
While multiple t-tests were used in this study, no prior adjustments were made to the significance levels because such adjustments are quite arbitrary (O'Keefe, 2003).

Table 8: t-tests and Effect Sizes

Hypothesis	Comparison	Mean	SD	t-test	*p* value	Cohen's *d*
H1A	Dynamic Control	12.813 10.133	1.7212 1.8465	4.172	0.000***	1.50
H1B	Static Control	12.400 10.133	2.9472 1.8465	2.524	0.019*	0.92
H1C	Verbal Control	11.563 10.133	3.5018 1.8465	1.434	0.165	0.51
H2A	Dynamic Verbal	12.813 11.563	1.7212 3.5015	1.281	0.213	0.45
H2B	Static Verbal	12.400 11.563	2.9472 3.5018	0.722	0.476	0.26
H2C	Dynamic Static	12.813 12.400	1.7212 2.9472	0.472	0.642	0.17

*p<.05, **p<.01, ***p<.001.
Dynamic = SCSE (Screencasting aided self-explanation),
Static = SSSE (Screenshot aided self-explanation),
Verbal = NVSE (Non visualization aided self-explanation),
Control = NOSE (No self-explanation).

Figure 5: Means plot of Quiz_2



Hypothesis 3 regarding an interaction between declarative knowledge (Quiz_1) and procedural knowledge (Quiz_2) was not tested because the ANOVA for Quiz_1 did not attain statistical significance and the subjects' performance in Quiz_1 was near the maximum possible, limiting the sensitivity of Quiz_1 for this population. No further statistical tests were performed with Quiz_1.

3.3.5.2 Qualitative Data

Qualitative data were collected from the learning experience surveys as shown in Appendix C. Qualitative data were used to supplement the findings of quantitative data analysis. Content analysis (Hsieh &Shannon, 2005) was carried out to code subjects' responses on their learning experience surveys, particularly from the three SE groups. The coding was done by going through all of texts on the subjects' survey responses and labeling the words and phrases

related to the questions of interest thus creating categories. A response was coded into multiple categories if a respondent's description addressed more than one idea. The initial coding was then reviewed to examine whether there were similar categories that could be merged into a more general category.

Table 9 shows the coding categories and frequency of the subjects' opinions about self-explanation. Subjects in the NOSE group were excluded because they did not perform self-explanation activities. Responses from the SCSE, SSSE and NVSE groups were initially coded into twenty-six categories and then reduced to eighteen categories based on similarity. Eighteen subjects from three SE groups described that SE prompts helped them better remember or retain new information. Eleven subjects explicitly said the SE prompts were helpful for their learning. Ten subjects thought the SE prompts helped them better understand what they learned. Seven subjects mentioned that the SE prompts helped them to catch parts that they did not fully understand, while seven subjects thought the SE prompts helped them solidify or reinforce their learning. As shown in Table 9, the subjects in different groups gave similar responses about how they benefited from self-explanation prompts for learning HTML, which can help explain why there were no significant differences on the two quizzes among SE groups.

Table 9: Subjects' opinions about self-explanation from learning experience survey

Code	Description	SCSE N=16	SSSE N=15	NVSE N=16	Total
1	Remember it better; retain the information; recall what I learned	5	7	6	18
2	Self-explanation is helpful	4	2	5	11
3	Understand well; better understanding	5	2	3	10
4	Feel awkward or weird	2	2	4	8
5	Identify knowledge gap. e.g., catch parts that did not fully understand	1	3	3	7
6	Strengthen my learning; solidify my learning; reinforce my knowledge	4	2	1	7
7	Enjoy or like the self-explanation activities	2	1	2	5
8	Review newly learned information	1	2	2	5
9	Revise mental models	2	1	2	5
10	Better absorb or digest the information	1	1	2	4
11	Do not need to say it out loud		2	2	4
12	Articulate newly learned information	1	2		3
13	New to self-explanation (SE); Take time to figure out how to perform SE	3			3
14	Teach someone; Teach myself	3			3
15	Test myself; assess myself	1	1	1	3
16	Self-explanation is useful	2		1	3
17	Formulate my ideas expressively	2			2
18	Difficult to remember	1			1

Table 10 shows the coding categories and frequency of the subjects' opinions about the challenges to create self-explanation. Subjects in the NOSE group were excluded because they did not perform self-explanation activities. Responses from the SCSE, SSSE and NVSE groups were coded into 22 categories. While the subjects' responses about the challenges to perform self-explanation activities varied with subjects and groups, some responses were more frequently coded into the same category across SE groups.

Table 10: Challenges to create self-explanation

Code	Description	SCSE N=16	SSSE N=15	NVSE N=16	Total
1	No or little challenge	2	4	5	11
2	I didn't know how to exactly describe some of the terms	3	2	3	8
3	The first one was a bit of a challenge, but it became easier thereafter	4	2	2	8
4	Did not remember all the information I had just learned	3	2	2	7
5	Felt awkward/odd speaking out loud to myself		2	3	5
6	It was challenging because it was something new to me	1		3	4
7	I wasn't sure exactly how detailed to be in my self-explanation	2	1		3
8	I was not used to explaining concepts I had only just learned		1	1	2
9	Hard to explain because HTML is very hands-on			2	2
10	Hard to determine the order of how I want to explain	1	1		2
11	How to summarize what I learned concisely and explain it quickly		2		2
12	It was annoying to screencapture everything		1		1
13	More difficult to think aloud when code became more complicated		1		1
14	Directions were unclear	1			1
15	Some concepts were hard to explain because they were more abstract and fundamental		1		1
16	I internalized the step-by-step process rather than the terminology	1			1
17	I was not convinced of my self-explanation			1	1
18	Did not use the exact terms	1			1
19	No feedback on how clearly I explained concepts	1			1
20	I kept rambling a lot	1			1
21	Slow down when I wanted to explain the concepts in my own words			1	1
22	The timing made me rush		1		1

As shown in Table 10, eleven subjects described they had no or little challenge when performing the self-explanation activities. Among these subjects, two were in the SCSE group, four were in the SESE group and five were in the NVSE group. One explanation for this distribution is that the subjects in the NVSE group did not use any computer-aided visualization technology for generating self-explanations so they demanded fewer cognitive resources for generative processing, and therefore felt no challenge or less challenged when performing self-explanation activities. Eight subjects mentioned they did not know how to exactly describe some of the terms. Eight subjects thought the first self-explanation was a bit of a challenge, but it became easier thereafter to perform self-explanations. Four (half) of the aforementioned subjects were in the SCSE group probably because the subjects were not familiar with the computer-aided visualization tool, Screencast-O-Matic, and they needed to allocate more cognitive resources for self-explaining the newly learned HTML concepts. Although there were only eight subjects across SE groups indicating the first self-explanation was a challenge, it was observed in the experiments that most subjects in SE groups performed more confidently in their latter self-explanation activities. These observations suggest that the subjects could generate better self-explanations with more practice, which would be likely to improve their learning outcomes. Seven subjects from three SE groups described that they did not remember the information they just learned to perform self-explanation.

Tables 10 shows the subjects' responses about whether Screencast-O-Matic (SOM) is helpful for them to explain HTML effectively. These responses were specifically collected from the SCSE group and were used to help understand how effectively this visualization technology aided the subjects to self-explain HTML.

Table 11: Screencast effectiveness on self-explanation

Participant	You were asked to use the Screencast-O-Matic to help you self-explain some HTML topics. Was it helpful for you to explain HTML more effectively? Please explain why or why not.
101	It was helpful, because it allowed me to gesture to parts of the HTML with my mouse instead of having to type them over and over again or attempt to explain them alongside whatever else I was trying to explain .
102	The combination of both a visual and auditory aspect helped me explain the HTML topics more clearly.
103	Yes, I think verbalizing and explaining knowledge helps me to retain it in my memory. Like I said before, it also forces me to be accountable for the information because I know I will need to remember and understand it.
104	I think it helped me explain HTML more effectively because if I am able to speak out loud and teach it again to myself, I realize it shows what I do and did not get, as well as organizing my thoughts about what I had just learned. It's easier when you can visualize it and type it up right there since I didn't know all of the terms to describe certain things sometimes.
105	Yes, because it encouraged me to talk to myself, and actually hear what I was saying. I do not think that I would have reasoned things out in such a manner without the prompt.
106	The SOM helped quite a bit because it allowed me to speak as well as demonstrate what I was saying by typing it out on the text editor for the viewer to see.
107	It was helpful after I got the hang of it. I did not realize I could talk and show my work on the computer at the same time.
108	Yes because being able to explain it yourself and put it into your own words is a very useful tool for learning I think.
109	It was helpful because the person who is watching me explain these things could see what I'm talking about instead of just wondering what I was doing or saying.
110	Yes because it forced me to know the information well enough to teach it. it just took a lot of time though.
111	It was helpful to self-explain what I was thinking in terms of what I thought about building html files. Sreencast-o-matic was helpful and easy to navigate to that aim.
112	Yes, it was definitely very helpful. Again it helped with the repetition and I was able to understand what I was doing using my own understanding of what I had previously read. Therefore, it was easy for me to learn and remember much of what I had read. However, I would not use my recordings to try to explain to someone, because if I was the one to be listening to it I would be able to follow since I simply repeated what I thought was necessary for me to understand for myself but not for others .
113	The SOM helped me by providing a visual from which I could theoretically study and review later. The most helpful part was, however, the knowledge that somebody could theoretically watch what I had done. Not wanting to look uneducated, I tried to be more thorough in my self-explanations than I would have been without the SOM.
114	Yes, because it is so much easier to explain things when you are able to add the dimension of seeing it happen on screen; HTML, I feel like, is a very visual experience, and so it would have been very difficult to explain through audio alone.
115	Yes it was. The way the Screencast-O-Matic looked allowed me to record what I had learned and not be cognizant of the fact that I was recording. It was definitely very helpful to learn HTML reading aloud, and repeat what I was learning again through the Screencast-O-Matic.
116	In retrospect, it did. The action of speaking aloud for the Screencast-O-Matic brought clarity to my level of comprehension for HTML. Though it would take a couple of tries to word the explanation to something I felt satisfied with, it allowed me to understand the content to a deeper level.

Some of subjects commented that Screencast-O-Matic was useful and effective to serve as a visual aid to help them self-explain HTML concepts. They said that it allowed them to move the mouse cursor to the parts they attempted to explain and to demonstrate the HTML code and the web page they created, which made the self-explanation tasks much easier. These comments include those made by participant #101, #104, #111 and #114 as shown in Table 11. Other participants, #106, #110 and #113, thought their self-explanations recorded by Screencast-O-Matic may be viewed by other people, forcing them to explain HTML concepts more thoroughly, even though self-explanation activities aim to help learners' cognitive reorganization of new information. These comments suggest the learners are more likely to perform better in their self-explanations if they know someone could learn from them. When they pay more attention to generating self-explanation, they are more likely to identify knowledge gaps and fill in missing information, which could ultimately enhance their learning outcomes.

Table 12 shows the subjects' responses about whether the Snipping Tool is helpful for them to explain HTML more effectively. These responses were specifically collected from the SSSE group and were used to help understand how effectively this visualization technology aided the subjects to self-explain HTML.

Table 12: Snipping Tool effectiveness on self-explanation

Participant	You were asked to use the Snipping Tool to help you self-explain some HTML topics. Was it helpful for you to explain HTML fundamentals more effectively? Please explain why or why not.
201	Yes, it did help me explain the new concepts more effectively, for I was able to choose which pieces of information I needed to help remind me of somethings I may have forgotten as opposed to going through each slide and losing more time by doing that.
202	Yes, because sometimes I didn't write down the exact stuff you needed to type out to get a certain style of writing but I had it right there in the image, and I could also see what the outcome of the stuff i coded was.
203	I usually like to rephrase things rather than copy down notes word for word. but when there was extensive information (such as when there was a list of example attributes) it was efficient to use the sniping tool.
204	It was helpful to compile information into a powerpoint, although as I mentioned above, it helps more to type out the actual sample code/practice code than to take screenshots of it.
205	On my computer, I just use the command-shift-4 to take a screenshot, so the snipping tool seemed kind of inefficient. It does help to take screenshots of the slides I was shown, so that I can put them in a powerpoint, but with my own code it's much easier to just copy and paste.
206	Yes. It was helpful to get screen shots, especially snipped screen shots of more visual explanations (like showing the code, and then showing how it is displayed on an HTML document/web page). The images and examples helped me understand more than the words and descriptions did, but both were integral parts to my understanding because the words and descriptions also helped clarify many concepts!
207	The snipping tool was helpful, but I could have also just typed the information out on the Powerpoint. Either way works, and it did help me learn the fundamentals effectively.
208	It was helpful as a visual tool to bring up information I learned. I am a visual learner so yes. Also, the snipping tool made it so I had to review the information and specifically choose important parts of the slides that would help me recall for self-explanation.
209	Yes. I could refer to screenshots I took to explain things that were difficult to verbalize, like what tags look like, or nested code.
210	Yes, it was helpful. Not the Snipping Tool specifically, but creating the examples to snip was very helpful. I think I would have gotten roughly the same result if I had used the left monitor (editor/browser) for my self-explanations instead of taking screenshots and pasting them into a PowerPoint. But I don't know, because I didn't do it that way.
211	It was very helpful to be able to use this, as it allowed me to pick out and select the exact pieces of information from the PowerPoints and text editing windows that I wanted to copy into the PowerPoints and remember and study from.
212	Well the snipping tool allowed me to capture some examples which I thought were the most helpful. However, it also allowed me to remember some of the finer details that perhaps would've been lost had I just paraphrased what I remembered (such as the slight difference between tags and elements).
213	I would have preferred rewriting it- it's both faster and forces me to review as I type and summarize.
214	yes, the Snipping Tool was very much helpful in explaining the HTML fundamentals more effectively because they served as a visual guide. On the other hand, they also made it easy for me to read off of the PowerPoint instead of memorize the answers.
215	Yes, and no. There were times when a screenshot really helped me recall information but I wanted to add my own memo or summary.

Participants #206, #208, #209, #211, #212 and #214 described that the Snipping Tool (ST) was helpful and effective as a visual tool to help them learn HTML, recall information and explain things that were difficult to verbalize such as what tags look like or nested code. Some participants like #204, #207 and #213 preferred to rewrite the information or type out the sample code or practice code instead of using the ST and thought the aforementioned ways were more efficient and effective for learning HTML. Overall, participants in both SCSE and SSSE groups viewed the Screencast-O-Matic and Snipping Tool, respectively, as a useful and effective visual aid to help them learn HTML and explain the concepts.

Chapter 4: Discussion of Research Findings and Limitations

4.1 Research findings

The first section of Chapter 4 includes discussion of research findings from the quantitative and content analyses. The discussion starts from the hypotheses tests and continues on the findings from the learning experience surveys. The second section includes discussion of research limitations.

4.1.1 Hypotheses tests

The results showed that self-explanation with the dynamic screencast and with the static screenshot both improved performance significantly with large effects of d = 1.50 and 0.92, respectively. There were no statistically significant differences between the three self-explanation conditions, although performance in the three conditions was in the order predicted. Table 13 shows the summary of hypotheses tests.

Although this study was designed for HTML beginners, many subjects answered all questions in Quiz_1 correctly, causing a ceiling effect that limited sensitivity of the test for measuring learning outcomes. Perhaps the first quiz was too easy to detect differences of learning outcomes among the groups. The scores were not weighted based on level of difficulty[23]. Alternatively, perhaps the participants in this study, who were recruited from colleges whose students typically were at or near the top of their high school graduating classes, were above average learners. Other explanations of ceiling effects could be that the training

[23] Several methods were used to weight scores by difficulty of items, but the statistical results were similar to those of the unweighted scores.

materials facilitated high levels of learning or the material being learned was at the beginner level.

The main difference between screencasts and screenshots is the capability of creating dynamic visualization (see Table 2, p.17). The learning material did not include subject matter that allows the participants in the SCSE group to take advantage of generating self-explanations with the aid of dynamic visualization (e.g., creating animation effects on web pages).

According to the t-tests, the three SE groups combined did perform better statistically than the NOSE group. While the SCSE and SSSE group alone also statistically performed better than the NOSE group, the NVSE group did not. One possible explanation is that some subjects in NVSE group explained the HTML concepts by reading the description on the slides and did not use their own words to explain those concepts. Thus, the effect of self-explanation for that group was too small to be detected. It is also possible that the review tasks performed by the NOSE group allowed a learner to navigate to previous web pages and review the slides quietly. This reviewing activity allowed the subjects to organize their thoughts, which could also enhance their learning outcomes, so the subjects from NVSE and NOSE groups would have similar learning performance.

Table 13: Summary of hypotheses tests

Hypotheses	Outcomes
H1A: SCSE > NOSE	Supported
H1B: SSSE > NOSE	Supported
H1C: NVSE > NOSE	Not supported, in predicted order
H2A: SCSE > NVSE	Not supported, in predicted order
H2B: SSSE > NVSE	Not supported, in predicted order
H2C: SCSE > SSSE	Not supported, in predicted order

4.1.2 Learning experience surveys

Finding 1: Subjects' Positive and Negative Opinions about Self-explanation. From the learning experience surveys, the subjects' responses regarding their opinion about self-explanation activities were coded into 18 categories. Some categories include responses from a specific SE group, while some categories have similar frequency of responses across the three SE groups. The results of coding the subjects' opinions about self-explanation showed some patterns. As shown in Table 9 (p. 37), among eighteen coding categories, fourteen are considered positive because they are related to the benefits of self-explanation and four are considered negative because they are related to the difficulty/awkwardness the subjects encountered during their self-explanation activities. The major positive opinions are summarized as below.

SE prompts helped the subjects:

- better remember or retain new information
- better understand what they learned

- learn
- catch parts that they did not fully understand (identify knowledge gap)
- solidify or reinforce their learning.

However, SE prompts made a few subjects feel awkward in having to rehearse and/or remember information or in figuring out how to perform the SE tasks. Moreover, some did not think they needed to speak out loud to learn.

There were more subjects from the NVSE group than from other groups who felt SE activities were awkward. One possible reason is that when performing SE tasks, those subjects talked to themselves out loud without using visualization technologies at the same time, which may increase the awkwardness. Another finding was that only subjects in the SCSE group thought it took time to figure out how to perform the SE tasks. An explanation for these responses was that creating screencasts required more cognitive resources to organize different pieces of information and use visualization technology. If the subjects did not practice well (e.g., rehearse in their mind), they may have been more likely to have found it was difficult to perform SE tasks.

Although the three SE groups used different ways to perform SE tasks, the subjects in different groups gave similar responses about how they benefited from self-explanation prompts for learning HTML, which may help explain why there were no significant differences on the two quizzes among three SE groups.

Finding 2: Some learners may experience cognitive overload when performing SE tasks. From the learning experience surveys, the subjects' responses regarding their challenges with self-explanation activities were coded into 22 categories. As shown in Table 10 (p.38), seven subjects from three SE groups said they did not remember the information they just

learned so they were unable to perform the self-explanation. Eight subjects mentioned they did not know how to describe some of the terms exactly. These subjects whose responses were coded into the aforementioned categories were likely to have cognitive overload problems because there was too much new information for them to process in the SE tasks. Cognitive load in psychology refers to the total amount of mental effort being used in working memory (Sweller, 1988). Heavy cognitive load can have negative effects on task completion, and the experience of cognitive load is not the same for everyone. Sweller (1988) differentiates cognitive load into three types: intrinsic, extraneous, and germane. Intrinsic cognitive load is the effort associated with a specific topic. Extraneous cognitive load refers to the way information or tasks are presented to a learner. And, germane cognitive load refers to the work put into creating a permanent store of knowledge, or a schema. He argued that instructional design can be used to reduce extraneous cognitive load in learners. Although the number of subjects indicating the experience of cognitive overload was small (15), their responses suggested that the learning materials and SE tasks presented to learners in this study can be improved.

Finding 3: Practice improves the quality of self-explanation. Eight subjects thought the first self-explanation was a bit of a challenge, but that it became easier thereafter to perform. Four of the aforementioned subjects were in the SCSE group and probably were not familiar with the Screencast-O-Matic, the computer-aided visualization tool so they could have needed to allocate more cognitive resources for self-explaining the newly learned HTML concepts. Although there were only eight subjects across SE groups who thought the first self-explanation was a challenge, it was also observed and written on the observation notes during the experimental sessions that most subjects in the SE groups performed more confidently and generated better self-explanations in their later SE tasks. Three subjects described that they were

not sure how detailed to be in their self-explanation. These observations suggest that the skills of self-explanation can be learned quickly and the subjects could generate better self-explanations with more practice, which is likely to improve their learning outcomes.

Finding 4: Computer-aided self-explanation may demand more cognitive resources than other self-explanation methods. Eleven subjects described they had no or little challenge when performing the SE tasks. Among these subjects, two were in the SCSE group, four were in the SESE group and five were in NVSE group. More subjects in NVSE group felt less challenged than those in other groups. One explanation could be that the subjects in the NVSE group did not use any computer-aided visualization technology for generating self-explanations so they demanded less cognitive resources for generative processing, and therefore felt less challenged when performing self-explanation activities. This explanation implied that demanding more cognitive resources could be one of the reasons that the subjects felt more challenged when performing computer-aided self-explanations.

Finding 5: Visual aids are important for learning HTML and SE tasks. Tables 10 and 11 show the subjects' responses about whether Screencast-O-Matic (SOM) or the Snipping Tool (ST) is helpful for them to explain HTML. These responses were collected from the SCSE and SSSE groups respectively and were used to help understand how effectively each visualization technology aided the subjects to self-explain HTML. Four subjects in the SCSE group commented that the SOM was useful and effective to serve as a visual aid to help them self-explain HTML concepts because it allowed them to move the mouse cursor to the parts they attempted to explain and demonstrate the HTML code and the web page they created, which made the self-explanation tasks much easier. Six subjects in the SSSE group said that the ST was helpful and effective as a visual tool to help them learn HTML, recall information and explain

things that were difficult to verbalize such as what tags look like or nested code. In general, participants in both groups viewed SOM and the ST, depending on their group, as a useful and effective visual aid to help them learn HTML and explain the concepts.

4.2 Limitations

There were several limitations in this experimental study. First, the learning materials for HTML were limited to a beginner level so the length of a learning session could be adequately managed in 90 minutes. The effects of different self-explanation approaches may be better differentiated in a longer study or with more advanced materials such as JavaScript, which can be used to animate effects on web pages. The subjects in the SCSE group could take advantage of generating self-explanations with the aid of dynamic visualization. Second, to minimize the time needed to run the experiments, the subjects did not get enough training for practicing self-explanation tasks at the beginning of an experimental session, which probably limited the effects of self-explanations. Third, each participant was tested individually, so the data collection was time-consuming and limited the number of participants in the study. A power analysis conducted with G*Power showed that with a sample of 60 cases across four groups, an ANOVA using alpha of .05 would have power of 80% to detect a large effect size of 0.45. Although the ANOVA did detect an overall effect (see Table 7, p.33), the sample was not large enough to detect small differences between experimental conditions. The observed pairwise differences ranged from d = 1.50 to .17 (see Table 8, p.34). Even with no adjustments for multiple tests, samples of 26 cases per group would be needed to have power of 80% to detect a large effect of d = .80; with 15 cases per group, the achieved power to detect such a large effect was only 56%. Fourth, the learning materials and quizzes were developed based on a pilot study in which the subject population was different from the one used in the experiments. As stated above,

participants in the study were recruited from colleges whose students typically were at the top of their high school graduating classes. Perhaps as a result of this selection of participants, the first quiz was too easy to detect differences in learning outcomes among the groups. Fifth, although the grading rubric for Quiz_2 was objective, a second grader was not used for checking reliability.

Chapter 5: Implications and Conclusions

5.1 Implications

This study was designed to extend understanding in the fields of self-explanation and multimedia learning. Self-explanation is generally accepted as an important, effective, and domain-general means to improve learning. Research has shown evidence that self-explanation benefits learning in many domains and across different age range groups. Multimedia learning research has found that adding visualizations (e.g., pictures, line drawings, videos) to learning materials benefits learners by helping them develop their mental models (Richard E.Mayer, 2005). Generating self-explanation with the aid of computer visualization technologies is likely to promote learning transfer and retention because it helps the learners to develop or revise their mental models, but it is also likely to demand more cognitive resources for the generative processing and the use of computer technology. Thus, this study examines whether it is worthwhile for a learner, when learning computer skills, to allocate more cognitive resources for generating self-explanations with the computer-aided visualization.

5.1.1 Effect of self-explanation with visualization technologies

This study extends studies of self-explanation by introducing a new way to generate self-explanation—with the aid of dynamic or static visualization technologies. The outcomes of this study show that self-explanation with a dynamic screencast and with a static screenshot both improved performance significantly with large effects of d = 1.50 and 0.92, respectively. There were no statistically significant differences between the three self-explanation conditions, although performance in the three conditions was in the order predicted. The results were not surprising because the effects of self-explanation between the three self-explanation conditions

could be very small, especially between the SCSE and SSSE groups. Both groups used a visualization technology to support their self-explanation activities. According to the results of a learning experience survey, the subjects in both groups commented that the technology they used was useful and effective as a visual aid for them to learn HTML concepts and perform self-explanation activities. The capability of creating dynamic visualization in screencasts did not give the SCSE group an advantage in performing self-explanation activities because the learning materials in the study did not include much dynamic content such as animation effects on a web page. Thus, both groups performed similarly, although the SCSE group was slightly better than the SSSE. The differences between the two groups were too small to detect with the sample of 62 subjects. While the study was designed for beginners, some subjects had more knowledge than they reported in a pre-survey, which along with the high-achieving population they were recruited from may have caused a ceiling effect on the post-training quiz.

5.1.2 Positive and negative opinions about self-explanation

From the learning experience surveys, among 18 coding categories, 14 are considered positive because they are related to the benefits of self-explanation and four are considered negative because they are related to the difficulty/awkwardness the subjects encountered during their self-explanation activities. The major benefits of performing self-explanation activities perceived by the research subjects include helping them to: (1) better remember or retain new information, (2) better understand what they learned, (3) catch parts that they did not fully understand (identify knowledge gaps), and (4) solidify or reinforce their learning. These positive opinions reinforce the conclusions of numerous research studies that self-explanation is an effective learning activity to increase learning (e.g., Heijltjes et al., 2015, Adams and Clark, 2014, McEldoon et al., 2013).

However, some subjects expressed difficulty/awkwardness during their self-explanation activities. These concerns include: (1) feeling awkward when attempting to perform SE tasks, (2) believing that they did not need to say it out loud when performing SE tasks, (3) finding it was difficult to remember the terminologies when performing SE tasks, and (4) taking some time to figure out how to perform SE tasks. These negative opinions provide opportunities to improve the design of self-explanation activities. For example, it may help to give good examples/guidelines of high quality self-explanation, give more time to practice self-explanation alone to reduce awkwardness, and improve the instructional design to reduce cognitive load (Sweller, 1988).

5.1.3 Challenges for learners to perform self-explanation

Some learners may experience cognitive overload. Some learners from three SE groups indicated that they did not remember the information they just learned to perform self-explanation, while others mentioned they did not know how to exactly describe some of the terms. These learners were likely to have cognitive overload problems because there was too much new information for them to process in the SE tasks. Sweller (1988) argued that instructional design can be used to reduce learners' cognitive load, for example, by improving the way information or tasks are presented to a learner (Sweller, 1988). Therefore, this finding suggests that the design of learning materials and SE tasks to minimize cognitive load for learners could be a key factor to implement self-explanation activities for learning new information effectively.

Practice improves the quality of self-explanation. Some learners described that they were not sure how detailed to be in their self-explanation, while others thought the first self-explanation was a bit of a challenge, but it became easier thereafter to perform self-explanations.

Lack of practice may be the main reason that the learners felt challenged at first when performing self-explanation activities. Although there were only eight subjects across SE groups who expressed their first self-explanation was a challenge, it was also observed in the experiments that most subjects in SE groups performed more confidently and generated better self-explanations in their later SE tasks. These observations suggest that the subjects could learn the skills of self-explanation quickly and generate better self-explanations with more practice, which is likely to improve their learning outcomes.

It is worthwhile to perform computer-aided self-explanation although it may require learners to allocate more cognitive resources. Among those learners who described they had no or little challenge when performing the SE tasks, two were in the SCSE group, four were in the SESE group and five were in the NVSE group. One explanation for this distribution could be that the subjects in the NVSE group did not use any computer-aided visualization technology for generating self-explanations so they demanded fewer cognitive resources for generative processing, and therefore felt less challenged when performing self-explanation activities. Thus, computer-aided self-explanations are more likely to demand more cognitive resources from the learners when they perform SE tasks. The results of statistical tests in this study show that learners in self-explanation groups who used a visualization technology performed better than those in the group without self-explanation activities, suggesting that it is worthwhile for a learner, when learning computer skills, to allocate more cognitive resources for generating self-explanations with computer-aided visualization.

