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A cross-disciplinary minor to engage student's creativity and engineering skills

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Whether it is creating computer graphics models of underwater shipwrecks or using art and creativity to help students learn computational thinking, Professor Zoë Wood's projects unite visual arts, mathematics and computer science. Via her NSF funded research projects she works with colleagues and students on robotics and computer graphics algorithms for shipwreck discovery and mapping which resulted in the discovery of a rare World War 2 airplane wreck. She works to increase the number of underrepresented students in her field through research projects, outreach activities and advising the student group Women Involved in Software and Hardware (W.I.S.H.). As co-founder of the interdisciplinary minor, Computing for the Interactive Arts, she believes in empowering students to realize their artistic visions via coding.

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A cross-disciplinary minor to engage student's creativity and engineering skills

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Abstract:

The computer science major at Cal Poly, San Luis Obispo is male dominated with only 24% female students, while the art and design major is female dominated with only 26% male students. Meanwhile, there is a growing need for students with both creative and technical skills with the interactive entertainment industry valued at billions of dollars. Uniting the creative disciplines of art and design and computer science allows students to explore multiple disciplines of high interest and creates a varied pool of students with good potential to form diverse teams, with research showing that diverse teams achieve better results. With these tenants in mind, in fall 2016, Cal Poly created the Computing for the Interactive Arts (CIA) minor to prepare students for technical, creative jobs (and creative, technical jobs) while working to bring together diverse teams for problem solving, potentially bridging the gender gap found in both art and computing.

In this paper, we present the CIA minor curriculum, which focuses on creating a collaborative, cross-disciplinary environment in which Art and Design students integrate coding and algorithmic thinking in creative works and in which Computer Science students apply the principles and methodology of design thinking to visual applications. The minor is composed primarily of existing courses with the addition of a two-quarter long capstone project, in which teams of students from mixed educational backgrounds work together to make a final creative, technical project. We also present demographic information about the three years of mixed disciplinary cohorts that have been admitted to the CIA minor. Each cohort averages 11 students who are a mix of computing and art majors, with a total of 27 students having completed the CIA minor capstone classes. Since the creation of the program, 69% of the students who have declared the minor are female, and 60% of the participating computer science majors are female.

Introduction:

To tackle complex problems, it is well documented that ethnic, cultural, and gender diverse teams achieve better results (Rock & Grant)[13]. In 2016, in part to address issues of diversity and problem solving in teams, Cal Poly created the Computing for the Interactive Arts minor (CIA). This cross-disciplinary minor is rooted in two important contexts. One being that

the interactive entertainment industry is a billion dollar industry; video game revenue in 2012 was valued at $14 billion and is expected to grow to $29 billion in 2021, with time spent engaging with digital media averaging 3.3 hours a day per person. There is clearly a need to prepare students with both creative and engineering skills to work in this field. The second important context for the creation of the CIA minor is the gender composition of fields relevant to interactive entertainment and the potential to help build and promote diversity in bringing together these disparate fields. The computer science major at Cal Poly has, on average, 24% female students, while the art and design major has 26% male students. Bringing together these populations creates an opportunity to bridge the gender gap. The union of these two fields has been shown to be successful in closely related academic programs[2,3], which is discussed in greater detail in the related works section below. The Computing for the Interactive Arts minor prepares students for technical, creative jobs (and creative, technical jobs) while working to bridge the gender disparities found in the fields of computing and art.

The CIA curriculum focuses on creating a collaborative, cross-disciplinary environment in which Art and Design students integrate coding and algorithmic thinking in creative works and Computer Science students apply the principles and methodology of design thinking to visual applications. The minor enables students from different disciplines to collaborate on projects requiring both a technical and a creative perspective. The minor is composed primarily of existing courses from the Art and Design (A&D) and Computer Science departments (CSC) with the addition of a two-quarter long capstone project, in which teams of students from diverse educational backgrounds work together to make a final creative technical project. Example capstone projects include a virtual reality introduction to the college campus, a virtual reality procedural worlds experience, a mixed-reality platform game design and play experience, and several creative video game designs.

This paper presents the results from the creation of a cross-disciplinary minor that allows students to explore the intersection of computing and creativity. More specifically, the paper presents the CIA curriculum, information on potential jobs, in-depth information about the minor demographics, and highlights of successes in the hopes of encouraging other colleagues to consider how much is gained from cross-disciplinary work.

