



## **Engagement in Practice (EIP): Differences in Perceptions between Engineering and Art Students in an Interdisciplinary Service-Learning Project**

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# **Engagement in Practice (EIP)**

## **Differences in Perceptions between Engineering and Art Students in an Interdisciplinary Service-Learning Project**

### **Abstract**

In spring 2019, we mentored a service-learning project embedded in one engineering course and one art course through interdisciplinary collaboration. The service-learning project used Touch Board and conductive paint to enable sound effects on two-dimensional compositions (drawings) of the clients, who were the young people on the autism spectrum at a not-for-profit organization. The class time of either course did not overlap with the time when the clients would be available, so not all students could participate in the service-learning project. The students who could manage to participate did so voluntarily. Meanwhile, the students from both classes created their own Touch Board projects: the engineering students were encouraged to use any sensors and actuators, and the art students were directed to create framed paintings with sound effects to render a presentation richer than using either painting or sound alone. Near the end of the semester, the service-learning project and the class projects from both courses were put on an exhibit, open to the public, and drew enthusiastic crowds. Lastly, two surveys, with IRB approval, were administered through Qualtrics to all the students, with both quantitative Likert scale questions and qualitative open-ended questions. The survey results showed encouraging evidence that the students were more aware of themselves and others. However, the interactions between the students and the clients were limited by everyone's schedule, and the survey results indicated that students tended to evaluate the project experience based more on professional skills than on civic engagement. The engineering students felt that the Touch Board was a natural extension from the Arduino board, and some of them did not regard the project experience as new or challenging. The art students, on the other hand, were excited to learn some new skills. If we were to do it again, we would strive to make the project challenging for all students and arrange the class time to best fit the project.

### **Introduction**

Incorporating service-learning into a single course is already challenging given the logistics and interaction with the service partners. Incorporating a common service-learning project into two courses in two drastically different disciplines (engineering and art) is an even more challenging task, as reported in this paper. As Nusaybah Abu-Mulaweh and William C. Oakes reported, it is a fine art to balance student learning and community relations in software-based service-learning [1], and our service-learning project involves coding in an Arduino IDE to use the Touch Board and conductive paint to convert still paintings of our clients to an interactive piece of art that produces sound when touched.

Mixed method [12] has been an effective approach to study the interdisciplinary service-learning project. The quantitative and qualitative questions provide insights into the effect of such a project on student learning as well as why it happens that way. This paper has adopted the mixed-method approach to study two research questions: (1) What is the effect of service-

learning on student academic enhancement, community engagement, and personal growth? (2)  
How is the collaboration affecting the progress of the project and learning?

Sonnenberg-Klein, et. al. [3] adopted Melker's external-internal (E-I) index [5] to capture the extent of student interaction between subgroups, which is an effective metric to differentiate ties within a large population. In our case, there were seven engineering students and eleven art students who worked with seven clients as much as their schedules allowed in one semester. The small sample size of our analysis was limited, and hence we compared it with the eighty-seven other students' quantitative survey results who have participated in all other service-learning projects on campus in spring 2019, and the trend on service-learning effect was similar. The open-ended questions provided much richer information on why our students thought the way they did.

Although interdisciplinary service-learning projects have been reported among various STEM (Science, Technology and Engineering, and Mathematics) programs, the collaboration between engineering and art is novel. This posed an unusual challenge in project design to achieve both groups of students' learning outcomes. Our study revealed the different expectations in the two groups of students, and the students have provided some good suggestions on improvement for the future.

## **Project Review**

This project was to use the Touch Board to enhance the client two-dimensional composition (drawings) to have sound effects. The clients used the Wacom tablet to generate electronic drawings that were printed out, found the soundtracks that were relevant to their drawings, and the students helped them to add conductive paint, program the Touch Board, and assemble the drawings and electronics onto a wooden board. The project evolved into its final form through multiple meetings between the clients and the students.

Neither class was aligned with the time when the clients were available (Friday 12 noon to 2:30 pm), and hence only the students who could make it participated in this service-learning project voluntarily. Some students were able to attend a few meetings, some not at all.

On Feb 1, 2019, the clients and helpers visited the graphic design studio on campus to learn to use the Wacom tablets and Illustrator software to draw on computers with the help of the art students.

On Feb 15, 2019, the clients and helpers visited campus to learn the basics of Arduino Programming. It was mostly the engineering students and a few art students who met with them. Each client was paired with one or two students. Every client was able to figure out an LED blinking program and attempted a few variations with motors, etc.

