DeWS: DESIGN SKILLS THROUGH WEB STIMULI

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Learning activities can be designed and developed to encourage students to actively engage in an open learning environment. The use of the Web as a tool to stimulate learning illustrates a paradigm shift in the teaching–learning process. Web-based stimulation is a process to encourage students to develop their skills in designing interface objects. DeWS (Design Skills through Web Stimuli) is a learning environment that encourages students to design interface objects using human-computer interaction (HCI) principles for user centered applications. This paper will present the findings of a DeWS pilot study on a group of 15 students in a Diploma in Computer Studies course in a private higher education institution. The study uses five techniques of guided learning with Web resources to stimulate the development of the design skills of five groups of first semester diploma students enrolled in the User-Interface Design module. Data were collected by means of observations and interviews. Students were given design tasks for completion within a certain time frame. Students were found to be able to produce appropriate design objects in the DeWS learning environment. Various learning outcomes related to designing skills were discovered when the web stimuli was used to engage the students in learning design skills.

Keywords: Design skills, web stimuli, human-computer interaction

Usage of the Web resources illustrates a paradigm shift in teaching and learning (Forsyth, 2001). Teachers have found innovative ways to utilize Internet resources to achieve the teaching and learning goals in their classrooms (Eyerdam, 2002; Sharon, 2003). Simulation has been significantly used to enhance instruction in higher learning (Weinstein, 2006). Many researchers have proven that simulation helps to improve teaching and learning (David et al., 2007; Diana et al., 2006; Lewis, 2003). Overall simulations affect the dynamic of teaching and learning especially on practical based instructional interface design where students learn through the guided learning approach (Jonassen, 2004). Mentor guided learning is found to be more motivating and encouraging to students (Brophy, 2004). An Interface Object consists of interface area, input supporting control, interface editing field and interface treatment type (Gervasi et al., 2005). Heuristic evaluation is used to evaluate interface objects for user centered design (Lewis, 2002). A case study was conducted by Zaphiris and Sri Kurniawan (2007) to study how the use of a simulation changed the students' learning method of interface design skills. The outcome was students' positive reaction towards the stimulation to enhance design skills. This paper outlines the empirical result of a study investigating the methods that students used to enhance designing skills. The case on how "DeWS" was used in a first semester diploma module titled User Interface Design on teaching students to design using Human Computer Interaction (HCI) principles is reported.

Literature Review

The study of the efficacy of Web as stimuli to develop design skills on interface objects are highlighted based on Behaviorist Theory (Ormrod, 1999). According to Ormrod, learning is a relatively permanent change in behavior due to experience. This refers to a change in behavior, an external change that we can observe. Earlier behaviorists Ivan Pavlov, Edward Thorndike, John Watson Edwin, Guthrie Clark, Hull and B. F. Skinner supported that learning is a change in overt, observable behavior (not concerned with internal processes). Ormrod also argued that learning

process is focused on stimuli and responses. If no observable change happens, then no learning has happened. Thomas et al. (1994) highlighted that design behavior has direct linkage with design principles and knowledge of a designer. Walkin (1990) recommended that the ability to learn to perform a particular behavior when a certain stimulus is present is called Stimulus-Response learning. Ruben (1979) elaborated that the conceptual underpinnings and instructional goals of guided design are more clearly related to the cognitive domains. More specifically the system is designed to facilitate cognitive learning (Bloom 1956; Guilford, 1970 and Gagne, 1970, as cited by Ruben, 1979) at higher levels through group interaction and instructor feedback clarification. Lower levels of cognitive learning (e.g., knowledge, application, memory, stimulus-response, chaining, and verbal association) are targeted with the basic instruction sub-system. Guided design ideally attempts to secure this lower order cognitive learning prior to higher order problem-solving (Gagne, 1970).

