AC 2009-1414: USING THE NINTENDO WII ® TO TEACH HUMAN FACTORS PRINCIPLES

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Abstract

This paper describes how to use of the Nintendo Wii® game console to teach students a variety of human factors principles. First, the concept of Signal Detection Theory (SDT) is explained using a personalized searching game on the Wii®. Next, an activity involving human sensory systems is discussed. Finally, a learning module that addresses control design and feedback, focusing on the game's controller (Wii Remote or Wiimote) is presented. Potential topic areas for future activities, including human computer interaction, are also discussed. The teaching activities described in this paper have been successfully used by the author in past semesters. A sampling of student feedback is provided in the paper. Finally, a discussion of how the activities could be extended to non-human factors courses and outreach activities is presented.

Introduction

The Nintendo Wii is a popular video game console that allows the player to interact with the games in many new ways. The focus of the Wii gaming system is its controller, called a Wii Remote. The wireless device functions much like a remote control, but has motion detecting technology that allows players to interact with the Wii games using motions. The Wii Remote detects motion and rotation in three dimensions. It also has features that involve other senses, including a rumble feature and speakers in the Wii Remote. Activities on the Wii include many sports activities (baseball, bowling, track and field, etc.), skill games, and classic video games. All games on the Nintendo Wii are centered on the Wii Remote[1-4].

Teaching styles that addresses multiple learning styles are considered to be the most effective for student learning[5-8]. Using the Wii in the classroom allows teachers to involve the active learners in the course. Generally speaking, the Wii is also effective in engaging students in course material. Engagement in the classroom has been shown to improve student learning and performance[9-12]. This paper presents three unique learning modules that utilize the Nintendo Wii to teach human factors concepts. Extensions for each activity outside of the human factors classroom, higher education, and for instructors without access to a Wii are also presented.

Three learning modules using the Nintendo Wii were created to teach human factors principles. The learning objectives for each module are shown in Table 1. Details for each module are discussed below. The modules have been used in both split level (junior, senior, graduate) and graduate level classes. The size of the courses has typically been between 15 and 30 entrolled students. However, each class has been a mixed-campus class, with some student participating in the classroom and others participating online.

Table 2. Learning Objectives

Module	Learning Objective "At the completion of the learning module, students will be able to…"
Signal Detection Theory (SDT)	1. Apply Signal Detection Theory to novel situations
	2. Explain the relationship between the four SDT outcomes
	3. Evaluate an operator's performance using SDT and suggest ways to improve performance
Human Sensory Systems	4. Explain the concept of redundancy in product design
	5. Describe how sensory feedback can impact operator performance
	6. Design a device that incorporates sensory feedback but is also customizable to account for individual differences
Control Design	7. Explain the impact of user preference and experience on product design
	8. Evaluate an existing device based on user performance
	9. Design a controller for a specific example considering user preference, task details, and performance requirements

Learning Module 1: Signal Detection Theory

Signal Detection Theory (SDT) is used in human factors to quantify an operator's ability to distinguish between a signal and noise in an environment. When presented with a stimulus, the operator must respond by saying "signal" or "no signal." Their decision making is impacted by the salience of the signals and environment, response bias, and individual operator sensitivity. Common applications of SDT include a security officer screening a bag at an airport, an inspector looking for quality flaws on product, and a doctor looking for abnormalities in test results.

To explain SDT using the Wii, the Find Mii game is used to create a personalized search and detect activity. The Find Mii game is available on the Wii Play games disc. To play the Find Mii game, players must identify their "Mii" character on a screen of multiple characters. Their Mii is created at the start of the game. Various screens are displayed that present multiple character configurations and layouts. Example screens are shown in Figure 1. For a general classroom discussion of SDT, allowing students to try the Find Mii game is effective on prompting discussion about the difficulties of search and detect tasks. It allows them to see how environment design (e.g. many characters create a noisy environment) can impact their performance.