On March 22, 2019, the clients were invited back to draw what they would like to use in the project using Illustrator and then choose a soundtrack to match that drawing. We intended to make their painting interactive with the viewers so that when the viewers touch an area on the painting that looks like a button, the associated soundtrack will play. We did a demo using a cat drawing, and the clients created many fun images and found soundtracks for each drawing.

On Mar 29, 2019, the faculty and students took this Friday as a working day to mark grids on the wood board, experiment with wiring options, and adjust the soundtracks from multiple copyright-free sources to be at a consistent volume. The project gradually came into shape.

On Apr 5, 2019, the clients came back to campus and watched how the project was being built. We talked about some challenges such as that the copper tapes might interfere with each other when two strips of copper tape are too close by, so we chose to use the insulated wires. The wire was hard to be stretched straight and we considered using electric tape to secure them. However, the electric tape peeled off after a day or two. The clients agreed with us to use the masking tape to secure the wires, which worked well. Also, an engineering student proposed to use nuts and bolts to fasten the wires to the electrodes on the Touch Board without using solder to obtain a secure but removable connection. The clients made several more drawings in this meeting, out of which, three drawings from the client teams were chosen to be added onto the project board, and the rest of the drawings were printed and given to the clients for them to keep. There was one client who missed the earlier session, so she made her drawing with traditional art media on paper at home. We scanned her drawing adding a place in which to paint the touch button, and then printed the revision and painted the touch button area using the conductive paint. Every client was included in this project production. We finished the service-learning project then.

On Apr 26, 2019, an exhibit was set up, open to the public to showcase the service-learning project, as well as the class projects from the two courses. The exhibit flyer is shown in Figure 1. The Touch Board needed to use batteries or power adaptors, and we kept the exhibit to be open for one day. Approximately 80 community members and students, some faculty members and administrators signed in and viewed the exhibition. A photo of the service-learning project with the visitors is in Figure 2. The service-learning project was intended to reveal how things work, so all the wiring and connections were bared in view, along with the masking tape used to secure the drawings. The engineering class projects demonstrated the potential of Touch Boards in a much wider realm of interaction and actuation beyond touch and sound. The art projects created aesthetic interactive two-dimensional compositions that responded to touch while all the working behind it was hidden behind the wood frame.

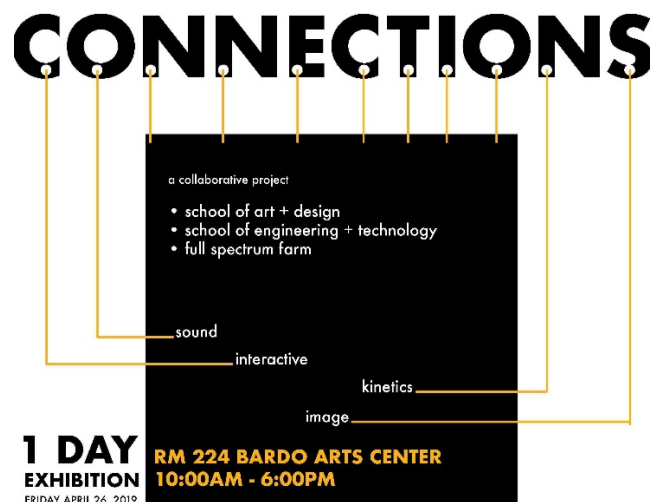


Figure 1. The exhibit flyer for the service-learning project, as well as the class projects from the engineering and art courses



*Figure 2. The service-learning project on exhibit and the visitors*

### **Quantitative Survey Results**

After the exhibit, two Qualtrics surveys were sent to the students in both classes through emails. All seven students in the engineering class had participated in the service-learning project at some point, as much as their schedules allowed. Eleven students in the art class (not the entire class) were able to participate in the project at some point. The first survey was about the service-learning experience and received five responses from engineering students and six responses from art students. The second survey was about interdisciplinary collaboration and received four responses from engineering students and eleven responses from art students. The answers to most of the questions were expected to be “agree” if the students felt benefited from the experience, but a few questions were written in negative tense and scattered in the survey, with an expected answer of “disagree”, to examine if the student had read the question statement or was alert when answering the surveys.

### ***On Service-Learning***

The Qualtrics surveys we sent to the two classes on service learning, although very similar, were not identical, due to both instructors’ subsequent revisions to the initially common surveys to fit our classes. The first difference was the scale used on the Likert scale. The engineering survey used a 4-level scale (Strongly Disagree, Disagree, Agree, and Strongly Agree, without Neutral). The art survey used a 3-level scale (Disagree, Neutral, and Agree). Therefore, the results from engineering and art students are presented separately in Figure 3. The statements in Figure 3 are reordered and grouped by their similarity. Another difference is a multiple-choice question on students’ majors. The engineering students are from electrical engineering, engineering with

mechanical concentration, electrical and computer engineering technology, and engineering technology. The art students are from graphic design, studio art, and art education.