According to Claire et al. (2006), Human computer Interface (HCI) is a sub-discipline of computer and information science that has been an important area of studies since the 1960s. This field of study is concentrated on the design, evaluation and implementation of interactive system for human use. They added that the design quality is measured in terms of effectiveness, efficiency and satisfaction. Thomas et al. (1998) explained that participants in stimulation studies of the interface led to the development of hypotheses concerning user's choice behavior. The re-design to reflect these hypotheses resulted in significantly improved performance. The current version of the interface appears to be more user-centered. According to Allen, Scott, and Morton (1994) taxonomy of input, process and output does provide a direct linkage to design behavior. Dym (1994) added that taxonomy allows us to classify design problems according to certain characteristics, and facilitate the organization of knowledge representation and reasoning schemes that would be used in modeling different kinds of design. Brown (1999) stated that the best way to ensure incorporation of HCI principles into system design is to build them into software tools that control the user interface.

Shneiderman (2001) elaborated that the user first selects an object and then selects the action to be performed on the selected object. He also added that the Graphical User Interfaces (GUI) are replacing the text mode command based languages. The concern has now shifted to the visual representation and display of the user's tasks objects and actions. Users interacting with a computer get to understand some high level concepts relevant to that system (Shneiderman, 2001). According to Smith and Gavriel (2001) heuristic evaluation is a systematic inspection of a user interface design for usability where the goal is to find the usability problems of the design so that they can be attended to as part of an iterative design process. Nielsen and Molich (1990) have recommended ten usability heuristics to evaluate the interface object.

Therefore the combination of higher and lower level of cognition can trigger design behavior change on interface objects. GUI is important to visually represent and display user's tasks objects and actions. HCI principles guide designers to design user centered design interface objects.

Objective and Research Questions

The objective of this study is to formulate techniques and guidelines to utilize web stimuli for student's design behavior change towards more effective and comprehensive user-centered interface objects, focusing on DeWS learning environment for first semester diploma students. Two major research questions guid this study, namely:

1. How do web stimuli techniques help students to design more effective and comprehensive user-centered interface objects?
2. How do web stimuli influence students' design behavior?

Methodology

The study was conducted during the first semester of the Diploma in Computer Studies course at a Malaysian institution of higher learning. The course provides broad coverage of software development, information technology concepts and principles and technical skills in network programming, security, operating system and database. User interface design is a first semester

module covering the characteristics of graphical and web interface design. The course helps students to develop an interactive program by adopting the user interface design process, justifying the choice of an effective interaction concept for a product, applying the principles of good screen design by using appropriate system menu, navigation scheme, windows and device-based controls in designing the interface of a program and using command and natural language in prototype development.

Treatment Using Design Skills through Web Stimuli (DeWS)

DeWS is a learning environment, a pilot project to study the design behavior on interface objects using human-computer interaction (HCI) principles. DeWS provides students with the Internet materials which are chosen as stimuli and also guide the students on what they need to do step by step. There are five stimuli used in DeWS:

1. Online reading
   The online reading stimulus is a website providing students with information, guidelines and principles that create user centered interface objects.

2. Screenshot
   The screenshot stimulus is a pictorial based stimulation on print screen of interface objects design steps (Figure 1).

3. Animation
   Animation stimulus is a flash animation which guides the student on how to create specific interface object.

4. Online design preview
   The online design preview is a stimulus where students are given a sample of code for an interface object and are asked to perform online modification followed by review.