Context:

As a large polytechnic school, serving 19,000 students, the College of Engineering is the largest of the colleges on the Cal Poly campus. The College of Engineering serves 6,124 students with 14 bachelors and 11 master's programs. Graduating students are very successful at obtaining jobs (with 90.6% of graduating students employed or attending graduate school within a year after graduation with the average salary of $71,000). Within this very technical setting,

we found that there has always existed a subset of students with a passion for creative visual arts, who struggled to combine their passions in technology and art. In addition, industry recruiters who came to interview our students would often comment on their technical strength but overall lack of an "eye" (i.e., an understanding of how visual elements work together, evidenced for example by the number of students who used solid red, green or blue elements in example computer graphics applications). In the art and design department, the students who wish to work in creative jobs in the high-tech industry, from video game design to animation and special effects, have struggled with finding employment in those fields due to the department's fairly traditional approach to art education.

In general, the interactive entertainment industry is a large industry. The use of special effects and computer graphics in full length film, television and the computer game industry has created a demand for employees who have both technical and artistic skills. In addition, numerous companies use design in their technical products in various ways (software interface, web pages, product design, etc) to enhance the user experience. As such, students with a combination of technical skills and design skills can pursue careers at companies focused on media (television, film and games) as well as at more traditional software companies. Example positions include: user experience/user interface (UX/UI) designers , concept artists, game designers, software engineer, effects artists, technical directors on full−length feature films, digital production artists, designers for a software engineering project (including web pages, user interfaces, etc.), for public art installations and performances, as well as designers of interactive narratives and experiences. Within the context of this growing industry and students' need, we choose to more carefully examine students' interest in creating a joint academic program between technology and art.

Related Work and Foundations of CIA

Programs focused on the integration of engineering and art for the purpose of interactive entertainment are not new. Some of the older successful programs include, Carnegie Mellon's "Integrative Design, Art and Technology' program, USC's "Interactive Media & Game Division", Clemson's "Digital Production Arts" and Georgia Tech's long history of promoting computing via their 'media computation' focus. The success of the Georgia Tech program at promoting a more diverse computing student population is well documented (Guzdial (2003)[8], (2013)[9]). In particular, using this type of art+CS focus has shown success at reducing failure rates in introductory computing courses (Forte & Guzdial (2004)[6]; Rich, Perry & Guzdial (2004)[14]; Sloan & Troy (2008)[16]; Wood et. al (2018)[18]) and in encouraging students to take additional courses (Sloan & Troy (2008)[16]; Forte & Guzdial (2005)[7]; Tew, Fowler, & Guzdial (2005)[17]). Similar programs likewise report impressive gender mixes in their student body. Barker, et al. (2005)[3] report 52% of the students enrolled in a similar program focused on

interactive entertainment are women, and 62% of their graduates are women. A recent publication, examining a six year longitudinal program of "Computing in the Arts", reports that 45.5% of its graduates are female (compared to only 19% females in their more traditional computing major) (Bares (2018)[2]).

Within this context, in the fall of 2012 and of 2013, a survey of over 300 Cal Poly students, including 193 Computer Science majors and 40 Art and Design majors, was conducted. Students were asked if they were "interested" in a minor, which encompassed both disciplines, offered in either CSC or A&D departments. An overwhelming majority of both A&D and CSC majors responded positively to the creation of a minor; the majority of the students chose to locate the minor within their own department. Approximately 160 students expressed an interest in a computer science minor that focused in art, while approximately 130 students expressed an interest in an art minor focused in computer science. Since the time of the survey we have unified these into a single cross−disciplinary minor (CIA).

The CIA minor

The CIA minor has been developed as a cross-disciplinary studies minor (CDSM), with carefully selected coursework to direct Art & Design and Computer Science students through a collaborative, cross−disciplinary experience. The CIA minor requires students from the different majors (CSC and A&D) to enroll in a sequence of classes to build up their skills in the diverse disciplines. The CIA minor culminates in a capstone experience in which art majors and computer science majors come together to develop a creative project produced via combined principles of art/design and the methodology of design thinking with algorithmic thinking. Students in the CIA minor receive specific training in design principles, algorithmic thinking, software tools and software development environments that will enable them to apply for technical positions in creative fields such as television, film, computer games and interactive installation art.

