# Measuring Technology Acceptance of Makey Makey as an Input Device in a Human-Computer Interaction Class

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Abstract: Students from a human-computer interaction course used the input device called Makey Makey Classic (a low-cost digital interface) for creating a video game controller, based on the topic of user interface development. A study was conducted to analyze how students accepted the use of the Makey Makey in class. After students used the Makey Makey for playing a video game, they filled out the Technology Acceptance Model version 2 (TAM2) questionnaire. Results indicated that most of the students perceived the Makey Makey as very useful and easy to use in class and they would like to use it again in further classes where prototyping is required. However, results could be affected by the "novelty effect." Further longitudinal studies are needed to see if student technology acceptance of the Makey Makey will remain positive through longer periods of time. This is in line with the so-called "maker movement" where easy-to-use and low-cost technology is used as hands-on learning material.

### Introduction

The 4<sup>th</sup>-year Human-Computer Interaction (HCI) course taught at the Bachelor of Computer Science of Algoma University, Canada, includes a class on user interface (UI) development. A UI can be defined as the point of contact between the user and the computer (or any digital device such as a mobile phone), and the place where they communicate and exchange information (Shneiderman et al., 2009). UIs can be bi-directional, where both input and output sensors and devices are involved in its development. The UI topic is an important part of an HCI course, and should be taught with both theoretical and practical (hands-on) components and activities. In our UI development class, students needed to learn and apply concepts on interactive UI design using specialized hardware and software,

which involved tinkering with everyday objects and some electronic components for designing, developing and testing a UI. UI development should be based on the interface design paradigm of user-centered design (UCD) (Gulliksen et al., 2003), which involves user participation in all the UI development steps and improving UI prototypes iteratively. In order to learn and practice UI development, we devised a class where students created an interactive video game controller and used it with an online video game. To do that, students used a low-cost and open-hardware digital device called Makey Makey Classic (http://www.makeymakey.com/) for creating a medium-fidelity prototype of the video game controller. A medium-fidelity prototype is a model of an interface with limited functionality, capable of being improved later to become a high-fidelity (almost complete) prototype (Coyette et al., 2007). They are useful for testing new ideas and alternatives for designing interactive UIs.

The Makey Makey is an electronic device that allows users to connect everyday objects such as fruits, Play-doh (R) (modeling material for children), coins, pencil and paper drawings to computer programs. Using a circuit board, alligator clips, and a USB cable, the device uses closed-loop electrical signals to send the computer either mouse click signals or keyboard strokes. The Makey Makey simulates the following inputs: the arrow keys, W,A,S,D,F,G keys, the enter key, the space bar and 6 inputs for mouse motion (left, right, up, down, left and right buttons). In order to close the electric circuit, the user needs to hold or touch an earth (ground) wire connected to the Makey Makey, and another wire must be connected to the everyday object, which must be conductive. We decided to include the Makey Makey in our HCI course for developing video game controllers because most of our students like to play video games and we thought it could be a nice way of motivating them to learn UI development. Thus, it is possible to easily simulate video game controller buttons and functions with a Makey Makey, making it ideal for creating prototypes of interactive UIs. The Makey Makey has been used in other research projects with success, supporting users' creativity and motivation for building prototypes of input devices easily and in a short time, for example, the projects described in Rogers et al. (2014) and Lee et al. (2014).

However, how do we know if students like and come to accept new technology (the Makey Makey) for making interactive prototypes in class? How do we know if the Makey Makey will be useful for students in further HCI classes? The Technology Acceptance Model (TAM) (Davis, 1989) is a computing theory that analyzes how users come to accept and use a particular technology, usually new one. As Davis (1989) pointed out, the TAM suggests that when users are presented with a new technology, some factors influence their decision about how and when they will use it, including:

- **Perceived usefulness** (PU): "the degree to which a person believes that using a particular system would enhance his or her job performance".
- **Perceived ease-of-use** (PEOU): "the degree to which a person believes that using a particular system would be **free from effort**".

The TAM is related to usability, because both analyze how people interact with technology and what is the user's reaction about it. *Usability* is the learnability and ease of use of a human-computer interface. It generally measures the effectiveness, efficiency and satisfaction of use of a digital device (Nielsen, 2012). Unless ease of use of UIs from usability, TAM focuses on analyzing the users' subjective perception, acceptability and adoption of new technology (Dillon, 2001), such as the Makey Makey.

We can use everyday objects in HCI for enhancing or supporting some UI interaction styles and for conducting special tasks in an innovative way, creating new gaming user (player) experiences. For example, students can create and customize their own video game controller, such as the one shown in Fig. 1, experimenting with new keyboard arrow sizes and shapes using Play-doh (R) and the Makey Makey device.