5. Video.
   Video stimulus is where students are given a video to view on interface object design.

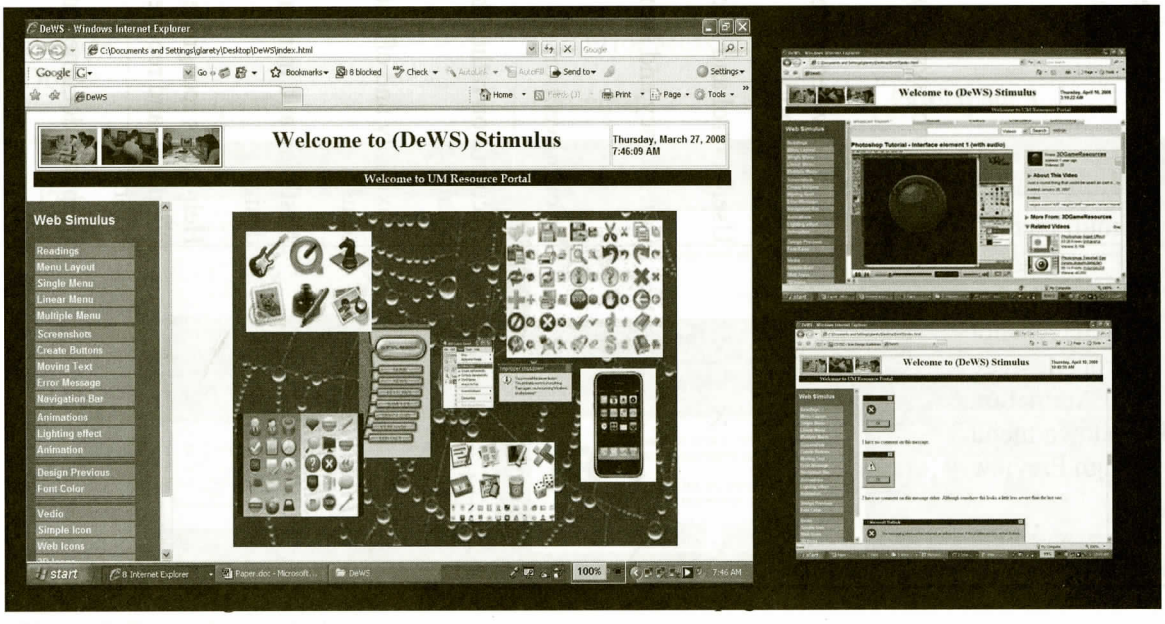


Figure 1. The screen shot of DeWS stimulation page

Data Collection Procedure

A case study was conducted on a group of 15 students from the Diploma in Computer Studies course in a private higher education institution. The students were divided into 5 groups of 3 students. Each group engaged separately with a web stimulus. Each group member was briefed on the process. Session 1 was divided into 3 parts. In part 1 the students were asked to design an interface (pre-design). In part 2 the students were asked to go through the stimulus and in part 3 the students were asked to re-design the interface object (post design). Each part in section 1 was allocated 15 minutes. In session 2, the students were engaged on the same interface objects for 15 minutes after a week. The designs were collected and evaluated. After a month from session 2, session 3 was conducted. Students were asked to design the same interface object that they designed in Session 1 and 2. Data were collected from observation, interview and the design evaluation. The pre and post design evaluations were compared. The students were observed during each design session and interviewed after completing the sessions. The result from the design evaluation, observation and interview were triangulated to assure the reliability of collected data and the validity of conclusions.

Evaluation

The ten usability heuristics adopted from Nielsen and Molich (1990) were used to evaluate the interface objects. The criteria are: visibility of system status; match between system and the real world; user control and freedom; consistency and standards; error prevention; recognition rather than recall; flexibility and efficiency of use; aesthetic and minimalist design; help users recognize, diagnose, and recover from errors; and help and documentation. Usability heuristic criteria analysis was conducted with five web stimuli techniques. Table 1 displays the criteria of evaluation used to evaluate the interface object.

Table 1
Usability Heuristic Criteria Analysis

Evaluation Criteria / Stimuli method	Visibility of system status	Match between system and the real world	User control and freedom	Consistency and standards	Error prevention	Recognition rather than recall	Flexibility and efficiency of use	Aesthetic and minimalist design	Help users recognise, diagnose, and recover from errors	Help and documentation
Reading		X		X		X	X	X		
Icon design										
Screenshot	X	X	X	X	X	X	X	X	X	
Error Message										
Animation	X	X	X	X		X	X	X		
Dropdown menu										
Design Preview	X	X		X		X	X	X		
Video	X	X	X	X		X	X	X		

The pre and post interface objects from sessions 1, 2 and 3 from the 5 groups of students on 5 different techniques of web stimuli were evaluated using the usability heuristic evaluation. The outcome of the evaluation on the pre-design will indicate student's knowledge of design principles.

The outcome on the post design evaluation will indicate how the stimuli have influenced students' design concept and understanding. Sessions 2 and 3 are conducted to ensure that the students show a behavioral change on design behavior. The outcomes from sessions 1, 2 and 3 will indicate whether a change can be identified from the design behaviour observation. This will indicate whether the stimulus using web material influences student design behavior. All students were interviewed after each session to triangulate data, to explore how web stimuli changed their design behavior in integrating HCI principles.