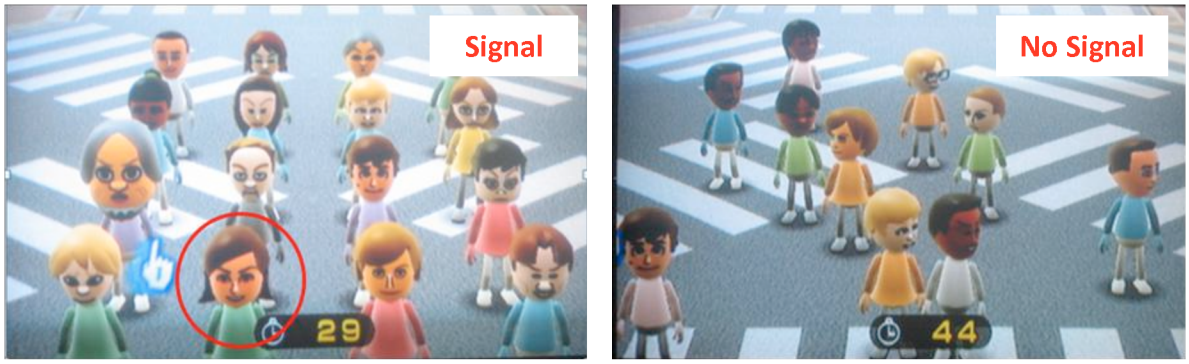

Figure 1. SDT Exercise Screenshots

For a more detailed activity to explain SDT, a PowerPoint slideshow was created using Wii screenshots, similar to Figure 1. The slide show contains 20 images, and is timed to display an image for one second, followed by a three second pause. This repeats for all 20 images. Students record on a data collection sheet whether or not they detected a signal in that image. In this case, a signal is a particular Mii character, typically the instructor's Mii.

After the initial data collection period, the instructor provides the correct answers for each of the twenty images (signal or no signal). Students are given ten minutes to calculate SDT outcomes: hit, miss, false alarm, and correct rejection rates. A classroom discussion then follows centering on the following questions:

- What aspects of the task made it challenging? Did any aspects make the task easy?
- How do you define good performance for this Wii search and detection task?
- Who had the best performance in the class? Why?
- Who had the worst performance in the class? Why?
- How does performance on the Wii task relate to operator sensitivity and response bias?
- If the Wii task was your everyday job, how would your performance change over time?
- How could your performance be improved?
- Do you think the results we found with the Wii task can be applied to other detection tasks (e.g. security screeners, quality control inspectors, police officers)?

The discussion questions are an excellent way to lead the students into deeper comprehension of the SDT concepts, and how the environment can be improved to support detection tasks.

Learning Module 2: Human Sensory Systems

Human sensory systems include vision, auditory, tactile, taste, and olfactory (smell). This learning module focuses on the human tactile system, which is often overlooked in human factors design. In this activity, the tactile sense is applied the presentation and display of information. The Wii Remote, shown in Figure 2a, is central to this learning module. The

rumbling feature on the remote is used to demonstrate the importance of human senses as it relates to operator performance. The importance of feedback is also discussed.

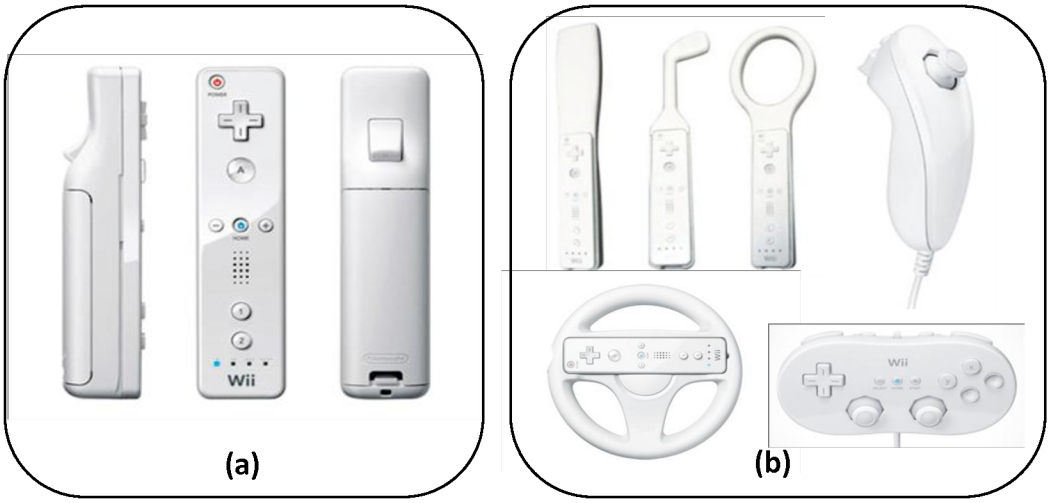

Figure 2. Wii Controllers (http://www.cise.ufl.edu/~brossen/ve/images/wiimote.jpg)