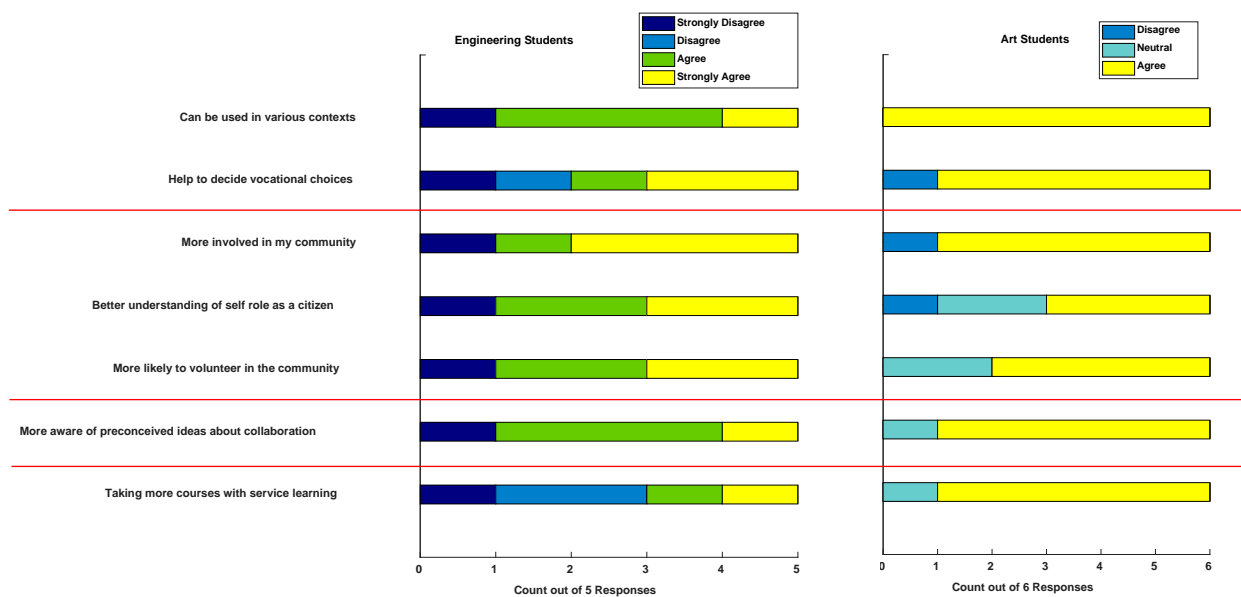


Figure 3. The bar charts on service learning questions in both courses

The first and second statements in Figure 3, “The service component of this course helped me to see: How the project I learned can be used in various contexts” and “Think about my vocational choices”, are on **academic enhancement**.

The third to fifth statements in Figure 3, “Learn how I can become more involved in my community”, “Have a better understanding of my role as a citizen”, and “Become more likely to volunteer in the community in the future”, are on **community engagement**.

The sixth statement in Figure 3, “Become more aware of some of my own preconceived ideas about working with others”, is on **personal growth**.

The last statement in Figure 3, “Consider taking more courses that include service-learning”, is on their future desire to do more service-learning or not.

In Figure 3, one engineering student disagreed with all the questions, and we looked into the answers by the same student in the open-ended questions and the instructor’s anonymous Students Assessment Instruments (SAI) scores for the course.

In the SAI course evaluation of the engineering instructor, the students’ comments are below.

Positive Comments:

*“amazing experience, service learning aspect was awesome”*

*“It’s fun and informative”*

*“The class is amazing.”*

## Suggestions or Negative Comments:

*“Since the outside of class participation seemed to play a large role in this course (the touchboard project outside of class) I would have liked to see that explained in the course description.”*

*“increase the number of mini projects and difficulty”*

The engineering course is a special topic course that changes its theme every time it is offered. The course syllabus in spring 2019 listed service-learning project’s details and the expectation for students to work outside of class time, and the syllabus was provided during recruitment, but the student might have assumed that this course would be similar to previous offerings when there was no service-learning yet.

Overall, the students had a positive course and project experience. The engineering students have already learned about Arduino programming before they started the Touch Board service-learning project and wished that the project could be more complex. Having a better meeting schedule and having a more challenging project for the engineering students would help.

The last question in Figure 3 seemed to indicate that the majority of the engineering students appeared not to want to take a service-learning course in the future, which could be due to the reason shown in SAI comments above, and the fact this was the first time such a course was offered, and the course delivery could be improved.