5.1.4 Importance of Visual Aids in Computer Skill Acquisition

Responses to the learning experience survey indicated that some research subjects in both the SCSE and the SSSE group found that the Screencast-O-Matic or the Snipping Tool was

useful and effective to serve as a visual aid to help self-explain HTML concepts. This is because it is difficult to verbalize what HTML tags look like or explain nested code. A similar experience would be expected in the context of learning other computer skills such as learning JavaScript[24] or Python[25]. Providing visual aids is not only helpful and effective for learners in their process of acquiring new computer skills, but also helps the learners to verbalize their hands-on experiences when they attempt to explain what they learned. Visual aids can also help the learners create or revise their mental models of how things work, such as what the learners will see after the computer code is executed. Therefore, visual aids are an important part of instructional design in computer skill acquisition. They are also useful to facilitate self-explanation activities when learning new computer skills.

5.1.5 Implications for Researchers

This research contributes to the body of self-explanation literature by showing that self-explanation is an effective learning strategy in the context of computer skill acquisition. Although no statistically significant evidence was found to determine which computer-based visualization technology is superior to the other in supporting self-explanation activities on learning HTML, both groups with computer-based visualization technology significantly performed better than the group without self-explanation and the performance in the three self-explanation conditions was in the order predicted (SCSE > SSSE > NVSE). The research outcomes imply that the effects of self-explanation with dynamic visualization are likely stronger

[24] JavaScript is a high-level, dynamic, untyped, and interpreted programming language (https://en.wikipedia.org/wiki/JavaScript).
[25] Python is a widely used high-level, general-purpose, interpreted, dynamic programming language (https://en.wikipedia.org/wiki/Python_(programming_language))

than those with static visualization, but further research needs to be done to provide stronger evidence.

The findings of this research can help researchers to better design a study in a similar learning context. This study used learning material for HTML fundamentals at a beginner level. The 90-minute learning session was not long enough to include more advanced HTML code. Longer learning sessions or more advanced learning materials may better test the effects of self-explanation with computer-based visualization technologies. More training time for self-explanation activities may also enhance their effects on learning. However, there could be a trade-off between the time required for an experimental session and information overload. Besides, the length of an experimental session may affect the participants' willingness and effort to complete the experiments. Developing learning materials in a concise but sufficient manner is critical for research using a design similar to the current study.

5.1.6 Implications for Practitioners

Self-explanation activities can be applied in many ways in training settings. These activities can be conducted in either a laboratory-supervision mode or a learner-control mode. In the first mode, the learners sit in a computer lab and follow the instructions to complete learning sessions and self-explanation activities with certain time limits, while in a learner-control mode, the learners can be anywhere they want to digest the learning materials and perform self-explanation activities without time limits. In the learner-control mode, the learners have more control over their self-explanation activities. They can use more time to practice self-explanation, for example, when students are asked to create screencasts to self-explain some subjects they are learning. They can take time to organize their thoughts and practice their explanations. These

activities can be iterative until the learners feel satisfied with their explanations. The advantage of this approach is that the learners have no time limit and without supervision they experience less awkwardness, so they can comfortably take more time to identify their knowledge gaps or revise their mental models while performing self-explanation activities. The learners may benefit by using this more free-style approach to enhance their knowledge retention and transfer. Screencasts are particularly useful for this learner-control mode of self-explanation when students are assigned to learn subject matter that lends itself to interactions with computers.

The self-explanation activities do not need to produce overt outputs, namely to self-explain out loud. In a laboratory-supervision mode, the learners can self-explain what they learned in a covert way such as self-explaining things quietly or in their mind. Covert methods could reduce the awkwardness that some research subjects commented on in the learning experience surveys.

Although every learner has his/her own way to explain things, it would be good practice to give learners guidelines or examples of high-quality self-explanation. No matter in which mode learners use to perform self-explanation, a model of good self-explanation can help learners to generate better self-explanations, which are likely to improve their learning.

5.2 Future Research

Future research can compare the effectiveness of different self-explanation modes with respect to more advanced coding such as creating animation effects. Researchers can also extend the current research by conducting a longitudinal experiment, which allows the learners to study the learning materials from beginner to intermediate levels. This extension would better test the effects of self-explanation on knowledge retention and transfer over a longer period.

Researchers can also implement computer-aided self-explanation in other knowledge domains, such as mathematics, engineering, biology, architecture or any other subjects that requires visual aids to help learners study.

5.3 Conclusions

In this study, an experimental study was conducted to determine to what extent computer skill learners can benefit from generating self-explanations with the aid of different computer-based visualization technologies. The experiment tested two common computer-based visualization technologies, screencast and screenshot applications, and also self-explanation without visualization. The two computerized visualization technologies showed promise for improving instruction with self-explanation in that performance on a learning task was substantially and significantly better than when self-explanation was not used. The study did not detect statistical differences between the three methods of stimulating self-explanation, although the pattern of results was as predicted.

Qualitative data showed that the subjects believed that self-explanation activities can be integrated into the context of learning computer skills and help them to better retain and understand the new information. Self-explanation activities can also help learners to identify their knowledge gaps, so they know how to solidify their learning. The qualitative data also revealed the learners' challenges to perform self-explanation activities. This knowledge can be used to improve the design of self-explanation implementation for future studies.

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Appendix A: Learning Materials

The learning materials were presented to the research subjects on a website created by the researcher. There were four different versions of web pages on the website, but each subject was able to access only one version. Each version of web pages was designed for each experimental group listed below.

Four presentation versions on the website

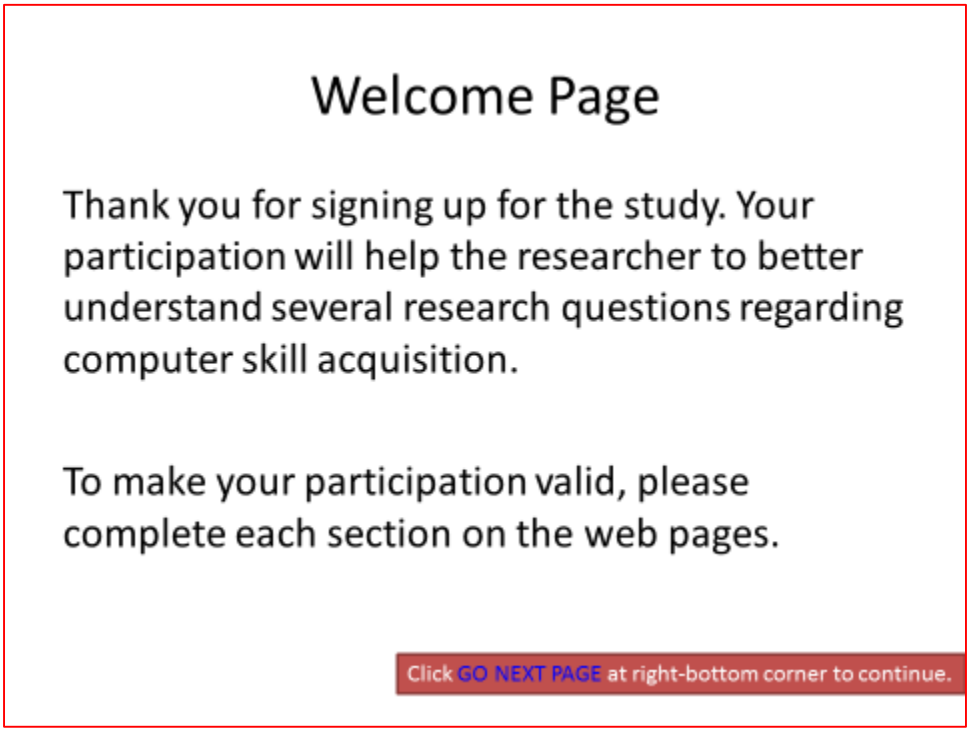
Version 1: for NOSE group

Version 2: for NVSE group (SE without visualization aid)

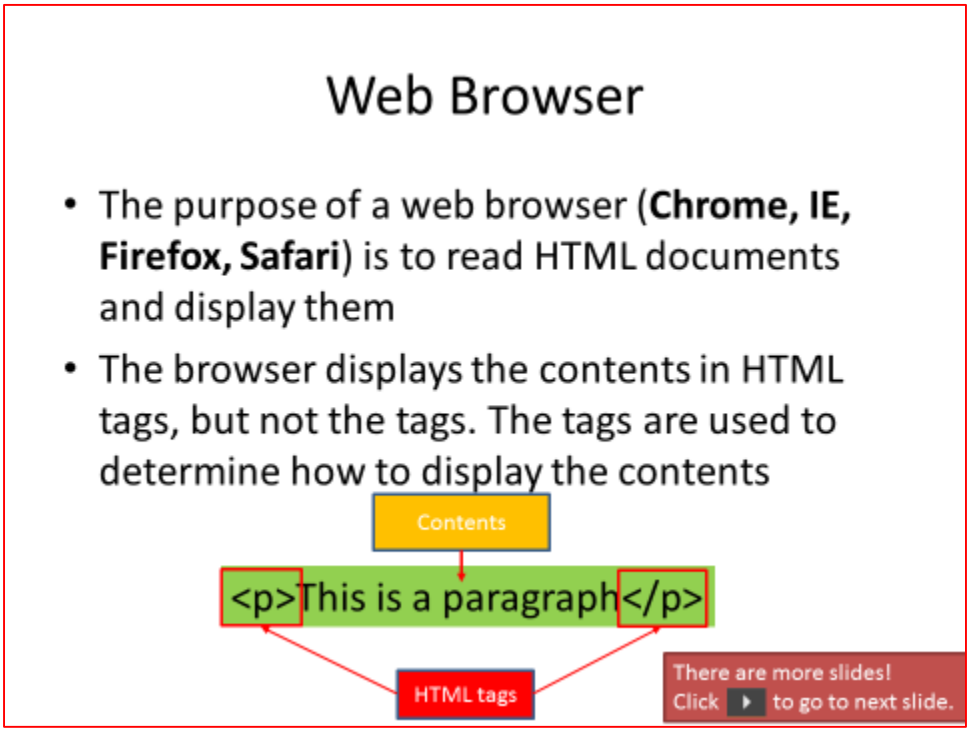
Version 3: for SSSE group (SE with screenshot visualization aid)

Version 4: for SCSE group (SE with screencast visualization aid)

Welcome page: (version 1 to 4)

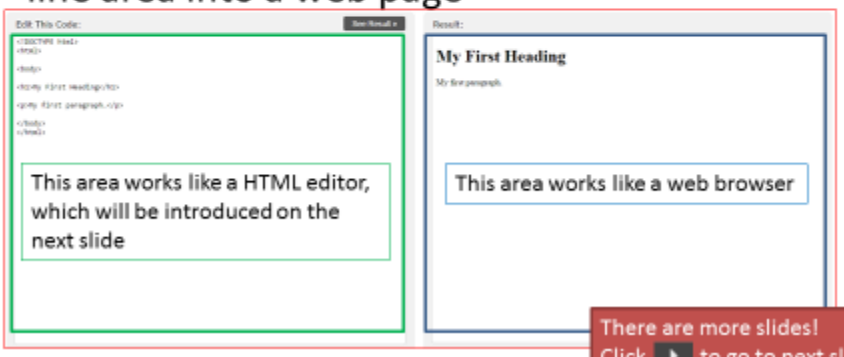


Pre-training pages (version 1 & version 2):



Web Browser

- On the other computer screen, you will find that the blue-line area works like a web browser which turns the code in the green-line area into a web page



There are more slides!
Click ▸ to go to next slide.

HTML Editor

- HTML can be edited by using a professional HTML editor like:
  - Adobe Dreamweaver
  - Microsoft Expression Web
  - CoffeeCup HTML Editor
- To learn the fundamentals of HTML , it is recommended to use a simple text editor like Notepad (PC) or TextEdit (Mac)

There are more slides!
Click ▸ to go to next slide.

HTML Editor

- On the other computer screen, you will find that the green-line area works like a HTML editor. By clicking the "See Result" button, you can see how the HTML code is presented in the blue-line area, which works like a web browser

HTML Editor

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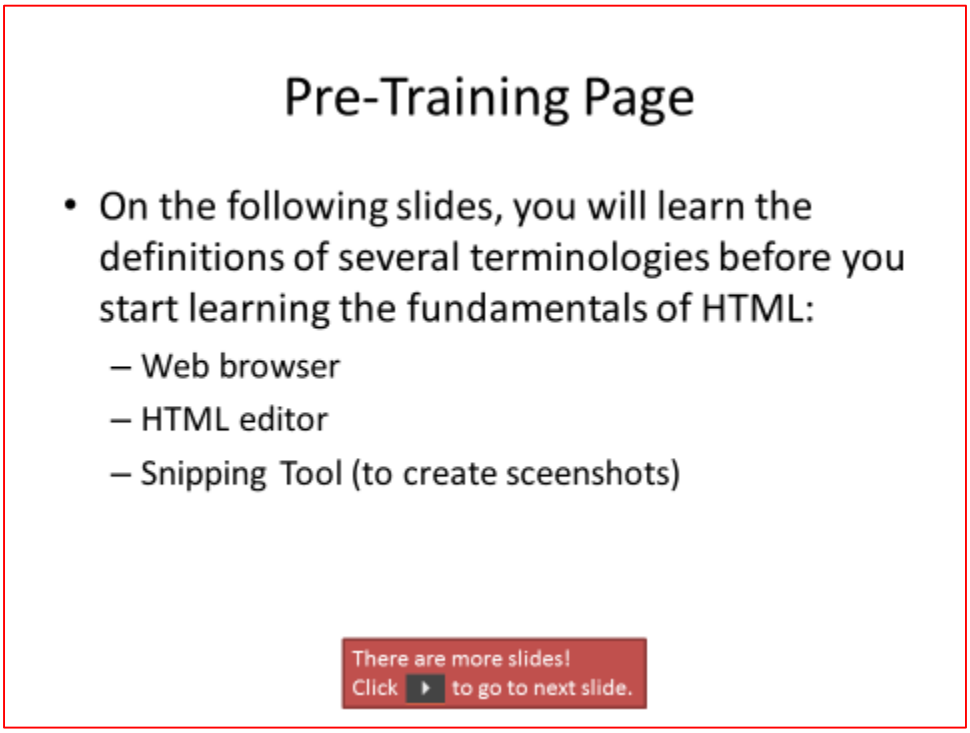
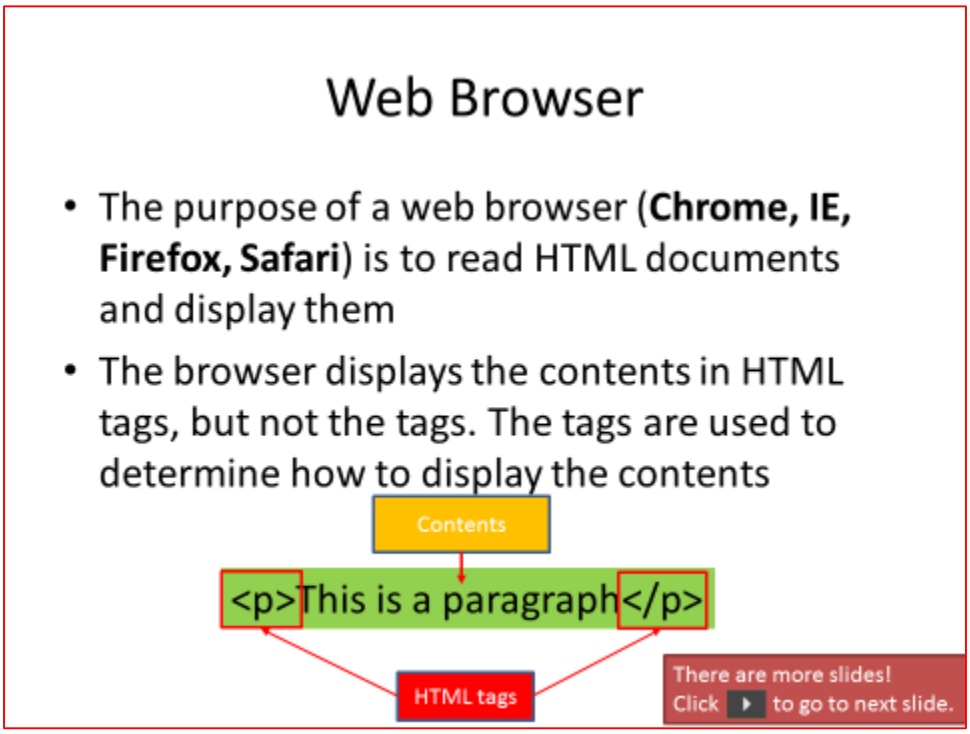
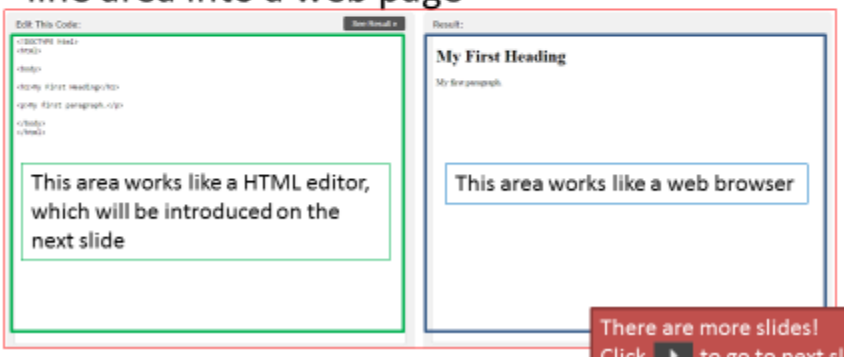
Pre-training pages (version 3):





Web Browser

- On the other computer screen, you will find that the blue-line area works like a web browser which turns the code in the green-line area into a web page



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There are more slides!
Click to go to next slide.

HTML Editor

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HTML Editor & Web Browser

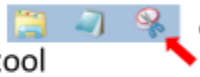
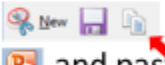
- You can always use the HTML editor and the virtual web browser to test the HTML code
- Testing the HTML code will help you to learn HTML fundamentals

Snipping Tool

- Snipping Tool is an application used to create screenshots
- A screenshot (or screengrab) is an image taken by the computer user to record visible items displayed on the monitor
- Computer screenshots can be used to demonstrate any visual part on a computer monitor
- They are often used for complementing word communication (printed or spoken words)

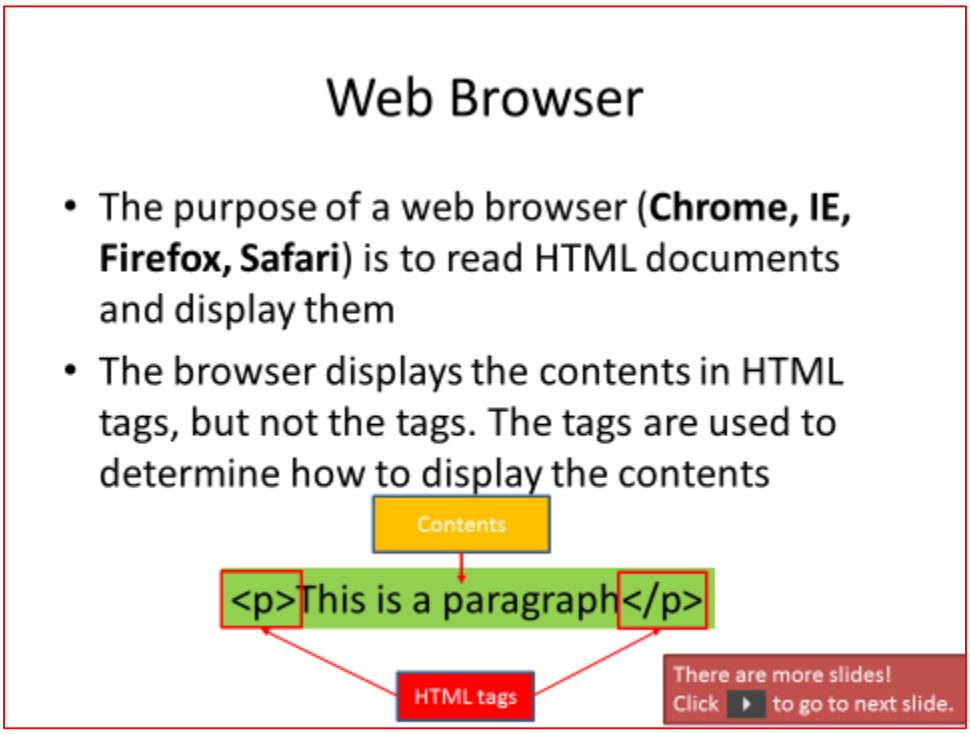
There are more slides!
Click ▸ to go to next slide.

Snipping Tool

- You will use Snipping Tool to complete several tasks in latter sections
- **Please follow the steps to capture a few screenshots**
  - Click on Snipping Tool icon  on the tool bar to launch the snipping tool
  - Click on New and click again to drag the cursor around the area you want to capture
  - Release the mouse click to capture the screenshot
  - Click on  Copy icon to copy the screenshot
  - Click on  and paste it on the a PowerPoint slide
  - Repeat the steps to capture another screenshot
  - Minimize the  window and go to next page

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

Pre-training pages (version 4):



Web Browser

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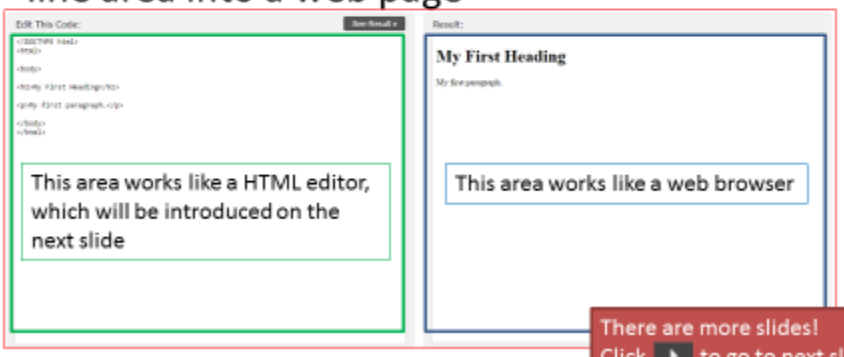

There are more slides!
Click ▸ to go to next slide.

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There are more slides!
Click ▸ to go to next slide.

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HTML Editor & Web Browser

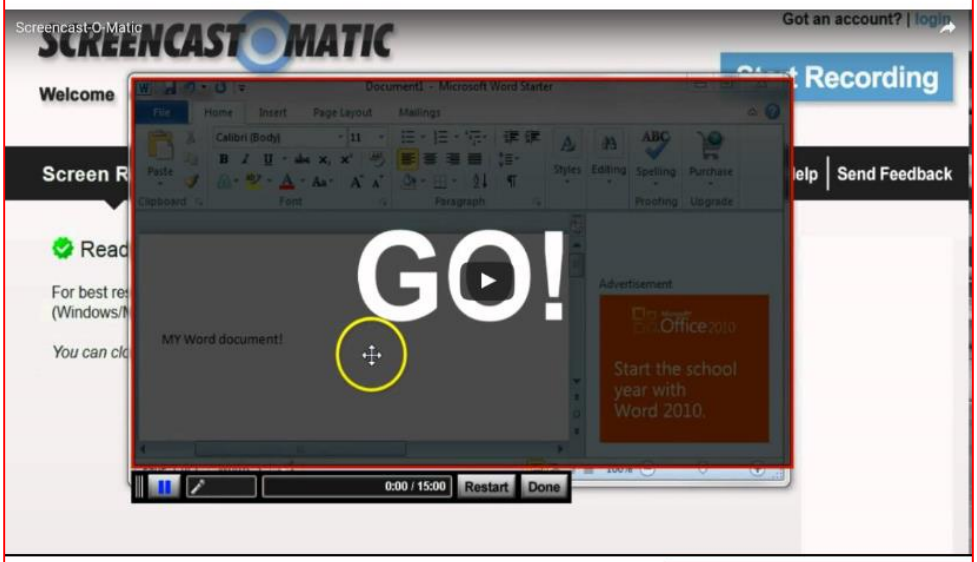
- You can always use the HTML editor and the virtual web browser to test the HTML code
- Testing the HTML code will help you to learn HTML fundamentals

Screencast-O-Matic

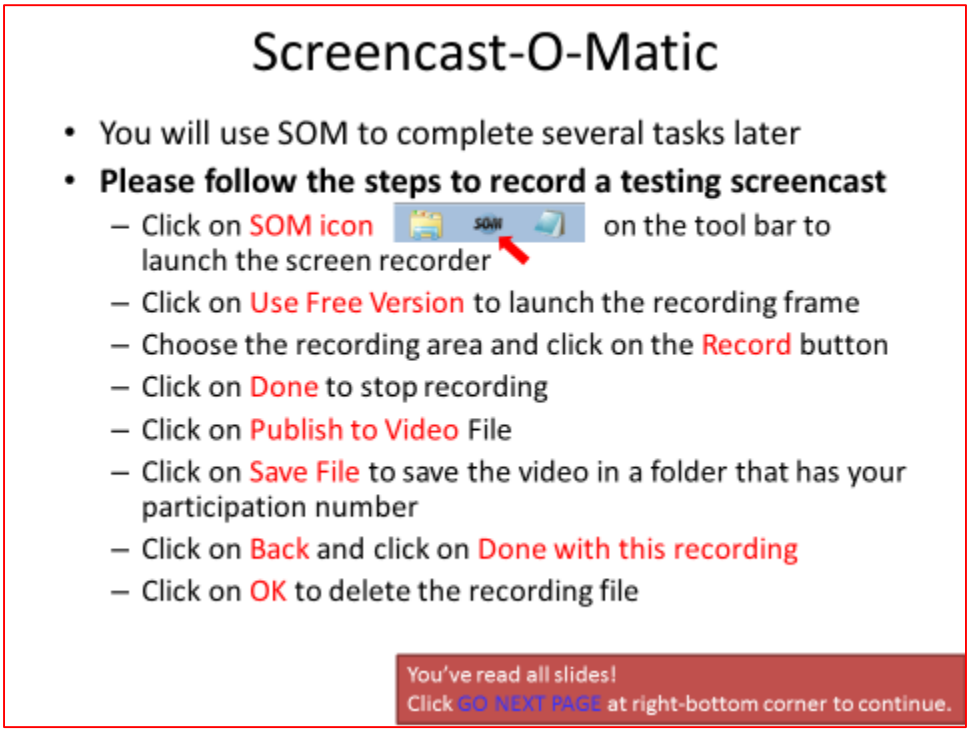
- Screencast-O-Matic is an application used to create screencast
- A screencast is a digital recording of computer screen output, also known as a video screen capture, often containing audio narration.
- A screencast is essentially a movie of the changes over time that a user sees on a computer screen, enhanced with audio narration
- Please click on the Play button to watch a short video about SOM on the next slide

There are more slides!
Click ▶ to go to next slide.