The CIA Curriculum Learning Objectives are as follows:

- Produce a strong body of work and/or professional portfolio via combined principles of art/design and the methodology of design thinking with algorithmic thinking.
- Establish and maintain a rigorous creative and technical practice that is productive and professional.
- Employ an articulate, sophisticated visual, verbal, and technical vocabulary related to art and design from a range of styles and periods.
- Apply comparative reasoning in evaluating works of interactive art and design.
- Contribute to diverse, cross-disciplinary, collaborative interactive computing endeavors as a team member.

- Resolve problems at the interface of art and design and computer science through innovative thinking and visual expression.
- Demonstrate an ability to evaluate ethical consequences in creative expression, technical innovation and professional practice.
- Practice lifelong learning, inquiry, and discovery via directed self-research and inquiry for artistic and technical projects.

These objectives are obtained through the combination of existing courses present in the Computer Science and Art & Design programs, thus requiring little institutional overhead. The creation of the minor did require the addition of two joint capstone courses.

For additional context, Cal Poly defines a cross-disciplinary studies minor (CDSM) "as a set of curricular requirements comprised of coherent groups of courses tailored for each partner program such that all students from target majors develop (1) depth in the partner discipline, (2) focused study in their own discipline, as well as (3) focused study in the mutual domain of the minor." This designation also imposes constraints on the curricular requirements for such minors. In particular, of note when considering the structure of the program, a CDSM must require at least as many upper-division units as lower-division units (to expose students to some depth within the field) and may only require between 3 and 6 (quarter long) courses (equivalent to 12 and 24 quarter units) beyond the coursework that can be satisfied by major degree requirements. These constraints, the set of skills to be developed and the experiences to be had by those participating in the minor, and the desire to impact time-to-graduation as little as possible have each affected the structure of the program.

In general, the minor is composed of the following required courses:
ART 182 Foundation in Digital Art I: Introduction to image creation and manipulation, design, illustration, and layout/composition using digital tools, with an emphasis on visual problem solving and creative expression.
ART 183 Foundation in Digital Art II: Development of digital skills in image creation, design, illustration, layout, and simple animation. Emphasis on visual problem solving, creative expression, and narrative.
ART 384 Digital 3D Modeling and Design: Development of skills and techniques in the use of three-dimensional design and modeling via digital technology. Capabilities of current software in the design and modeling of three-dimensional form.
CSC 123 Introduction to Computing: Use of a supportive software development environment to design, develop, and test applications in a selected topic domain that demonstrates the potential of careers in computing.

CSC/CPE 101 Fundamentals of Computer Science I: Basic principles of algorithmic problem solving and programming using methods of top-down design, stepwise refinement and procedural abstraction.
CSC/CPE 202 Data Structures: Introduction to data structures and analysis of algorithms. Abstract data types. Specification and implementation of advanced data structures.
CSC/ART 350 Computing for Interactive Arts Capstone I: Definition and specification of a team-based creative collaboration on a digital interactive art project (e.g. animation, video game, interactive media display, etc). Research and techniques, project planning and project team organization, prototype creation.
CSC/ART 450 Computing for Interactive Arts Capstone II: Team-based design, construction and deployment of a collaborative interactive computational art project typically found in the fields of animation, game design, and interactive media. Management of interdisciplinary teams, documentation, creative development, testing, and assessment.

These core classes in the minor were selected to give students from the different majors not only a sense of the other discipline, but also to support the student's development of the necessary skills to work on a collaborative art and computing project in the capstone course. In terms of introducing the art students to computing, following the research (Alvardo & Dodds (2010)[1], Dodds, et. al. (2008)[7], Hambrusch, et. al. (2009)[11], and Haungs et. al. (2012)[12]) that shows that a context-based introduction to computer science is a more inclusive strategy, we require that the art students start their computing experience with CSC 123. This course is a context-based introduction to computing for students with no programming background. In addition, for development of computer science skills, we wanted students to experience an entire year of programming, including an introduction to data structures, allowing them to develop the skills to create stand alone computer applications. Students completing the data structures course have been exposed to both the analysis of algorithms and the implementation of data structures which are a core foundation for all later computer application development.

The art courses were selected based on feedback from industry advisors and to give computer science students a basic knowledge of visual composition. The beginner classes (ART 182 and ART 183) aim at teaching how to drive the eye of the viewer through the various visual elements of a 2D or 3D composition and how to convey a strong message and a story through a single image. The content of these two courses changes every year based on technological advances. For example, we used to focus the design and demos on 2D skills only, but have recently incorporated video game design and 3D elements using the Unreal Engine, as it allows beginning art and computer science students to make projects with ease, without requiring programming skills. The third art CIA minor core class, ART 384, focuses on conceptual and technical skills in 3D, such as character design, use of lighting, materials and textures, rendering

engines, as well as bone structures and rigging. The current software used is Autodesk Maya, as recommended by industry advisors and due to the ability to script the software.

