Warm Robot Classroom_Using Wearable Technology as a Gateway to Culturally Responsive Teaching

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Abstract. [Warm Robot classroom] is related to answer the question of introduce computational thinking teaching aids and course design by studies robots and wearables with social humanity. The discussion is about how to cultivate students with the rational technology thinking and humanity empathy? The research method includes design and research on cultural response teaching curriculum with the composition of product designers and electronic engineers, planning of teaching contents, and solicitation of teaching and learning of cultural responses from more than five kinds of different cultural backgrounds through the a one semester course. Develop the performances from different cultural groups through 3D printing, laser cutting and digital embroidery creations and assess the applicability of course design.

This course was held with 64 participants (9 different countries, 5 backgrounds). We describe our experience in designing and organizing a wearable course. We will show that (1) Three interactive modules of difficult levels of soft wearable prototypes. (2) The culturally responsive curriculum. (3) The learning outcome of the teaching implementations with interactive toolkits from the final performance.

The result shows that curriculum with different background works together can built students from either side to response to each other.

Keywords: Cultural issues in learning with collaboration technologies
Wearable technology · Smart textiles · Interactive design

1 Introduction

Today's classroom is no longer about analysis, but synthesis. Even though crosscutting and cross-cultural curricula are eagerly awaited for learning, it is even harder to get to an accomplishment. Wearable Technology is related to Interaction, it supposes to be two-way and two-sided; therefore, designing interaction wearable device is to add up both left and right brain apogee at the same time. There are two possibilities to achieve this, to train up a person with both abilities or to work in an integrated manner. Which one is better?

[Warm Robot classroom] includes the learning of wearable technology contents and culturally responsive teaching paradigms by group different cultural and professional

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P. Zaphiris and A. Ioannou (Eds.): LCT 2018, LNCS 10925, pp. 239–253, 2018.
https://doi.org/10.1007/978-3-319-91152-6_19

backgrounds to experience the co-work process and shown the result in a performance on a music show. The course proposal is from "A Warm Robot Classroom_Development and Commercialization of Smart Textiles Interactive Toolkits with Cultural responsive Features" featuring was awarded a grant from the Ministry of Science and Technology (MOST-106-2511-S-130-001 -).

In collaboration with the Department of Electronic Engineering, we launched three innovative programs on workshop teaching and product development and course syllabus. The course is a combination of new media technologies such as interactive LED and laser light projection, interactive air drum music wear that combines sound adapted from the different culture and direction with orientation sensors.

The final presentation, "International Cultural Fusion Wearable Technology Music Workshop presentation" showcased the splendid achievements of new media, science, technology, and intercultural collision. International students are invited to provide international culture to discuss and collaborate with designers and engineers. Through the sound and light effects and music performances, the cultural characteristics of different countries are highlighted.

The program is divided into three parts:

(1) Three different levels of difficulty in teaching cases and interaction packages: Robot, in terms of technology, can be simplified as easy for the study of circuit of how to control the light shine, motor, heat and sound. On the other hands, it can also be developed into clouds data technology and the Internet of Things items. The so-called intelligent world is created by the output behavior and controlled by the input data sensing. The teaching cases of sensor (input) and feedback (output) components are consistent with the teaching content actively and enhance the interest of participation. Wearable technology or Smart Textiles are good materials to express cultural response characteristics and have the concept of science and technology simultaneously. The project is a combination of new media technologies such as interactive LED and laser light projection, interactive music wear that combines sound and direction with body orientation.
(2) Culturally Responsive Teaching: Product designers and an electronic engineers will be team up to plan teaching content and plan. 9 international students are invited to provide international culture to discuss and collaborate with designers and engineers. Participants of different cultural groups will help to interpret their own culture with teammates; designers are responsible for sketches, 3D printing and digital embroidery sewing, etc. Engineers are responsible for the programming and electronic elements. The syllabus evaluations are done in this section.
(3) The stage performance: Through the sound and light effects and music performances, the cultural characteristics of different countries are highlighted. The webpage is the communication platform of showing the smart textiles application cases and teaching materials. And it is also for teachers and learners to share application resources to enhance students' motivation and interest in learning science. She further shared that even though cross-cutting and cross-cultural curricula are eagerly awaited for learning, it is even harder for us to realize what are their accomplishments.