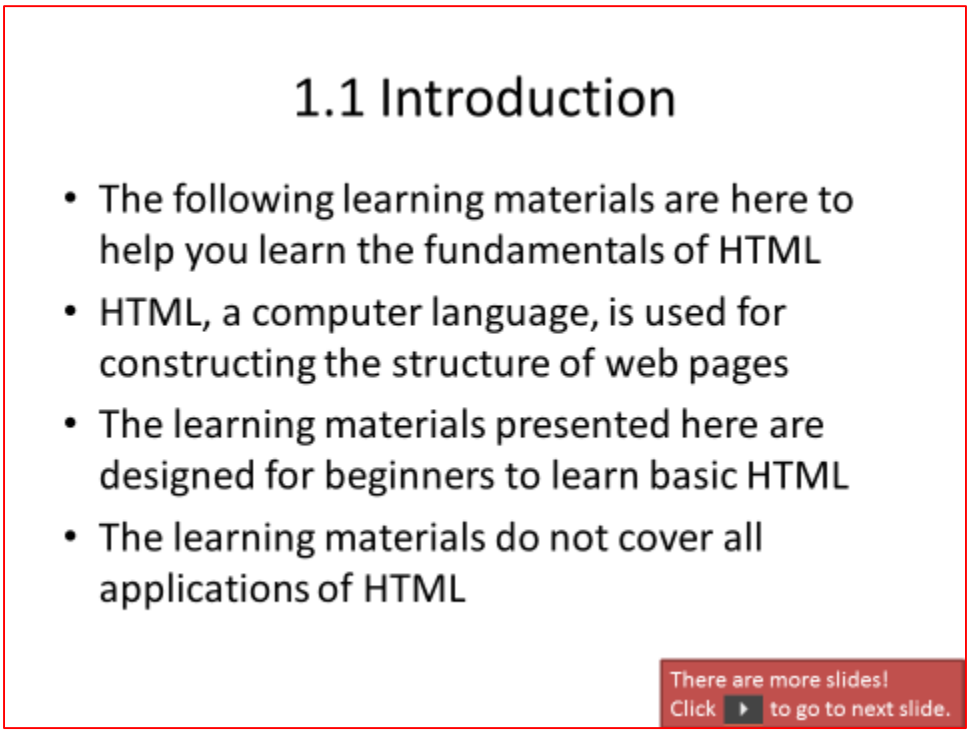
Screencast-O-Matic

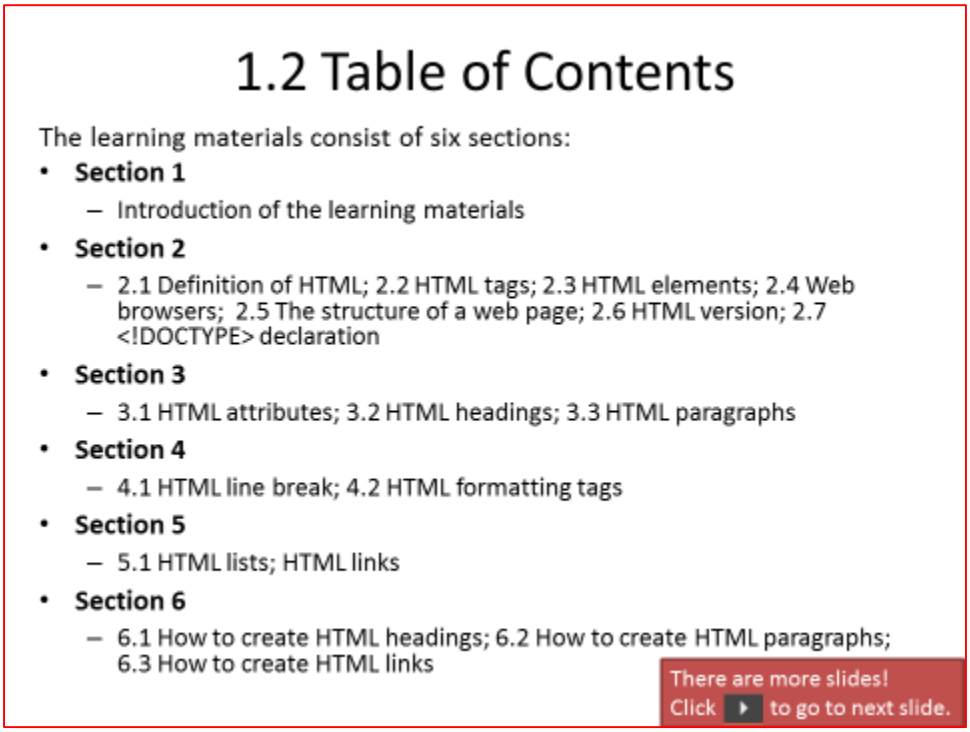


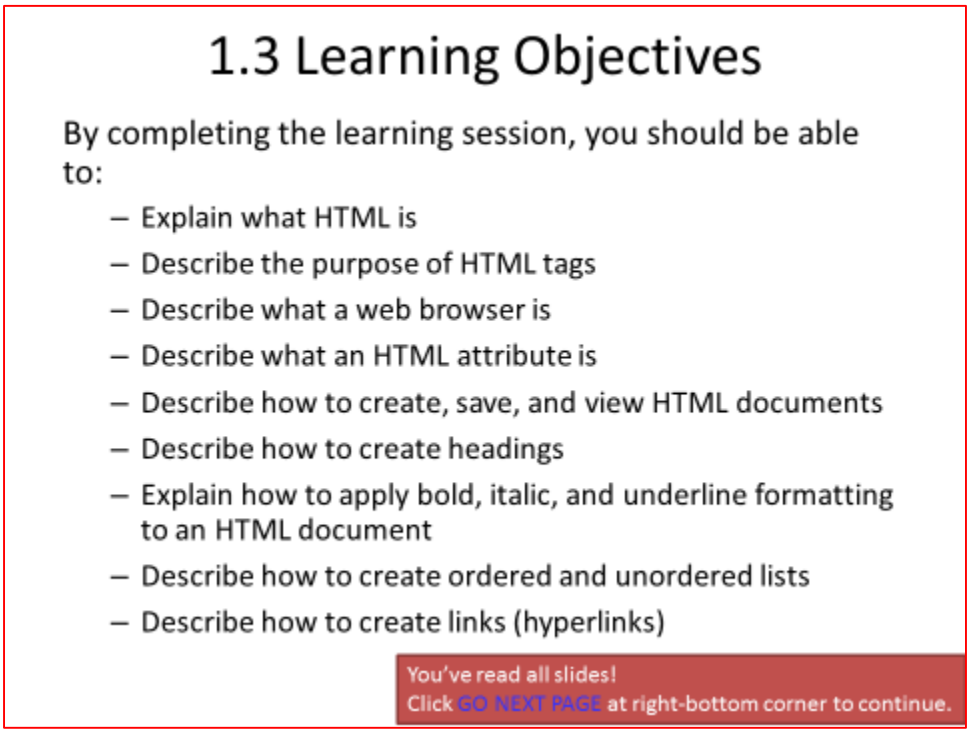
There are more slides!
Click ▶ to go to next slide.



1.1-1.3: Introduction page (version 1 to 4)







2.1-2.3: HTML, HTML tags and elements (version 1 to 4)

2.1 What is HTML?

- HTML is a language for describing the structure of web pages
- HTML stands for Hyper Text Markup Language
- HTML is called a markup language because it uses a set of markup tags
- The tags describe document content
- HTML documents contain HTML tags and plain text
- HTML documents are also called web pages

There are more slides!
Click ▸ to go to next slide.

2.2 What are HTML tags?

- HTML markup tags are:
  - usually called HTML tags
  - keywords (tag names) surrounded by angle brackets like <html>, <body> and
  - used in pairs like and
- The first tag (e.g.,) in a pair is the start tag, the second tag (e.g.,) is the end tag
- The end tag is written like the start tag, with a forward slash before the tag name

There are more slides!
Click ▸ to go to next slide.

2.2 What are HTML tags?

- Start and end tags are also called opening tags and closing tags
- Therefore, in general, HTML tags appear as: <tagname>content</tagname>
  - e.g., This is a paragraph
- HTML tags are used to define HTML elements which are the building blocks of web pages
- There are many kinds of elements in HTML, but only some common elements are included in the learning materials

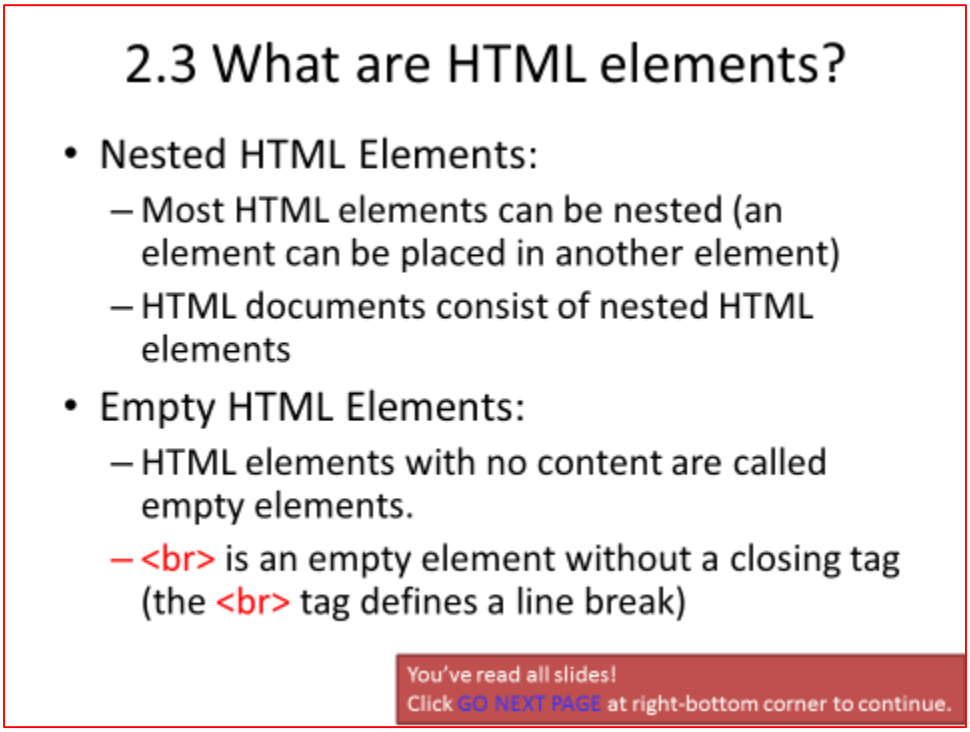
There are more slides!
Click ▸ to go to next slide.

2.3 What are HTML elements?

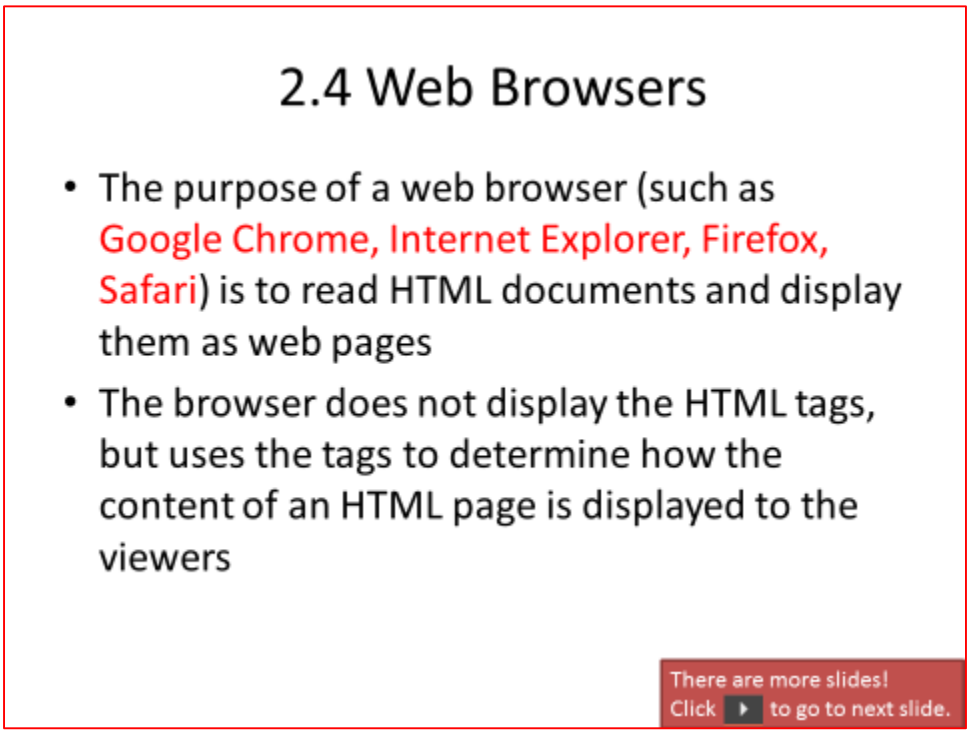
- "HTML tags" and "HTML elements" are often used to describe the same thing
- But strictly speaking, an HTML element is everything between the start tag and the end tag, including the tags
  - For example, this is a paragraph element:

    ** This is a paragraph **

There are more slides!
Click ▸ to go to next slide.



2.4-2.5: Web browsers and the structure of a web page (version 1 to 4)



2.4 Web Browsers

- HTML code of an HTML document:

```
<!DOCTYPE html>
<html>
    <head>
        <title>My First Page</title>
    </head>
<body>

<h1>My First Heading</h1>

<p>My first paragraph.</p>

</body>
</html>
```

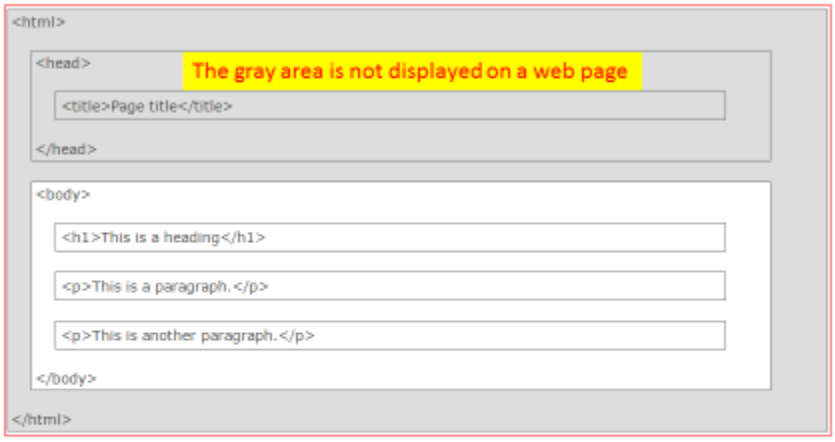
There are more slides!
Click to go to next slide.

2.4 Web Browsers

- HTML code (on previous slide) displayed on a web browser:

There are more slides!
Click to go to next slide.

2. 5 The structure of a web page



- The image shown above is a visualization of an HTML page structure
- Each HTML document (each web page) is constructed by HTML elements

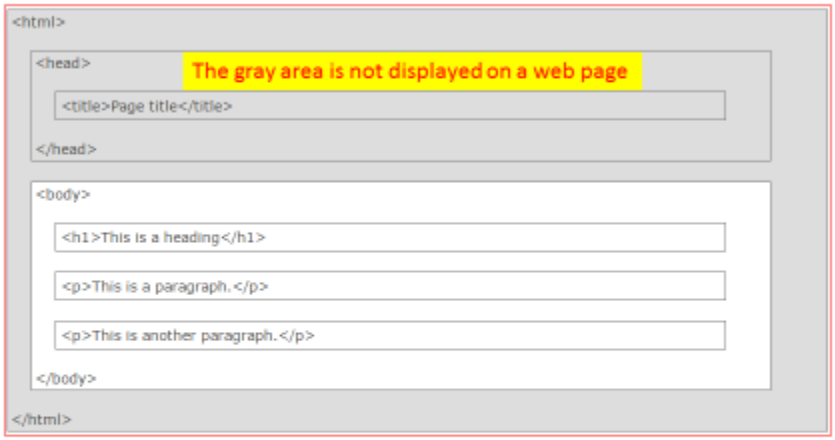
There are more slides!
Click ▸ to go to next slide.

2. 5 The structure of a web page

- The <html> is the root element, which has two main nested elements, <head> and <body>
- The <head> element is a container for metadata (data about data)
- HTML metadata is information about the HTML document such as title, styles and other meta information
- Metadata is not displayed on a web page
- Only the elements nested in the <body> element are displayed by a web browser

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

2. 5 The structure of a web page



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There are more slides!
Click ▸ to go to next slide.

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You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

2.6-2.7: HTML version, DOCTYPE declaration (version 1 to 4)

2.6 HTML Versions

- Since the early days of the web, there have been many versions of HTML
- The latest version of HTML is HTML5

Version	Year
HTML	1991
HTML 2.0	1995
HTML 3.2	1997
HTML 4.01	1999
XHTML	2000
HTML5	2014

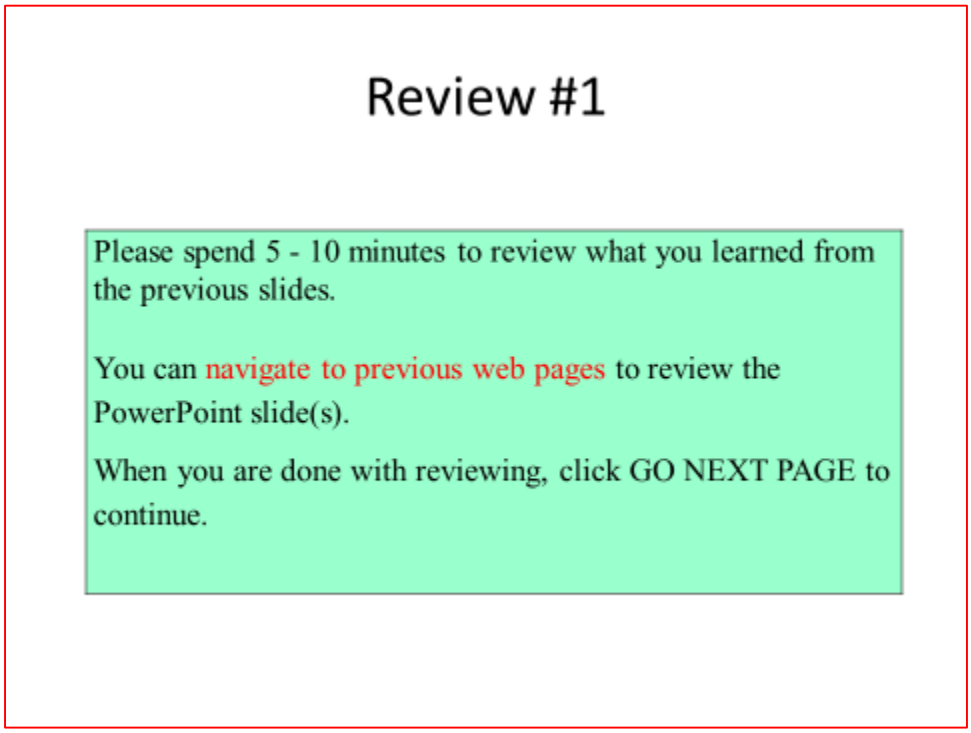
There are more slides!
Click ▸ to go to next slide.

2.7 <!DOCTYPE> declaration

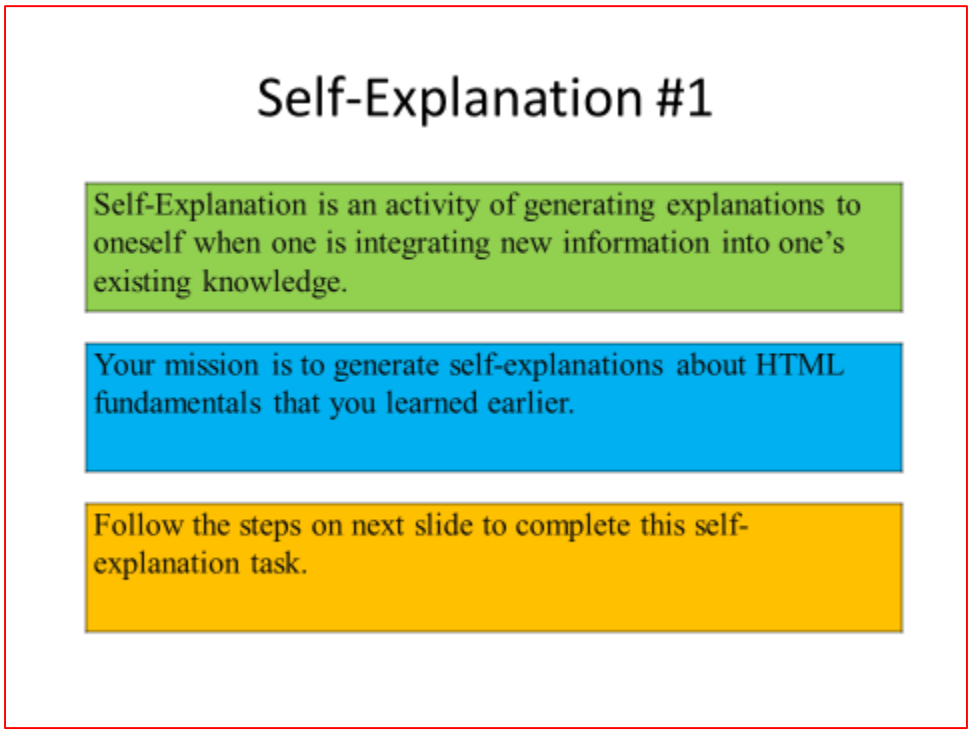
- All HTML documents must start with a type declaration
- The <!DOCTYPE> declaration helps the browser to display a web page correctly
- There are different document types on the web
- To display a document correctly, the browser must know both type and version.
- The <!DOCTYPE> declaration for **HTML5** is **<!DOCTYPE html>**

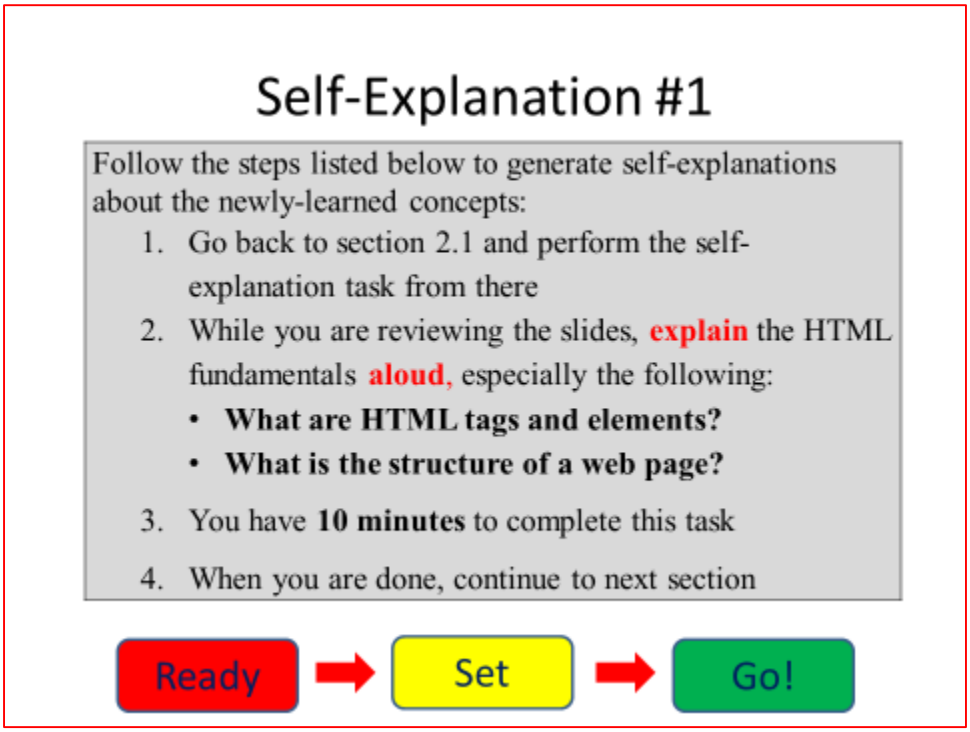
You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

Review #1 (version 1):

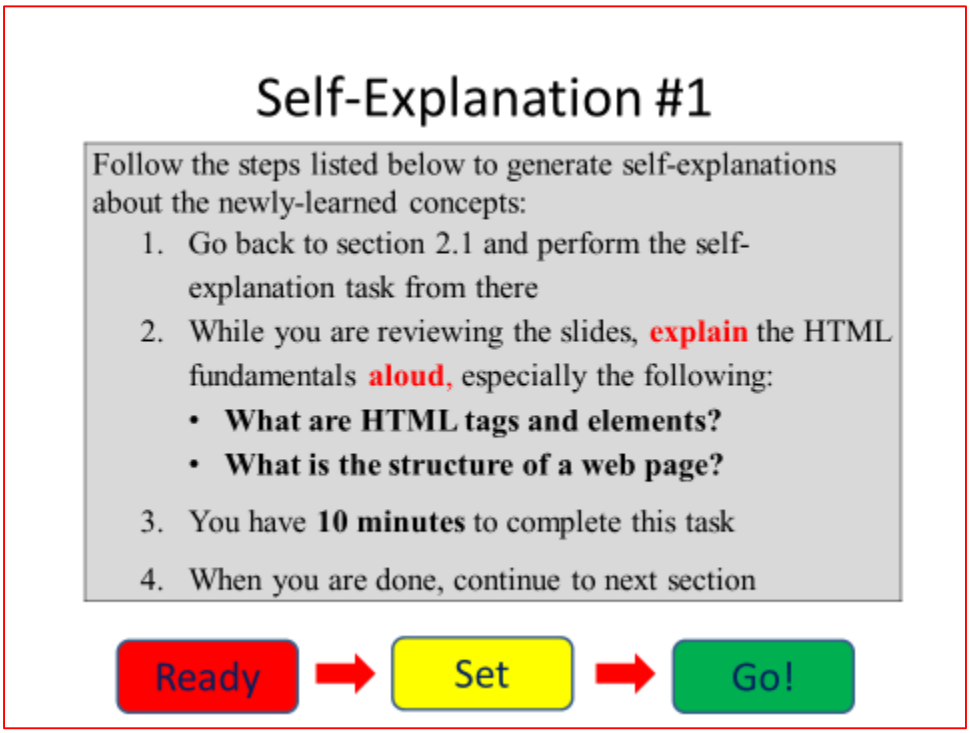


Self-Explanation #1 (version 2):





Self-Explanation #1 (version 3):



Self-Explanation #1

You can follow the steps listed below to generate self-explanations about the newly-learned concepts:

1. Review the slides in the previous web pages
2. Organize important pieces of information in your mind
3. Use the Snipping Tool to capture screenshots from the **Editor and Browser window** as the visualization aid
4. Copy and paste the captured screenshots on PowerPoint slides
5. Use the PPT slides to **self-explain** (think aloud) the HTML fundamentals listed on the next slide

There are more slides!
Click to go to next slide.

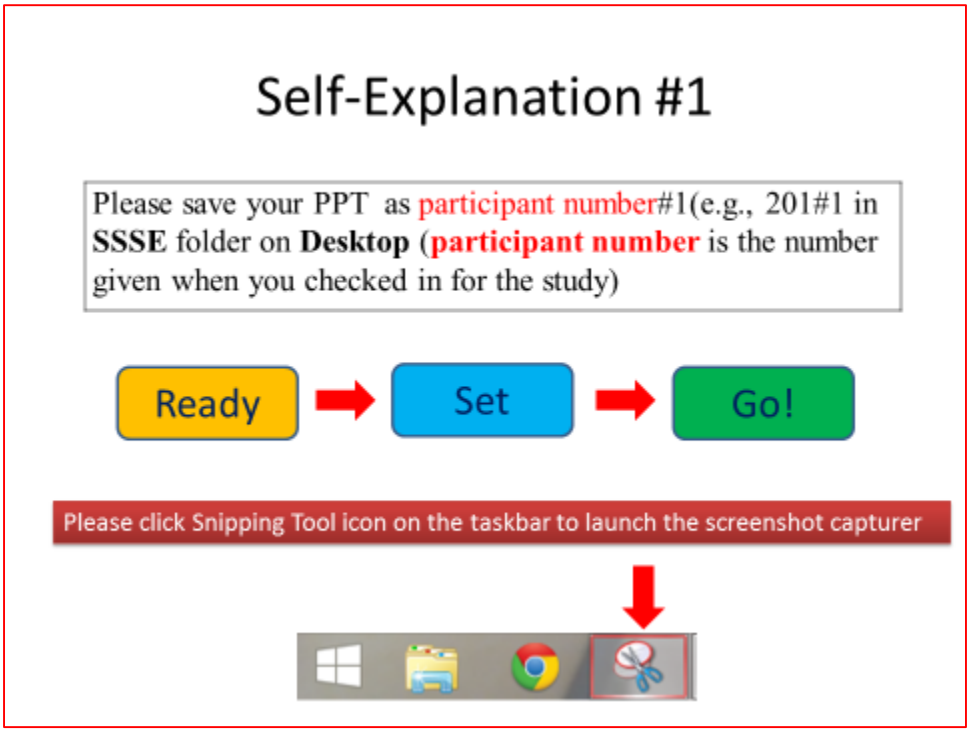
Self-Explanation #1

You have **10 minutes** to review the learning materials and use the screenshots to help you self-explain the following concepts :

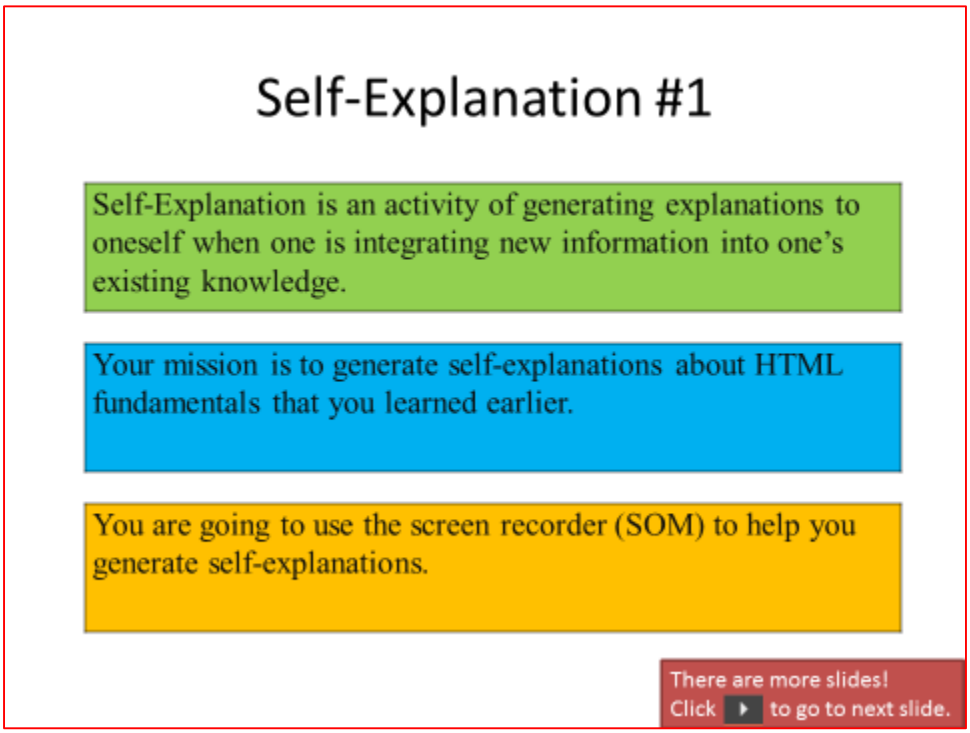
- **What are HTML tags and elements?**
- **What is the structure of a web page?**

You can navigate to previous web pages to review the PowerPoint slide(s) to help you complete this task

There are more slides!
Click to go to next slide.