In addition, in order for students to deepen their basic skills and gain exposure to specific technical specialties within each discipline, they choose from a selection of approved upper-division courses from both Art (8 units/~2 courses required) and Computer Science (8 units/~2 courses required):

- CSC 371 Game Design
- CSC/CPE 378 Interactive Entertainment Engineering
- CSC/CPE 471 Introduction to Computer Graphics
- CSC/CPE 473 Advanced Rendering Techniques
- CSC/CPE 474 Computer Animation
- CSC/CPE 476 Real-Time 3D Computer Graphics Software
- CSC/CPE 478 Current Topics in Computer Graphics
- CSC/CPE 480 Artificial Intelligence
- CSC/CPE 481 Knowledge Based Systems
- ART 302 Figure Drawing
- ART 334 Illustration I: Techniques and Tools
- ART 383 Digital Video I
- ART 388 Interaction Design II
- ART 434 Illustration II
- ART 474 Collaborative Studio: Rendering, Animation and Modeling

However, for the next catalog, additional newly developed courses have been added to this list: ART 376 The Art of Mixed Reality, ART 470 Conceptual Art and Storyboarding for Games & Animation, and CSC 377 Introduction to Mixed Reality. These new classes were added to address some of the concerns current students have cited about access to a limited selection of classes (see the below section regarding student and faculty reflections). These new courses will be offered starting in 2019, and will serve CIA minors and discipline specific majors as well:

ART 376 The Art of Mixed Reality: Conceptual creation, storytelling, interface design in 3D virtual and augmented realms, visual styles and use of metaphors. A theory-based view of mixed reality (MR) worlds, including coding and software, the making of 3D assets, technical challenges and constraints. The students will develop, research, write and propose their own idea for a MR project.

ART 470 Conceptual Art and Storyboarding for Games and Animation: Critical thinking and technical skills in the making of concepts and stories for animations and games. Thumbnail

sketching, character design, storyboarding, reels, digital color and contrast to convey emotions, tonal sketches, transitions, camera moves and cinematic events.

CSC 377 Introduction to Mixed Reality: Project-based study and application of Mixed Reality (MR) topics including integrated mixed reality development environments, Human Computer Interaction (HCI) peripherals, 3D environment scanning, physics interaction, diminished reality, motion capture, facial recognition, and visualization hardware.

In addition, we are actively planning for the next catalog cycle to repurpose these `approved' course lists as `recommended' lists and to allow 'any upper division' Art (8 units/~2 courses required) and Computer Science (4 units/~1 course required) course to increase flexibility and to help reduce time to graduation. The number of computer science units was reduced to ease the curricular burden of the program for Art & Design students.

The two quarter capstone series is the crowning experience for CIA minors and allows them to work in cross disciplinary teams with students from various majors working together to build a creative and technical project. Students have been given the option to work with proposals from industry or on their own proposed projects. Thus far students have chosen to follow their own creative inspiration under the guidance of the advising faculty. Example capstone projects include virtual reality experiences, mixed reality, and traditional video games. Some projects are highlighted here: http://users.csc.calpoly.edu/~zwood/teaching/CIA/ Projects from additional classes in the CIA minor's curriculum can be seen here: http://www.computingforinteractivearts.com/gallery.html

Minor Demographics

Once the minor was approved in 2016, students who had already enrolled in the minor courses, applied formally for the minor. Thereafter, any student who completed the first course not in their major (i.e. CSC 123 for art students or Art 182 for computer science students), could apply for the minor. Initially we projected that approximately 20 students per year may wish to join the minor (with two−thirds of those students starting as Computer Science majors and one−third coming from Art majors). However, to scale up the program slowly, we have admitted half that number each of the first three years. To manage resources, we aim to serve a minor population of at most 50 students total.

We present demographic information about the three years of mixed disciplinary cohorts, which have been admitted to the CIA minor. Thus far we have been able to accept all the students who have applied to the minor each year. Cohorts average 10 students with a mix of academic backgrounds in terms of majors. In addition to Art and Design and Computer Science,

motivated students from closely related majors, Graphic Communication (GRC) and Liberal Arts and Engineering Studies (LAES), have also been admitted to the minor.