The program, with representatives from Germany, France, Marshall Islands, Tuvalu, Korea, Malaysia, Indonesia, Mongolia and Hong Kong participated in this program activity. Department of Product Design, Electronic Engineering, Information Engineering, Tourism, International College and other students. For two consecutive weekends, teachers and students conducted experiments in the course of "Cultures of International Culture Wearing Technology Music workshop". The results were released and the We Warm Plan completed.

The publication of this achievement passing out the messages that with technology and art allows us to be warmer and closer of the relationship. For more information, please use the following link.

fb.me/wwplan

2 Literature Research

The advent of digital technology in the field of product design is a phenomenon that is part of a global context: the increasing computerization of our societies requires indeed to reconsider their functioning, as well as our ways of living and being in the world. The advent of digital technology in the field of product design is a phenomenon that is part of a global context: the increasing computerization of our societies requires indeed to reconsider their functioning, as well as our ways of living and being in the world. Warm Robot class is a course offered to students in several disciplines. We design and development the teaching aids sponsor by the MOST. Students learned and worked in teams to develop, design, build, and test prototypes with those applications. At the end of the semester students showcase their efforts at the final presentation of a performance show (Fig. 2).

Designers learn and apply the engineering process: defining functional requirements, conceptualization, analysis, identifying risks and countermeasures, selection, and physical prototyping. However Engineer learn from the designers for aesthetics, usability, and the emotional purpose. There are a key issue in-between designers and engineers which is the culture presented by the international students from Germany, France, Marshall Islands, Tuvalu, Korea, Malaysia, Indonesia, Mongolia and Hong Kong.

There are some terms while developing this course and teaching aids that is culturally responsive teaching, wearable technology, and digital performance.

2.1 Culturally Responsive Teaching Paradigms

Culturally responsive teaching (CRT) is defined as using the culturally characteristics, experiences, and perspectives of ethnically diverse students as conduit for teaching (Gay 2002). The student population in Taiwan compare to US remains fairly mono racial but becoming increasingly culturally and linguistically diverse. Many Taiwanese students are lack of experience to cooperate with other cultural students, so attracting international students to participate in the curriculum has become the focus of research. The course was designed according to "the Relevant Themes of Culturally Responsive Teaching"; and offered to students in several disciplines and cultures, hopefully the international outlook of students can be built by this project.

Table 1. Relevant themes of culturally responsive teaching (Aceves and Orosco 2014)

Culturally Responsive Teaching Practices		
Relevant Themes of CRT Emerging Evidence-Based	Emerging Evidence-Based CRT Practices	Recommended CRT Approaches and Considerations
Instructional Engagement Culture, Language, and Racial Identity Multicultural Awareness High Expectations Critical Thinking Social Justice	Collaborative Teaching Responsive Feedback Modeling Instructional Scaffolding	Problem-Solving Approach Child-Centered Instruction Assessment Materials

2.2 Wearable Technology

Smart textiles have often reminiscent those can deliver exceptional performance with light, sound, electricity, input and feedback. They were also commonly defined as detection of physiological signals, mood changes, and feedback information to the controller to determine what is the reaction on the textiles.

Smart Textiles are able to sense stimuli from the environment, to react and adapt to them by integration of functionalities in the textile structure. The stimulus as well as the response can have an electrical, thermal, chemical, magnetic or other origin. The Smart Textiles or E-Textiles usually contain both sensing and feedback components. It can sense, test and collect information about people or the environment, such as body temperature or human action. Output through the shining light, temperature changes, image display and other feedback electronic message transmission allow users to feel the situation changes. Smart Textiles, due to the characteristics of sensing and feedback, is different from the general fabric, but also because of the softness is different from electric plastic product. Specific textiles can replace the hard circuit, or show the light and temperature feedback.

The extent of intelligence can be divided in three subgroups:

- Passive smart textiles can only sense the environment, they are sensors;
- Active smart textiles can sense the stimuli from the environment and also react to them, besides the sensor function, they also have an actuator function;
- Finally, very smart textiles have the gift to adapt their behavior to the circumstances (Dadi 2010).