Figure 2 shows the reading stimuli which are used as stimuli for icon design. The Internet resource used was the online article on guidelines for icon design by Marcus (1992) and Mullet and Sano (1995). Students were asked to read this article after their pre-design session. Upon completion they were asked to re-design their work. Figure 2 shows the students' design outcomes during session 1. Students' initial designs were saved as pre-design and after the stimulation as post design.

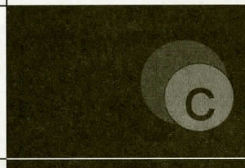
Interface Object	Icon Design		
	Participant 1	Participant 2	Participant 3
Pre-design			
Post -Design			

Figure 2. Pre and post design on icon design

Figure 3 shows the pre and post design results using screenshot technique. The material used was the screenshot from Bolton (2003), a review on error message article. In this article there are samples of good and bad designs of error messages.

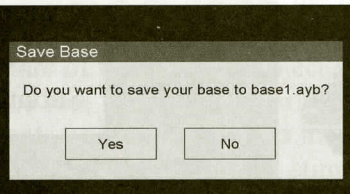
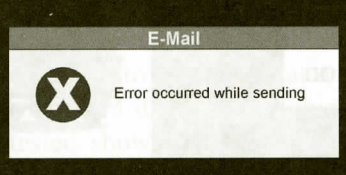
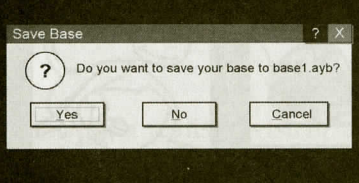
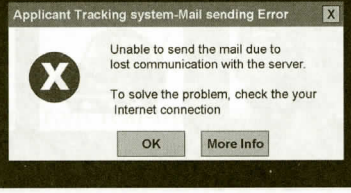
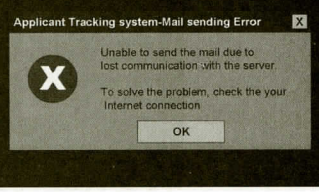
Interface Object	Error Message		
	Participant 1	Participant 2	Participant 3
Pre-design			
Post-Design			

Figure 3. Pre and post design on error message

Figure 4 shows the pre and post design using animation technique. The material used the animation to show Flash menu design animation from Flzone.net.