Self-Explanation #1 (version 4):



Self-Explanation #1

You can follow the steps listed below to generate self-explanations about the newly-learned concepts:

1. Review the slides in the previous web pages
2. Organize important pieces of information in your mind
3. Use the screencast recorder as the visualization aid to help you explain the concepts
4. Record a screencast when you are self-explaining

There are more slides!
Click ▸ to go to next slide.

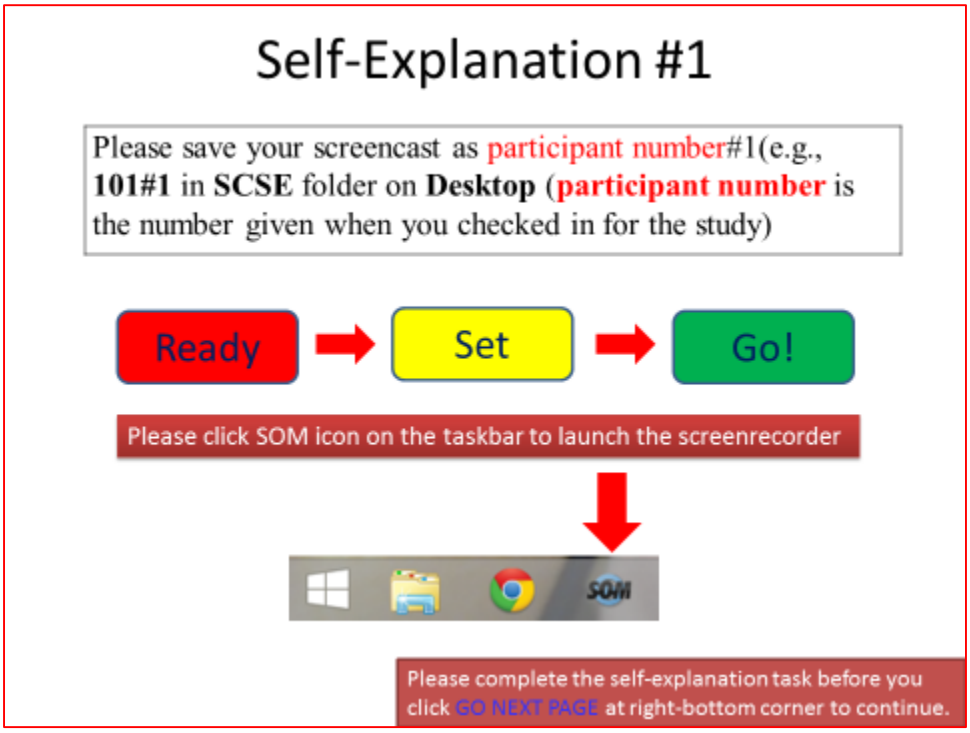
Self-Explanation #1

You have **10 minutes** to review the learning materials and create a short screencast to self-explain the following concepts:

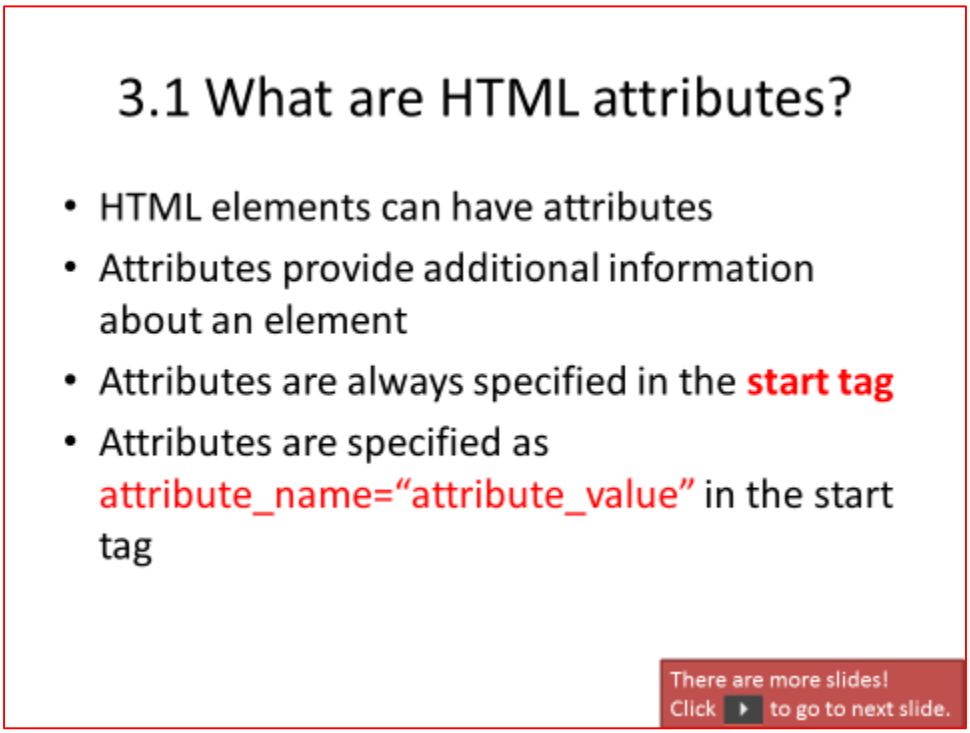
- **HTML tags and HTML elements**
- **The structure of a web page**

You can go to previous web pages to review what you learned

There are more slides!
Click ▸ to go to next slide.



3.1-3.3: HTML attributes, headings and paragraphs (version 1 to 4)



3.1 What are HTML attributes?

Attribute example:

- THIS IS A PARAGRAPH
- The paragraph element shown above has a **title** attribute and is displayed on a web page as THIS IS A PARAGRAPH
- When a user moves the cursor over the paragraph, the information "About HTML attributes" is shown

There are more slides!
Click ▸ to go to next slide.

3.1 What are HTML attributes?

- Below is a list of some attributes often used on a HTML element:

Attribute	Description
title	Specifies extra information about an element (displayed as a tool tip)
src	Specifies the source of an image
href	Specifies the URL (web address) for a link
id	Specifies a unique id for an element

There are more slides!
Click ▸ to go to next slide.

3.1 What are HTML attributes?

- Attribute values should always be enclosed in quotes
- **Double** style quotes are the most common, but single style quotes are also allowed.
- Example: <img src="0001.jpg">, the src attribute specifies the source of an image

There are more slides!
Click ▸ to go to next slide.

3.2 What are HTML headings?

- Headings are defined with the <h1> to <h6> tags
- <h1> defines the most important heading
  <h6> defines the least important heading
- H1 headings should be used as main headings, followed by H2 headings, then the less important H3 headings, and so on

There are more slides!
Click ▸ to go to next slide.

3.2 What are HTML headings?

- Headings are useful:
  - Search engines use your headings to index the structure and content of your web pages
  - Since users may skim your page by its headings, it is important to use headings to show the document structure
- HTML heading tags should be used for headings only. Don't use heading tags merely to make text BIG or BOLD

There are more slides!
Click ▸ to go to next slide.

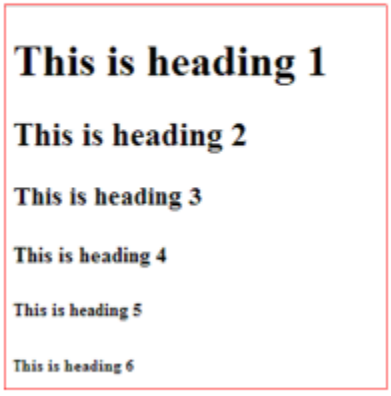
3.2 What are HTML headings?

- Examples for HTML headings:

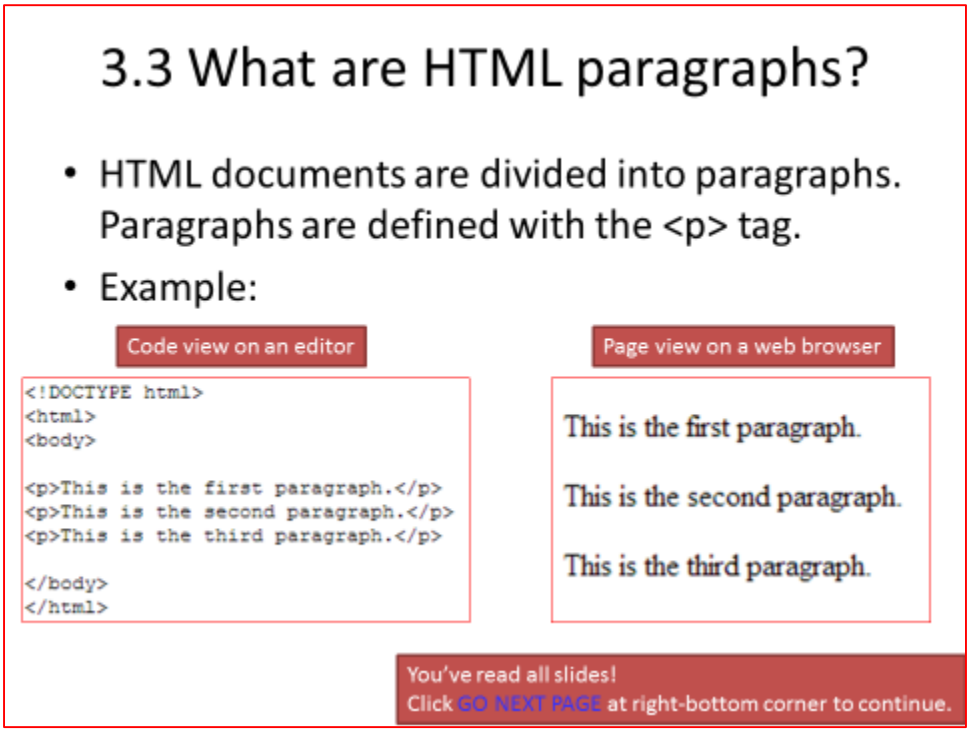
Code view on an editor

```
<!DOCTYPE html>
<html>
<body>

<h1>This is heading 1</h1>
<h2>This is heading 2</h2>
<h3>This is heading 3</h3>
<h4>This is heading 4</h4>
<h5>This is heading 5</h5>
<h6>This is heading 6</h6>

</body>
</html>
```

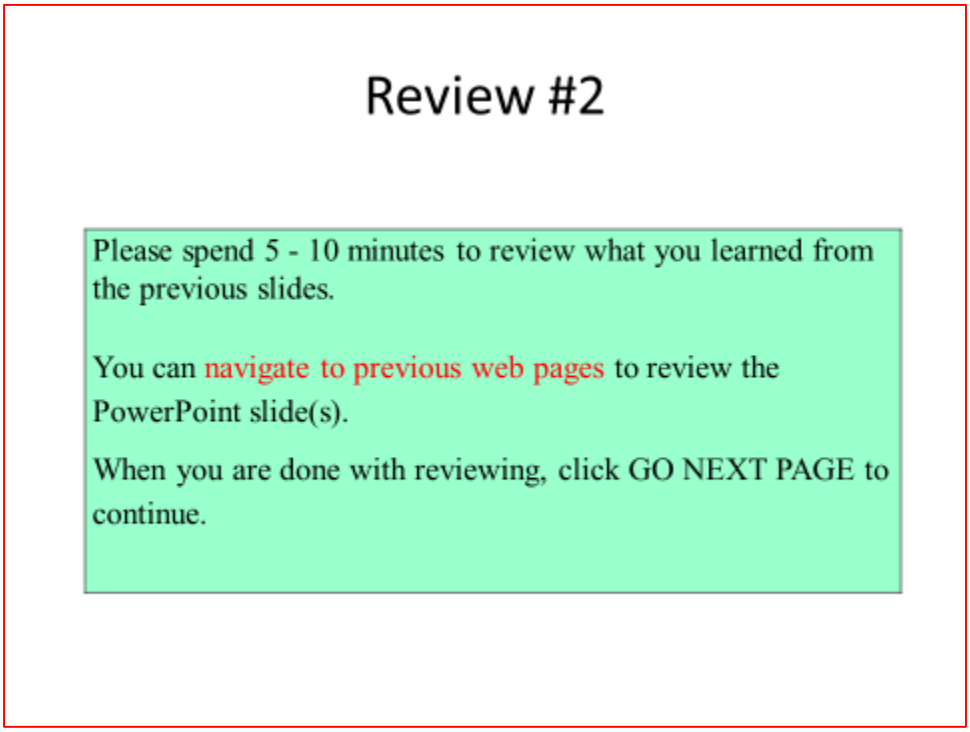
Page view on a web browser



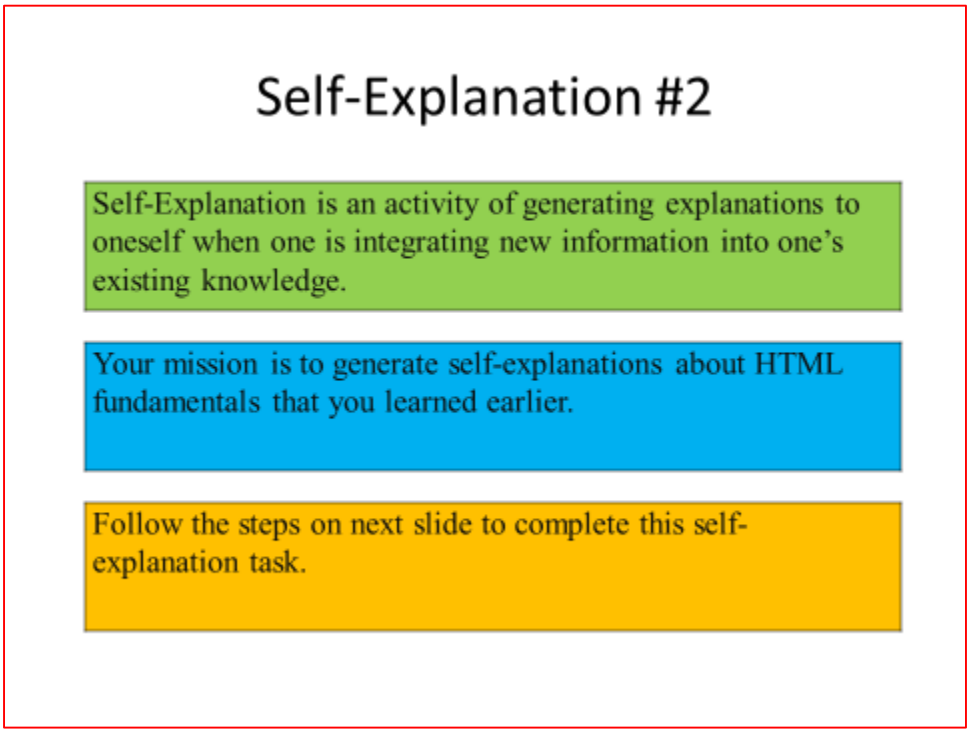
There are more slides!
Click ▸ to go to next slide.

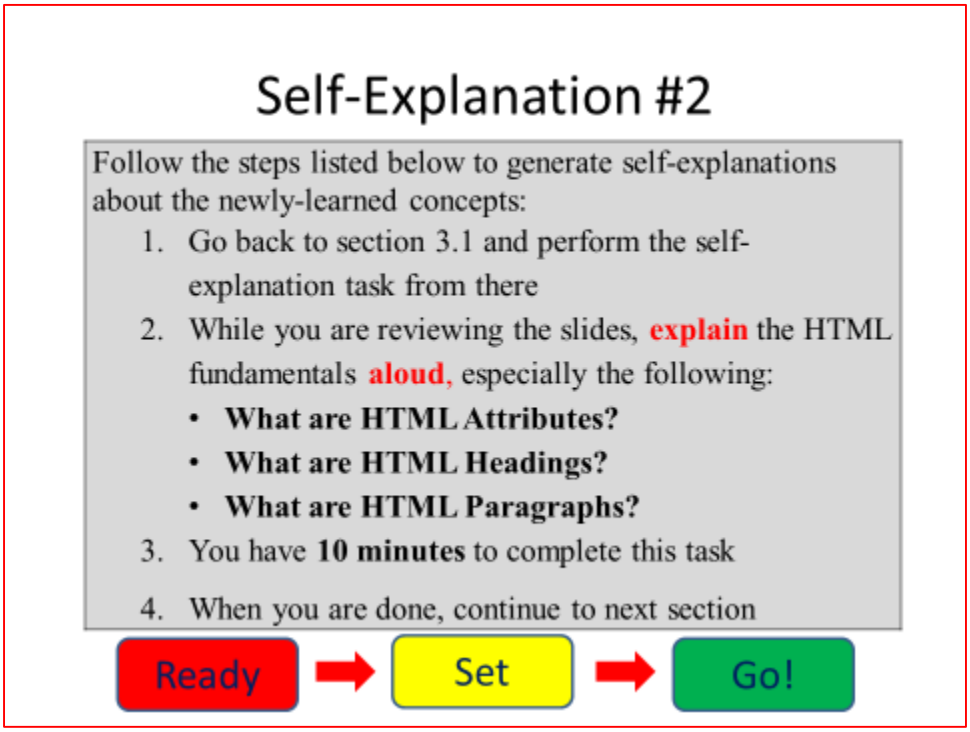


Review #2 (version 1)

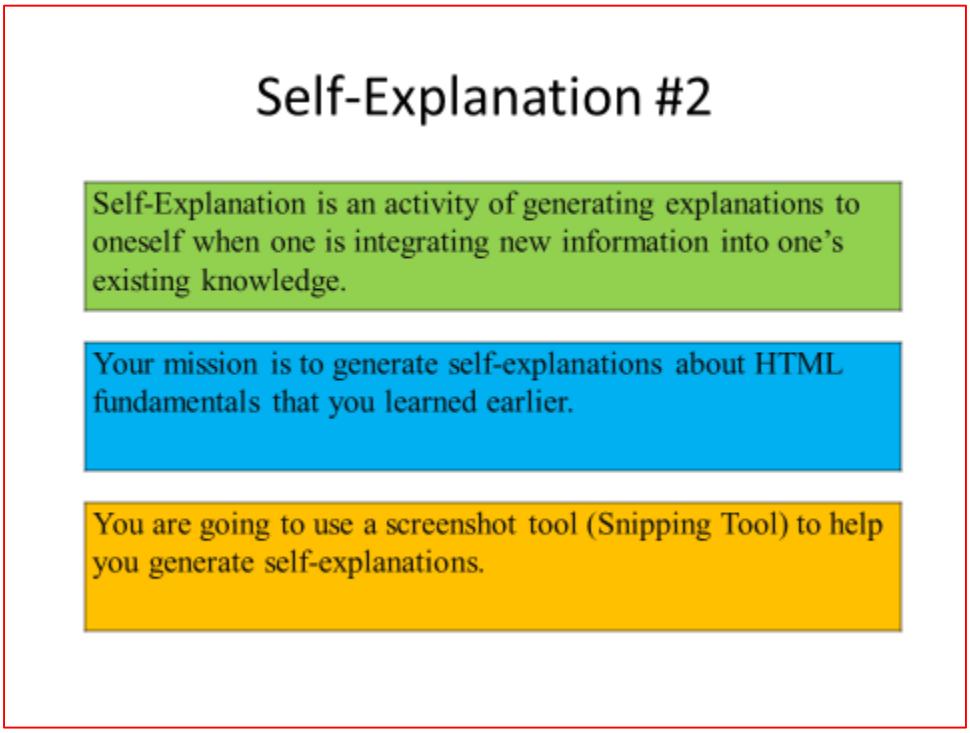


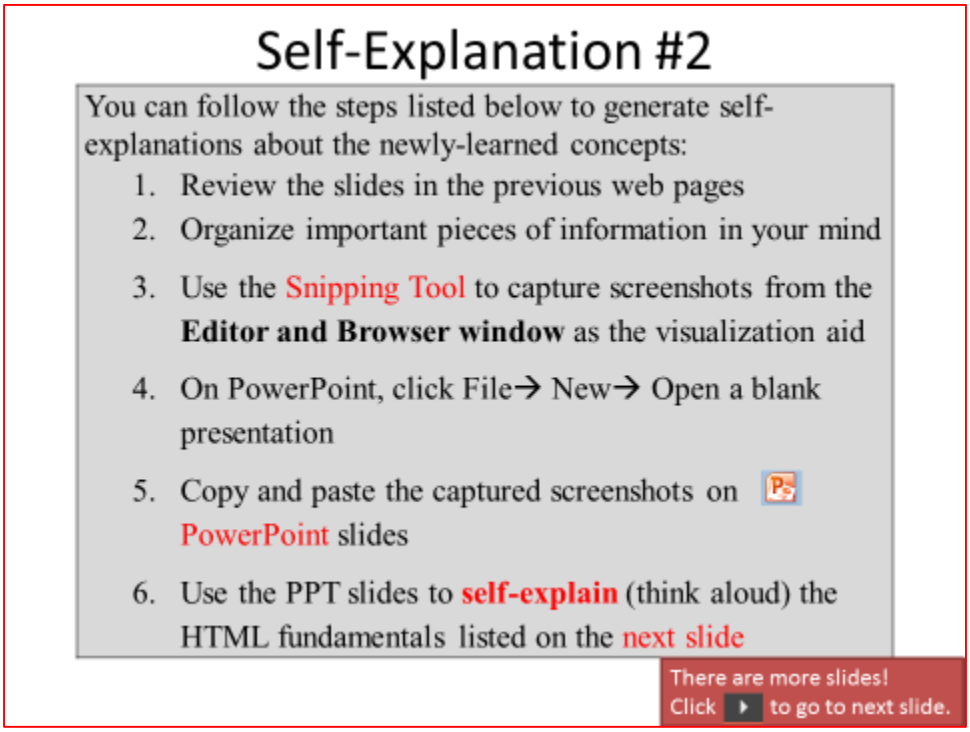
Self-explanation #2 (version 2)





Self-explanation #2 (version 3)





Self-Explanation #2

You have **10 minutes** to review the learning materials and use the screenshots to help you self-explain the following concepts :

- **What are HTML Attributes?**
- **What are HTML Headings?**
- **What are HTML Paragraphs?**

You can navigate to previous web pages to review the PowerPoint slide(s) to help you complete this task

There are more slides!
Click ▸ to go to next slide.

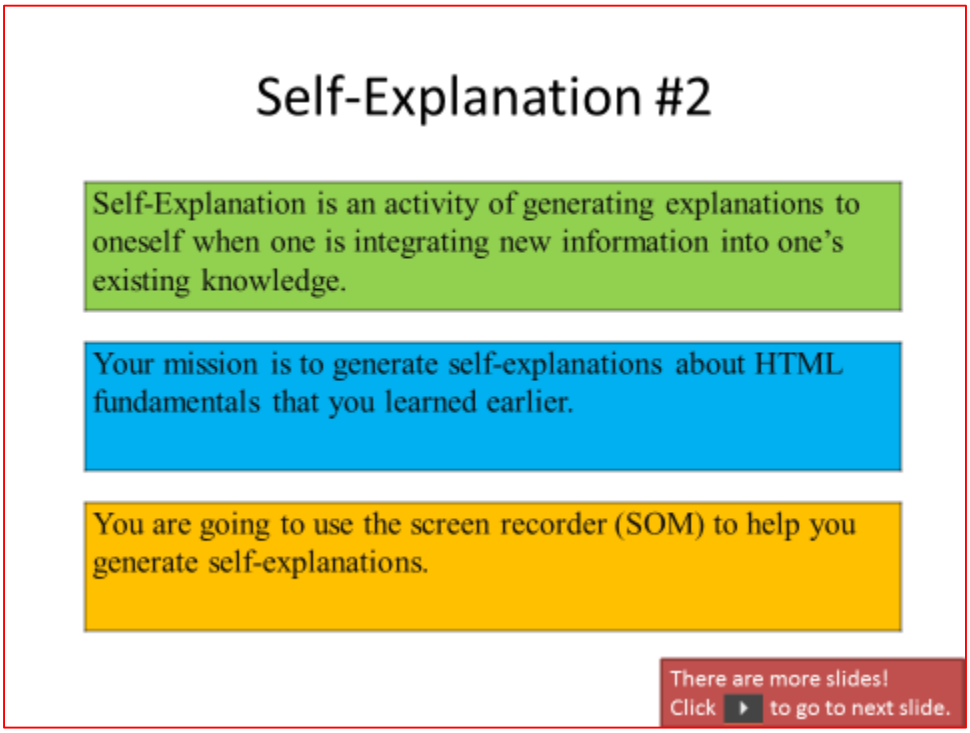
Self-Explanation #2

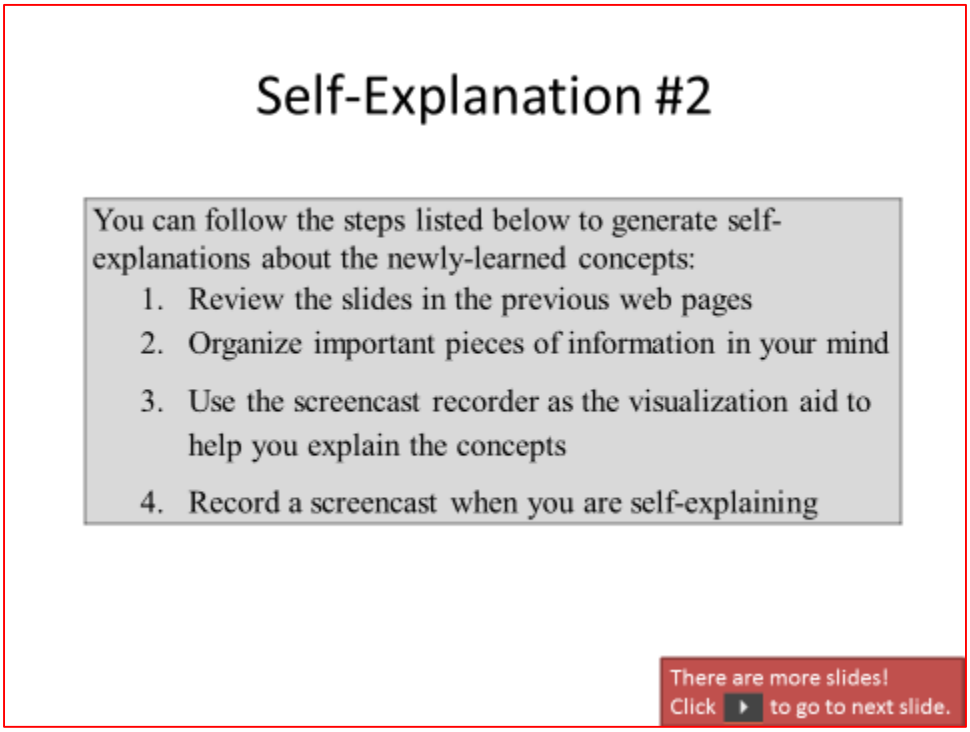
Please save your PPT as participant number#2(e.g., 201#2 in **SSSE** folder on **Desktop** (**participant number** is the number given when you checked in for the study)

Ready → Set → Go!

Please click Snipping Tool icon on the taskbar to launch the screenshot capturer

Self-explanation #2 (version 4)





Self-Explanation #2

You have 10 minutes to review the learning materials and create a short screencast to self-explain the following concepts:

- **HTML Attributes**
- **HTML Headings**
- **HTML Paragraphs**

You can go to previous web pages to review what you learned

There are more slides!
Click ▸ to go to next slide.