Basically, 5 functions can be distinguished in an intelligent suit, namely: Sensors, Data processing, Actuators, Storage, Communication. (Van Langenhove and Hertleer 2004) When study wearable technology, Smart-Textiles are essential elements to be

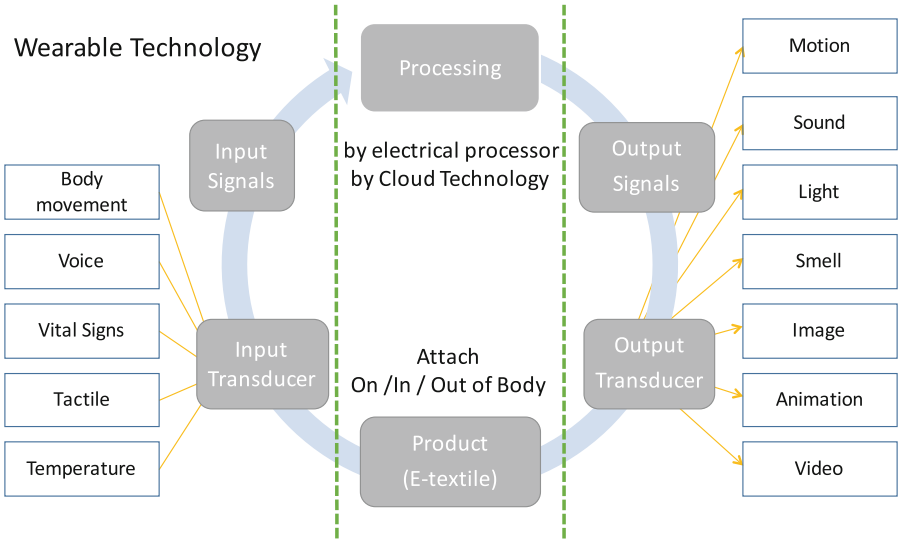


Fig. 1. Process of digital/analog transmission

considered, which incorporates elements of design and fashion and thus it is more gender-neutral than robotics. It is also caters to a much broader range of children's social goals and desire for self-expression (Lau 2009).

Using textiles to design a robot could be an interesting combination of contradictions. We began by surveying the adaptable and accessible smart textiles material in Taiwan to make sure the following production without any doubt which mostly from Taiwan Textile Research Institute (TTRI 2011)and textile industry (Chen 2012). (Chen 2014) Even though those textiles are not defined as "Smart Textiles", but we found that it is quite useful in the idea development as shown in Fig. 1 (Bonato 2005).

2.3 Assessment of Teaching Aids Design

Assessment helps the learner to make more meaningful, dynamic challenging and effective teaching aids. Any consideration must begin with a need analysis, which will help to develop material that enhances all skills.

Another significant aspect of teacher-designed aids is the setting of goals and objectives for the learners. It gives a sense of direction of the course and helps to achieve teaching and learning proficiency. Proper selections of activities will be useful in attaining the purpose of teaching aids.

2.4 Digital Performance

Steve Dixon and Barry Smith, gave the following definition of 'digital performance': "We define the term "digital performance" broadly to include all performance works where computer technologies play a key role rather than a subsidiary one in content, techniques, aesthetics or delivery forms. This includes live theater, dancer, and

performance art that have been digitally created or manipulated; robotic and virtual reality performance; installations and theatrical works that use computer sensing/activating equipment or telemeter techniques; and performative works and activities that are accessed through the computer screen" (Dixon and Smith 2007).

In order to practice culturally responsive teaching by introducing wearable technology in design class, we arranged a digital performance stage for students to present what they have learned and their feedback of collaborative teaching for the assessment. Students work in teams to design, build, and test prototypes with real world applications. At the end of the semester students showcase their efforts at the final presentation. At the end student teams display and pitch their inventions and marketability to a panel of judges, invited guest, media, and their peers, while competing for cash prizes. This is an excellent opportunity for sponsors to see how the teams conceptualized their project. The assessments of this performance have two important criteria Technology and Culture.

