Queer Lights: Combining technology, LGBTQA and diversity topics in an accessible and inclusive learning environment

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Abstract: This paper describes efforts over the past two years to create a new course at the University of Massachusetts called "Queer Lights" that combines elements of electrical engineering, LGBTQA topics, and the foundations of diversity. The course has the following description: "Queer Lights will cast light on lesbian, gay, bisexual, trans, queer, and asexual (LGBTQA) topics while the students in the class literally cast light—building LGBTQA-themed electronic light displays. An engineering professor will teach the students how to create and program the displays, and the director of the Stonewall Center will lead the students in discussions about LGBTQA issues in the news and in their own lives. Some of the topics to be covered include the intersections of racial and LGBTQA identities, the campus climate for LGBTQA students, and the legal and political rights of LGBTQA people today". The intent is to offer students from all campus majors an interesting, accessible combination of topics and an inclusive learning environment.

1. Introduction

STEM fields, and engineering in particular, struggle to achieve diversity [1]. There is anecdotal evidence to suggest that students who identify as LGBTQ change out of STEM majors at high rates. The recent study by Cech and Waidzunas [2] concluded that lesbian, gay, and bisexual students did not have equal access to opportunity when studying engineering owing to an oppressive climate in some engineering schools. LGBTQ+ students who are interested in technology can have fewer opportunities to pursue their interest because of the heteronormative, male dominated atmosphere in many technology focused classes and the lack of out LGBTQA students [2,3]. This is unfortunate, especially given that up to 20% of college students might identify as LGBTQ+ today according to recent surveys [4,5]. Education focused on engineering and technology topics leads to good job prospects and careers; moreover, science shows us that a greater diversity of perspectives in engineering teams leads to better results [6]; it is thus both a moral and practical imperative to find ways to achieve greater diversity within engineering and technology fields.

This paper describes experiences developing a new course at UMass Amherst, called Queer Lights, that aims to share the excitement and potential of electronics and computing with students who might not otherwise experience these topics by pursuing an engineering major. The course has the following description: "Queer Lights will cast light on lesbian, gay, bisexual, trans, queer, and asexual (LGBTQA) topics while the students in the class literally cast light—building LGBTQA-themed electronic light displays. An engineering professor will teach the students how to create and program the displays, and the director of the Stonewall Center will lead the students in discussions about LGBTQA issues in the news and in their own lives. Some of the topics to be covered include the intersections of racial and LGBTQA identities, the campus climate for LGBTQA students, and the legal and political rights of LGBTQA people today". The intent behind the course is to offer students from all campus majors an interesting, accessible combination of topics and an inclusive learning environment.

We offered the course as a one-credit seminar two times during 2016 to ~40 students from diverse academic disciplines, personal interests and backgrounds, including many with no prior background with computer programming or electronics. We used the Arduino computing platform [7] combined with programmable light-emitting-diode (LED) lighting technology and encouraged students to design and build projects that expressed some aspect of identity. An example project, shown in Fig. 1, is a wearable light-up pin that shows the colors of the pride flag (ROYGBV) or the pansexual flag (pink, yellow, blue); the process of creating this

Figure 1. Example Project: Light-up PRIDE pin

pin provided opportunities to focus discussion on identity and meaning issues behind the flag colors. End-of-semester surveys and course assessments indicate students appreciated the course and indicate that the course formula (ie, combining instructors having different expertise, covering LGBTQ+ and programmable lighting topics, and aiming toward a semester-long integrating project) can be an effective way to introduce students to technology and LGBTQ+ content while promoting experiential learning, self-expression, and experimentation. Surveyed students expressed interest in devoting more time to LGBTQ+ topics, Arduino hardware and software, and hands-on experimenting and many were frustrated with their inability to complete their projects to their satisfaction during a one-semester 1-credit course. Since there is a limit to what can be included in a 1-credit course (~14 meeting hours over a semester), we are now expanding this into a 4-credit Social World course at UMass Amherst. Section 2 of this paper describes the first offering of the course during Spring 2016; section 3 describes the second offering during Fall 2016, where changes were made in the schedule based on student feedback and instructor experience. Section 4 describes the logic and plan to implement this course as a 4 credit course in the future. Section 5 offers conclusions, and references are given in section 6. The appendices to this paper reproduce verbatim comments that students have provided about their experiences in this course.