Self-Explanation #2

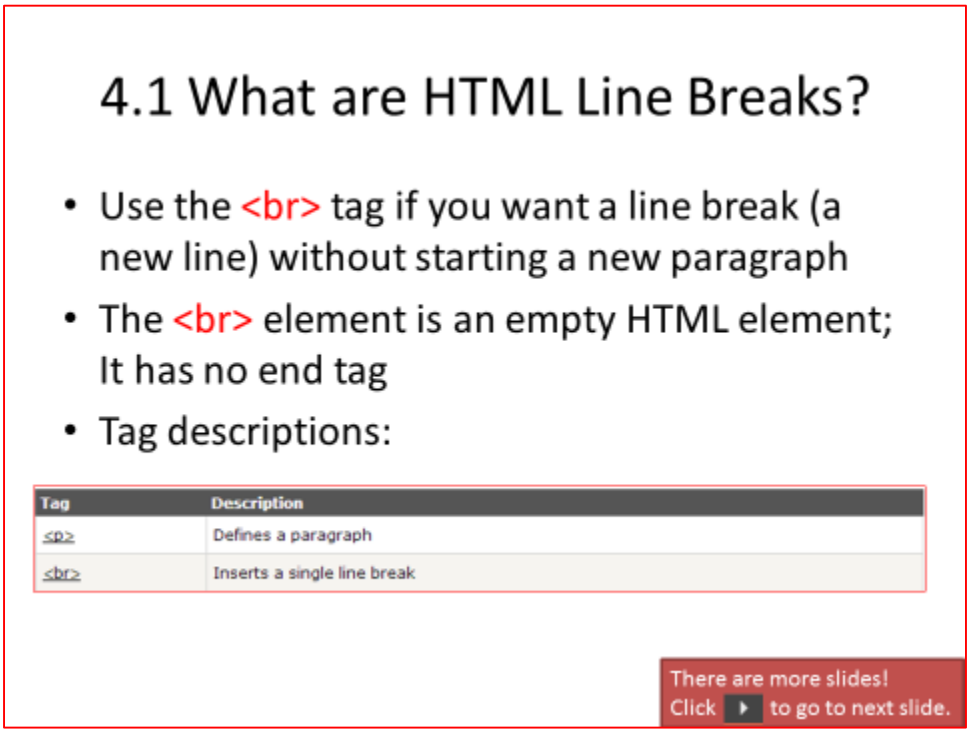
Please save your screencast as participant number#2(e.g., **101#2** in **SCSE** folder on **Desktop** (**participant number** is the number given when you checked in for the study)

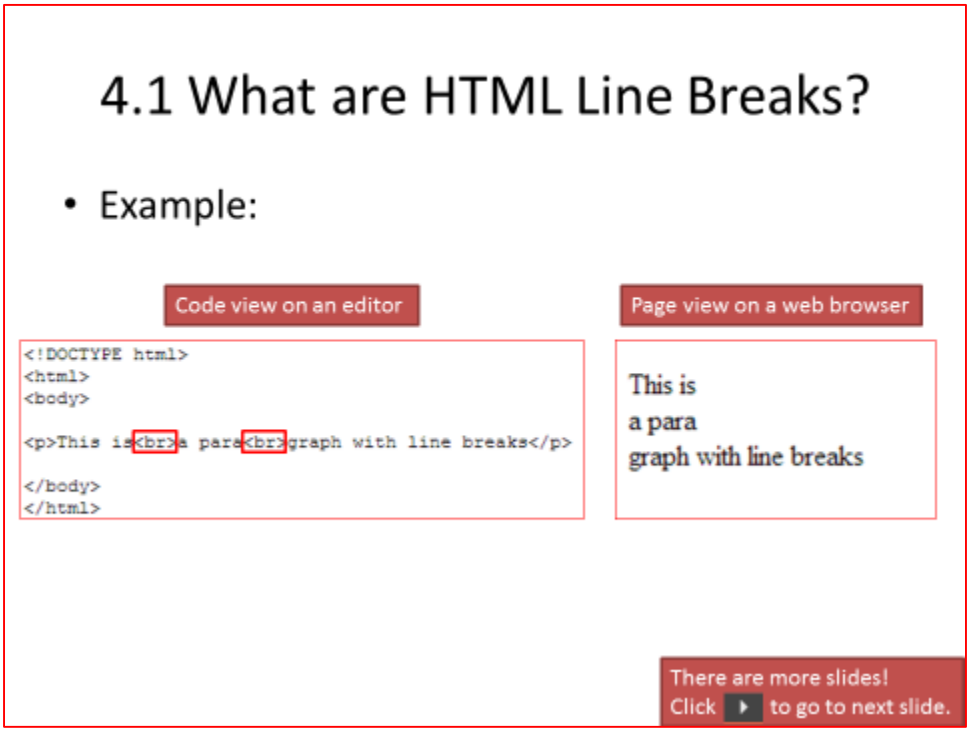
Ready → Set → Go!

Please click SOM icon on the taskbar to launch the screenrecorder

Please complete the self-explanation task before you click GO NEXT PAGE at right-bottom corner to continue.

4.1-4.2: HTML line break (version 1 to 4)





4.2 What are HTML Formatting Tags?

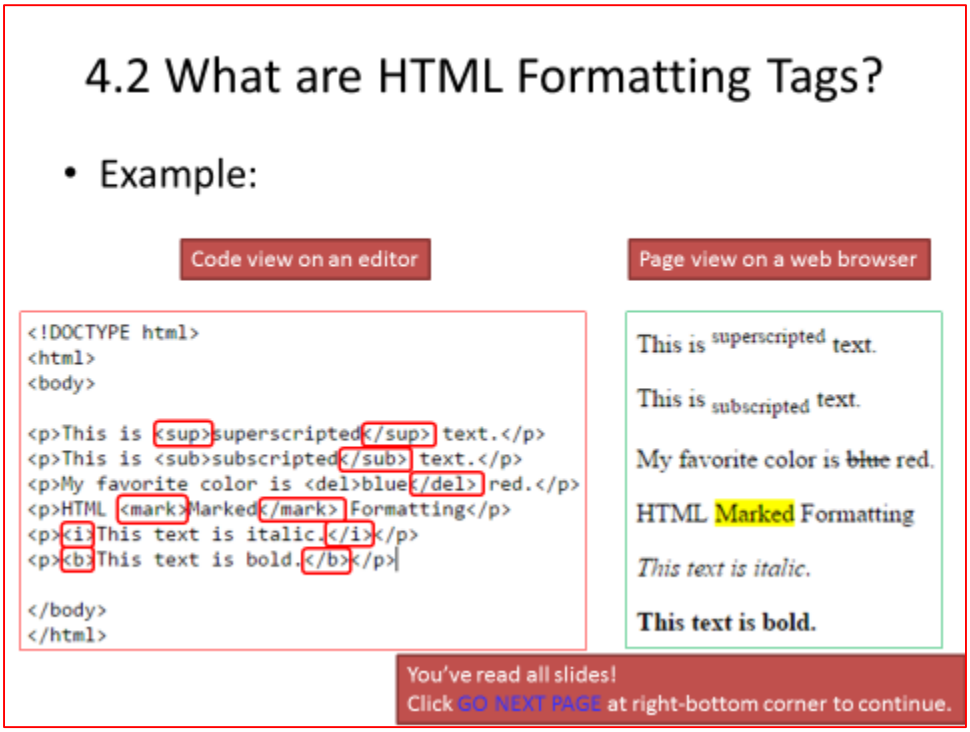
- HTML uses tags like <b> or <i> for formatting text to be displayed as **bold** or *italic*
- These HTML tags are called formatting tags
- Formatting tags were designed to display special **types of text**

There are more slides!
Click to go to next slide.

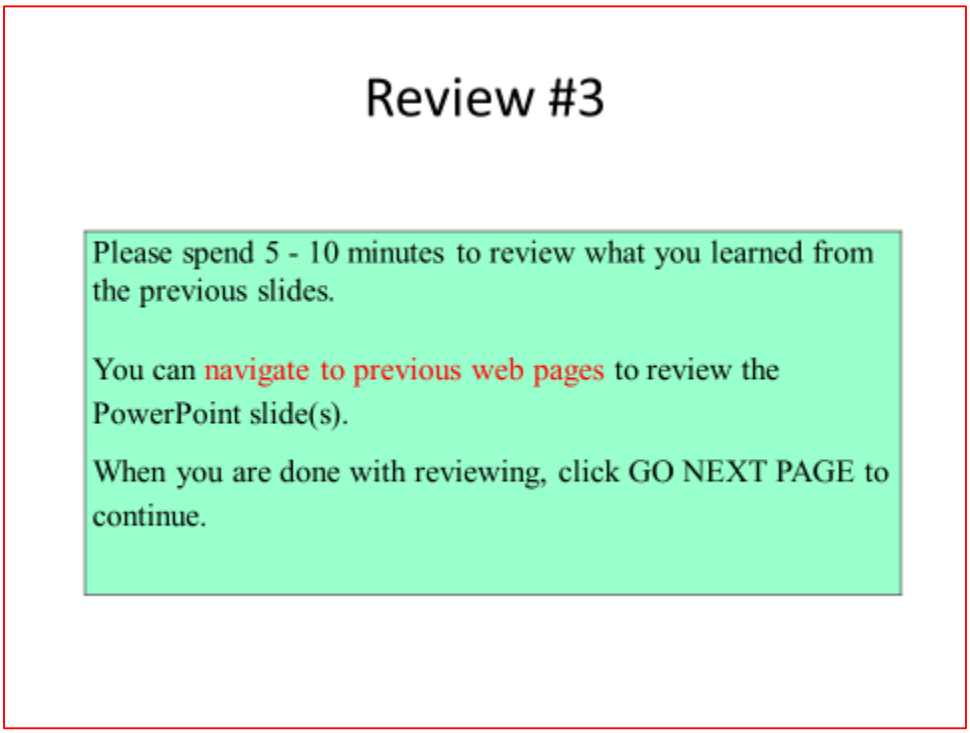
4.2 What are HTML Formatting Tags?

- The <sup> tag defines superscripted text
- The <sub> tag defines subscripted text
- The <del> tag defines deleted text
- The <mark> tag defines marked or highlighted text
- The <i> tag defines italic text
- The <b> tag defines bold text

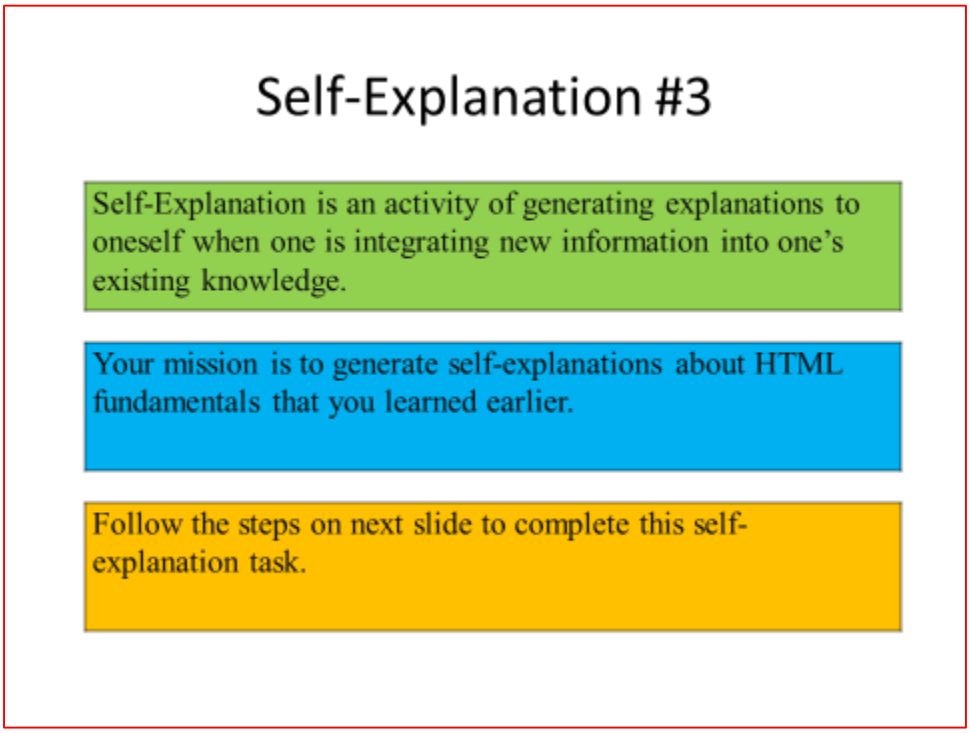
There are more slides!
Click to go to next slide.

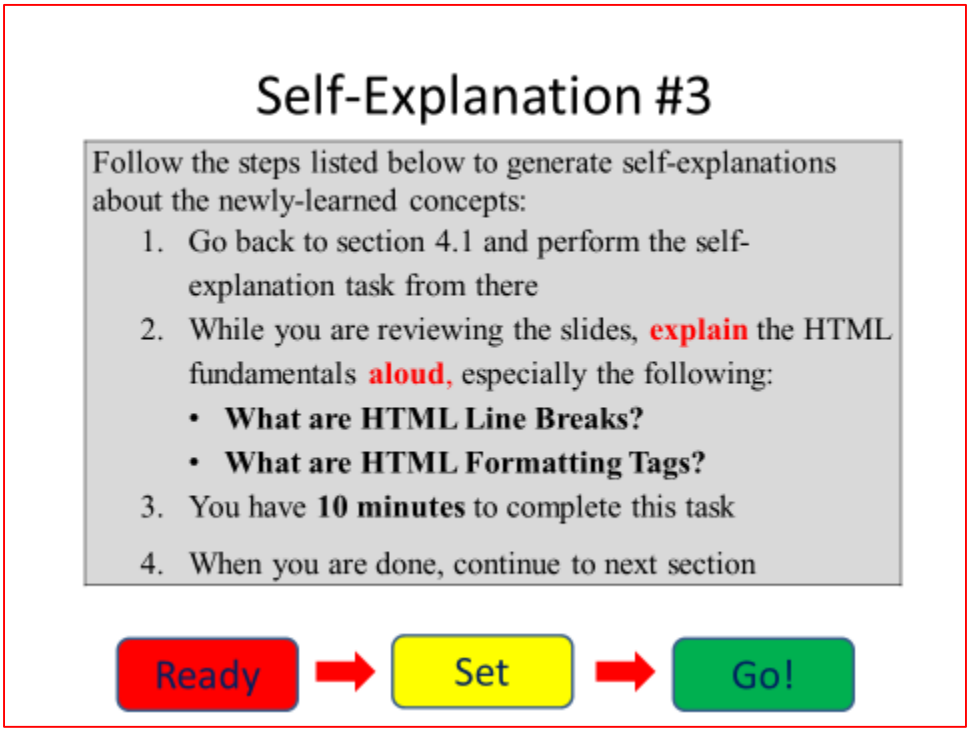


Review #3 (version 1)

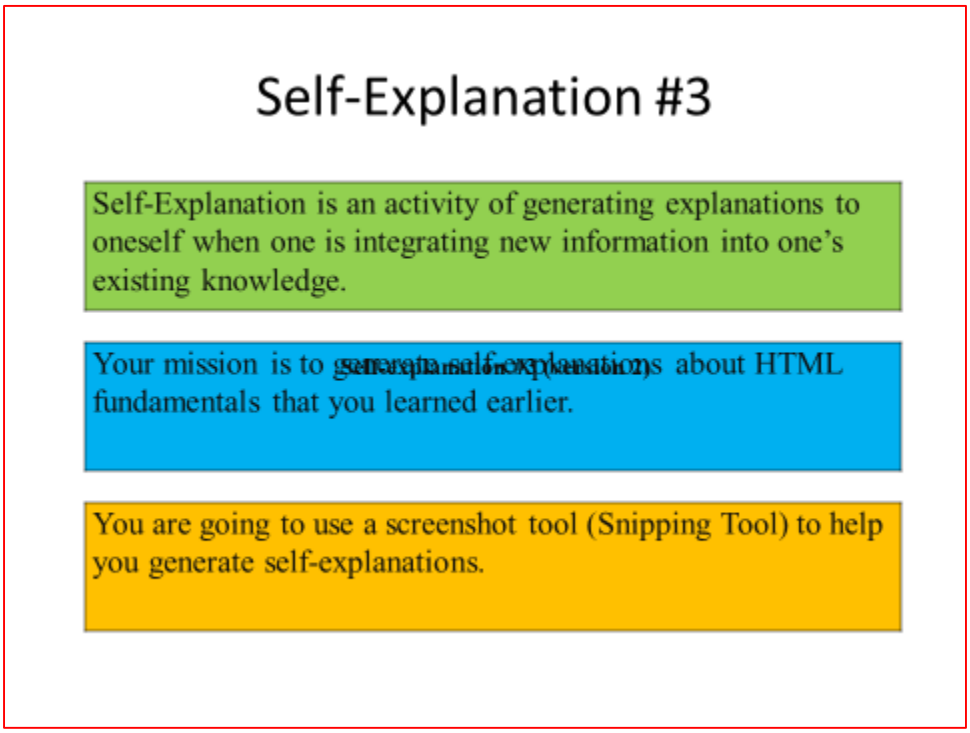


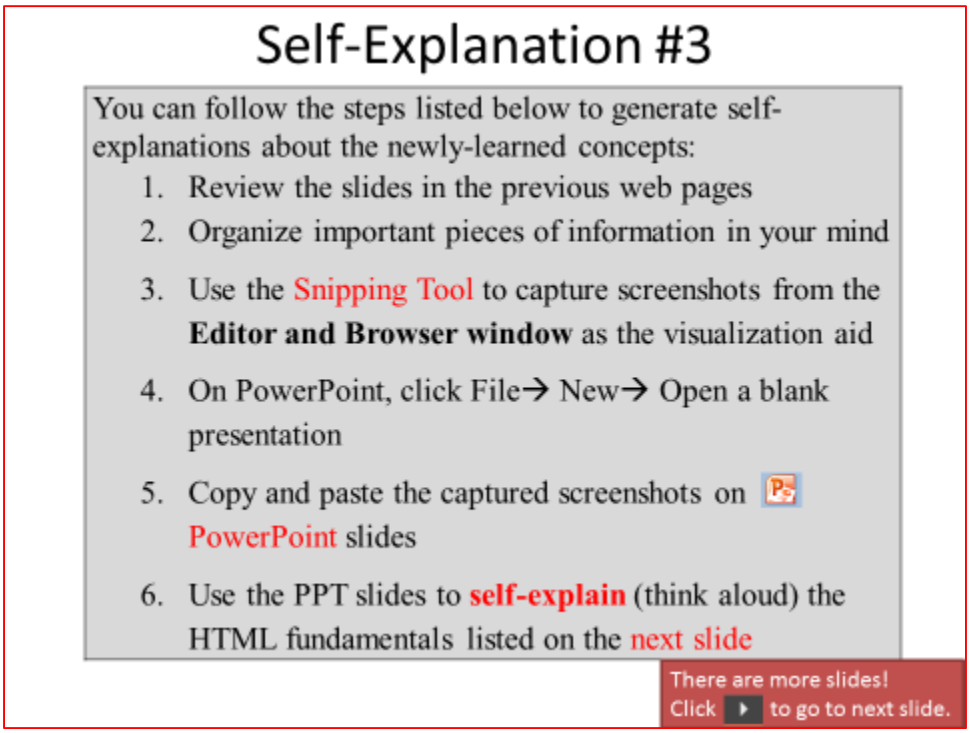
Self-explanation #3 (version 2)





Self-explanation #3 (version 3)





Self-Explanation #3

You have **10 minutes** to review the learning materials and use the screenshots to help you self-explain the following concepts :

- What are HTML Line Breaks?
- What are HTML Formatting Tags?

You can navigate to previous web pages to review the PowerPoint slide(s) to help you complete this task

There are more slides!
Click ▸ to go to next slide.

Self-Explanation #3

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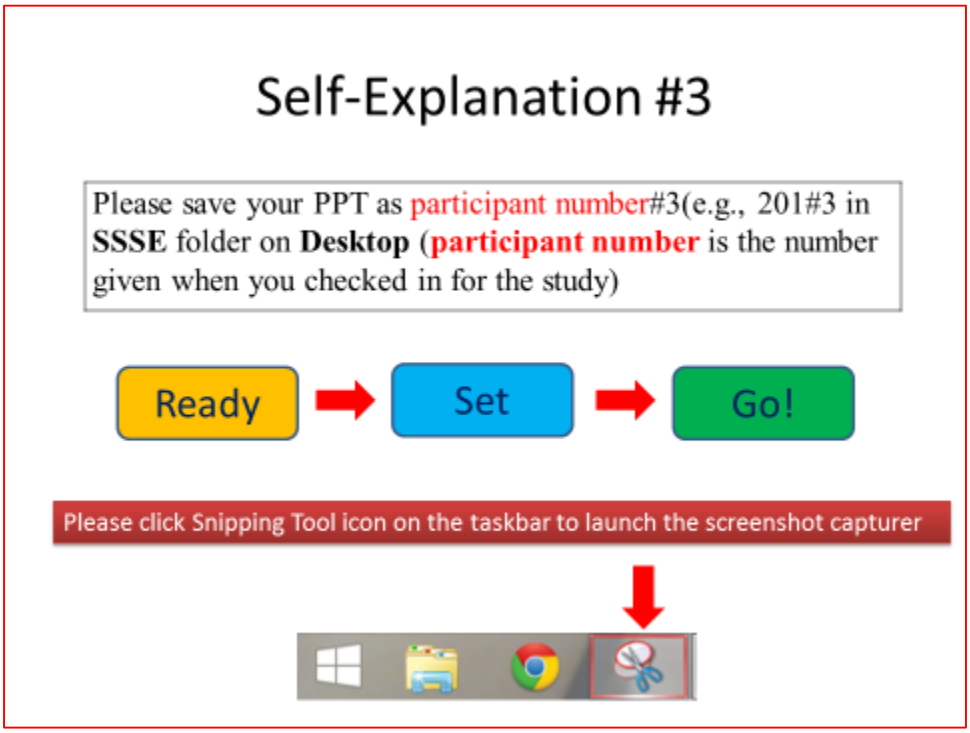
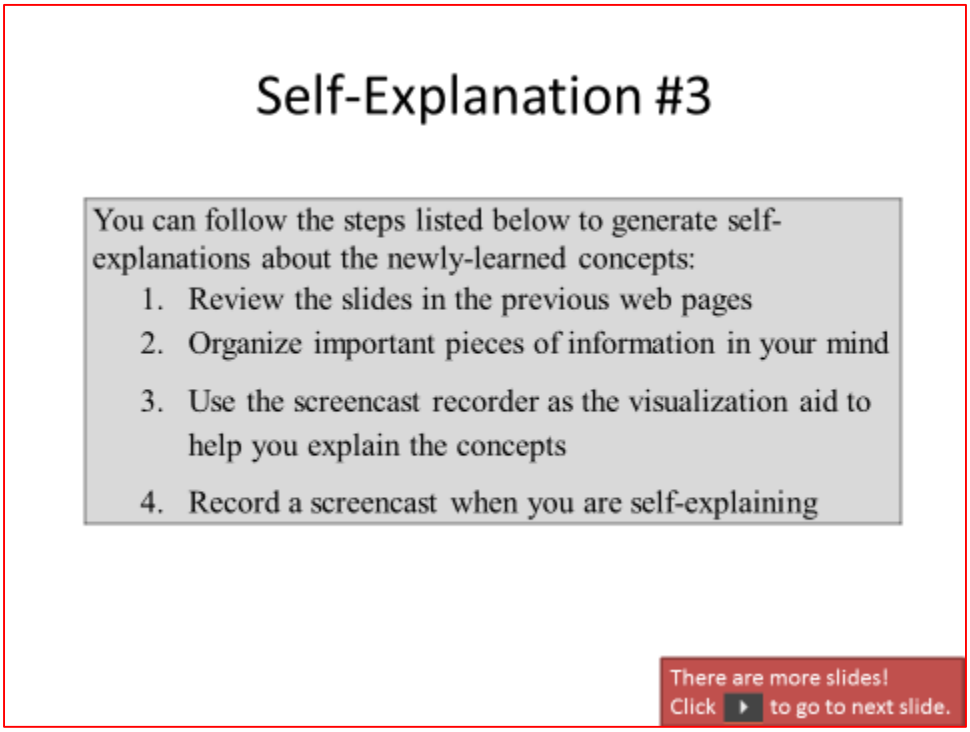
Ready → Set → Go!

Please click Snipping Tool icon on the taskbar to launch the screenshot capturer

Self-explanation #3 (version 4)





Self-Explanation #3

You have 10 minutes to review the learning materials and create a short screencast to self-explain the following concepts:

- **HTML Line Breaks**
- **HTML Formatting Tags**

You can go to previous web pages to review what you learned

There are more slides!
Click ▸ to go to next slide.

Self-Explanation #3

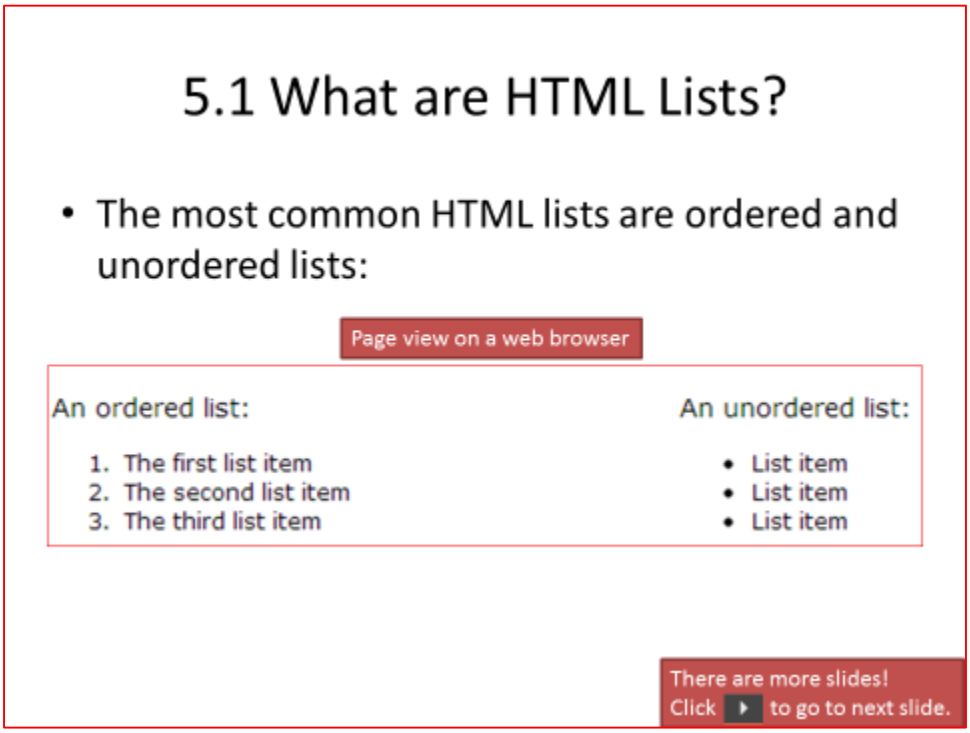
Please save your screencast as participant number#3(e.g., **101#3** in **SCSE** folder on **Desktop** (**participant number** is the number given when you checked in for the study)

Ready → Set → Go!

Please click SOM icon on the taskbar to launch the screenrecorder

Please complete the self-explanation task before you click GO NEXT PAGE at right-bottom corner to continue.

5.1 HTML list



Unordered List

- An unordered list starts with the <ul> tag. Each list item starts with the <li> tag.
- The list items are marked with bullets (typically small black circles).
- Example code and how the code is displayed in a browser:

Code View

```
<ul>
<li>Coffee</li>
<li>Milk</li>
</ul>
```

Page View

- Coffee
- Milk

There are more slides!
Click ▸ to go to next slide.

Ordered List

- An ordered list starts with the <ol> tag. Each list item starts with the <li> tag
- The list items are marked with numbers
- Example code and how the code is displayed in a browser:

Code View

```
<ol>
<li>Coffee</li>
<li>Milk</li>
</ol>
```

Page View

1. Coffee
2. Milk

There are more slides!
Click ▸ to go to next slide.

Description List

- A description list is a list of terms, with a description of each term
- The <dl> tag defines a description list.
- The <dl> tag is used in conjunction with <dt> (defines terms) and <dd> (describes each term)

Code View

```
<dl>
<dt>Coffee</dt>
<dd>- black hot drink</dd>
<dt>Milk</dt>
<dd>- white cold drink</dd>
</dl>
```

Page View

Coffee
- black hot drink
Milk
- white cold drink

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

5.2 HTML Links

5.2 What are HTML Links (Hyperlinks)?

- The Web is based on hyperlinks.
- Each web page contains active links to other pages, which in turn link to even more pages, until presumably the entire Web (or at least a great chunk of it) is bound together
- In fact, that is where the name "web" comes from
- Hyperlinks can connect to different parts on a web page, to other web pages within a web site, to web pages on other web sites, and to many types of web and non-web content

There are more slides!
Click ▸ to go to next slide.

5.2 What are HTML Links (Hyperlinks)?

- The HTML <a> tag defines a hyperlink.
  - A hyperlink (or link) is a word, group of words, or image that you can click on to jump to another document
  - When you move the cursor over a link in a web page, the arrow will turn into a little hand
  - The most important attribute of the <a> element is the "href" attribute, which indicates the link's destination
  - By default, links will appear as follows in all browsers:
    - An unvisited link is underlined and blue
    - A visited link is underlined and purple

There are more slides!
Click ▸ to go to next slide.