3 Process

There are three different backgrounds in this projects, designers, engineers, and international students from the other cultures out of Taiwan. The course is built around four main topics, but each part adopts a different perspective on them. Part 1 is an introduction to digital fabrication knowhow. It starts by focusing on 3D printing and laser cutting, and then considers how this affects the group project. Part 2 is comprehensive of the other cultures. In Part 3, the course starts by focusing on learning wearable interaction design, and then considers how these installations can respond to culture. In Part 4, all students undertake a development unit in which they research an aspect of culture in their subject for a digital performance and run the wearable technology show on stage. The course for Part 1 covers:

- 3D printing practice.
- Laser cutting Practice.

Students who have completed Part 1 will join with those international students who are starting in Part 2. Together they have 3 seminars together and work in either subject-specific groups or general groups. The course for Part 3 covers:

- Circuit board Layout with light sensor and LEDs.
- Laser light arts and applications.
- Air Drum with 3-axis accelerometer.

3.1 Course Contents and Pedagogy

There are four types of content: design, culture, wearable technology, and performance. The performance is echoes of the culture and technology learning by designers, engineers, programmers, and the international students.

Table 1 presents the syllabus of our warm robot course, which consists of four parts, with one to two set tasks per level. The set tasks serve, as mini-checkpoints to

Table 2. Warm robot course contents. Totally 36 h

Part 1st - Maker (6 h)	
Contents:	Knowing the skills of making 3D printing and laser cutting prototypes (6 h)
Tasks:	Designers tried out the digital fabrication machine and work out a prototypes Making visual props that enable cultural transmission
Learning outcomes:	Groups work out prototypes of one from 3D printer and one from Laser cutting machine
Part 2nd - Culturally Responsive (6 h)	
Contents:	Knowing the different culture aspects and value (6 h)
Tasks:	International students introduce their culture by PPT Discuss the content for the wearables and performance
Learning outcomes:	Students should give his LED board a look and apply their design on their own clothes Basic electrical knowledge: voltage, conductivity and resistance
Part 3rd - Wearable Technology (18 h)	
Content 1: Electronic Board (3 h)	
Tasks:	Electronic Circuit Theory Circuit Design
Learning outcomes:	Students should give his LED board a look and apply their design on their own clothes Basic electrical knowledge: voltage, conductivity and resistance
Content 2: Laser Light Application (3 h)	
Tasks:	Create simple circuite with Laser Light head, Mercury switch, and light sensors
Learning outcomes:	Make wearable component and design the laser light effect
Content 3: Air Drum Project (12 h)	
Tasks:	Create a complex Air Drum with 3-axis accelerometer
Learning outcomes:	Students should be able to record the voices, write a program that reads in signals from 3-axis accelerometer and send signals to the speakers
Part 4th - Digital performance (6 h)	
Contents:	Run a show following the culture contents with wearable devices
Tasks:	Discuss the entire performance axis and media applications
Learning outcomes:	Knowing how to integrate with different background

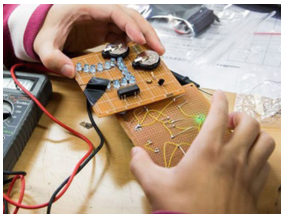
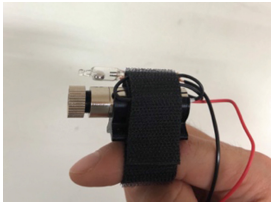
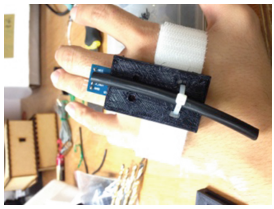
make sure that the students have understood the course contents presented in that particular level. The learning outcomes of each level are also listed in the Table 2.

3.2 Prototypes for Idea Development and Teaching Aids

To support this robot course, we designed 3 modules of wearable prototypes. These prototypes were provided to the students as teaching aids to construct wearable

technology of electronic devices and the instructions with limited components. This allows the students from having to not worry about technical issues when constructing their circuits, and makes the learning and trial-error process quicker and more enjoyable.

Table 3. Three teaching aids design to support the [warm robot class]

		
1. Electronic Board	2. Laser Light Application	3. Air Drum

These teaching aids prototypes were designed by the following requirements:

1. **Quick and iterative assembly on body:** It should encourage trial-and-error experiments among its users by allowing quick and iterative assembly of a diverse variety of electronic components, including different microprocessors.
2. **Minimum sewing or soldering:** The wearable teaching aids would have to be usable to the users who are beginners without much skill in either sewing or soldering. Therefore, the use of electrical wires, plastic insulation, and solder are avoided or kept at a minimum.
3. **Allow iterative development:** To allow students to learn the basic fundamentals without having to be concerned about material imperfections (such as overly-high resistances), the fabric should support active and hands-on learning and iterative construction and design.