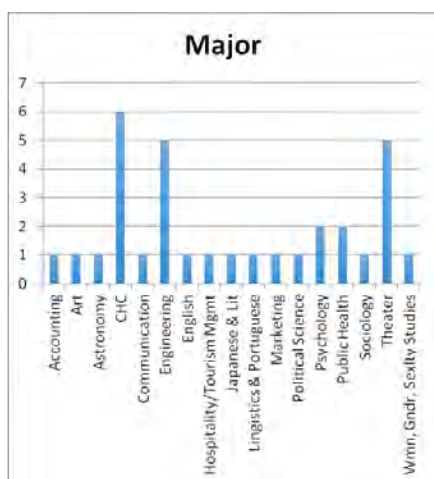## 2. First Course Offering: One Credit Seminar, Spring 2016

Figure 2 Student Majors

Queer Lights was initially developed in collaboration between UMass Amherst and Southern Illinois University Carbondale [8] and both universities offered the course as a one-credit seminar in the Spring of 2016. The UMass course was listed in the online course registration catalog in mid-January 2016 and enrollment reached the capacity limit of 25 students within three weeks, indicating that there is strong student interest in the course. The course ran for 10 weeks, from the second week of February until the end of April. Week-by-week descriptions of the course experience on both the UMass and SUI campuses were published in [8]. Here, we summarize the UMass experience and place that experience in the context of the course evolving from a twice-offered 1-credit seminar to a 4-credit Social World elective proposal.

The Spring 2016 UMass seminar was jointly taught by the director of the campus Stonewall Center [9], the director of the student union craft center [10] and an electrical and computer engineering professor. Students were surveyed about their (self-reported) academic majors. The students come from a wide range of campus majors, including literature; theater; astronomy; management; communications; linguistics; psychology; women, gender, and sexuality studies; public health; engineering; sociology; art; and accounting as shown in Fig.2. In this figure, "CHC" represents participation in Commonwealth Honors College, which is a dual-major category. The majors having the largest representation are theater and engineering. On the first day of class,

Figure 3. Student background knowledge

students were asked to self-assess their knowledge background in electronics and computer programming, with results shown in Fig. 3. During the first meeting, the instructors and students took turns introducing themselves, including indicating their gender pronouns. Students were also asked what they wanted to discuss in the course and they indicated a number of topics related to identity, technology, and art. Among the identities mentioned by students were asexual people, queer people of color, and trans people, which often reflected their own identities. Students were introduced to the Arduino microcontroller, which is described in product literature as "an open-source electronics prototyping platform based on flexible easy-to-use hardware and software…intended for artists, designers, and inventors…"[7]. Students were asked to indicate, via survey, their level if interest in learning about the Arduino computing platform. The results shown in Fig. 4 show that the enrolled students tended to be very interested in learning about Arduino programming.
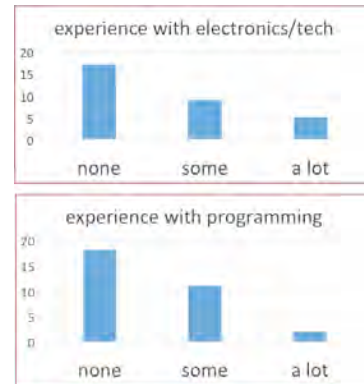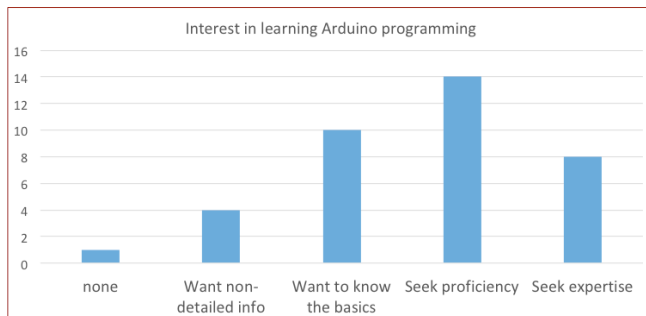

