

## **JOINING COMPUTING AND THE ARTS AT A MID-SIZE UNIVERSITY**

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### **ABSTRACT**

This paper describes two NSF-funded collaborations among faculty members in the Computer Science, Art, Music, and English departments at a public university in the Northeast USA. Our goal has been to create undergraduate learning opportunities across the university, focusing on connecting computer science to creative and expressive domains. In past publications, we have focused on student learning outcomes. This paper reports on the motivations, opportunities, and challenges for the faculty members involved.

### **INTRODUCTION**

The decline in enrollments in computer science is well-documented, yet paradoxically, we are keenly aware of the deep and increasing role that computer science has in every other field of inquiry [10]. Two recent programs established by the National Science Foundation invite us to respond by “broadening participation” and “revitalizing” computing education [7][8].

Like many others, we have responded by making explicit the connections between our field and others. In particular, we are developing a set of learning opportunities that join computing and the arts. We are inspired by Horswill and Novak’s recent work at Northwestern in developing the “Animate Arts” program [4].

This paper presents four course collaborations developed as part of two NSF grants, *Artbotics* and *Performamatics*. We discuss issues we encountered that would be relevant to other colleges or universities that may go down a similar path.

### **THE COURSE COLLABORATIONS**

The heart of our collaborations has been the development of two types of courses: (1) new courses that are open to students from across the university, and (2) pairings of upper-level courses for majors, in which a joint project is developed for students in the two courses.

The new courses, which we refer to as “hybrid” courses, are designed so that all students participate equally in all coursework. In our Artbotics course, for example, which combines computing, robotics, and interactive arts, all students are expected to

engage in all of these areas. In the other course model, which we call “synchronized,” we encourage specialization.

This section briefly presents four courses: two hybrid courses, Artbotics and Tangible Interaction Design, and two synchronized courses, pairing an upper-level graphical user interface (GUI) computer science course with (1) a web art course and (2) a music education course.

### **Artbotics**

The Artbotics project is funded by a grant from the NSF Broadening Participation in Computing program and aims to increase the appeal of CS by combining it with art and robotics. The project includes a 100-level undergraduate course, an after-school program for high school students, and a collaboration with the Revolving Museum, a participatory art museum in the city where our university is located. The Artbotics work preceded the other activities described in this paper and has been reported in prior publications [5][6][11][12].

The undergraduate course has 150 minutes of lecture and 60–120 minutes of laboratory meeting time per week. In each of its two offerings (Spring 2007 and Spring 2008), the course attracted a multi-year, multi-disciplinary mixture of slightly more than 20 students. Starting with the first offering, we dual-numbered the course in both the CS and Art departments and arranged for general education (GenEd) credit corresponding to each department. This numbering arrangement allowed us to offer our technical students, such as our CS majors, necessary arts and humanities GenEd credit, while our arts and humanities majors could receive required technical GenEd credit.

The class itself engages students in hands-on work with robotics materials in the service of creating new media art. A series of labs at the beginning of the class teaches students core principles of robotics, including sensing, actuation such as movement, sound, and light, and programming. Lecture, reading, and discussion introduce the history of new media art beginning in the early 1900s, as well as the essential computing concepts students will need to carry out their work. The course culminates in a 4-week project that is exhibited at the Revolving Museum. Students work individually in the labs and may choose individual or group final projects.

As we developed and refined the course, we strove for balance along a number of dimensions. We wanted to assure equal weight to the computer science and art content. We wanted students to have high standards for their work products—particularly those that were to be installed in the museum—but recognized that they were learners as well. We wanted students to be individual learners, responsible for all course material, but also benefit from peer collaborations.

### **Graphical User Interface Programming I + Web Art & Design II**

The first work conducted with the support of the Performamatics grant was an instance of our “synchronized” courses, a collaboration between a CS professor teaching an upper-level Graphical User Interface (GUI) Programming course and an Art professor teaching an upper-level Web Art & Design course. The CS course is the first of a two-semester senior capstone sequence that focuses on building GUIs in Java and the human factors of user interfaces. The Art course builds on technical knowledge that students

have previously gained in languages such as HTML, JavaScript, and CSS, as well as the department's six-course foundations program.