3.3 Collaborative Teaching and Learning

A culminating course proposed by this research was offered to students in several disciplines. Students work in teams to design, build, and test prototypes. At the end of the semester students showcase their efforts at the final presentation.

Warm Robot Class provides students the opportunity to work with open-ended, interdisciplinary challenges. They learn and apply the engineering design process: defining functional requirements, conceptualization, analysis, identifying risks and countermeasures, selection, and physical prototyping.

After Student teams learn from the teaching aids with collaborative teaching, they should have the abilities to design and build working, physical prototypes to validate their presentations. By working in teams they develop leadership skills and group

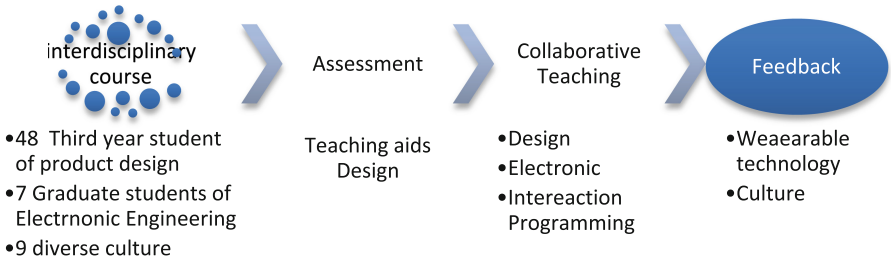


Fig. 2. Syllabus collaborative teaching and learning

dynamics; dealing with scheduling conflicts, meeting weekly deliverables and deadlines; and communication among team members in culturally and linguistic diverse ways.

3.4 Final Presentation Activity_Digital Performance

Proper selections of activities will be useful in attaining the purpose of teaching aids. The final presentation also afforded us the opportunity to see how well the workshop allowed the participants to exercise the creativity. At the end student teams display and perform their wearable digital shows on a prepared stage in front of judges, invited guest, media, and their peers, while competing for cash prizes. This is an excellent opportunity for sponsors to see how the teams conceptualized their project.

There are three collaborative teachers were invited from EE, English teacher from International College, and a movie director, and the director of Tao-Yuan Art Center to be the judges for the performance. Our evaluations were performed using surveys with two measurements. Each measurement has two criteria as shown in Tables 3 and 4.

Table 4. Assessment of the final presentation.

Culture representation: 50%	Wearable technology: 50%
Symbol transformation 25% Teamwork 25%	Technology and media application 25% Visual and sound effect on stage 25%

4 Result

We want to investigate along three angles. First, we wanted to see whether the wearable teaching aids design was inspiring to the students. Second, we wanted to know whether working with diverse culture had helped to simulate the student's imagination? Third, we wanted to know whether working with diverse professions had helped to exercise their creativity and gained some knowledge about technological and programming concepts?

Our evaluations were performed using surveys and feedback from the students. To gauge the difference that every prototype was created, we used 4 post-course surveys

after each section of the course and the final presentation to know that if they were inspired by the course and how they felt about the level of difficulty of the tasks.

4.1 Course Outline, Schedule, and Contents

This course was held with 64 participants. 9 different countries from Germany (1), France (1), Marshall Islands (1), Tuvalu (1), Korea (1), Malaysia (1), Indonesia (3), Mongolia (1) and Hong Kong (2). 5 backgrounds from design (41), electronic engineering (7), information management (1), information engineering (5), Tourism (3). In order to perform collaborative teaching, the course was held on two weekends and one evening in December 2017. Syllabus and timetable are as shown in Table 5.