The first three cohorts of the minor consisted of:

Year	**Total**	**Computing**	**Art & Design**	**LAES or GRC**
2016	**11**	5	5	1
2017	**11**	5	3	3
2018	**8**	4	1	3

In addition, one student in 2015, a female computer science major, was able to complete the minor and is included in all total counts.

Overall, the female population across the 3 years is 20 students out of the total 30 students, which means that 67% of declared minors are female. Breaking down these demographics per year:

Year	**Female students**	**Male students**
2016	**9 (75%)**	2
2017	**7 (64%)**	4
2018	**3 (37.5%)**	5

And more specifically, 9 out of the 15 computing majors who have declared the minor are female (60%):

- Year zero (2015): 100% of computing majors are female (1 out of 1)
- Year one (2016): 60% of computing majors are female (3 out of 5)
- Year two (2017): 60% of computing majors are female (3 out of 5)
- Year three (2018): 50% of computing majors are female (2 out of 4)

Examining the demographics of those who declared the minor, we find that the minor boasts 67% female students overall, and on average 60% of the Computer Science students in the minor are female (while the department average for computing majors is only 25% female). We acknowledge that the size our student pool is small, however, the minor is clearly attracting a much more gender diverse population than the Computer Science major.

Amongst the 27 students who have "completed the CIA capstone", and in theory could have graduated or will soon graduate, 11 students have graduated with the CIA minor (8 non-computing (i.e., Art, GRC, or LAES) and 3 Computing students (CSC/CPE)), 100% of which are female. Note that two students declared the minor, took the capstone class, but then did not graduate with the minor. Of the 11 students who graduated with the CIA minor and have jobs, 8 have jobs that are related to the tech industry in some way, which is 72% of the CIA minor graduates.

Student and faculty reflections

We surveyed the 27 students who have completed the CIA capstone and received twenty-one responses. Of those, 100% of the respondents stated that they believe the minor increased their creative skills and eighteen out of twenty-one respondents reported that the minor increased their technical skills. Eighteen out of the twenty-one respondents said they would recommend the minor to other students, (the remaining three respondents said they would "maybe" recommend the minor). Seven of the eight respondents who have graduated said that they feel that the "CIA minor contributed to <their> job search in a positive way". Some specific comments from students about the benefits of the minor include:

- *"Working in interdisciplinary teams helped me the most!"*
- *"loved the experience, for me it was mainly a source of exposing me to a lot of subjects that I otherwise would not have. I thoroughly enjoyed the art classes, and felt stretched in a different way than my technical classes which was beneficial even if I didn't become an expert or work in the field. It contributed to my hobbies outside of school a lot. .... But even so, I benefited a lot as a person and had a good talking point that showed diverse interests when interviewing with companies."*
- *"Was a great opportunity to learn more skills related to what I'm really interested in. Though, the courses collectively felt a bit undirected, and the limited selection of eligible art courses made scheduling a bit difficult. All in all though, the minor was an awesome opportunity, and great chance to meet super cool people."*
- *"I liked that the capstone was a project, team-based class, and as a result a lot of the personal experience relies on the quality of the teammates"*

When considering the success of this program, it is important to note that for art students, especially the studio art concentration which requires only one digital foundation class (one quarter long) in the four-year degree, the CIA minor is a substantial undertaking with 24 additional units (~6 courses) to complete the programming classes in the computer science department. For these students there would be very little chance to obtain employment in most technology-driven companies without the CIA minor. We highlight a few exemplary students' experiences: One of the most recent graduates, Sabrina, who holds a Bachelor of Fine Arts (BFA) with the graphic design concentration (June 2018), obtained an internship right after

graduation, focusing in user experience at Disney (Los Angeles). Another recent graduate, Audrey, who obtained a BFA with the studio art concentration (June 2018), also found employment after graduation as a design intern at Shutterfly (Redwood City). Chelsea, who obtained a BFA with a concentration in graphic design (June 2017), is currently a web developer and designer at Meiji Techno America (San Francisco). Rachel, who graduated in graphic communication with a digital media concentration (June 2017), is currently a user experience designer at Veritas Technologies (San Francisco). Marii, who obtained a Bachelor of Arts in the Liberal Arts and Engineering Studies major (December 2017), is currently a technology strategy consultant at Indigo Slate (Bellevue, Washington).