5.2 What are HTML Links (Hyperlinks)?

HTML Link Syntax

The HTML code for a link is simple. It looks like this:

```
<a href="url">Link text</a>
```

The href attribute specifies the destination of a link.

Example:

- visit California
- The <a> tag in this example will display like this: visit California
- Clicking on this hyperlink will send the user to the homepage of the State of California
- Tip: The "Link text" doesn't have to be text. It can be an image or any other HTML elements

There are more slides!
Click ▸ to go to next slide.

5.2 What are HTML Links (Hyperlinks)?

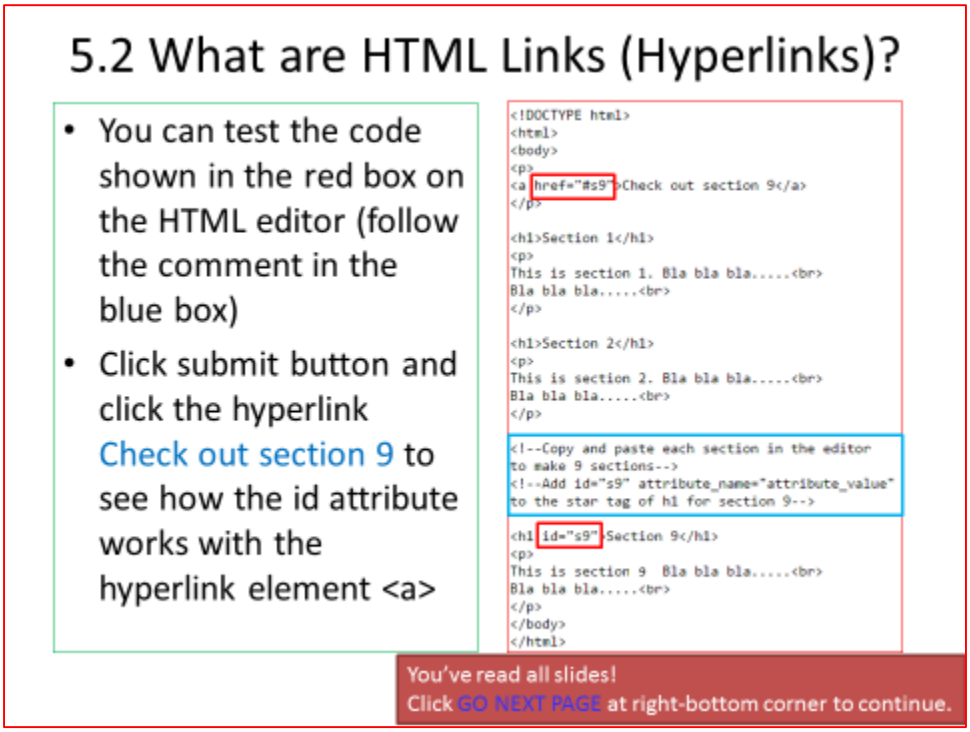
- **Create a HTML bookmark link**:
  - **HTML bookmarks** are used to allow readers to jump to specific parts of a Web page
  - Bookmarks are practical if your website has long pages
  - To make a bookmark, you must first **create the bookmark**, and then **add a link** to it
  - When the link is clicked, the page will scroll to the location with the bookmark

There are more slides!
Click ▸ to go to next slide.

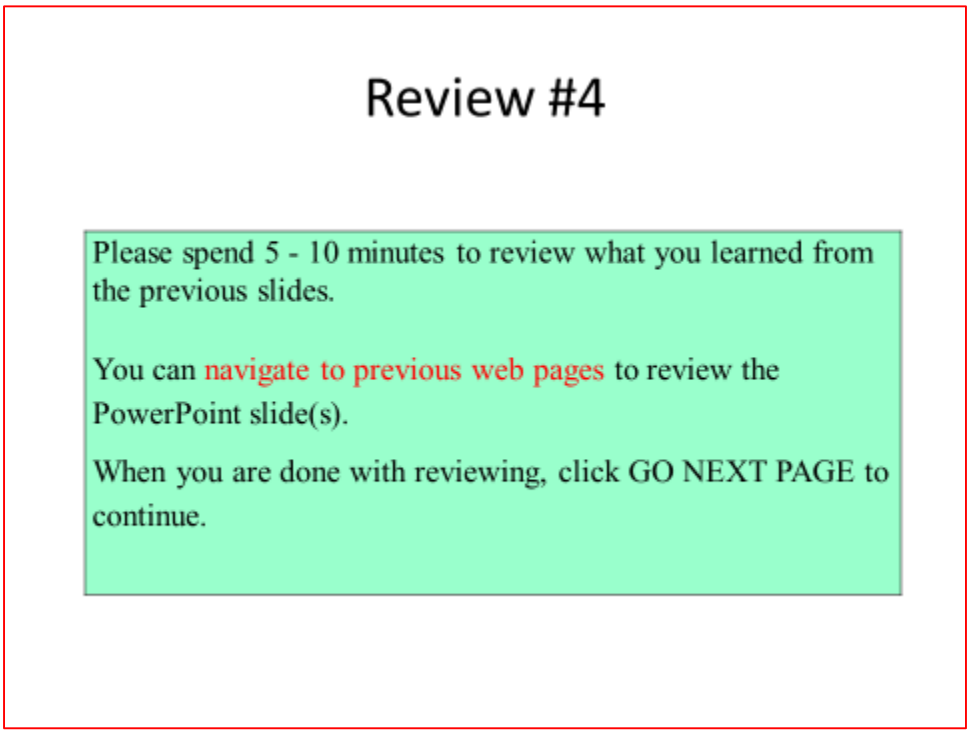
5.2 What are HTML Links (Hyperlinks)?

- Use the code shown on the next slide to create a bookmark link
- First, create a bookmark with the **id** attribute
  - <h1 id="s9">Section 9</h1>
- Then, add a link to the bookmark (id="s9"), from within the same page
  - Check out section 9
  - The <a> tag will create a link to an element with id "s9"

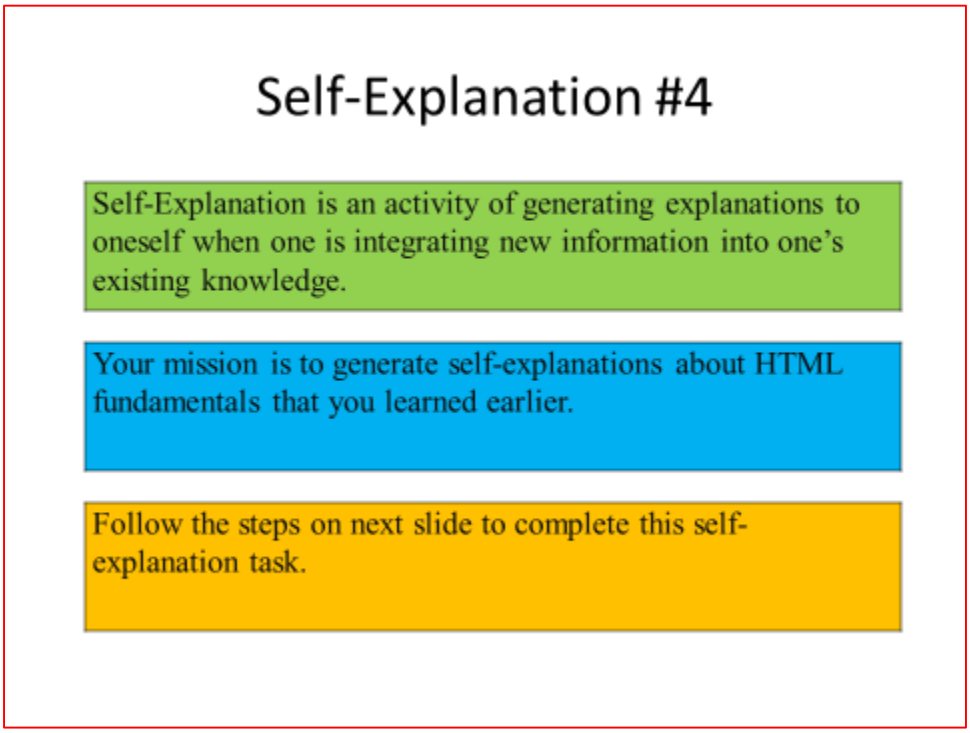
There are more slides!
Click ▸ to go to next slide.

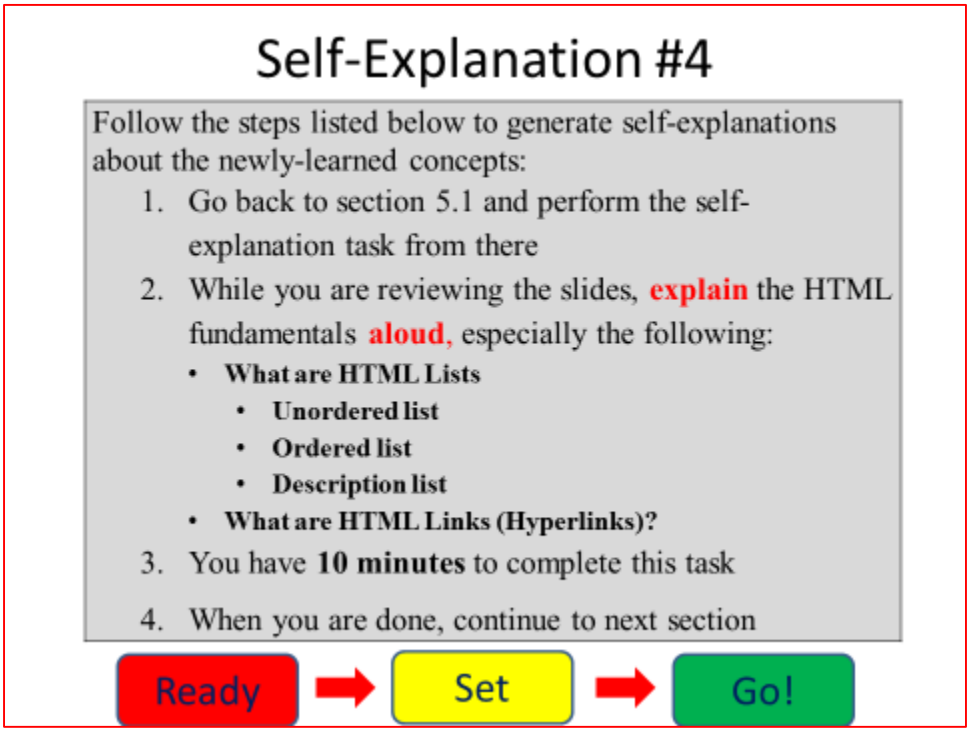


Review #4 (version 1)

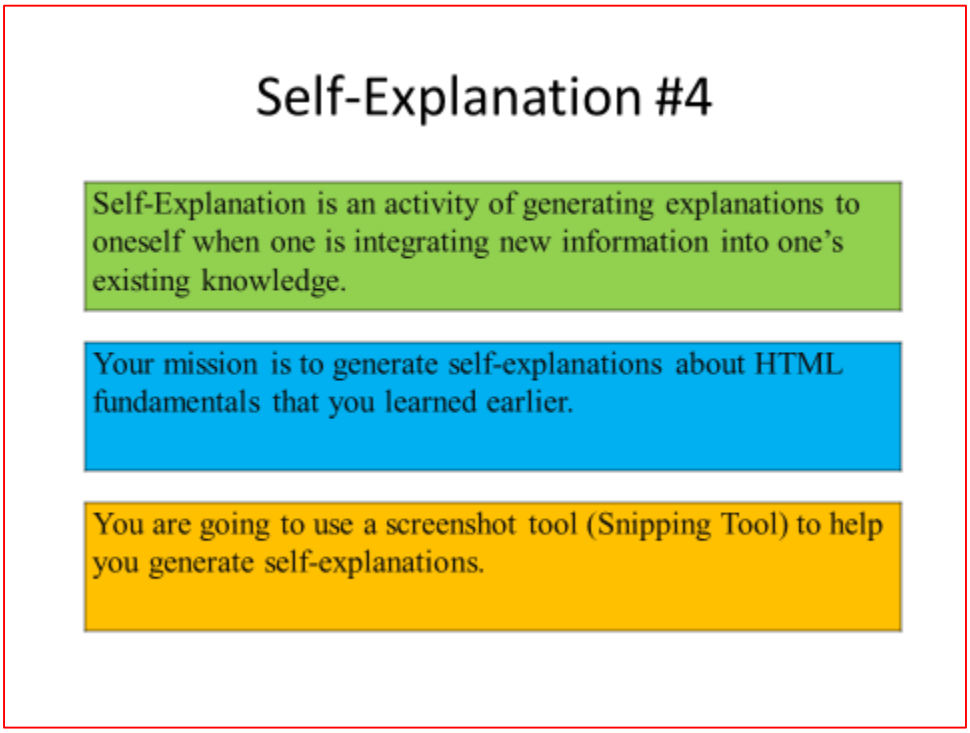


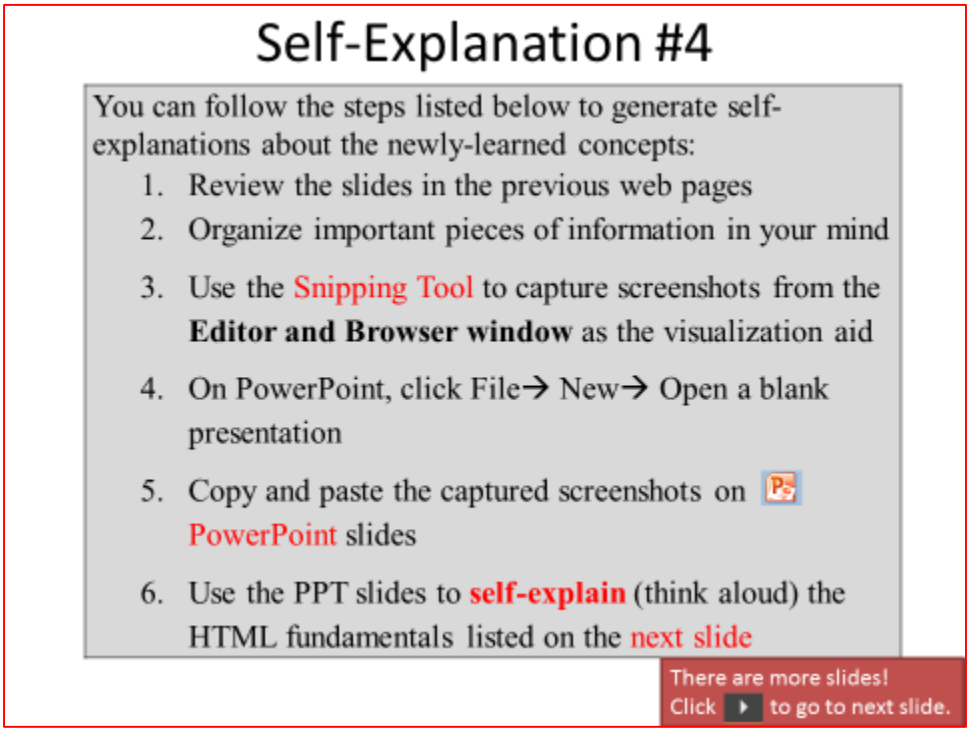
Self-explanation #4 (version 2)





Self-explanation #4 (version 3)





Self-Explanation #4

You have **10 minutes** to review the learning materials and use the screenshots to help you self-explain the following concepts :

- What are HTML Lists
  - Unordered list
  - Ordered list
  - Description list
- What are HTML Links (Hyperlinks)?

You can navigate to previous web pages to review the PowerPoint slide(s) to help you complete this task

There are more slides!
Click ▸ to go to next slide.

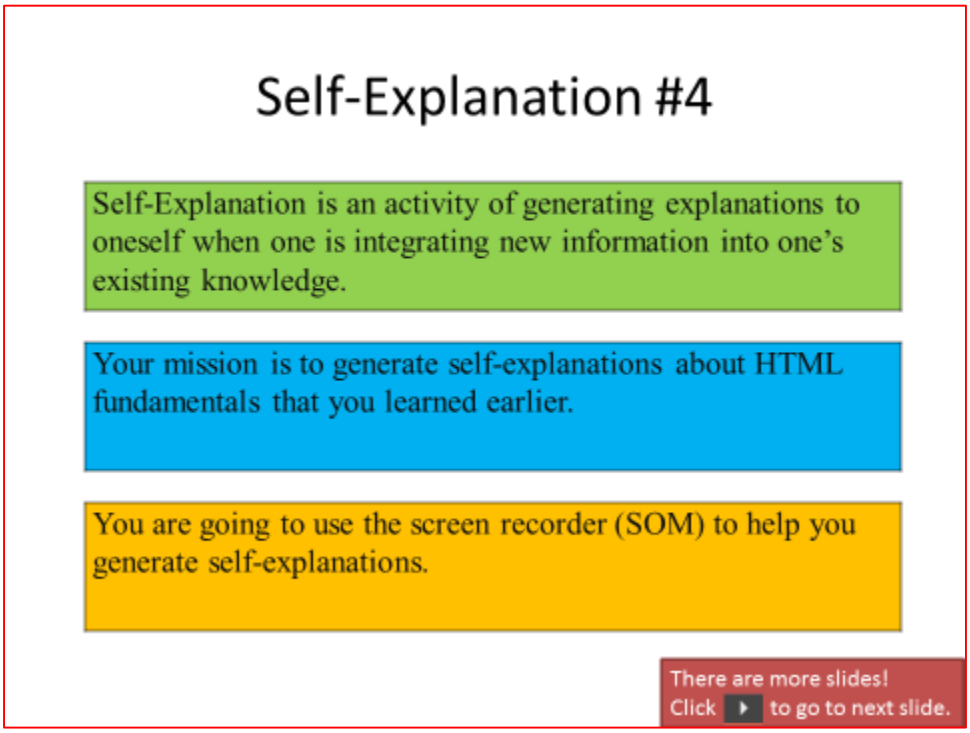
Self-Explanation #4

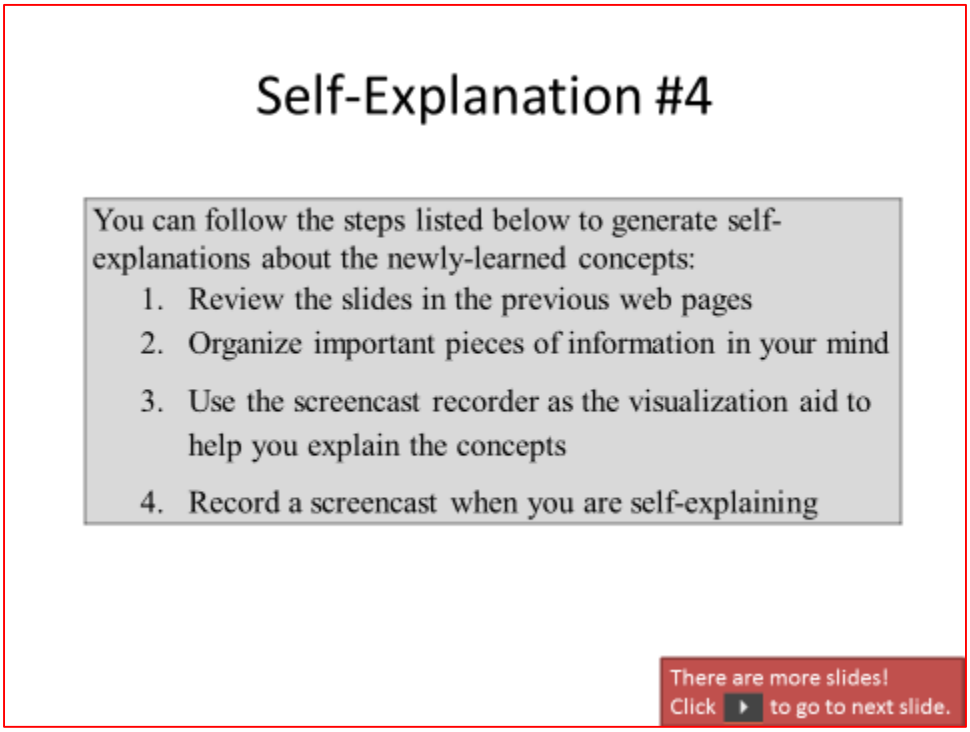
Please save your PPT as participant number#4(e.g., 201#4 in **SSSE** folder on **Desktop** (**participant number** is the number given when you checked in for the study)

Ready → Set → Go!

Please click Snipping Tool icon on the taskbar to launch the screenshot capturer

Self-explanation #4 (version 5)





Self-Explanation #4

You have 10 minutes to review the learning materials and create a short screencast to self-explain the following concepts:

- HTML Lists
  - Unordered list
  - Ordered list
- HTML Links (Hyperlinks)
  - Links to web pages
  - Links to bookmarks

You can go to previous web pages to review what you learned

There are more slides!
Click ▸ to go to next slide.

Self-Explanation #4

Please save your screencast as participant number#4(e.g., **101#4** in **SCSE** folder on **Desktop** (**participant number** is the number given when you checked in for the study)

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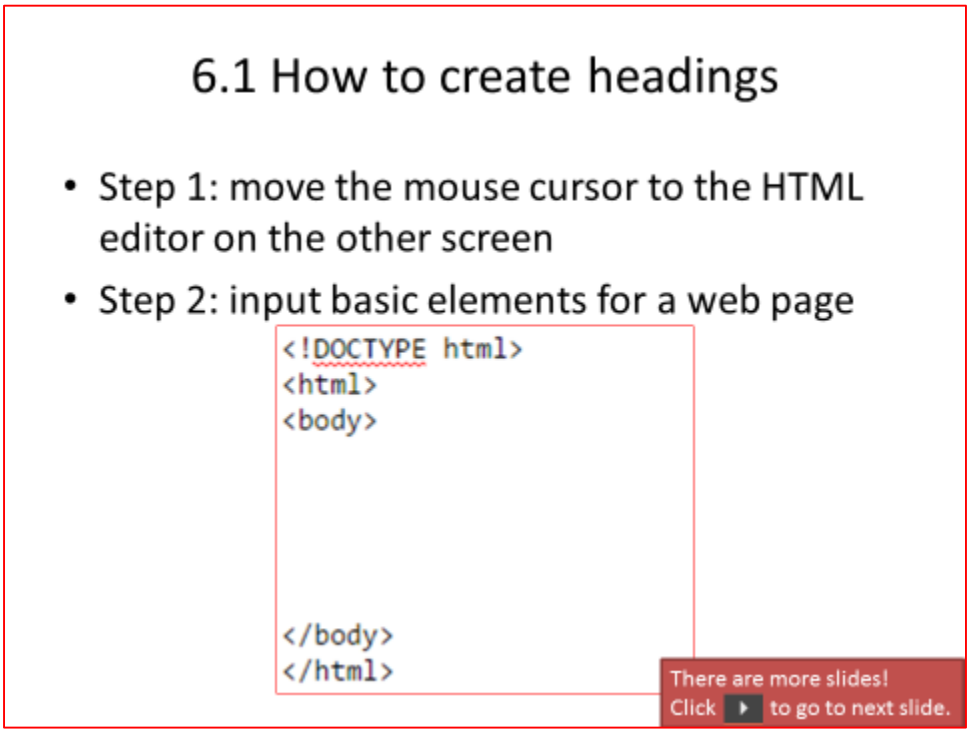
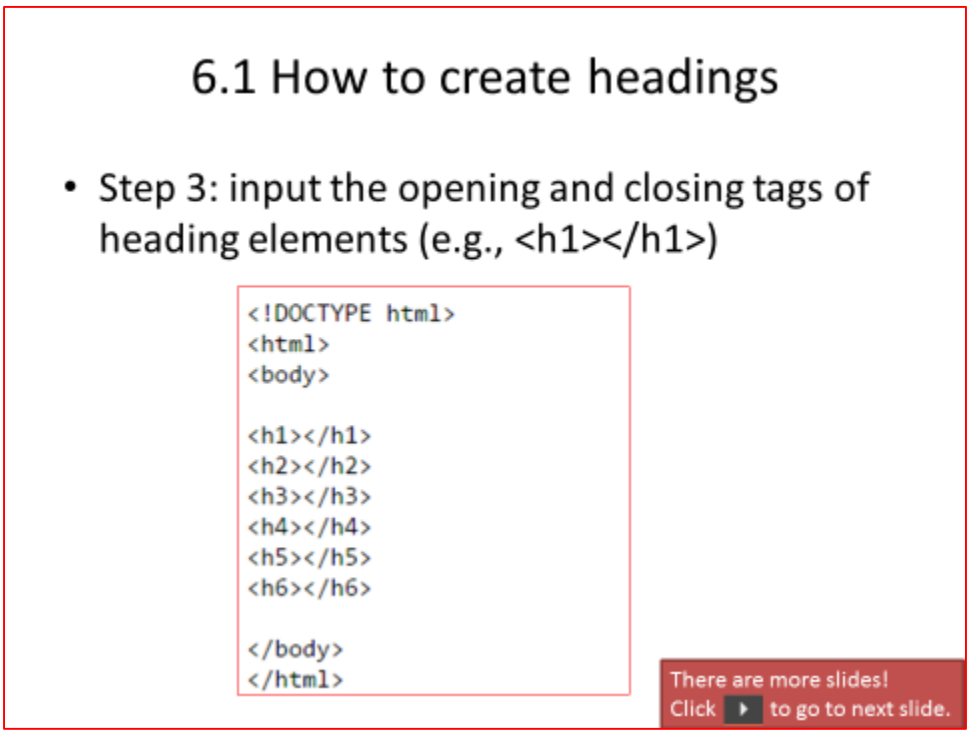
Please click SOM icon on the taskbar to launch the screenrecorder

Please complete the self-explanation task before you click GO NEXT PAGE at right-bottom corner to continue.

6.1 How to create Headings (version 1 to 4)





6.1 How to create headings

- Step 4: input the contents of headings into the heading tags (e.g., <h1>This is Heading 1</h1>)

```
<!DOCTYPE html>
<html>
<body>

<h1>This is heading 1</h1>
<h2>This is heading 2</h2>
<h3>This is heading 3</h3>
<h4>This is heading 4</h4>
<h5>This is heading 5</h5>
<h6>This is heading 6</h6>

</body>
</html>
```

There are more slides!
Click ▸ to go to next slide.

6.1 How to create headings

- Step 5: click "See Result>>" to see how the code is displayed in a web browser

This is heading 1

This is heading 2

This is heading 3

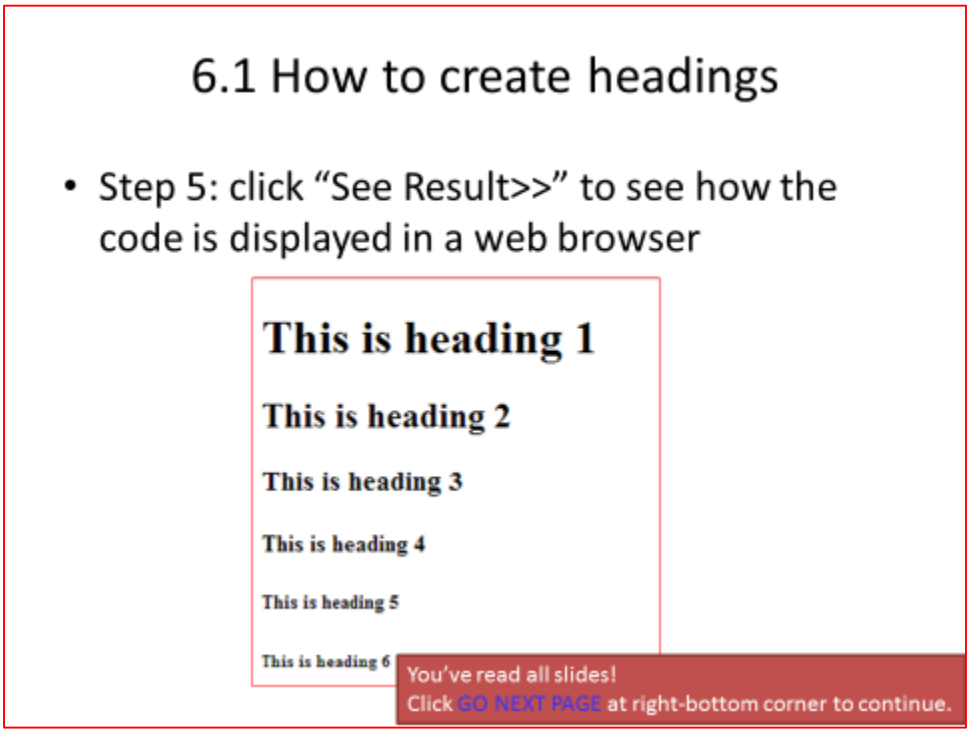
This is heading 4

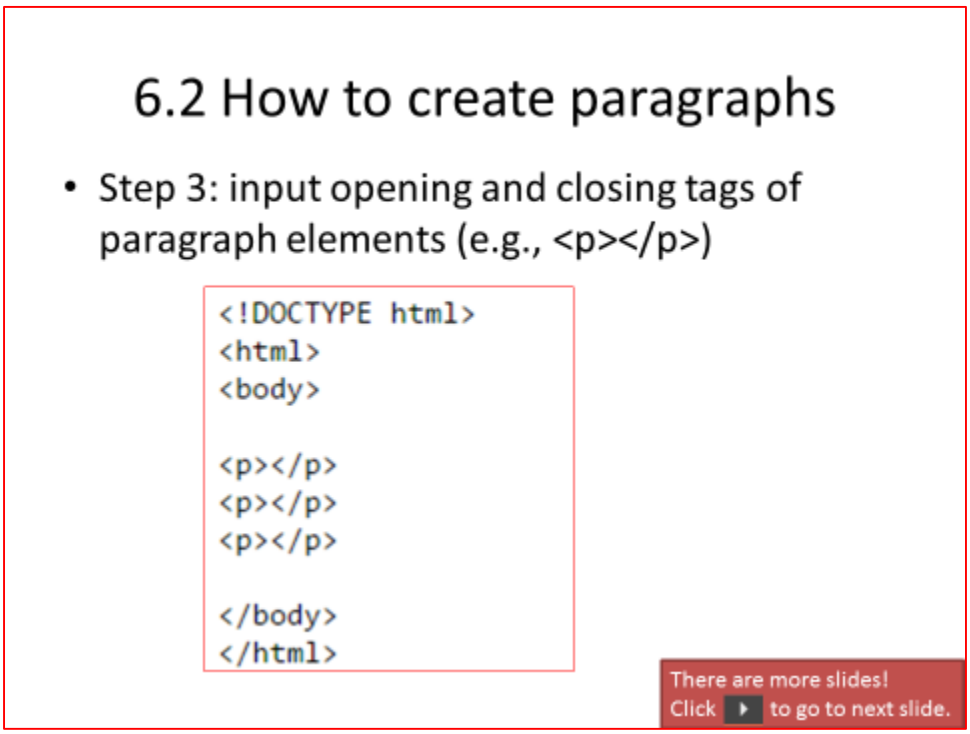
This is heading 5

This is heading 6

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

6.2 How to create paragraphs (version 1 to 4)





6.2 How to create paragraphs

- Step 4: input the contents of a paragraph into the paragraph tags (e.g., This is Paragraph 1)

```
<!DOCTYPE html>
<html>
<body>

<p>This is the first paragraph.</p>
<p>This is the second paragraph.</p>
<p>This is the third paragraph.</p>

</body>
</html>
```

There are more slides!
Click ▸ to go to next slide.