#### The Study

Taking into account the capabilities of the Makey Makey, we devised as study on the use of Makey Makey as a tool for supporting learning of UI development in classroom. The objective of the in-class activity was to iteratively develop an interactive prototype of a video game controller using the Makey Makey and evaluate its technology acceptance. This activity lasted about an hour. Forty-six undergraduate computer science students (all males, with an age average of 20 years) participated in teams, all from the HCI course. There were no females registered in the course. Each team used a Makey Makey kit, and created a video game controller prototype using Play-doh (R), pencils, paper and coins, which made four simulated keyboard arrow keys for moving a video game character up, down, left or down. After creating the prototype, students played an online version of the game Pac-Man (R) (http://www.freepacman.org/) using the controller they created, where each team connected the Makey Makey to a laptop. The task in the game was to play it freely for some minutes using all the simulated arrow keys from the Makey Makey interface. The set up is shown in Fig. 1, which shows the simulated four keyboard arrow keys made with Play-doh (R). The students touched the Play-doh (R) arrow keys in order to move the Pac-Man (R) character around in the game.



Figure 1: A video game controller made with Play-doh (R) and a Makey Makey Classic interface.

The learning objective of our UI development class was to foster experiential learning through the use of easy-to-use and interactive technology. In the first part of the class, UI development theory was taught. The second part of the class was devoted to the actual development of the video game controller with the Makey Makey. In order to measure how students liked and accepted the Makey Makey (new technology used in class) as a prototyping tool for interacting with a video game, each student filled out the Technology Acceptance Model version 2 (TAM2) questionnaire (see Appendix 1) at the end of the class (Venkatesh & Davis, 2000). Each item from the questionnaire had a 7-point Likert scale (1=strongly disagree, 7=strongly agree).

## **Findings**

Fig. 3 shows the averaged results from the Likert scales of the TAM2 questionnaire that participants filled out in the study. All the students perceived the Makey Makey as very useful and easy to use in the HCI class. In addition,

many students expressed that the Makey Makey could be useful in further HCI classes.

All the teams created more than one version of the video game controller iteratively, testing different materials and shapes for the arrow keys. Some teams used coins as the arrow keys, as shown in Fig. 2. The creation and improvement of various versions of video game controllers was based on the user-centered design (UCD) paradigm (Gulliksen, 2003), also taught at the beginning of the class.



Figure 2: Video game controller made with the Makey Makey and coins.



Figure 3: Averages of each Likert scale from the TAM2 questionnaire (1=strongly disagree, 7=strongly agree), n=46.

## Conclusions

Although results from the TAM2 were very promising and positive, they could be affected by the "novelty effect." Further longitudinal studies are needed to see if student technology acceptance of the Makey Makey will remain positive through longer (e.g. a semester) and repeated periods of time in HCI classes.

The use of Makey Makey in class is in line with the so-called "maker movement" (Stager, 2014; Halverson & Sheridan, 2014), where easy to use and easily accessible technology is used as hands-on learning material, and the activity described above is supported by a number of educational theories such as Kolb's Experiential Learning model, which states that students learn through concrete experiences, observing and reflecting on doing (Kolb, 1984).

The Makey Makey is a low-cost technology that can be afforded by small-budget schools. It is a versatile tool that can be easily integrated to human-computer interaction and other courses, since it allows for many simple projects and hands-on students activities, from simple UI prototyping to fully-fledged interactive applications. At the end of the class, some students actually wanted to buy a Makey Makey kit for themselves for tinkering with it in their spare time. According to both the TAM2 questionnaire results and students' comments made during the class, the Makey Makey motivated students to continue using it, and this study arouse students' curiosity on how to use a simple piece of technology for creating complex yet useful human-computer interfaces, effectively applying HCI principles and theory.

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# Appendix 1: TAM2 Questionnaire Used in our Study (Venkatesh & Davis, 2000)

	Strongly disagree	Moderately disagree	Somewhat disagree	Neutral	Somewhat agree	Moderately agree	Strongly agree
Intention to Use							
1. Assuming I have access to the system, I intend to use it.							
2. Given that I have access to the system, I predict that I would use it.	•	•		•	•		
Perceived Usefulness							
3.Using the system improves my performance in my activity as student.	•		•	•			
<ol> <li>Using the system in my activity as student increases my productivity.</li> </ol>	•		•		•		
5.Using the system enhances my effectiveness in my activity as student.	•		•		•		
6.1 find the system to be useful in my activity as student.		•			•	•	•
Perceived Ease of Use							
7.My interaction with the system is clear and understandable.							
8.Interacting with the system does not require a lot of my mental effort.	•	•	•	•			•
9.1 find the system to be easy to use.		•				•	
10.1 find it easy to get the system to do what I want it to do.					•	•	
Subjective Norm							
11.People who influence my behavior think that I should use the system.	•	•				•	•
12. People who are important to me think that I should use the system.						•	
Voluntariness							
13.My use of the system is voluntary.							
14.My supervisor does not require me to use the system.						•	0
15.Although it might be helpful,							