The minor does have limitations and challenges. Several students commented that getting into the A&D electives they wanted was particularly difficult:

- *"Would love to have classes aimed specifically for CIA minors (VR, storyboarding, more 3D modeling). Sometimes it can be really difficult to get into art classes as a CS major. This hinders a student's ability to graduate on time."*
- *"Even though I loved that I took part in getting the CIA minor, I feel like there is a very limited amount of art classes listed under the art requirements. I have heard a couple of people decided not to pursue the minor because they didn't know that they could ask if a certain art class would be counted or not. Another issue would be art classes are already impacted, art professors may not let a computing major student into their classes whether it be the student isn't as educated in the art field, having too many students already, or both. "*
- *"Make it easier for CSC students to take art electives. I know this isn't easy to do, but I feel like that is my biggest complaint with the minor."*

We have recently addressed these concerns with the proposal and addition of the new courses (ART 376 The Art of Mixed Reality, ART 470 Conceptual Art and Storyboarding for Games & Animation, and CSC 377 Introduction to Mixed Reality), presented above.

In addition, some of the Art and Design students find the transition to computer science courses very challenging:

- *"CSC 101, 202, and 203 were much harder than the classes I chose to take in upper division CPE that had more to do with the minor. The difficulty of those standard computer science courses is intimidating to Art majors and is one of the reasons there's not as many art majors in the course. The minor is appealing to CS majors because Art is a welcome break from CS, but CS to an Art major is one of the most challenging things an Art major can do."*

We see this problem echoed in class experience, for example, the five A&D students, who took introduction to programming in Fall 2017, all elected to not pursue the CIA minor, despite

passing the first programming course. They justified it explaining that to them programming "took too long". This fall, the majority of the Art and Design students have chosen to continue with programming classes, but attrition is a serious concern as the Art and Design students are in classes with primarily Computer Science majors and the culture of the course work is very different than in Art courses. As a computer science department we are actively exploring alternatives for introducing computing to non-majors.

Finally, working across two fields, instead of one, is always challenging in terms of trading breadth for depth:

- *"The biggest issue I've had so far is that I don't feel as though I have as solid of a portfolio as people who do only art or computing. I'm not sure what to do about this though since it seems like an inherent problem to trying to split time between two big areas."*
- *"I would have loved more classes that provided me opportunities to add completed work to my portfolio. The capstone was a great opportunity, but it'd be nice to have more projects to add as well. I'm personally interested in working with VR, MR, gaming, or technical artistry, which are all fields that require strong portfolio work. It'd be nice to have opportunities to have more material to show during those kinds of interviews."*
- *"The classes required for the minor seemed appropriate on the art side. I wouldn't say I was unprepared for any of the required prerequisites, but I was hoping for something a bit more of a deeper knowledge on the design level. The 3d modeling courses were fine, but I felt my drawing ability limited some of my potential in the 2d classes. This may have been something that ART 101 would have helped with, but I was unable to grab a spot in my time at cal poly. "*

This issue on its own perhaps contributes to the fact that, of those surveyed who graduated, only 25% identify as "working at a job that is related to CIA in any way". Interestingly, those in just technical software jobs do not classify them as such, only the respondents employed in jobs that includes both art and technology responded yes, such as User Experience Designer at the Walt Disney Company and Programmer at Wayforward, a gaming company, with the student noting *"job role involves constant management of assets and interfacing with art teams, experiences I felt were provided in the CIA minor that would not be available as just a CS major"*.
We still consider the minor a success because students being placed in technical jobs cite the positive influence of CIA on their job and academic experience. Even though it is still early in the minor's existence, it is worth considering if jobs related to interactive entertainment can be served by a minor as opposed to a full major or master's program (which many of the other nationwide programs are).

Overall, although the program is still in a nascent state, we feel that the CIA minor is serving an important population of students who are both creative and technical. It is worth noting that this cross disciplinary minor was created at the same time as a `data science' minor between the computer science department and the statistics department (Dekhtyar & Schaffner)[4]. Comparing the two minors, 32 students have completed the capstone in Data Science of which 7 are women (22%). In many ways, the emergence of these minors mirrors the nationwide effort to promote CS+X type academic programs, which intend to "educate the bilinguals of the future" (Lohr)[13]. Long term, we must consider whether this kind of boutique minor is appropriate versus a more flexible program that allows students to mix computing with any discipline. At this time, we feel confident that the minor is serving our students and we encourage others to consider if a CIA program could work at their school.

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