6.2 How to create paragraphs

- Step 5: click "See Result>>" to see how the code is displayed in a web browser

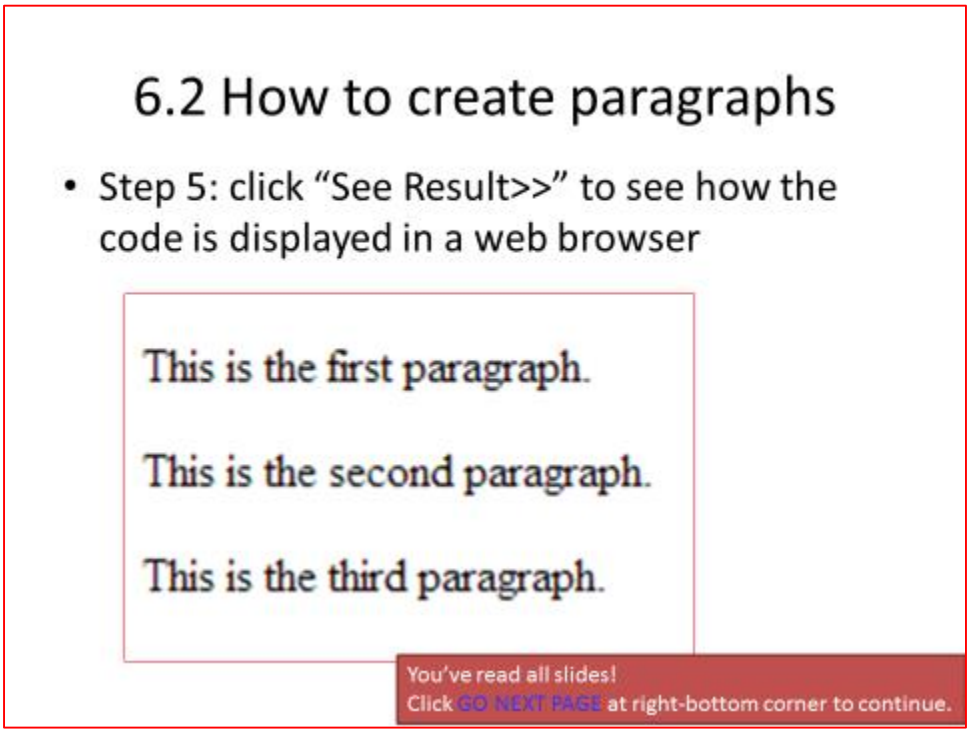
This is the first paragraph.

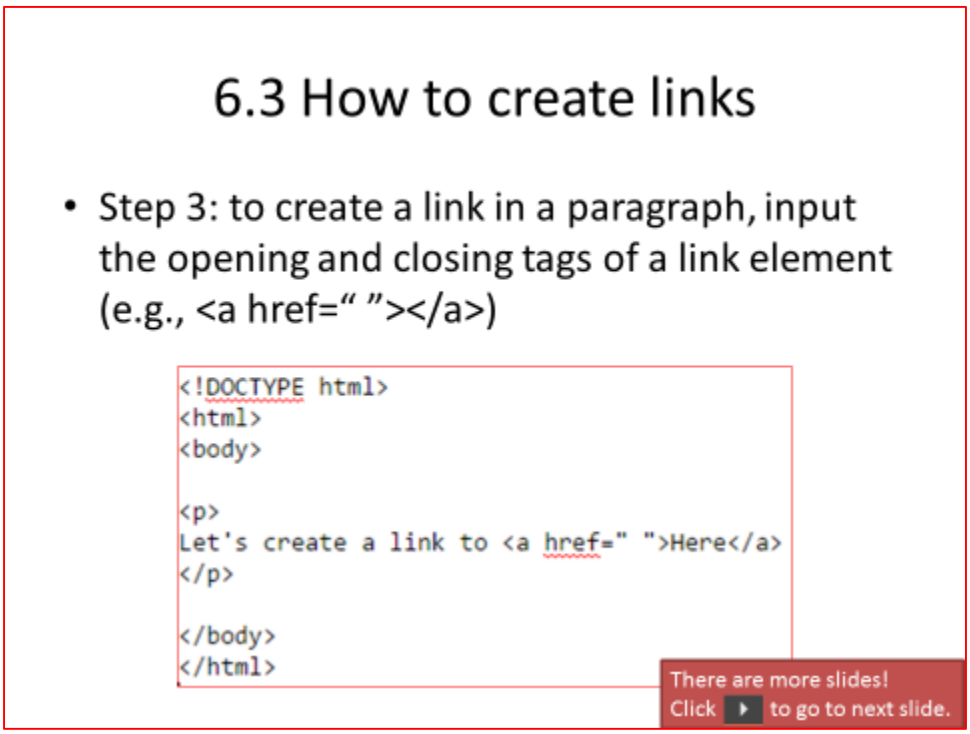
This is the second paragraph.

This is the third paragraph.

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

6.3 How to create links (version 1 to 4)





6.3 How to create links

- Step 4: input the destination of the link into the **href** attribute (e.g., Facebook)

```
<!DOCTYPE html>
<html>
<body>

<p>
Let's create a link to <a href="http://facebook.com ">Facebook</a>
</p>

</body>
</html>
```

There are more slides!
Click ▸ to go to next slide.

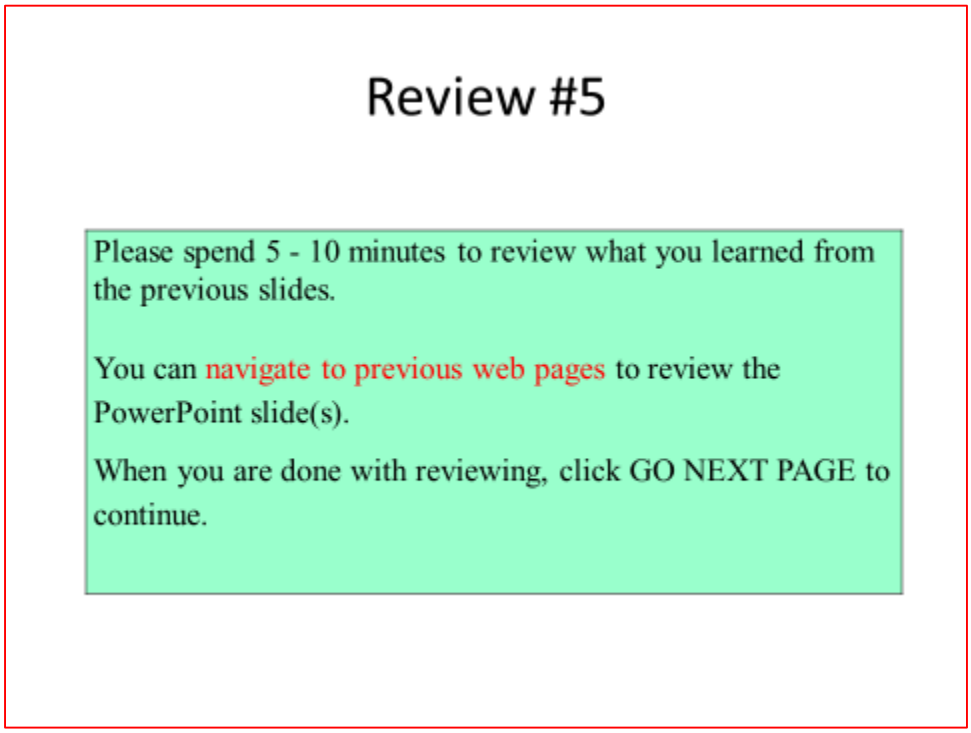
6.3 How to create links

- Step 5: click "See Result>>" to see how the code is displayed in a web browser

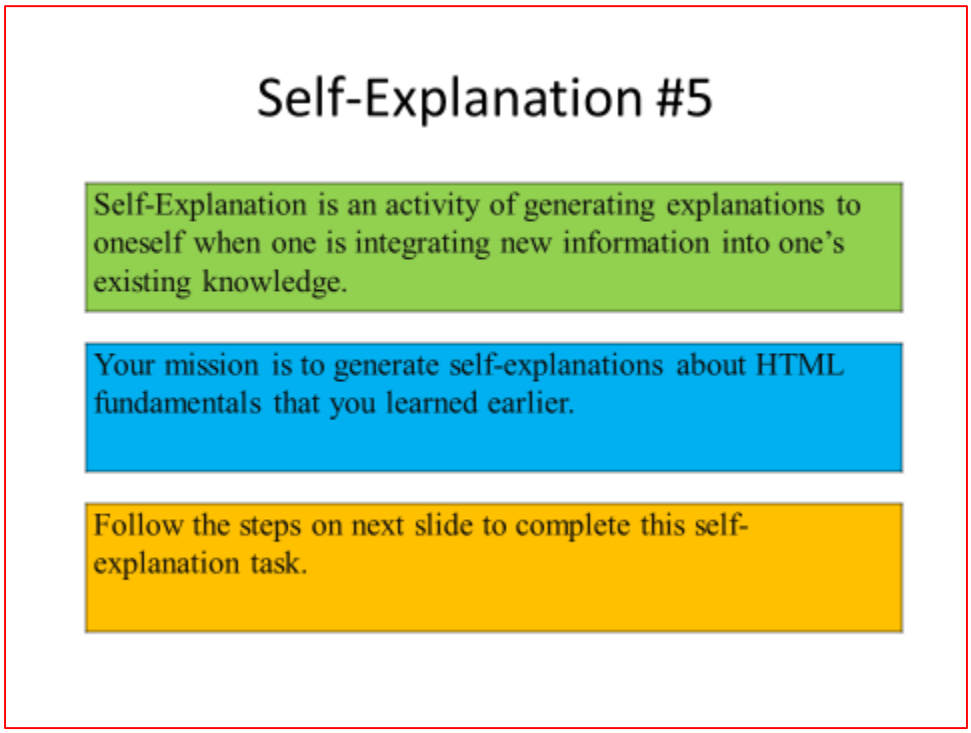
Let's create a link to Facebook

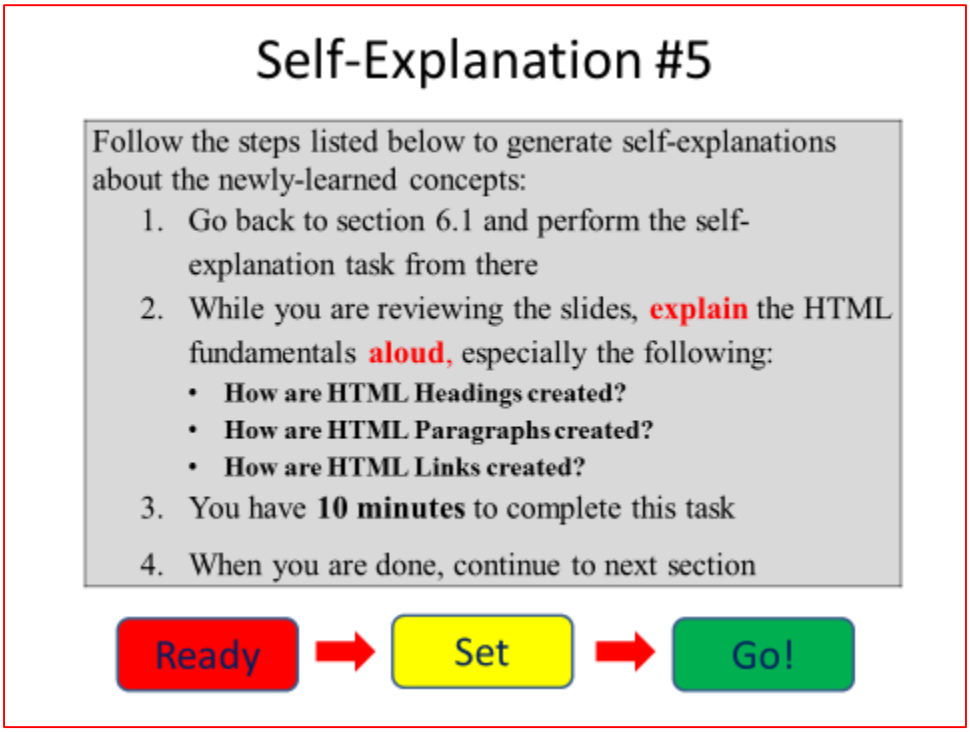
You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

Review #5 (version 1)

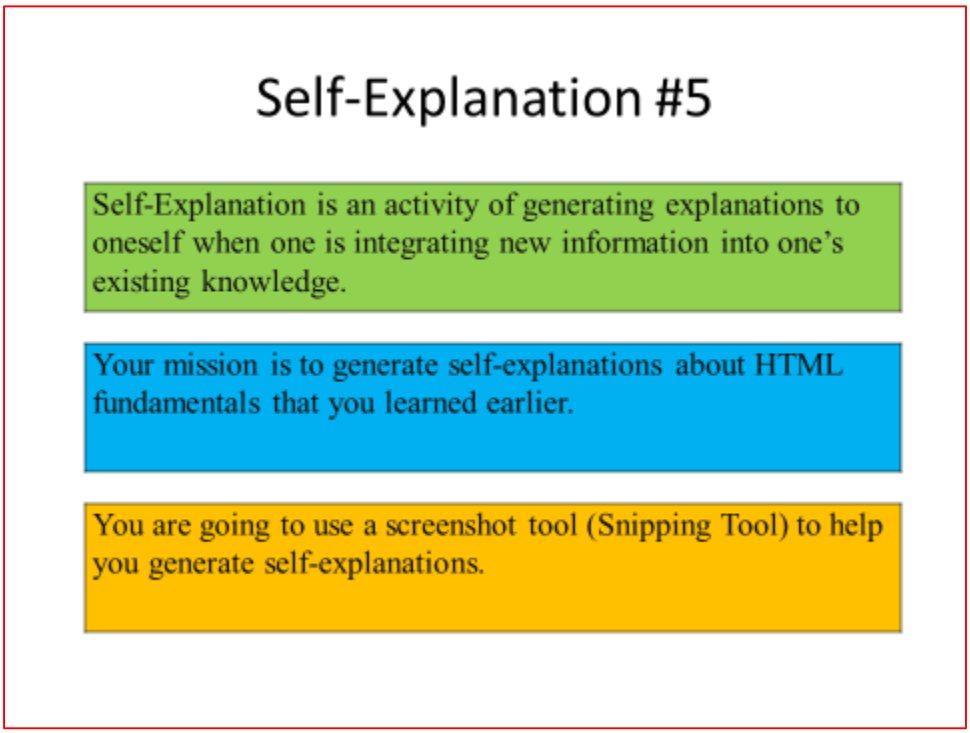


Self-explanation #5 (version 2)





Self-explanation #5 (version 3)



Self-Explanation #5

You can follow the steps listed below to generate self-explanations about the newly-learned concepts:

1. Review the slides in the previous web pages
2. Organize important pieces of information in your mind
3. Use the Snipping Tool to capture screenshots from the **Editor and Browser window** as the visualization aid
4. On PowerPoint, click File→ New→ Open a blank presentation
5. Copy and paste the captured screenshots on PowerPoint slides
6. Use the PPT slides to **self-explain** (think aloud) the HTML fundamentals listed on the next slide

There are more slides!
Click to go to next slide.

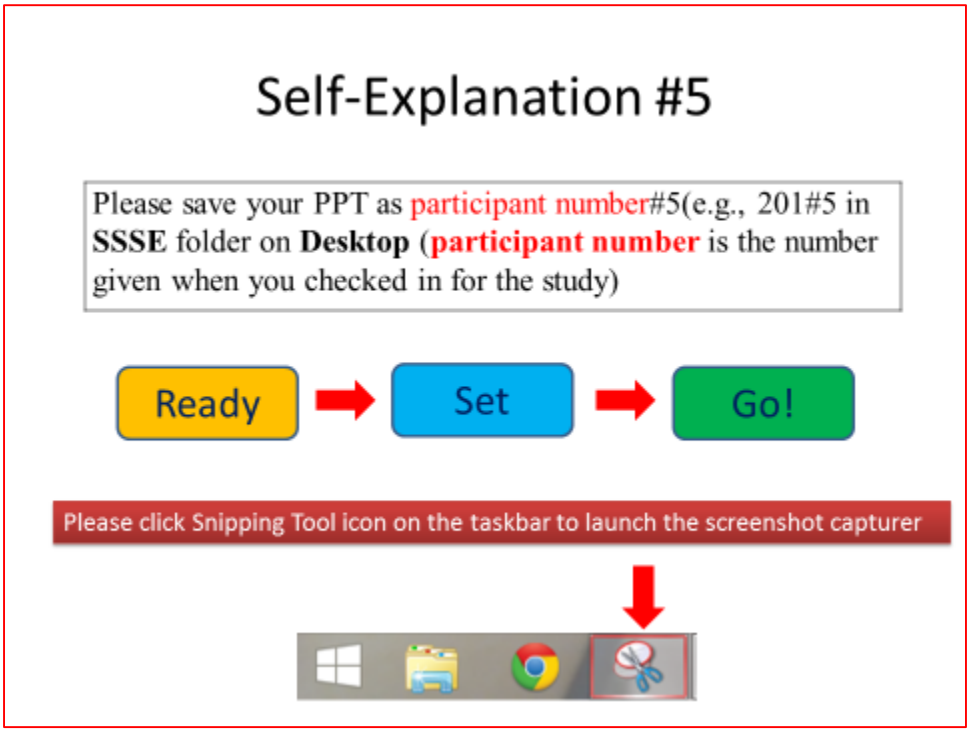
Self-Explanation #5

You have **10 minutes** to review the learning materials and use the screenshots to help you self-explain the following concepts :

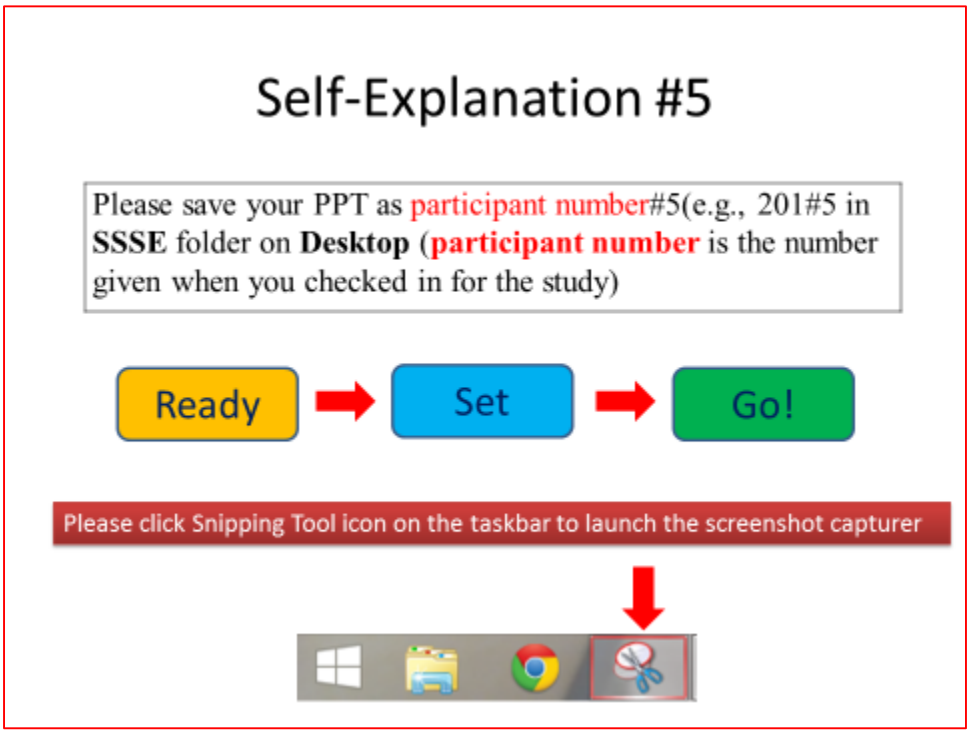
- **How** are HTML Headings created?
- **How** are HTML Paragraphs created?
- **How** are HTML Links created?

You can navigate to previous web pages to review the PowerPoint slide(s) to help you complete this task

There are more slides!
Click to go to next slide.



Self-explanation #5 (version 4)



Self-Explanation #5

You can follow the steps listed below to generate self-explanations about the newly-learned concepts:

1. Review the slides in the previous web pages
2. Organize important pieces of information in your mind
3. Use the screencast recorder as the visualization aid to help you explain the concepts
4. Record a screencast when you are self-explaining

There are more slides!
Click ▸ to go to next slide.

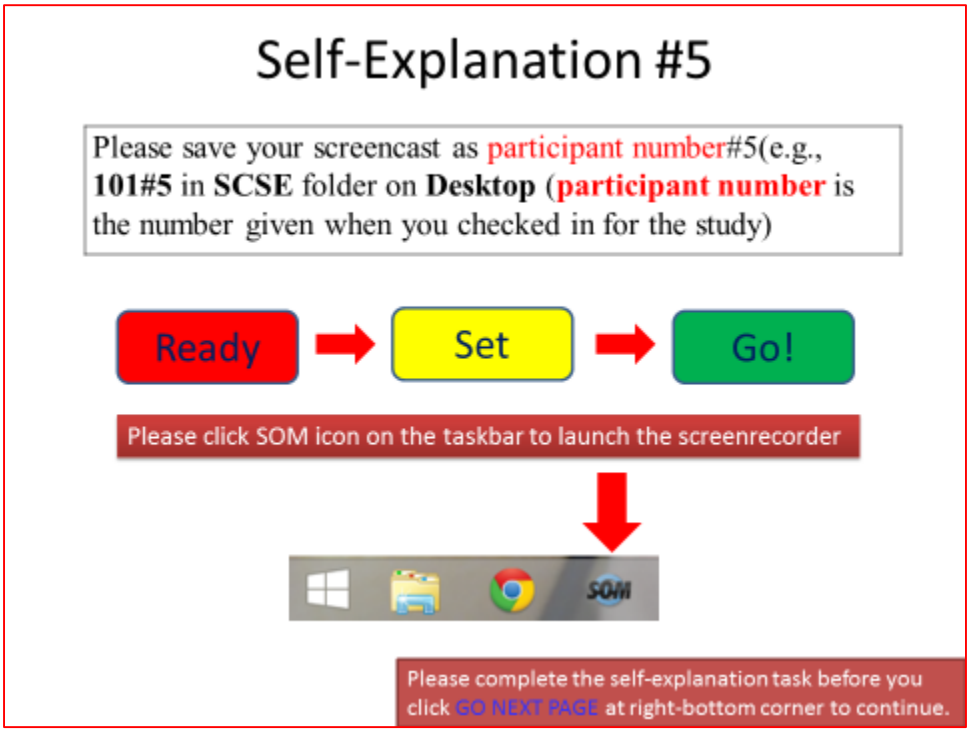
Self-Explanation #5

You have 10 minutes to review the learning materials and create a short screencast to self-explain the following concepts:

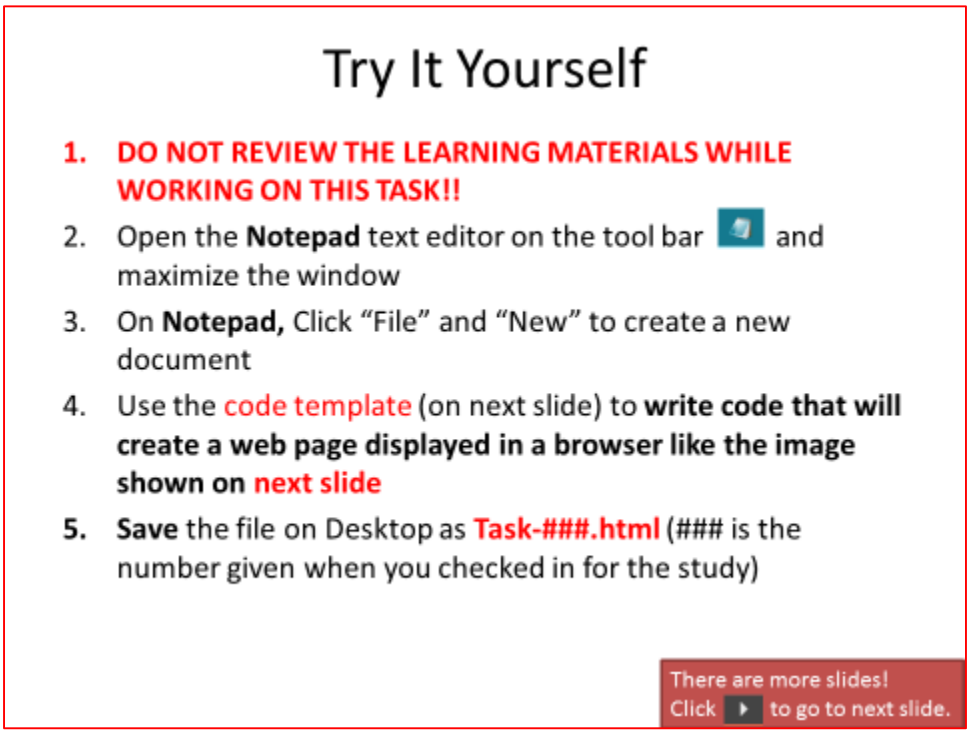
- **How** are HTML Headings created (step by step)?
- **How** are HTML Paragraphs created (step by step)?
- **How** are HTML Links created (step by step)?