For this learning module, any Wii game can be effective. Generally, using a multiplayer game such as bowling (on the Wii Sports game disc) yields the best results. Start the activity by having a group of students play the game with the rumble feature turned to off. Encourage the students to be vocal about their experience as they play. While they play, the rest of the class should observe, taking note of their performance, how the overall play experience progresses, and comments that the players make. After a round or two of game play, have the students turn the rumble feature to on. Once again, the rest of the class should observe the performance and any comments made by players. Common observations based on this activity include the impact of rumble strips increasing play excitement, reducing overall play time (rumbles signify when it is your turn), and improving play accuracy.

To help students connect these results to human factors concepts, the following questions are used to lead a discussion session:

- Was the vibration feature effective at providing you feedback? How so?
- How are tactile senses used in industry to communicate information?
- In the Wii game, did the tactile feature (rumble) duplicate other information given to your visual or auditory sense? Did you find this redundancy helpful?
- How is redundancy used in industry when designing displays? Is the same information often provided to multiple senses?
- Do people have the same capability in terms of their senses? How can we incorporate these differences in display design?

Learning Module 3: Control Design

The third learning module helps students comprehend the need for design guidelines for human operator controls. The Nintendo Wii is centered on the Wii Remote. However, there are many optional accessories for the Wii, including many other controllers, as shown in Figure 2b. The controllers include add-ons to look like sports equipment (golf club, baseball bat, etc.), a steering wheel, or a classic controller, for example. This in class activity allows students to evaluate various controller designs and examine the impact of controller design on performance.

For this learning module, any Wii game that frequently uses a second controller type can be effective. Generally, a Wii Sports game such as baseball is effective. Start the activity by having a group of students play the game with the Wii remote as the controller. Encourage the students to be vocal about their experience as they play. While they play, the rest of the class should observe, taking note of their performance, how the overall play experience progresses, and comments that the players make. After a round or two of game play, have the students use the classic game controller. Once again, the rest of the class should observe the performance and any comments made by players. Finally, complete a third round of game play using the Wii controller add-ons (e.g. baseball bat shape controller). Common observations based on realistic nature of the controller add-ons, the difficulty in using the static classic controller, and confusion regarding the placement and labeling of buttons.

Once again, after multiple students have had a chance to try the various controllers, the following discussion questions are used to connect the game to human factors concepts:

- Which controller was the easiest for you to use? Which was the most frustrating?
- How similar/different are the controllers? What impact does this have on performance?
- Was there a change in performance based on which controller you used? Why?
- What does your change in performance say about control design?
- How did your past experience impact your use of the controller? Would account for an operator's past experience be important if designing a control in industry?
- Are any of the Wii controllers adjustable? If so, what benefit does that provide the user?

Results from Student Surveys

All three learning modules have been used by the author successfully in past semesters. In the spring 2009 semester, formal feedback from the students in the course Human Factors Engineering course was collected. A total of nine students completed on online survey regarding their experience with the SDT in class exercise. All survey questions were formatted using a 5-point Likert scale, anchored by Strongly Agree and Strongly Disagree response. The first question (see Table 2), shows a mean response of 4.67. This demonstrates that students felt strongly that the Wii activity was fun. The survey responses also indicated that the activity was

viewed as an effective teaching method. However, these results need to be validated by measuring actual student learning performance. Results from the survey are shown in Table 2.