Table 5. Time table of the warm robot class

Date	Time	Contents	Notes
12/2 (Sat.)	9:00–9:30	Registration (30 min)	Camp T-shirt
	09:30–10:30	Keynote_Aqua Chen Digital Fabrication performance	Course outline and introduction
	10:30–12:00	Ice breaking and mixing group 9 teams (4Design,1EE,1-2 Intl.)	Culture comprehensive
	12:00–13:00	Lunch break	
	13:00–14:20	Student presentation, topic 1–4	Q& 10 min/group
	14:20–14:30	Break	
	14:30–15:30	Student presentation, topic 5–9	10 min/group
	15:30–16:00	Group discussing	
Part 1: Visual Symbol			
12/3 (Sun.)	9:00–12:00	Electronic board workshop	Instructed by EE
	12:00–13:00	Lunch break	
	13:00–16:00	Wearable laser applications	Instructed by New Media Artist Mr. Kao
Part 2: Vocal Symbol_ Air Drum			
12/9 (Sat.)	09:00–12:30	Introduction of Arduino, Sensors Knowing the programing methods	Instructed by New Media Artist Mr. Lin
	12:00–13:00	Lunch break	
	13:00–16:00	Figure with the use of sound library. Basic graphics and sound processing, the basic program of drawing	
12/10 (Sun.)	9:00–12:00	Arduino + processing Program Arduino signal into the Processing to control image or sound	

(*continued*)

Table 5. (*continued*)

Date	Time	Contents	Notes
		Lunch break	
	13:00–16:00	Combine air drum electronic components and devices with the installation Combined the program with the actual operation of the rehearsal	
Final Presentation_Digital Performance show			
12/22 (Fri.)	15:00–17:00	Rehearsal	Five Judges: EE Design English Center Art Center Movie Director
	17:00–19:30	Finals by 9 groups (judge and award)	
	19:30–20:00	Closing ceremony	

4.2 Surveys of the Collaborative Course and Wearable Technology Learning

The survey focuses on the interest of if working in an integrated manner in the related subject better? The questionnaire was designed with Likert scale. Student gave feedback right after each Wearable course and the Final performance on stage. Table 6 presents the survey questions. There are approximately 50 respondents include 5 majors, 10 cultures.

Table 6. Survey questionnaire and Summary of Survey Data

Questions for the survey
1. How satisfied you are with the schedule of this course?
2. Your satisfaction with the venue arrangement?
3. Your satisfaction with the content of this course?
4. Your satisfaction with the practicing your profession of this course?
5. Your satisfaction with the lecturer ‘s teaching skills and ability to express?
6. Your satisfaction with peers of the other culture?
7. Your satisfaction with peers of the other professional background?
8. How satisfied you are with the overall sense of the course?

The result shows that the more difficulty the project is, the satisfaction with peers of the other professionals and or cultures get higher (Figs. 3 and 4).

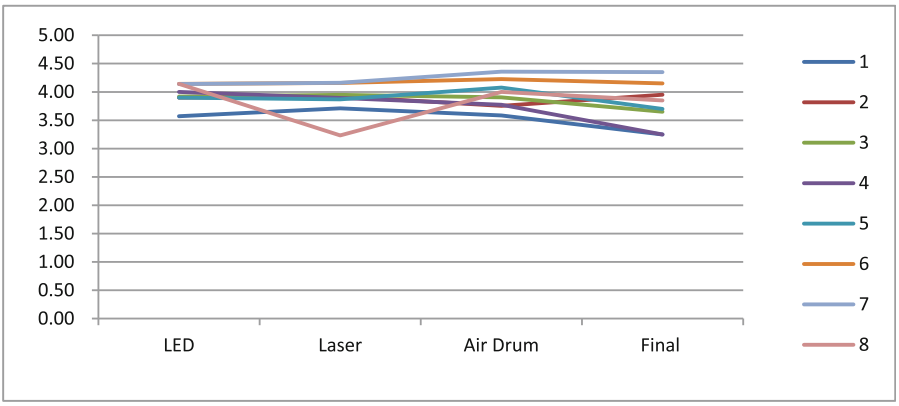


Fig. 3. Variation line chart of 8 questions.