Figure 4. Students' indicated interest in learning about Arduino Programming

The class was led through a series of introductory exercises involving blinking light emitting diodes (LED's) and simple Arduno scripts, and students were then instructed to plan for a semester-long programmable light project that had a form factor and programmed light pattern specifically meaningful to themselves. Most of the time during the 10 weeks of the course was devoted to students working on these projects. Most students were able to complete a project by the end of the semester and example projects are shown in Fig 5 including a "tron dress", shadow box painting representing a family with a gender-transitioning member, and a light-up skateboard.
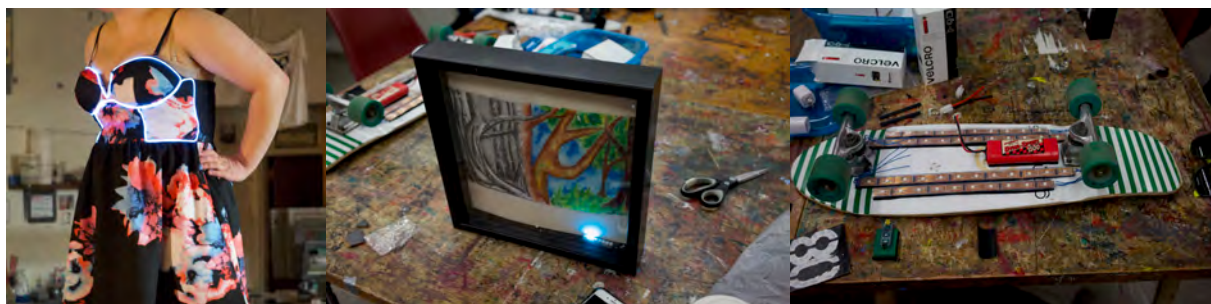

Figure 5. Example Semester-Long Light-Up Projects

A survey administered at the end of the course asked students to compare their knowledge of electronics, computing, and Arduino technology prior to, and after completing, the course. These results, shown in Fig 6,

illustrate how students' sense of knowledge of these areas improved markedly.

Figure 6. Student self-assessment

The instructors' original plan was to have students use their class time for both building their projects and discussing topics related to the experiences of LGBTQ+ individuals. For example, during one class early in the semester, the instructors asked the students to work in teams of two to experiment with Red-Green-Blue (RGB) LED's, batteries, and breadboards while having the students engage in discussions amongst groups of four. The idea was to have each student spend ~ 5 minutes discussing topics that might include race, gender, and sexuality. Our observation was that the student teams of two were so intently focused on building their circuits that they had little time to talk to each other, let alone talk in a small group. During the next class, students were given time to discuss their identities and personal experiences in pairs or small groups for the first 15 minutes of class. Students were asked, as volunteers, to share any info about their conversations from the previous week and to sketch their intended project. Some students shared how other people have reacted to them taking the class but most students got to work immediately on their projects.
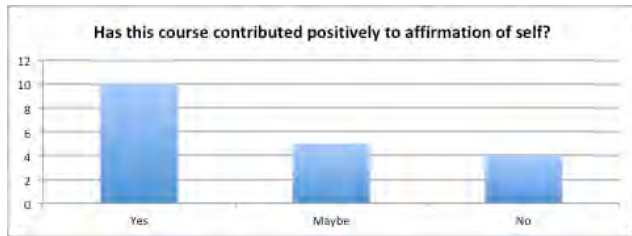
Figure 7. Student survey responses about LGBTQ+ topics (a), course inclusiveness (b), and contribution to affirmation of self (c)

In total, this seminar included 10 hours of class time, of which a combined total of ~ 1 hour was spent on structured discussions of LGBTQ+ topics, and the remaining 9 hours were devoted to constructing the light-up projects. The course assessment at the end of the semester asked students whether they had a better understanding of LGBTQ+ topics as a result of this course (Fig 7a); other questions asked the students to compare how inclusive they though this course was compared to other courses on campus (Fig 7b) and the degree to which this course has contributed positively to affirmation of self (Fig 7c). Students were also asked their opinions about how the LGBTQ+ content, the Tech content, and the Craft content of the course might be improved. They were also given the opportunity to add any additional information they wanted to add to the survey. Verbatim answers to these questions are included in Appendix 1. Sixteen surveys were submitted out of 24 registered students, corresponding to a 67% response rate. Taken together, the students would have preferred to have more of the class time spent on facilitated discussions of LGBTQ+ topics and they would also like to have had more time for learning about the technology elements and working on their projects. One student comment seems to synthesize the impressions shared by many: "Overall, this was a very good experience. I wish I got to finish my project, but I still had a lot of fun. It was really nice to see and be part of a collaboration between the Craft Center, Stonewall and Engineering." This first experience with the course indicated that there was a demand among a broad cross section of student majors for an accessible course on LGBTQ+, electronics and technology topics that would be taught in an inclusive way. The experience also indicates that the number of hours available in a 1-semester course is too few for the objectives. Both of these indications were also borne out in the second offering of the seminar.