Table 2. Student Feedback Data for SDT Exercise (n=9)

Survey Question	Mean	SD
1. The Wii activity was fun.	4.67	0.50
2. I learned more about SDT from the Wii activity.	4.44	0.73
3. I will perform better on SDT exam questions because of the Wii activity.	4.22	0.67
4. I would like to see more activities similar to this in my courses.	4.44	0.73
5. I will remember more about SDT because of the Wii activity.	4.33	0.71
6. Activities such as this increase my motivation in a course.	4.33	0.87
7. I can confidently apply SDT to various situations because of the Wii activity.	4.22	0.83
8. I can confidently complete SDT calculations because of the Wii activity.	4.22	0.67
9. The Wii activity was more effective in learning the material than regular lecture.	4.67	0.50
10. I have talked to others about the Wii activity.	3.13	1.64

Comments:

- I thought it was a fun, useful tool for learning about signal detection theory.
- Slightly off-topic, but I think a confounding variable in the activity was the viewing angle of each student. The screen may be more difficult to see from the sides of the room than from the center.
- It was interesting and had a different teaching approach.
- It is fun and helps me to understand and remember the theory.
- The Wii SDT activity was an innovative and interactive activity that helped to and enforce understand the different components of SDT. I think this type of activity is something that students can relate too because it is familiar and it also shows that a product that was designed for entertainment can have other practical and learning as well as training aspects associated with it.

Modification of Learning Modules

Each of the activities presented in this paper could be used outside of the human factors classroom as well. Introductory Industrial Engineering courses, outreach events, and K-12 education are all platforms where these activities could be used. The design and method for using each activity remains the same, however discussion questions would be modified to fit the audience level. For example, presenting the material to high school students would justify the need for more generalized discussion content. This could include topics such as including the human in the design process, usability issues, and individual differences. Modifications for various class sizes could be done by splitting larger classes into small groups for the discussion questions. Additionally, in classrooms where using a physical Wii is not feasible, discussing Wii examples can still be an effective teaching method. Chances are, the majority of students in the

course are familiar with the Nintendo Wii, and will be able to relate these activities to their personal experiences even if an actual Wii game is not played in class.

Future Work

The current modules have been revised over multiple semesters based on student feedback. However, when new feedback is collected, the modules are updated and revised. The modules are currently being expanded to include homework/lab activities that follow the in class activity. Additional learning modules using the Nintendo Wii are currently being developed. These include other human factors concepts such as attention, mental workload, and human computer interaction. The learning modules are also being tested on non-human factors students to obtain feedback from a diverse student population.

A validation plan to assess the impact of the activities on student learning is being developed. The assessment would indicate, beyond student perceptions, whether the activities achieved any value with respect to student learning outcomes and performance. Preliminary plans for the learning validation include a pre- and post-activity content based test, as well as testing two different groups of students (activity and no activity). The results of these measures would help determine if the activities improved student learning as expected.

Bibliography

1. Croal, N., & Kashiwagi, A. (2006, May 29). Playing with gaming: Nintendo's recently unveiled Wii gaming console could cap off a remarkable comeback. Newsweek, archived at http://www.newsweek.com/id/47942.
2. Gadgets. (2006, November). Engineering and Technology, 1(8), 46-47.
3. Snider, M. (2006, May 10). Video-game makers unveil the fun to come. USA Today, 5D.
4. Voth, D. (2007). Evolutions in gaming. Pervasive Computing, IEEE, 6(2), 7-10.
5. Felder, R. M. (1996). Matters of style. ASEE Prism, 6(4), 18-23.
6. Felder, R. M., & Brent, R. (2005). Understanding student differences. Journal of Engineering Education, 94(1), 57-72.
7. Felder, R. M., Felder, G. M., & Dietz, E. J. (2002). The effects of personality type on engineering student performance and attitudes. Journal of Engineering Education, 91(1), 3-17.
8. Prince, M. J. (2004). Does active learning work? A review of the research. Journal of Engineering Education, 93(3), 223-231.
9. Felder, R. M. (1995). A longitudinal study of engineering student performance and retention. Instructional methods and student responses to them. Journal of Engineering Education, 84(4), 361-367.
10. Felder, R. M., Felder, G. M., & Dietz, E. J. (1998). A longitudinal study of engineering student performance and retention. Comparisons with traditionally taught students. Journal of Engineering Education, 87(4), 469-480.
11. Prince, M. J., & R. M. Felder. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. Journal of Engineering Education, 95(2), 123-138.
12. Smith, K. A., Sheppard, S. D., Johnson, D. W., & Johnson, R. T. (2005). Pedagogies of engagement: Classroom-based practices. Journal of Engineering Education, 94(1), 87-101.