For the CS students, the entire course was organized around production of a unified project (a software application with drag-and-drop features) with artwork elements developed in collaboration with the Art students. For the Art students, production of design concepts and artwork for the CS students' programs was one of several class projects.

While essentially the same material was introduced in the CS course that had been covered in past semesters (*i.e.*, using the Swing toolkit, applying object-oriented programming concepts, and implementing progressively more complex GUIs), the project-based focus triggered a radical reorganization of the pedagogical approach and a significant acceleration of the content presented. Instead of basing the course on specific GUI components and examples of their use, each assignment built upon the previous one as students progressively developed their software application. The projects became the driver of course content, students' questions drove classroom discussions, and the choice of lecture topics was guided by problems that needed to be solved for students to accomplish their projects [3].

### **Graphical User Interface Programming II + General Music Methods II**

The students from the first semester of the two-semester GUI programming sequence were given the opportunity to continue the multi-disciplinary approach in the subsequent spring. The second "synchronized" Performamatics course involved a joint project between GUI Programming II and General Music Methods II, a course in the university's music education program [2].

The highlight of the Music Methods course is a "Found Instruments" project, in which students are asked to find everyday household or commonplace objects that can produce various pitches or timbres. The students compose a musical piece that can be performed on these "found instruments" and then devise a notational system to represent these pieces. The learning objective of this assignment is to have students think about how one learns a new symbol system from the perspective of a novice.

Before the collaboration with the CS course, the music methods students would test their notational systems by having their peers perform the pieces. This was also done in the collaboration, but then the CS students tested the compositions as well as being assigned the task of creating a software application that implemented the notation.

The joint project was well received by students in both courses. As the CS students were largely musical novices, the music students saw surprises in their notational systems, which were modified as the CS students transformed them into applications. For example, one CS student implemented a design that left out the ability to represent a musical rest (a pause where no sound is playing). This is obviously a crucial concept, but one that the CS student had missed. The CS students appreciated working in interdisciplinary teams, which they realized would characterize their forthcoming professional lives. Both groups of students recognized the creative nature of the work done by their peers from the other department.

## **Tangible Interaction Design**

Tangible Interaction Design (TID) is a new, “hybrid” course begun under the Performamatics grant that combines ideas from computing and the graphic design arts. The course focuses on understanding how people interact with designed objects in their daily lives, with an emphasis on graphic communication and interaction with computational devices. A study of the design process connects the two academic disciplines.

Like Artbotics, TID was approved for GenEd credit and attracted a diverse mixture of students from across the university. In its first offering (Fall 2008), there were 15 male and 7 female students, first-year students through seniors, and 11 academic departments represented.

The course introduces students to the principles of product design via Donald Norman’s book *Design of Everyday Things* [9]. Each student writes an essay (with photos) documenting a well designed and poorly designed object in their daily lives and submits it as a wiki page on the course website. In subsequent assignments, students design a computer interface using MIT Scratch software, a board game using an original template, and a mechanical interactive character/puppet that is initially prototyped in cardboard and then fabricated on a laser cutter. In the final course project, students work in pairs developing an interactive installation (on the theme of educational games and toys) that incorporates sensing, computing, and interaction. The students’ projects are exhibited at one of our two partner museums.

## **DISCUSSION**

### **Benefits for the Academic Departments and Their Students**

At our institution, the curricula of the CS, Art, and Music departments have two properties in common: all are overfull and none has a strong tradition of offering service courses to other majors. However, each has derived benefits from the collaboration.

For the CS department, our work has made new learning opportunities available to our students. They have seen valuable examples of how our discipline can be put into practice and have completed project-based learning that otherwise would only be available in our capstone project courses.

For the Art and Music departments, the collaboration has offered students the opportunity to take courses that involve an advanced use of technology, thus complementing the existing required courses. The faculty involved are enthusiastic about providing these creative interdisciplinary experiences for their students.

Presently, we are planning a collaboration between CS and our Theatre Arts program (which is housed in the English department). This will follow the “synchronized” course model, bringing together students in a Theatrical Design course and a Software Design course to work on computer-based projects in theatrical lighting and scenic design. The Theatre Arts program director is eager to provide her students with additional technology-rich coursework, since contemporary theatre incorporates significant use of technology and the program presently has fewer offerings of this nature than she would desire. We are also developing a new hybrid course based on the CS and Music collaboration and inspired by the Found Instruments project.