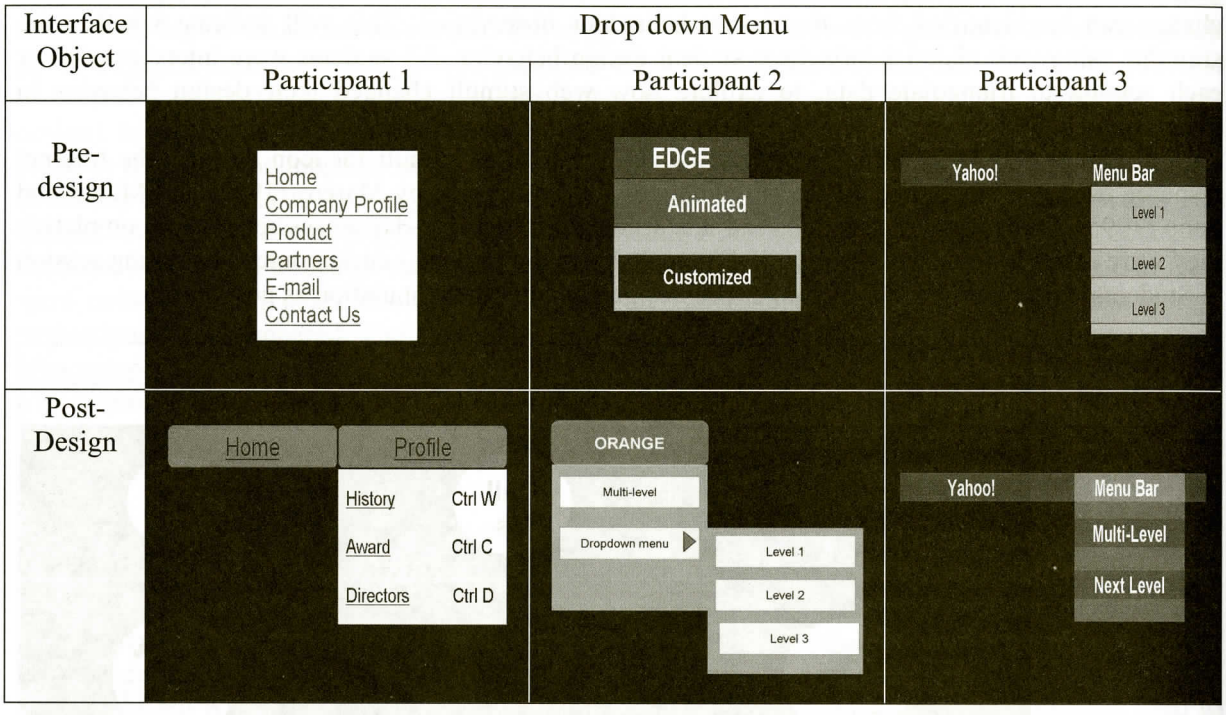


Figure 4. Pre and post design on dropdown menu

Figure 5 shows the pre and post design using online preview technique. The materials used are from w3schools.com, a website that provides online preview based on the changes done. Students are required to write a JavaScript on animated object upon mouse over effect.

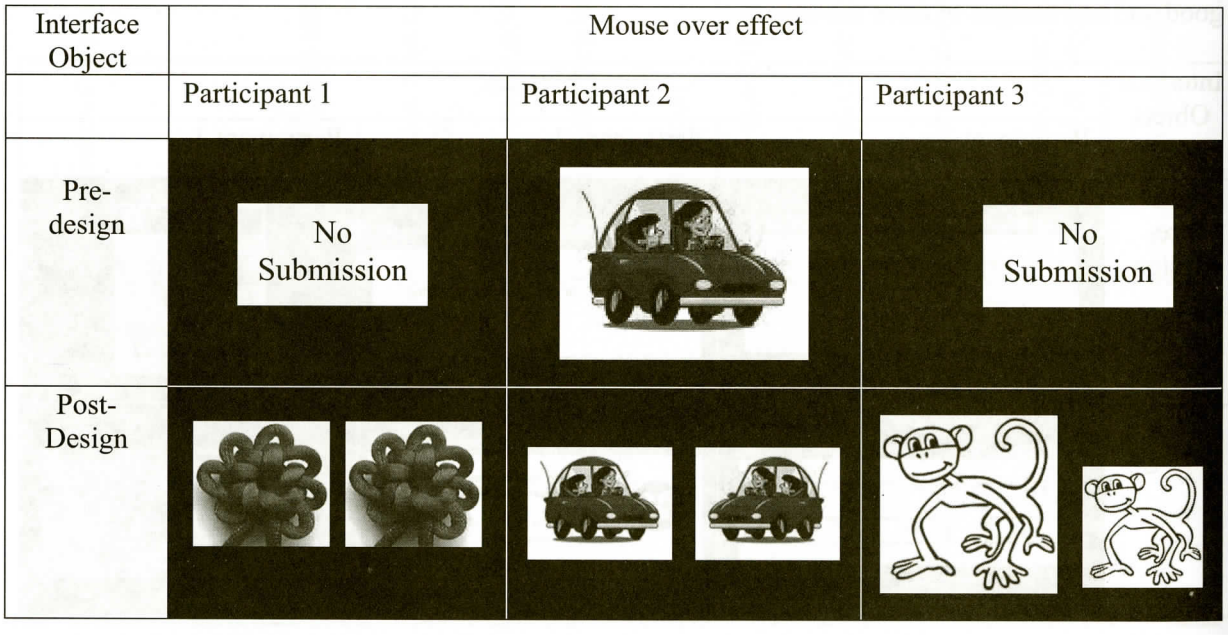


Figure 5. Pre and post design on mouse over effect

Participant 1 and 3 were unable to do the pre-design where they agreed that they have no idea of the design task given to them. After the stimulation they were able to submit the design as in Figure 5.

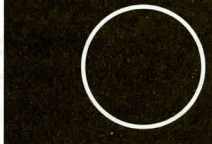
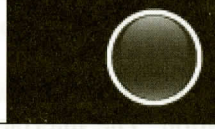
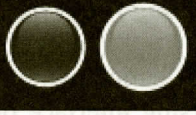
Interface Object	**Button design**		
	Participant 1	Participant 2	Participant 3
Pre-design		No Submission	No Submission
Post- Design			

Figure 6. Pre and post design on button design

Figure 6 shows the pre and post design using video stimuli. The material used was the Photoshop Interface element 1 from You Tube. Participant 2 and 3 were not able to provide the pre-design before the stimulation. Participant 3 produced two designs as post design.