3. Second Course Offering: One Credit Seminar, Fall 2016

A restructured version of the seminar was offered at UMass during the Fall of 2016. The schedule was increased from 10 to 13 meetings, and meetings alternately took place in the Stonewall Center – which is

Figure 8. Course design for second offering

configured for discussions of up to 25 people, and the Craft Center – which is a facility specifically designed and operated for constructing student hands-on projects. This schedule and arrangement allowed for more didactic inquiry of topics related to the experiences of LGBTQ+ individuals. The LGBTQ+ content was increased by adding an Allyship training session, hosting a Speaker's Bureau where four LGBTQ+ identified individuals spoke about their experiences in, and after, college and they took questions from the students, and hosting presentations by experts in Queer Latinx migration and gender non-conforming youth. The instructors' sense is that,

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by restructuring the course this way, and incorporating 5 hours of structured programming around LGBTQ+ identity and experience topics, many of the concerns expressed by students during the Spring 2016 course were addressed. This is discussed in greater detail below.

The Fall 2016 course devoted seven hours to working in the Craft Center, whereas the Spring 2016 course devoted nine. The difference was apparent, and many projects were in danger of not being completed in time for the last class. Most of the projects relied on use of a pre-programmed test pattern for their light projects rather than a light pattern of their own design, because the students lacked the time and knowledge to program the lights. This represents a shortcoming in the course design, since the student-programmed light pattern is a key construct to cohere the LGBTQ+ and electronics/programming parts of the course.
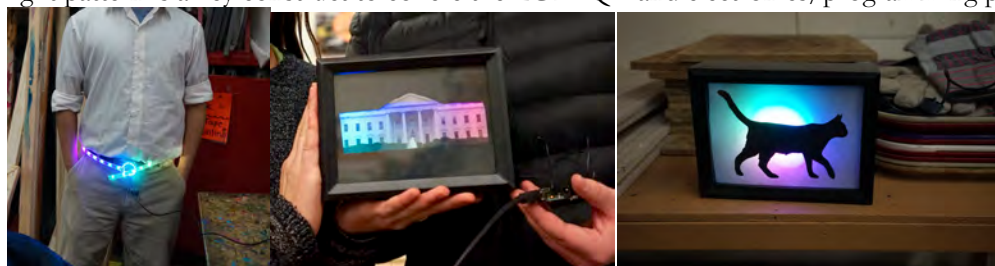

Figure 9. Examples of light projects during Fall 2016

Examples of student projects during this instance of the course, shown in Fig 9, include a light-up belt, a shadow box inspired by the rainbow colors illuminating the White House after Marriage Equality became law[11] and a shadow box depicting a pet cat. The different installations undertaken by the students opened up some discussion about topics such as how to package and provide power to electronics. The shadow boxes, for example, had space to house the Arduino and plugged into the wall electrical outlet using a standard USB power adapter. The belt, on the other hand, was fragile and required more current than was practical by batteries. In general, these tradeoffs permitted the students to think about some of the topics that are important to systems engineering, although the time available for these discussions was limited.