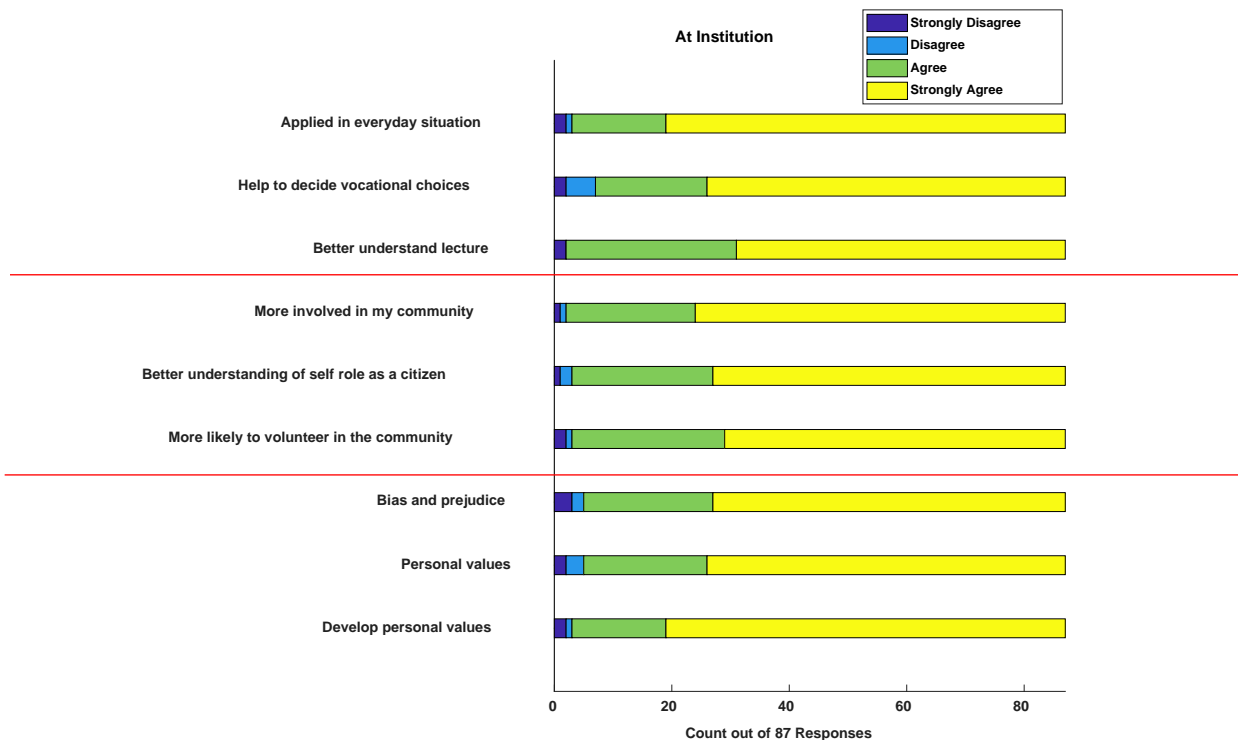
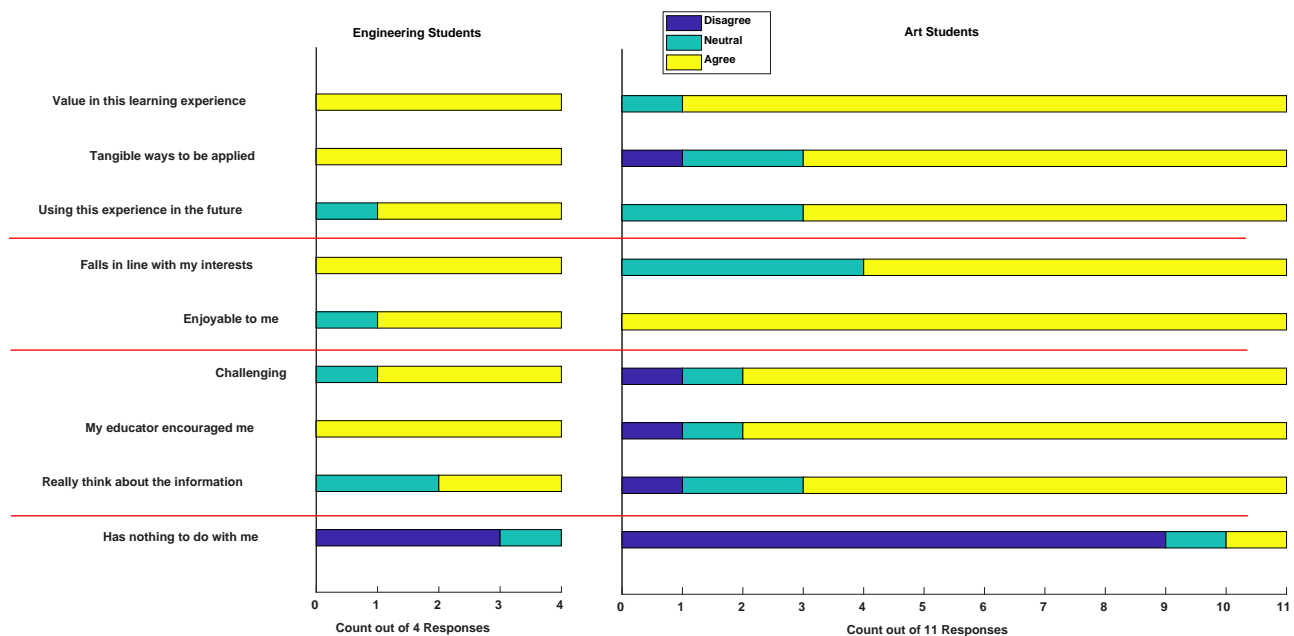