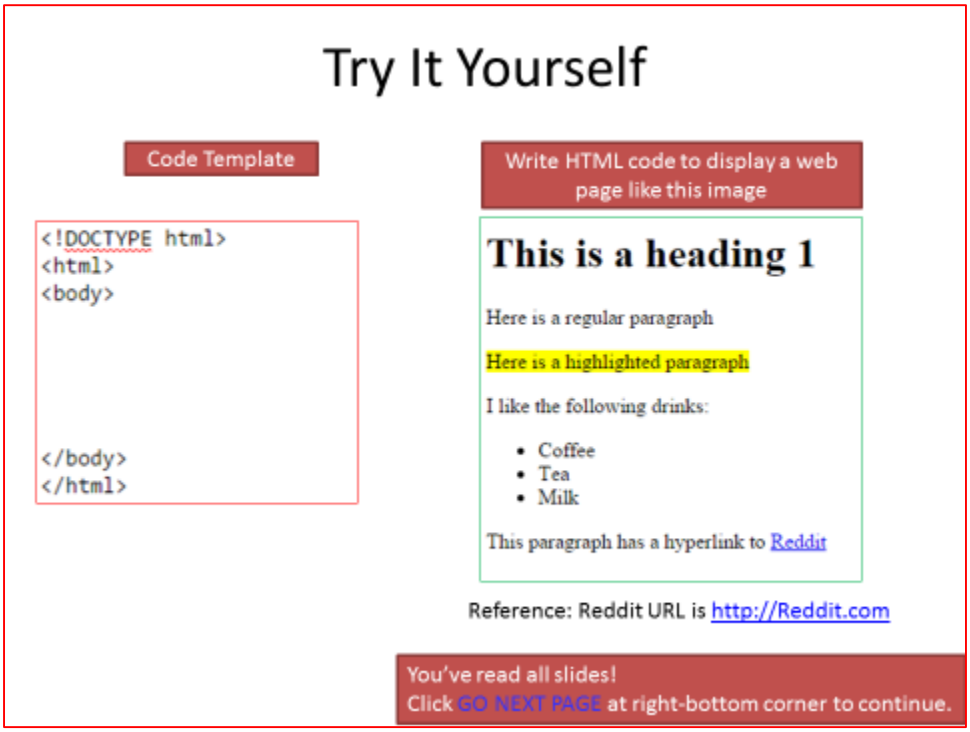
You can go to previous web pages to review what you learned

There are more slides!
Click ▸ to go to next slide.



Try it yourself page (version 1 to 4)





Thank you page (version 1 to 4)

Appendix B: Quiz_1 and Quiz_2

Quiz_1

How much have you learned?

Please maximize Notepad application on the left screen before taking this quiz.

* Required

Participant: *

Please input your participant number (e.g., 101)

What does HTML stand for? *

- Hyperlinks and Text Markup Language
- Hyper Text Markup Language
- Home Tool Markup Language

Which of the following statements is NOT true? *

- The <html> is the root element, which has two main nested elements, <head> and <body>
- The <head> element is a container for metadata (data about data)
- All elements nested in both <head> and <body> elements are displayed by a web browser

Which of the following is a paragraph element? *

- This is a paragraph
- <paragraph>This is a paragraph</paragraph>
- This is a paragraph
- <p\>This is a paragraph

Choose the correct HTML tag for the largest heading *

- <head>
- <h1>
- <heading>
- <h6>

A page title is one type of metadata, which of the following elements can enclose a <title> element? *

- Head
- Body
- Paragraph

What is the correct HTML tag for inserting a line break? *

- <lb>
- <break>
-

Choose the correct HTML tag to make a text bold *

- <b>
- <bold>
- <big>

Choose the correct HTML tag to make a text italic *

- <i>
- <italic>
- <ita>

What is the correct HTML for creating a hyperlink? *

- MyWebsite
- www.mywebsite.com
- <a>http://www.mywebsite.com
- www.mywebsite.com

Which of the following is to create a link within the same web page? *

- <a href="url" new>
- <a href="url" target="new">
- <a href="url" target="_blank">
- <a href="#3">

What tag do you use to make a numbered list? *

-
- <dl>
-
- <list>

What tag do you use to make a bulleted list? *

- <list>
-
-
- <dl>

What tag do you use to create a list item for a numbered list or a bulleted list? *

-
-
- <list>
-

Which of the following is correct HTML to create a description list *

- <dt><dl>Coffee</dl><dd>- Black hot drink</dd></dt>
- <dl><dt>Coffee</dt><dd>- Black hot drink</dd></dl>
- <dd><dt>Coffee</dt><dl>- Black hot drink</dl></dd>

What is the correct HTML for inserting an image? *

- <image src="image.gif" alt="MyImage">
- <img alt="MyImage">image.gif</img>
- <img src="image.gif" alt="MyImage">
- <img href="image.gif" alt="MyImage">

Submit

Quiz_2

Try It Yourself

1. **DO NOT REVIEW THE LEARNING MATERIALS WHILE WORKING ON THIS TASK!!**
2. Open the **Notepad** text editor on the tool bar  and maximize the window
3. On **Notepad,** Click "File" and "New" to create a new document
4. Use the code template (on next slide) to **write code that will create a web page displayed in a browser like the image shown on next slide**
5. **Save** the file on Desktop as **Task-###.html** (### is the number given when you checked in for the study)

There are more slides!
Click ▸ to go to next slide.

Try It Yourself

Code Template

```
<!DOCTYPE html>
<html>
<body>




</body>
</html>
```

Write HTML code to display a web page like this image

This is a heading 1

Here is a regular paragraph

Here is a highlighted paragraph

I like the following drinks:

- Coffee
- Tea
- Milk

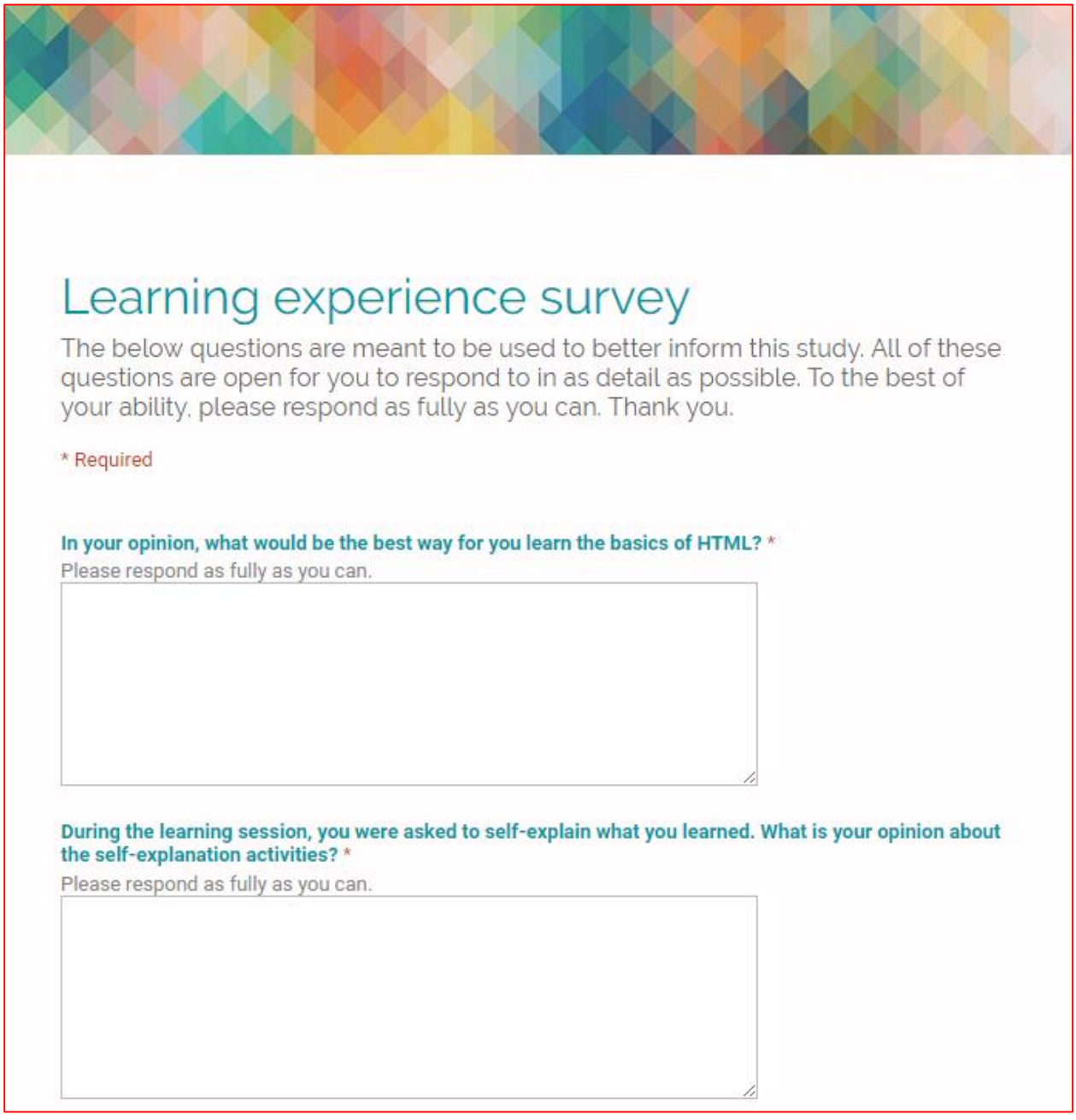
This paragraph has a hyperlink to Reddit

Reference: Reddit URL is http://Reddit.com

You've read all slides!
Click GO NEXT PAGE at right-bottom corner to continue.

Appendix C: Learning Experience Survey

Version 1: SCSE group



Learning experience survey

The below questions are meant to be used to better inform this study. All of these questions are open for you to respond to in as detail as possible. To the best of your ability, please respond as fully as you can. Thank you.

* Required

In your opinion, what would be the best way for you learn the basics of HTML? *

Please respond as fully as you can.

During the learning session, you were asked to self-explain what you learned. What is your opinion about the self-explanation activities? *

Please respond as fully as you can.

Did you have any challenges to create self-explanations? If yes, what were they? *

Please respond as fully as you can.

You were asked to use the Sreencast-O-Matic to help you self-explain some HTML topics. Was it helpful for you to explain HTML more effectively? Please explain why or why not. *

Please respond as fully as you can.

To what extent did you achieve the learning objectives? *

	1	2	3	4	5	6	7	8	9	10	
Barely achieved	○	○	○	○	○	○	○	○	○	○	Highly achieved

Additional demographic questions

What is your current academic program/major? *

Are you a graduate or undergraduate student? *

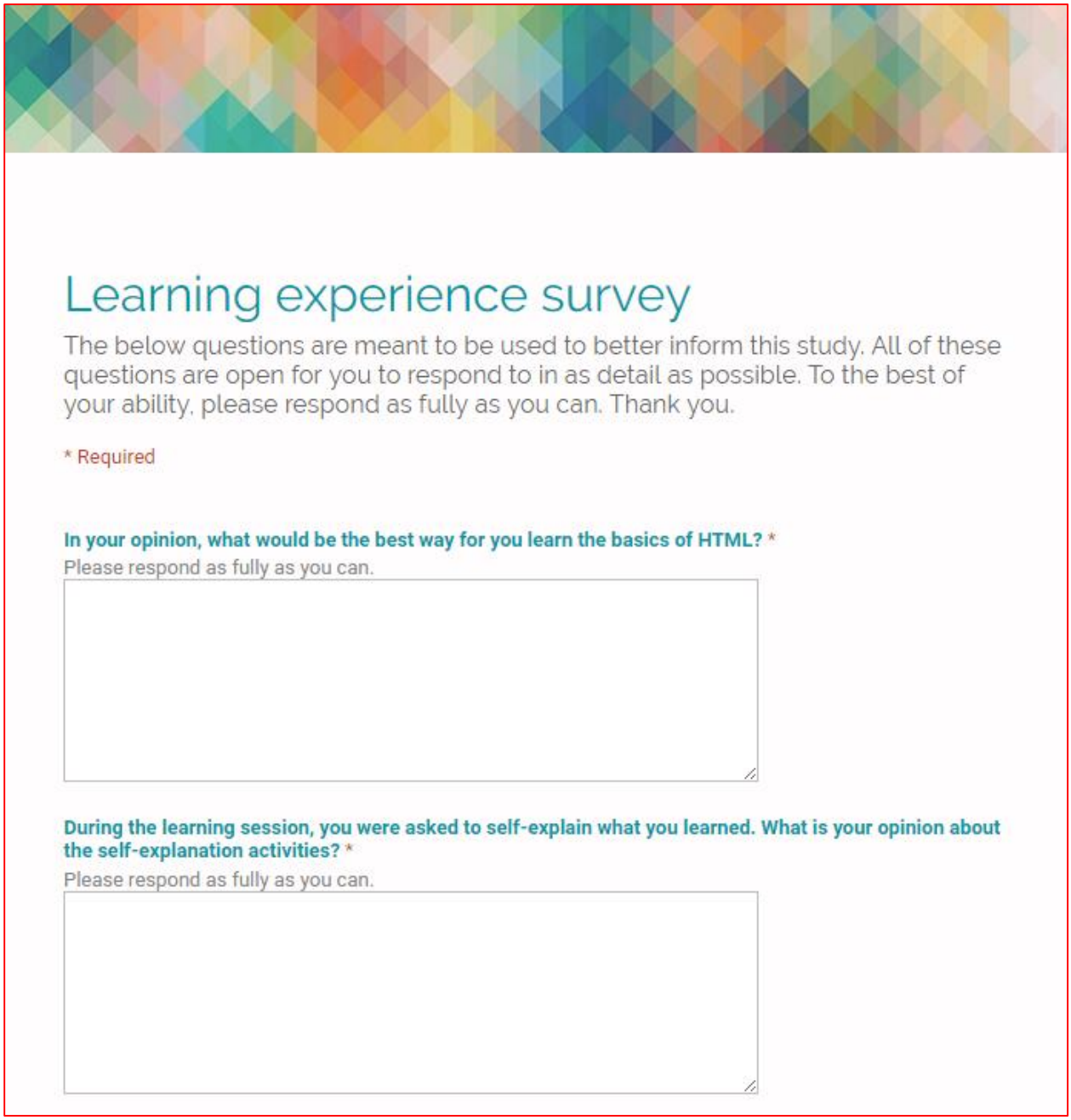
- ○ Graduate
- ○ Undergraduate

Which year are you attending your academic institution? *

What is your participant number? *

Submit

Version 2: SSSE group



Learning experience survey

The below questions are meant to be used to better inform this study. All of these questions are open for you to respond to in as detail as possible. To the best of your ability, please respond as fully as you can. Thank you.

* Required

In your opinion, what would be the best way for you learn the basics of HTML? *

Please respond as fully as you can.

During the learning session, you were asked to self-explain what you learned. What is your opinion about the self-explanation activities? *

Please respond as fully as you can.

Did you have any challenges to perform self-explanation tasks? If yes, what were they? *

Please respond as fully as you can.

You were asked to use the Snipping Tool to help you self-explain some HTML topics. Was it helpful for you to explain HTML fundamentals more effectively? Please explain why or why not. *

Please respond as fully as you can.

To what extent did you achieve the learning objectives? *

	1	2	3	4	5	6	7	8	9	10	
Barely achieved	○	○	○	○	○	○	○	○	○	○	Highly achieved

Additional demographic questions

What is your current academic program/major? *

Are you a graduate or undergraduate student? *

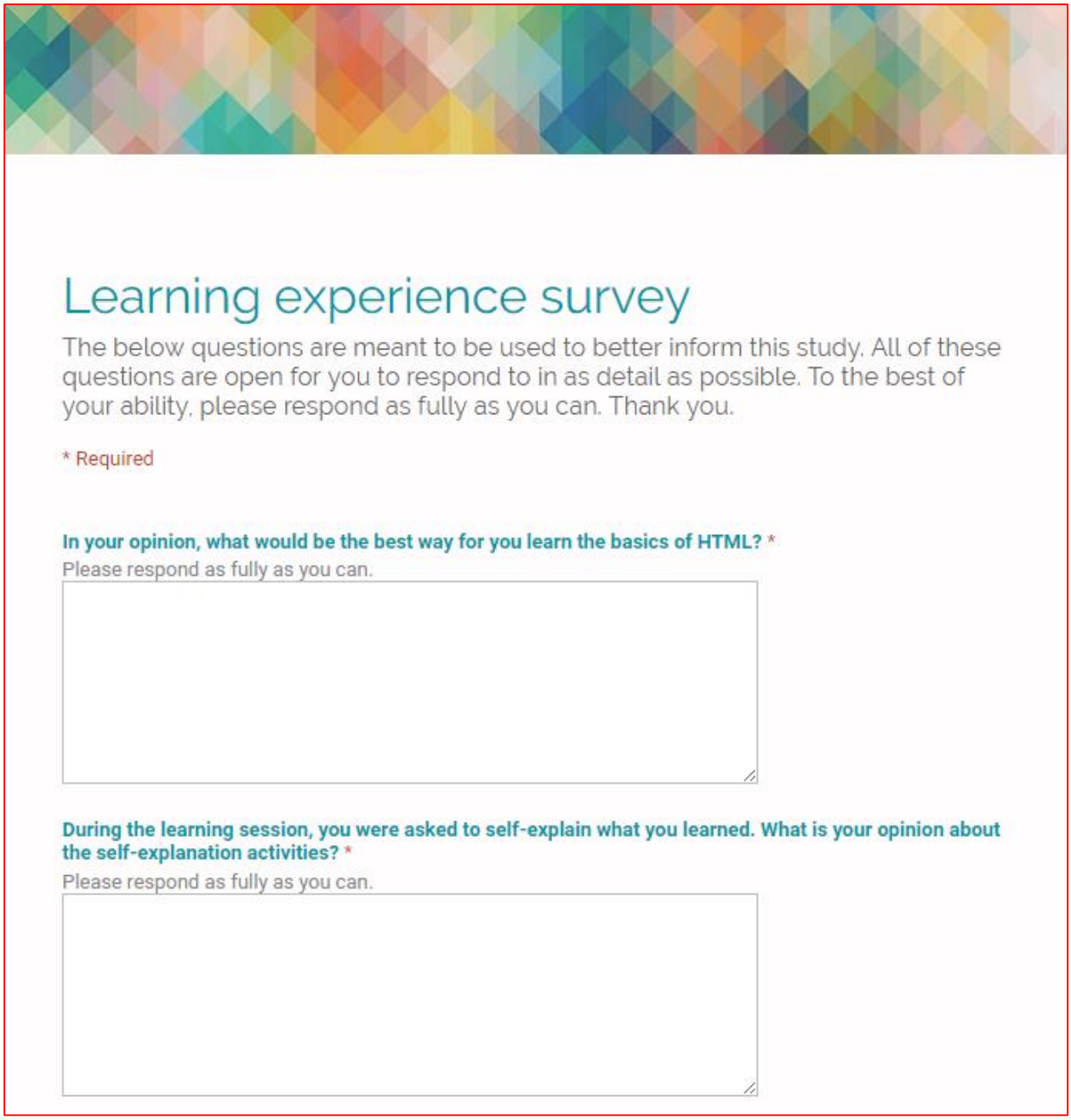
- ○ Graduate
- ○ Undergraduate

Which year are you attending your academic institution? *

What is your participant number? *

Submit

Version 3: NVSE group



Learning experience survey

The below questions are meant to be used to better inform this study. All of these questions are open for you to respond to in as detail as possible. To the best of your ability, please respond as fully as you can. Thank you.

* Required

In your opinion, what would be the best way for you learn the basics of HTML? *

Please respond as fully as you can.

During the learning session, you were asked to self-explain what you learned. What is your opinion about the self-explanation activities? *

Please respond as fully as you can.

Did you have any challenges to perform self-explanation tasks? If yes, what were they? *

Please respond as fully as you can.

To what extent did you achieve the learning objectives? *

	1	2	3	4	5	6	7	8	9	10	
Barely achieved	○	○	○	○	○	○	○	○	○	○	Highly achieved

Additional demographic questions

What is your current academic program/major? *

Are you a graduate or undergraduate student? *

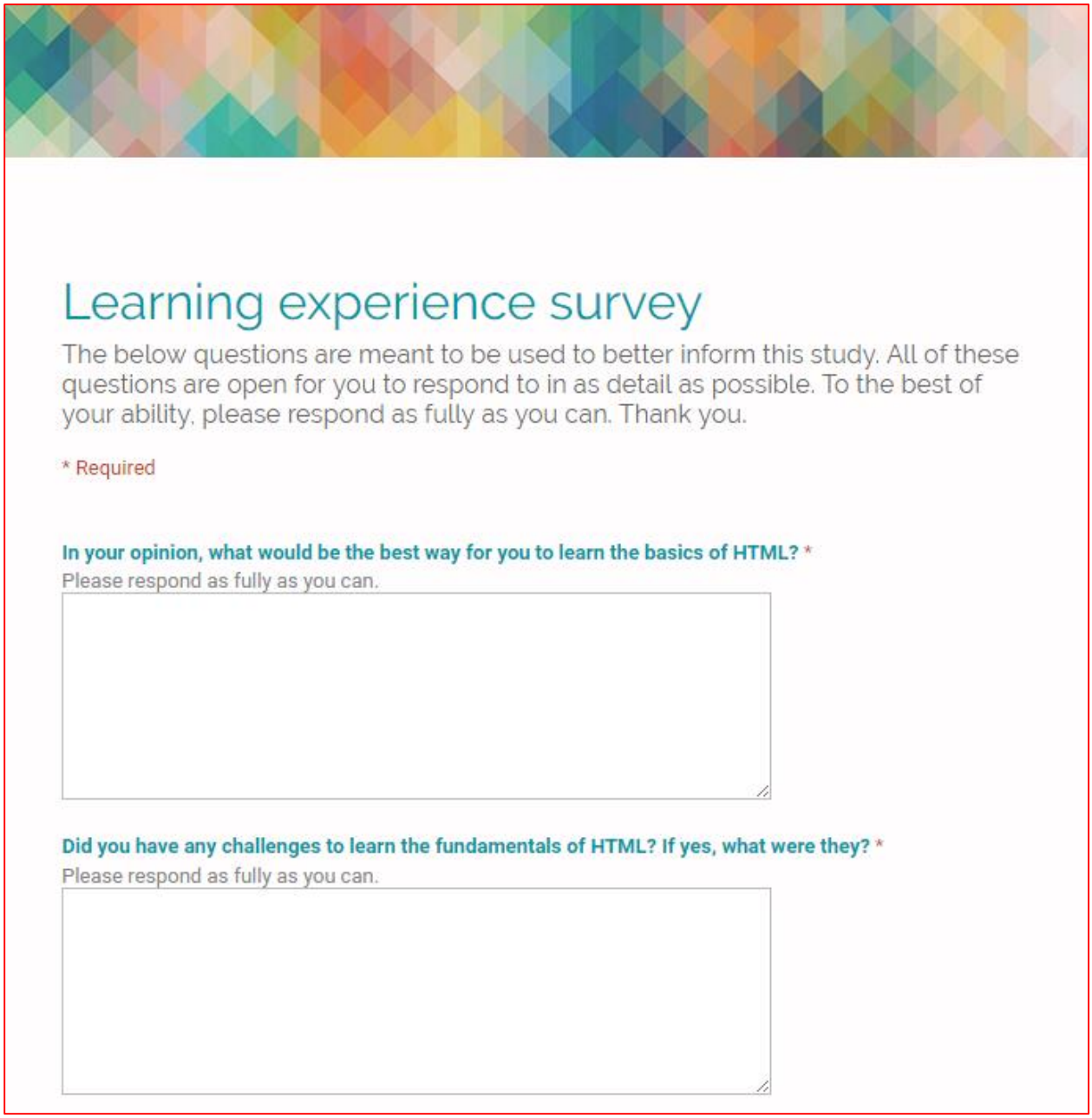
- ○ Graduate
- ○ Undergraduate

Which year are you attending your academic institution? *

What is your participant number? *

Submit

Version 4: NOSE group



Learning experience survey

The below questions are meant to be used to better inform this study. All of these questions are open for you to respond to in as detail as possible. To the best of your ability, please respond as fully as you can. Thank you.

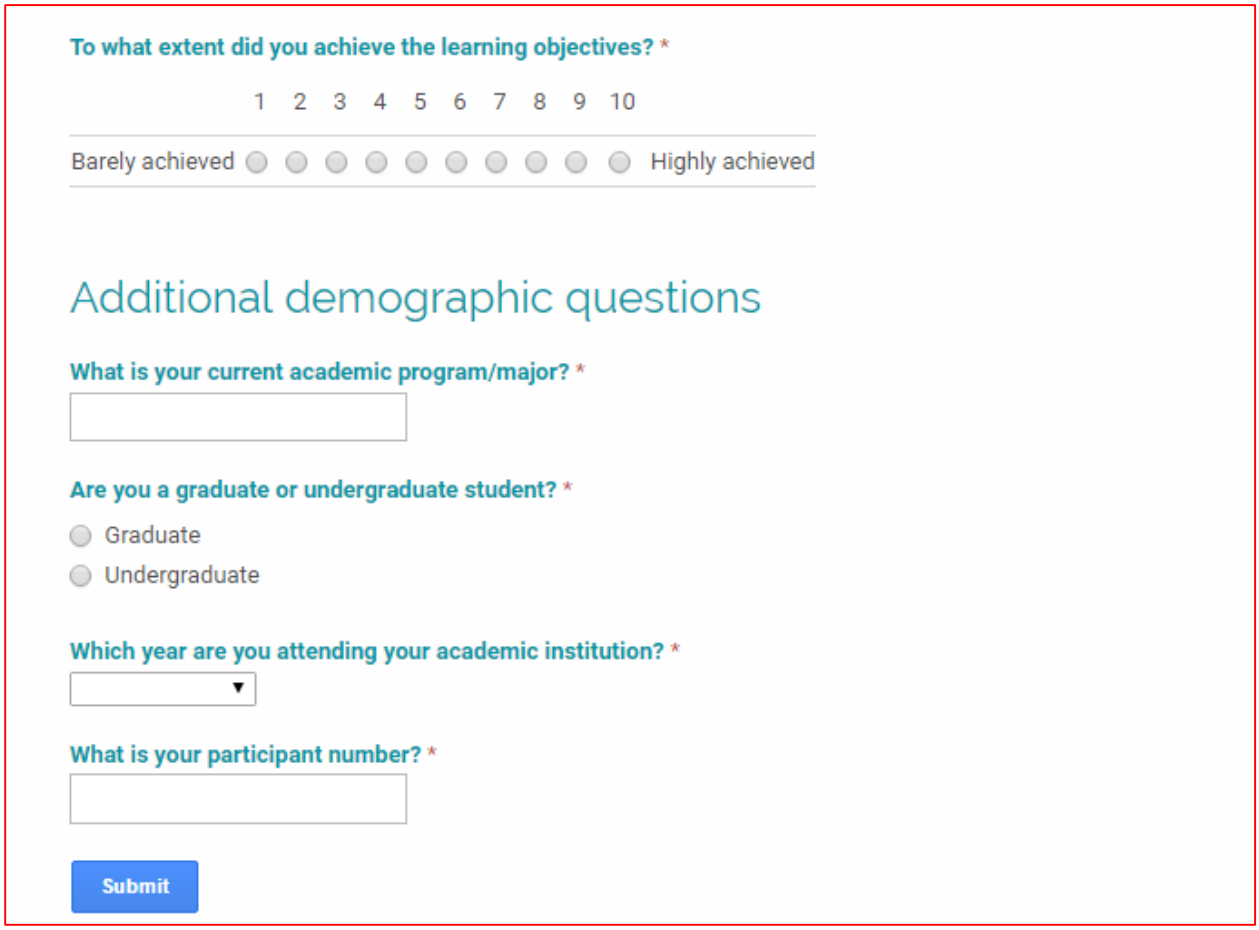
* Required

In your opinion, what would be the best way for you to learn the basics of HTML? *

Please respond as fully as you can.

Did you have any challenges to learn the fundamentals of HTML? If yes, what were they? *

Please respond as fully as you can.



Appendix D: Quiz_2 Grading Rubric

HTML code for Quiz_2:

```
<!DOCTYPE html>
<html>
<body>

<h1>This is a heading 1</h1>

<p>Here is a regular paragraph</p>

<p><mark>Here is a highlighted paragraph</mark></p>

<p> I like the following drinks:</p>

    <ul>
       <li> Coffee </li>
       <li> Tea</li>
       <li> Milk</li>
    </ul>

<p> This paragraph has a hyperlink to <a href="http://Reddit.com"> Reddit </a></p>

</body>
</html>
```

Grading rubric:

Criteria to mark zero score	Example
Miss entire element	Miss entire p element, **<p>text….</P>**
Miss either the opening tag or the closing tag	Miss the closing tag, **<p>text….**
Use a wrong opening tag or closing tag	Use a wrong closing tag, **<p>text….<p>**
Use wrong tag	Use wrong tag, **<hi>**, instead of **<mark>** for highlighting text
Use wrong attribute	Use wrong attribute, <a **link**= “http://Reddit.com”>, instead of <a **href**= “http://Reddit.com” to create a hyperlink
Any typographical error	A typo on href attribute, <a **herf**= “http://yahoo.com”, instead of correct attribute, <a **href**= “http://yahoo.com”>
Miss any part of quotation on the value of an attribute	No quotation used on the value of href attribute, <a href= http://yahoo.com>, instead of correct use of quotation, <a href= **“**http://yahoo.com**”**>
Incorrect placement of element content	Wrong: Correct: **Reddit**

Score for tags or attributes:

Tags or attributes	Score
<!DOCTYPE html>	1
<html>	1
<body>	1
<h1>	1
1st <p>	1
2nd <p>	1
<mark>	1
3rd <p>	1
	1
1st	1
2nd	1
3rd	1
4th <p>	1
<a>	1
href attribute	1