The UMass office of Planning and Assessment conducted a Student Response To Instruction (SRTI, [12]) assessment of the seminar on the last day of the semester. Out of 18 students enrolled, 12 responded to the assessment, corresponding to a response rate of 67%. Figure 10 shows mean and standard deviation scores for responses to five global assessment questions about the course and instruction, along with comparison scores for all courses on campus and all engineering courses. Mean responses for Queer Lights are within a standard deviation of the means for the two sets of comparison scores, however two responses stand out. "Instructor showed personal interest in helping students learn" scored a 5 out of 5 with 0 standard deviation; this high score could be related to both the nature of this course and its small number of students. "Overall, how much do you feel you learned in this course" received a mean score of 3.4 which is nearly a full standard deviation below the campus-wide average. This may be due to the challenge of incorporating two distinct topics – learning about the experiences of LGBTQ+ people and learning about electronics and computer programming – into a 1 credit seminar. The SRTI form provides space for students to give answers to a set of open-ended questions, and the 24 responses are included, verbatim, in the appendix to this paper. One third of these comments are requests that future versions of the course devote more time to learning. One comment reads: "I really enjoyed this class and love how it ties engineering in with LGBTQIA+ topics. I also think it's a great idea to advertise the course in the email because that's how I found out about it." Another reads: "This was a great course. I really wouldn't mind meeting more during the week so we can have more time discussing LGBTQIA+ topics and so we have more time to pursue larger projects."

Fall 2016 Results for Queer Lights	This course		Campus-Wide		All Engin Courses	
	Mean	SD	Mean	SD	Mean	SD
Instructor showed personal interest in helping students learn	**5	0	4.7	0.47	4.6	0.53
Instructor stimulated student participation	4.5	0.96	4.6	0.57	4.3	0.66
Overall, how much do you feel you learned in this course?	* 3.4	0.86	4.1	0.79	3.8	0.83
Overall rating of this instructor's teaching.	4.3	0.72	4.4	0.61	4.3	0.65
Overall rating of this course.	3.9	0.76	4.2	0.74	4	0.77

Figure 10. SRTI Summary Statistics and Comparisons

Student surveys and instructor impressions both indicate that the second iteration of the course was more effective at integrating the LGBTQ+ and "Tech" aspects of the course. Indeed, none of the kinds of negative student comments from the first course instance were seen in the Fall 2016 surveys in this connection. However, the number of hours available in a 1-credit seminar was still limiting the degree to which the course objectives could be achieved. This is borne out both in the student comments and in the instructors' observations of project completion.

4. Design of new four-credit General Education Course

The two instances of a one-credit Queer Lights seminar both indicate there is student demand for a course that combines LGBTQ+ and electronics/programming topics. Alternating the meeting locations between the Stonewall Center and the Craft Center and focusing the semester on an LGBTQ+ themed project are constructs that appear to effectively merge the two themes and make the course coherent. The number of hours available in a one-credit seminar is insufficient for adequately covering the two theme areas and completing the student projects, so it is clear that this course needs to expand to more than a single credit. Expanding to two or more credits immediately encounters the challenge of how students will fit the course into their schedules. One-credit seminars are easy for students to fit into their schedules and they are a relatively low-commitment and low-risk undertaking for students. When considering courses that carry more than a single credit, students need to give consideration to the other course commitments they have as well as the many university, college, and major requirements they have. At UMass Amherst, as elsewhere, students are required to complete four four-credit Social World electives, and we are now in the process of expanding Queer Lights into a four-credit course that could count toward one of these electives while also satisfying the recently-revised university diversity requirement [13]. The new syllabus design is summarized in Fig 11. In this design, the semester is divided into four modules, two focused on experiences of LGBTQ+ people, and two focused on electronics and programming. The Experiences modules emphasize theories and methods of social science areas, while the electronics modules emphasize physical science and analytical thinking theories and methods. The modules alternate and build toward the semester-long project involving a computer-programmed electronic light display that represents some aspect of LGBTQ+ identity or experience. The meeting locations shift back and forth between the Stonewall Center and the Craft Center, following the successful model from the Fall 2016 seminar. Weekly topics and activities within the modules were designed to both assess and support disciplinary learning and to support the interdisciplinary experience of the course. For example, a lab experiment in the first electronics module has students building and programming a set of lights representing LGBTQ+ identity flags (eg, ROYGBV pride rainbow and the pansexual flag). Another example is the focus of the second Experience module on the experiences of college students as well as people in STEM. This design devotes 18 hours of class time to LGBTQ+ experience topics, compared to 6 hours in Fall 2016. Similarly, the design devotes 18 hours to electronics and programming, compared to 8 hours in Fall 2016. These increases, combined with a reasonable expectation that students would also contribute significant out-of-class time to the course, addresses the time-constraint challenge encountered during the two one-credit offerings of Queer Lights.