Figure 4. The bar charts on service learning questions to all other students who took a service-learning course on campus in spring 2019

We obtained the data from all the other service-learning courses on campus in spring 2019 on the comparable questions in Figure 3. There were 87 responses, all in the 4-level Likert scale, as shown in Figure 4. The first three statements in Figure 4 are on **academic enhancement**. The next three statements in Figure 4 are on **community engagement**. The last three statements in Figure 4 are on **personal growth**. Despite the very limited data size in the survey to our service-learning project, its overall trend is similar to the full-campus data. Relatively speaking, the service-learning project might not influence the students' vocational choice as much, given the available topic of the projects, but overall the students have learned tremendously in the process.

### *On Interdisciplinary Collaboration*

The Qualtrics surveys we sent to the two classes on collaboration used the same 3-level Likert scale (Disagree, Neutral, and Agree). The questions common to both engineering and art students are reordered by their categories and presented in Figure 5. There were more questions in the engineering survey than in the art survey, and those extra questions are presented in Figure 6, which are also reordered by the categories of those questions.



*Figure 5. The bar charts on interdisciplinary collaboration questions common to both engineering and art students*

The first three statements in Figure 5, “I can see value in this learning experience”, “I can think of tangible ways in which this learning experience can be applied”, and “I can see myself using this learning experience in the future”, are the worthiness and usefulness of the learning.

The fourth and fifth statements in Figure 5, “This learning experience falls in line with my interests” and “This learning experience was enjoyable to me”, are on the alignment of student interest to the project.



The sixth to eighth statement in Figure 5, “The learning experience was challenging”, “My educator encouraged me to experiment in this learning experience project”, “The learning experience required me to really think about the information”, are on the difficulty of the project.

The last statement in Figure 5, “This learning experience has nothing to do with me”, is a filler question scattered in the survey with an expected answer of “Disagree” to check if the students read the question. The majority of the answers is negative to show that the students had read the questions and answered as expected.