Students' designs after session 2 and 3 were collected to identify the change in design behavior. Five samples were gathered to observe behavior change on students relating to interface objects.

Results

From the data, it can be seen that the use of the Web stimuli can enhance student learning of designing skills based on the four characteristics described below.

Mental Picture

Many of the students reported that the main advantage of the web stimuli was that it helps them to construct a mental picture of the Interface object. Firstly, the web stimuli allowed the students to form a mental picture of the interface object's physical layout which enabled them to design it. One of the students stated that "animation clearly indicates how to operate what we need to design". This shows that the students were able to form a mental picture of the interface objects that they needed to design. The analysis on the five different stimuli tested shows that the post- design is comparable to the heuristic evaluation outcome of the pre-design. The mental picture can guide the students on the design behavior in future.

Visualization

The stimuli showing a realistic visualization from real-time web resources, screenshots, animations, online previews and videos were used. Students were given a real time example to trigger ideas on interface objects which allowed them to make predictions or generate explanations on the interface objects. The evaluation on the pre and post design shows that the students can generate ideas to design usable interface objects in sessions 2 and 3 as compared to the pre design session. This shows that the stimulation on the realistic interface object can help them to adapt the usability design concept easily.

Creativity

The web stimulation allows students to be more creative in designing interface objects. From the five stimulation techniques it is found that the students are able to produce usability concerned design compared to the pre-design. From the design evaluation it is found that students are able to extend their creativity using the samples in the form of screenshot, animation, online preview and video better compared to only using the online reading stimuli.

Conceptual Model

From the data collected, it is found that the stimuli given to the students were able to help them construct a conceptual model on interface object design.The conceptual model was able to help students to integrate ideas and concepts on interface object design so that it is understood by the users in the intended approach.

Conversing Interface Objects

The evaluation conducted on post-design shows that the stimuli encouraged students to design more conversing interface objects compared to the pre-design evaluation. The interface objects produced after the stimuli are more user centered compared to the students' design before the stimuli. Therefore, stimulus allows students to adapt usable design concept directly from the stimulus rather than from the theory. This strategy influences the student' design behavior more effectively compared to classroom-based lecture on user-centered design.

Consistent Design Behavior

From the evaluation conducted in sessions 2 and 3, the students show positive outcome on their design behavior towards interface objects. This indicates that the stimuli given to the students can influence their design concepts.

Recommendations

The findings from this study can be used by instructional designers, lecturers and tutors to design stimulus based lessons to help students learn design skills using web-based resources. It is recommended that the choice of stimuli should be appropriate to the students' ability and maturity levels. Before using the web content as stimuli for interface object design, it is vital that they be selected and evaluated for appropriateness. The evaluation criteria include the following: 1) The authority of the author. Tutors need to find out the evidence that the author of the web information is an expert in the field about which he or she is writing. Author's qualifications, credentials and connections to the subject are vital to measure the quality of the information available; 2) Last update of the Information on the webpage. Tutors need to find out whether the current information is up-to-date and that the links work. This can also be an indicator of the web page quality. Tutors need to check the references to verify if there is a complete list of works cited, credible referencing, and authoritative sources. The important point is to question the author's relationship to the subject, whether or not he is able to give an "expert" opinion which can indicate the accuracy of the information; 3) Content soundness. Tutors need to ensure that the authors are not biased, and are not selling or promoting a product, nor taking a personal stand on a social/political issue; the authors should be objective. Bias is not necessarily "bad" but the connections should be clear.

Conclusion

The findings show that Web based stimulation can help students to develop skills in designing interface objects. DeWS as a learning environment encourages students to design interface objects using human-computer interaction (HCI) principles for user centered applications. The integration of

stimulus-response learning and guided learning encourages exploration of higher cognitive learning of designing skills. The stimuli can be utilized to change design behavior. Therefore web stimuli is capable of encouraging students to explore their understanding of design concepts besides having a significant influence on design behaviors of the students.

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