New Four-Credit Queer Lights General Education Course Schedule			
Date	Location	Topic	Assessment
Week 1	Stonewall Ctr	Intersectionality & Systems of Oppression	
Week 2	Stonewall Ctr	Multiple Identity Development	MDDI Mapping
Week 3	Stonewall Ctr	Nonbinary Gender & Sexual Identity Dvlp	
Week 4	Craft Ctr	Electronics Basics	Reflection Essay
Week 5	Craft Ctr	Introduction to Computers	Light Candles Exeriment
Week 6	Craft Ctr	Engineering Systems	LGBTQ+ Flags Experiment
Week 7	Stonewall Ctr	College Experiences of Trans Students	
Week 8	Stonewall Ctr	College Experiences of LBTQ+ Students of Color	
Week 9	Stonewall Ctr	LGBTQ+ People in STEM	Reading Response Essay
Week 10	Craft Ctr	Project Design & Specification	Project Design & Spec
Week 11	Craft Ctr	Work on Light Projects	
Week 12	Craft Ctr	Work on Light Projects	
Week 13	Craft Ctr	Project Presentation	Final Project Presentation
	LGBTQ+ Experiences	18 hours	
	Electronics	18hours	
	Presentation	3 hours	
	Total	39 hours	

Figure 3. Course design of a new 4-credit version of Queer Lights

5. Conclusion

Our objective has been to combine two academic themes, one related to the experiences of LGBTQ+ individuals and the other related electronics and computer programming in a course that is viewed by students as inclusive and accessible. A semester-long project focused on a programmable LGBTQ+ themed light display serves as a nexus to integrate the LGBTQ+ and "tech" topics. The first two instances of the course indicate that this integrating mechanism can be effective and students appreciate the course, especially when both themes are actively and structurally maintained though out the semester. The number of course hours in a one-credit seminar is too small for the scope of this course, so the next logical step is to expand the course as a four-credit Social World elective that would be open, accessible, and inclusive to all students, from all majors. *As of the time of submitting this draft ASEE CoNECD paper, we have received departmental approval for the new four-credit course. More important, however, we are just now submitting our proposal to have this course reviewed for designation as a Social World and Diversity elective course.*

6. References:

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[5] Accelerating Acceptance (2017), GLAD Report, https://www.glaad.org/publications/accelerating-acceptance-2017

[6] K.W. Philips, How diversity makes us smarter (2014), Scientific American, October 1, 2014.

[7] https://www.arduino.cc

[8] D. J. McLaughlin, G. Beemyn, P. Hodecker, and F.J. Harackiewicz, "Inclusivity in Engineering Education with LGBTQA Outreach, 2016 Northeast Regional ASEE Conference, South Kingston, Rhode Island, April 2016.

[9] https://www.umass.edu/stonewall/

[10] http://www.umass.edu/craftctr/

[11]http://www.slate.com/blogs/outward/2015/06/26/white_house_rainbow_lights_a_celebration_of_marriage_equality.html

[12] http://www.umass.edu/oapa/srti/

[13] https://www.umass.edu/gened/new-diversity-requirements

Appendix 1. Instructor-administered End-of-Semester Survey – Spring 2016
Verbatim student responses to open-ended questions.

How can we make the LGBTQ+ content of this course better?
- Perhaps a definite topic each week
- I think it is better to concentrate on either LGBTQ+ or craft or electric engineering
- Have more led discussions about topics
- Maybe have external readings (small)
- Facilitate more class discussion, a specific topic each class, for part of the class
- There could have been more educational components of LGBTQIA issues or celebrations in an impactful way that would allow us to integrate our tech/crafting experience (ie conceptualizing a pride float tech b/c of discussion or queer celebration
- Discuss more about topics and current issues
- More things that inspire discussion like videos
- More intentional LGBTQIA+ content, active rather than passive (fewer videos)
- More careful/deliberate facilitation (don't just expect student to facilitate and manage their own class discussions on topics)
- More topic diversity (we only talked about asexuality – that that was very surface level)
- Have more of a discussion about specific topics
- Have a better idea of what to talk about or a more organized plan for discussion + learning
- I feel like the LGBTQ+ content was kind of forgotten/dropped really early on – and when it was included the prompts were always vague – maybe more specific prompts/more accessible discussion structure (+ continue though out the semester)
- Explore the subject earlier on to build the foundation
- …talk about it…idk there was none of it
- I didn't like being required to give a pronoun during the introductions. I also didn't really learn anything or feel any more welcomed in the LGBTQ+ community. But it is ok because I never will.