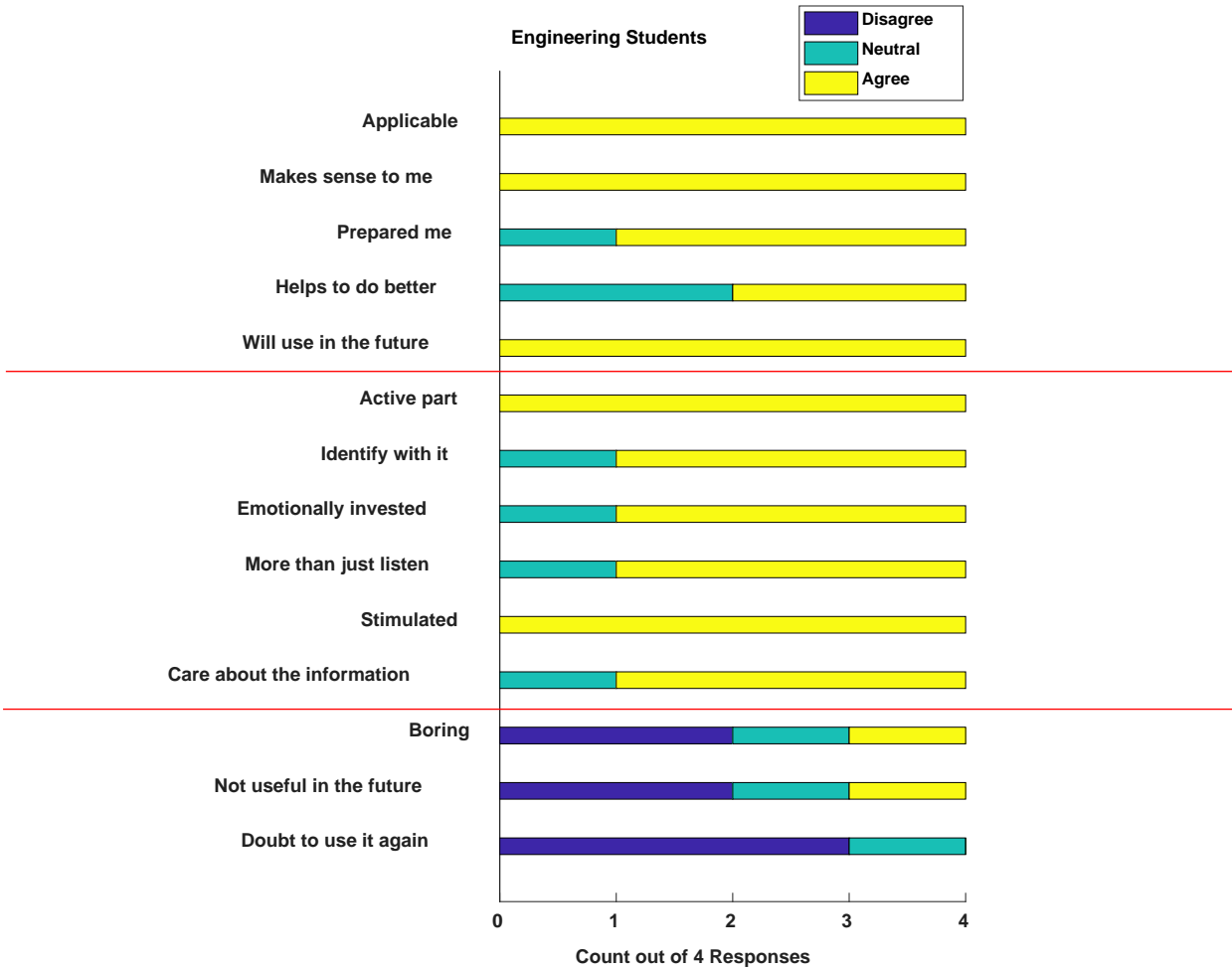


Figure 6. The bar charts on extra interdisciplinary collaboration questions that only the engineering students were asked

The first five statements in Figure 6, “This learning experience is applicable to me and my interests”, “The learning experience makes sense to me”, “I believe this learning experience has prepared me for other experiences”, “This learning experience will help me do my job better”, and “I will continue to use what I am being taught after this learning experience has ended”, are on the applicability of the collaborative learning experience.

The next six statements in Figure 6, “I feel like I am an active part of the learning experience”, “I can identify with the learning experience”, “I am emotionally invested in this experience”, “The

learning experience requires me to do more than just listen”, “I am stimulated by what I am learning”, and “I care about the information I am being taught”, are on the engagement of the students in the project.

The last three statements in Figure 6, “I find this learning experience boring”, “This learning experience will not be useful to me in the future”, and “I doubt I will ever use this learning experience again”, are the questions scattered in the survey with answers likely to be “Disagree”. These questions are stated in negative tense, with expected negative answers, to examine if the students are actually reading the questions and are alert during the survey-taking process. The majority of the answers are negative as expected.

## **Qualitative Survey Results**

The Qualtrics surveys included open-ended questions to both classes, and all the comments were presented in Appendix A: Qualitative Survey Results on Service Learning and Appendix B: Qualitative Survey Results on Interdisciplinary Collaboration. Summative statements are provided below.

### ***On Service-Learning***

On the positive side, the students enjoyed working with the clients and were glad to make the clients happy. It was a great learning experience, involving creativity, fun, and opportunity to give back. Meanwhile, it helped the students to open up to other people, and the communication skill they practiced is applicable elsewhere.

On the negative side, some meeting periods were more engaging than others. For instance, in the second meeting, the engineering students were engaged with the clients in a one-to-one Arduino programming learning. In the second to last meeting when the engineering students helped to assemble the service-learning project, there was a time when the board needed to be marked by grids, and the students were waiting. In the last meeting, we were envisioning that if the clients wanted modifications to the project that might require extra programming adjustment, the engineering students could be challenged, but people were happy with the project, and the project was not as challenging as the engineering students were expecting.