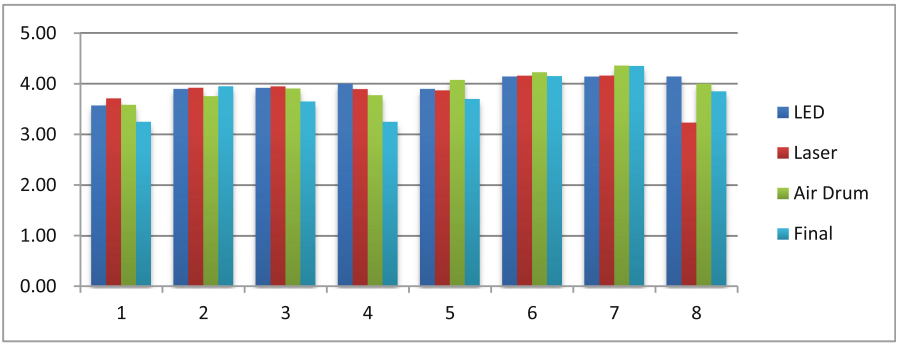


Fig. 4. Variation bar chart of 3 wearable technology learning feedback

5 Conclusion and Discussion

The Warm Robot Class is using composed wearable technology as gateway to design three different teaching aids for a digital performance activity in a course that allow students from different culture and major can cooperate with project base. We want to know if this course design will enhance interest and improve ability of both art and technology learning. From interviews with participants' opinions, we had gotten response as following description.

5.1 Advantage

(1) Teaching Aids Design

This study found that students who engaged in wearable teaching aids design demonstrated significant gains in their ability to diagram a working circuit, as well as significant gains in their understanding of current flow, polarity and connection.

Every wearable's teaching aids for all students is supported by the project plan exploring the specific applications and implications of these key ideas in their curriculum areas.

Students learn from the teaching aids and develop their own props for the final performance (Fig. 5).

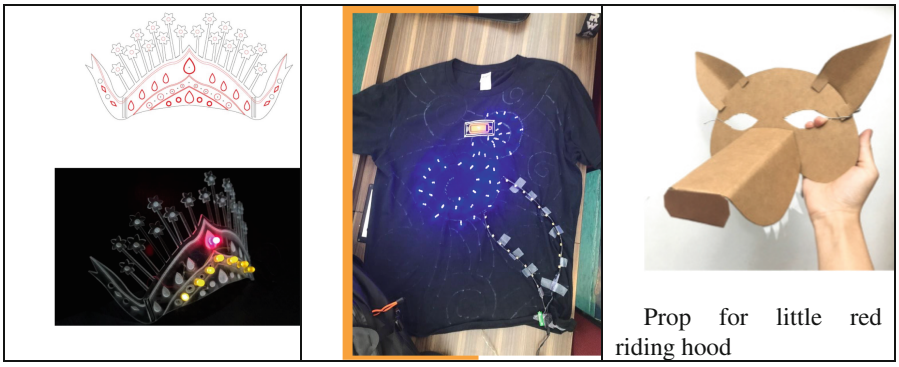


Fig. 5. Props developed from the knowledge of the teaching aid design.

(2) Collaborative Learning with Other Major and Culture

We also interviewed by feedback sheets to get the students' feeling as to whether they were inspired by the course and how they felt about the level of difficulty of the tasks. To train up a person with both abilities or to work in an integrated manner in the interaction design related subject, which one is better? The answer is a curriculum with both parts (art oriented right brain and engineering left brain) by collaborative learning, and willing to cooperate with different background will learn the most and achieve the best result.

5.2 Disadvantage

(1) Schedule

Due to the limitation of collaborative teaching from 3 different profession instructors, we have to adjust the schedule and take place the course on two weekends and two weeks later to give final performance on Friday evening. Although Students have high interest and enthusiasm to participate in the final performance but their feedback shown that practice time is not enough. They need more time to do better.

(2) Improvement of Teaching Aids Design

Laser light project is one of the teaching aids. When we want to shown the effect of laser light, the environment condition comes up to be the big issue to prepare. We rent two Frog machine to make the stage look foggy for the better effect to show the LED and Laser light. However, there are 9 groups have to give performance in sequence,

Fig. 6. Laser vs LED

then the laser light that have to adapt the media such as mirror or transparent acrylic will be difficult to move (Fig. 6).
Overall, The class has the following conclusion:

1. Culture bending enhances the learning interest.
2. The outcome of working together with the other professions is better than try do learn the skills and work by oneself.
3. Having the basic knowledge of the other major help build the bridge while communication.

Acknowledgments. This article is based upon work supported by the National Science Council of Taiwan (MOST MOST-106-2511-S-130-001 -), awarded to the author.

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