How can we make the Tech Content of this course better?
- More time – either 3-hour class or 2x each week
- Eliminate craft content + focus on tech content only
- External labs(?)
- More time
- It was fine how it is! I learned a lot in that department.
- Maybe a few more people to help out.
- Having a clear reference for all tech info
- Step-by-step demonstrations of how to code
- More time/people to help with the tech side
- Have a specific curriculum along with lectures/teaching
- I really appreciated the group lessons in the beginning – there may not be time, but maybe revisit those later as well?
- More handouts/study guides
- I feel like I hardly have any understanding of computer programming/working with Arduinos. I wish the teaching was more organized. I felt like we were expected to have prior knowledge of tech/computer programming which I did not.

How can we make the Craft content of this course better?
- Mini projects throughout the semester
- Significant number of unproductive delays between coming up with an idea and getting equipment
- Tutorials
- Also fine how it is! We had many people and resources available to us.
- Crafting is awesome!
- Showing more of the crafting options and what is available

- List of available materials
- It took a long time to get started on my project bc it was sometimes difficult getting instructor attention. If I were able to begin earlier, I may have been able to finish my project. Other than that, the crafting was very fun and fulfilling.
- None, very helpful
- I think the craft component was approached very well! Good balance of craft/tech – very accessible help.
- More guides

Anything else you'd like to add?
- Thanks!
- Great Job!
- I just wish there was more time in this class. We had everything else we needed, but I could have used more in-class time.
- Love the course, love the people!
- It was fun!
- Overall, this was a very good experience. I wish I got to finish my project, but I still had a lot if fun. It was really nice to see and be part of a collaboration between the Craft Center, Stonewall and Engineering.
- I really enjoyed this class.
- Such a great class – thank you all!
- A solid game plan is needed
- I felt like an outsider.

Appendix 2. SRTI Responses to Open Ended Questions from the Fall 2016 Queer Lights Course at UMass Amherst

What do you like most about this course and/or the instructors' teaching of it:
- Love the community and accepting environment and the opportunity to meet people.
- Great student teacher interaction/very motivated students/GREAT learning experience
- I liked being in Stonewall Center learning about LGBTQIA+ topics
- I really liked the speakers who were brought in. I also like how class time was split between the Stonewall Center and the Craft Center. I also really like how we were encouraged to use our creativity.
- I liked creating my project and learning more about the LGBTQIA+ community.
- I enjoyed putting the project together and seeing the finished project.
- Passion
- It was fun

What about this course and/or the instructors' teaching of it needs to be changed?
- More group bonding so that we could be closer to each other
- More course hours ☺
- Time spent in craft center needs to be less talk of planning and actually putting project into action. Please fill in awkward silence at the Stonewall Center when no one has questions to ask.
- I think if we could have been taught some of the Arduino code, it would have been pretty useful.
- More direction should be given and class time should be used more efficiently
- Budgeting time for the class should be more focused on working on and talking about the engineering aspect
- Interesting material, good discussions, fun project. Great exposure to craft center and Arduino.

What suggestions can you offer that would have made this course a better learning experience for you?
- More time to work on project
- More course hours ☺
- More one-on-one help that is more specific and problems can be solved right there.
- This was a great course. I really wouldn't mind meeting more during the week so we can have more time discussing LGBTQIA+ topics and so we have more time to pursue larger projects.
- Give more help when its needed and possible having another TA so the students will have more one-on-one help.
- More structure. More time in the craft center.

Any additional comments:
- Loved this class – Thank you!
- More course hours. Really great course idea.
- I really enjoyed this class and love how it ties engineering in with LGBTQIA+ topics. I also think it's a great idea to advertise the course in the email because that's how I found out about it.