There was also a comment that was surprising for us to hear as one student felt the client s/he worked with was not interested in it. The seven clients that the students worked with signed up to do this project voluntarily. The clients are on the Autism spectrum, and we want to use art and technology to bring forth their creativity. We are not sure if it is the way of communication that caused this misunderstanding, or if the client that the student worked with was truly unhappy to be there. During the second meeting, the clients all presented their Arduino programming work, and the helpers to the clients were amazed and said that they wouldn't normally do so. When one client missed a meeting, that client would work at home and bring back the work to us. On the exhibit day, the clients dressed up and visited their project with uttermost pride. The staff at the not-for-project organization all had very positive feedback on all of our meetings during this project.

## ***On Interdisciplinary Collaboration***

The students all had very positive comments on interdisciplinary collaboration. Their idea about collaboration have been strengthened. They enjoyed the hands-on nature of the project, applied their knowledge, and planned to use their skills in the future.

## **Conclusions and Future Work**

In an interdisciplinary service-learning project in spring 2019, the engineering and art students helped the clients on the Autism spectrum to convert their drawings to interactive art with sound effects when touched, using Touch Board and conductive paint. The meeting time when the clients were available was outside of either class time, and hence the students participated in the project on a voluntary basis. All seven students in the engineering course participated in the project at various meetings. Eleven students from the art course participated. Seven clients signed up to participate. The students did their own projects using Touch Board as well. Both the service-learning project and the class projects from both courses were on exhibit near the end of the semester. Then two Qualtrics surveys were sent to the students in both courses on service learning and collaboration, respectively. Both surveys included Likert scale questions and open-ended questions. Both quantitative and qualitative responses were presented.

The survey on service learning got responses from five engineering students and six art students. The results indicate that the engineering students enjoyed the project and the course overall. However, a few of them felt the Touch Board project was a natural extension from the Arduino programming that they had already learned in class, and they wished that the project could be more complex. The art students were pleasantly surprised by the project as they did not expect to program in a design course and they learned a lot. The survey results were also compared with eighty-seven students' responses who have participated in other service-learning projects on campus in spring 2019. Despite our limited sample size, the trend is similar. The students demonstrated community engagement and personal growth.

The survey results on collaboration got responses from four engineering students and eleven art students. The results are overall positive and the students enjoyed the collaboration and participated in the project actively.

This was the first time for both instructors to offer a service-learning project within designed service-learning courses with such close interdisciplinary collaboration. If we were to do it again, there are a few suggestions we can take from the students' comments.

1. Arrange a class time that is as aligned with the project time as possible.
2. Design a project where all students can take on a challenging task.

In the future, we plan to also strengthen the following aspects.

1. Communicate with both clients and students to notice any disengagement, if ever.
2. Remind the students that the clients on the Autism spectrum might communicate differently.
3. Coordinate the assessment and survey efforts to be consistent with the institutional standard.

Interdisciplinary service-learning projects are complex to manage and require a balanced task designation between students from different disciplines. However, the rewards are fruitful. We will improve upon the course delivery and assessment plan and share it with the engineering education community.

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## Appendix A: Qualitative Survey Results on Service Learning

### Q1. Describe your positive thoughts about your service experience.

*"My hope was to learn more about microcontrollers, programming, and actuators. And I did. The art didn't always seem relevant to those goals. But it was nice to make the people at Full Spectrum Farm happy."*

*"I thought the projects were fun to do and were a great experience although I did find it extremely boring to be there on days we weren't really needed we just kind of stay there."*

*"It was an awesome learning experience, however, the few days we met with Full Spectrum Farms varied. I felt that some kids were there because they had to be, not because they*

wanted to be. Maybe consider finding kids that want to explore the topic instead of forcing them.”

*“Really fun to work with the people from full spectrum farm.”*

*“It was interesting to combine the efforts of both Engineering and Art students, as well as to watch the kids at Full Spectrum Farm create.”*

*“It was fun and it felt like I was important.”*

*“It provided an opportunity to be involved and give back to my community as well as providing knowledge with working with others.”*

*“The experience allowed me to open up more to other people around me. I became more experienced with helping and instructing others in art programs.”*

**Q2.** How do you think past experiences influenced the manner in which you responded to this service learning project?

*“I think it inclined me to respond well and be patient I have done projects for service learning before.”*

*“I don't think past experience influenced my response, I solely thought of this based off of observation and judgement.”*

*“I have worked with people who have developmental disabilities before so it was easier to work with this population.”*

*“I normally hesitate to do group work, but I was a little more encouraged to dive in and see what is going on.”*

*“I didn't really think about whether or not I would be needed on any given day I just went to be sure in case I could be of any help.”*

*“Yes, because I have had numerous opportunities for dealing with volunteering.”*

*“I haven't done anything like this before so I really didn't have any past experience in this project other than creating art pieces. I really loved working with the young people from Full Spectrum Farm.”*