## **Benefits for the Faculty: Teaching, Research, and Recruitment**

One distinguishing feature of our project is that the course development and delivery has been conducted by two (or more) collaborating faculty. For each of us, it has been exciting to work alongside our colleagues and to see how our perspectives in our own disciplines change when presented with those of our colleagues in the classroom. Each of us has benefitted from creating an educational experience for our students that would not have been possible without the other's contributions. We are also modeling the benefits of collaborative practice in action.

As most of us teach courses only in our respective departments, the opportunity to work with students from across the university has been enjoyable. For example, in the CS department, the gender ratio is approximately 10:1 male to female, but our GenEd courses have drawn a more balanced mixture of male and female students. The challenge of presenting ideas from our discipline to non-majors has enhanced our teaching.

The NSF CPATH grant that supports Performamatics has "revitalizing" CS undergraduate programs as its focus. One effect already clear from our work is the revitalization of CS faculty, as evidenced, for example, by the transformation of the GUI Programming course and the enthusiasm of the professor responsible for that change.

The work has also led to new research opportunities for the participating faculty. Project faculty have co-authored several research papers about our collaborations, and Prof. Kim developed a kinetic installation piece, "Uri," that incorporated technology from the Artbotics course. We anticipate further research and creative activity between faculty as we continue to collaborate. Blending teaching with innovative collaboration and reflective evaluation that leads to scholarly production is a win-win for faculty, especially for junior faculty on the tenure track, who are under particular pressure to teach and do research.

Most recently, the Music department hired a new faculty member whose own work involves creative use of innovative technologies. The presence of the Performamatics project on our campus was one factor in his choice to join our institution.

## **Sustainability**

Both of the grants that supported our development work will end shortly, and we are considering how best to position our work for on-going impact and support within the university. Of the hybrid and synchronized courses, the latter are more easily continued, because as long as there are students interested in taking the corresponding upper-level electives, it is simply a decision of the two faculty to work together (and a bit of planning to coordinate scheduling).

As mentioned, we have structured the two hybrid GenEd courses (Artbotics and Tangible Interaction Design) with dual course numbering (both have a CS number and an Art number). As of this writing, Artbotics has been offered twice and TID has been offered once. In the three total offerings, we have been successful in recruiting approximately equal numbers of students to the sections offered by the CS faculty member and the Art faculty member. Thus, the CS and Art faculty departments are each seeing enrollment when these courses are offered.

As for course sustainability, however, the enrollment numbers of CS majors are small. Across the three total offerings, only 5 CS majors have participated. It is easy to imagine department chairs questioning the value of assigning their core faculty to these

classes unless there is a clear benefit to the department. On the positive side, 6 Music majors and 12 Art majors have taken one of these three classes.

We plan to address this with more effective recruitment of departmental majors into the GenEd courses. Each of the participating educators strongly believes in the value of the interdisciplinary courses, and increasing enrollments of our own majors would enable us to demonstrate this to our respective chairs.

## CONCLUDING REMARKS

Each of the two course formats discussed has its own advantages. The hybrid format has proved appealing to students for sound pedagogical reasons. By blending the materials of two different disciplines, these courses engage students profoundly in an area with which they are unfamiliar, and do so more successfully and powerfully *because* that unfamiliar material is blended with what is already familiar and interesting. It's the hard sciences that arts students often dread, and the arts and humanities that many science students find difficult. Hybrid courses are particularly helpful if they allow students to feel partly at home in a course that also requires them to master concepts in an unfamiliar field. The synchronized format, on the other hand, allows students to go in depth in their chosen discipline, while providing the benefit of seeing how their field relates to another.

We are confident that with more diligent recruiting, we will fill our hybrid courses with more majors and thus be able to justify their continued support from our departments. For computer science majors, the courses form a specialization of computer science in the arts; for music and arts majors, the courses offer creative opportunities to engage with computing [1]. We hope to expand public awareness about this work, and attract students to our institution explicitly to participate in these interdisciplinary approaches.

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