*“I've worked with special needs before and so I knew how to treat them.”*

*“I can't think of anything.”*

**Q3.** In what ways has this service-learning opened new perspectives for you?

*“Microcontrollers, actuators, and programming.”*

*“I don't think the project opened new perspectives for me.”*

*“Throughout the process, I kept an open mind, but following this experience, I wouldn't say it opened a new perspective for me.”*

*“new medium and tools to use.”*

*“I mean it showed me that being on the spectrum can mean a lot more than just Down syndrome.” (Note: Autism spectrum and Down syndrome are different.)*

*“It was simple to put it in my schedule and allowing me to be late because of other classes was very helpful to me personally.”*

*“It has opened my view on how to communicate with other people as well as with others that need help with everyday life.”*

*“I desire to have more opportunities to work with other departments and possibly more organizations like Full Spectrum Farm. It helped renew my love for teaching that had been a little bit lost in prerequisite classes.”*

**Q4.** In what ways do you think the service you provided was important to the community you worked with?

*“Yes, design and spatially implementing components for the project.”*

*“I don't believe I was the design person. The art was done solely by the farm students.”*

*“My ability to communicate well with others was a skill I could apply.”*

*“help them using illustrator and design the display”*

*“We helped arrange their board in an aesthetically pleasing method.”*

*“Assisting the people who needed assistance was my main job which was usually something to do with the software used and checking on everyone.”*

*“Due to the wide range of artistic freedom, it gave people the chance to create something that matters to them deeply. Instead of creating something that was restricted to a rubric made by the professor, teacher, or leader.”*

*“My skills to work with trial and error bases with new technology and coding. I had to design according to the board and the sounds. It also introduced an entirely new medium by adding sound to the art pieces and the fact that it would be touched.”*

**Q5.** What were the strengths and/or weaknesses of this project?

*“It didn't always seem thoroughly planned, but the final execution was nice.”*

*“Strengths were it was fun, engaging, and enjoyable to socialize with the students when we actually were working. The main weakness was definitely the project having a lot of downtime for the engineering students.”*

*“The biggest weakness I could see is the Full Spectrum Farm kids. Some of the kids didn't seem to be interested in the project.”*

*“Great ideas, wish it could be more complex.”*

*“The strengths were getting to see other people's ideas and getting to collaborate with them. Weakness would be the touchboards were not as adaptive as traditional microcontrollers like the Arduino.”*

*“I thought the project itself was very bland and did not require too much effort.”*

## **Appendix B: Qualitative Survey Results on Interdisciplinary Collaboration**

**Q1.** How did this multidisciplinary multimedia project enhance your course knowledge?

*“This gave me practice implementing the use of microcontrollers in a hands-on setting.”*

*“I didn't gain any specific knowledge in completing the touch board project it only strengthened prior knowledge.”*

*“It enhanced my understanding of microcontroller applications by demonstrating how they can be used in art and ways not traditionally thought of. Prior to taking this class, I knew quite a lot about microcontrollers, but using conductive paint was a great experience. Using a different board other than Arduino was cool, but since it used the same IDE it was very straightforward.”*

**Q2.** What did you learn through the various aspects of this project? How, specifically, did you learn it?

*“Yes I did, I really liked the hands-on aspect.”*

*“I didn't really learn anything I hadn't already the goal for us was to learn about the touch board before the project's creation.”*

*“I learned the limit of the touchboards, Further coding was learned through practice.”*

*“I learned how the Touch Board kit worked and ways to apply it. Learning about conductive paint was another cool feature. I learned this by hands-on work with the kit.”*

**Q3.** Why does this learning matter? Why is it important?

*“It gives you a great experience while still in school.”*

*“Learning matters because it is a way to continuously improve oneself. It is important because constant improvement is how we grow ourselves and others alike.”*

*“Microcontrollers are increasing being used in IoT and it is important to keep updated and capable of using technology to solve problems.”*

*“It’s always important to learn new things, learning never stops.”*

**Q4.** In what ways will you use the skills you have acquired?

*“I’ve learned lots of new programming tools with multiple interfaces.”*

*“I will definitely use the newfound patience and understanding in teaching others in my future whether it be other students or family members.”*

*“I will use my coding skills to solve other problems through technology.”*

*“When handling microcontrollers in the future is when these skills would come in handy.”*

**Q5.** Describe how this project has affected your ideas about collaboration.

*“My ideas about collaboration have strengthened I knew it was important to interact with others to achieve a goal I now see another way of doing so.”*

*“This was a fun mode of collaboration that didn’t require significant reliance on others.”*

*“I thought the collaboration was perfect, I think when creating the class try to mention the times when meeting Full Spectrum Farms so all the students can attend.”*