Discipline-based Modules to Promote Interdisciplinary Design Teams

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Abstract

Targeting the area of ***pervasive computing*** products, our objective is to prepare students to work with other disciplines in “leading edge engineering knowledge and skills.” We are developing theoretically grounded pedagogical tools for teaching engineering students to work in interdisciplinary teams on open-ended design projects. So far, we find that:

- self-managed teaming can lead to higher order thinking (like interdisciplinarity)
- instructors have a significant influence as role models, even in self-managed teams
- learning through discipline-focused hands-on exercises helps students better understand other perspectives
- peer teaching through discipline-focused hands-on exercises helps students gain confidence.

Introduction and Objectives

Successful pervasive computing products require a balance of engineering, design, and marketing throughout their development phases. Bringing together students from each of these fields, our main objective is to intervene in students' discipline-based, content-driven education and to foreground the process of ***critical thinking***. Our goals are for students to:

- appreciate their disciplinary grounding
- achieve critical awareness of the value of other disciplinary perspectives
- engage in cognitively flexible design processes.

Developmental History of Innovation

Serendipity brought the original team of instructors together six years ago. With the goal of working across disciplines in both research and teaching, the team provides students with a “product opportunity area” each year, giving students the task of deciding what the right product should be before they design it. We base our process on the practices of innovative product design companies such as IDEO and MAYA.

Learning Activities and Materials

We have developed a set of hands-on exercises for business, design, and engineering to:

1. Give the students a better idea of what's expected of their final deliverables.
2. Help students build a shared vocabulary, a shared sense of responsibility, and a shared understanding of each other's capabilities.
3. Give students a chance to demonstrate their expertise while coaching their teammates through the exercise in their particular discipline.

For the computer engineering module, we have them develop a simple toy using an Arduino microcontroller board and some sensors, accompanied by user-friendly data sheets.

What It Does: The accelerometer measures acceleration in all three axes of movement. Acceleration is the change in the speed of an object. It's the feeling of being pushed into your seat on an airplane during take, or being pushed to one side when a car makes a sharp turn.

How it Works: Each axis has a small arm inside the chip that bends as the accelerometer is moved around. Based on how much the arms bend, the accelerometer knows how much acceleration it has experienced.

What It Tells You: Force is related to acceleration by the weight of an object. If the accelerometer is hit, bumped, or dropped, it will know from what direction and by how much it was disturbed. Also, the accelerometer can determine how much it has been rotated around each axis. Tilt is commonly used to do motion capture for video games, commonly on the Nintendo Wii.

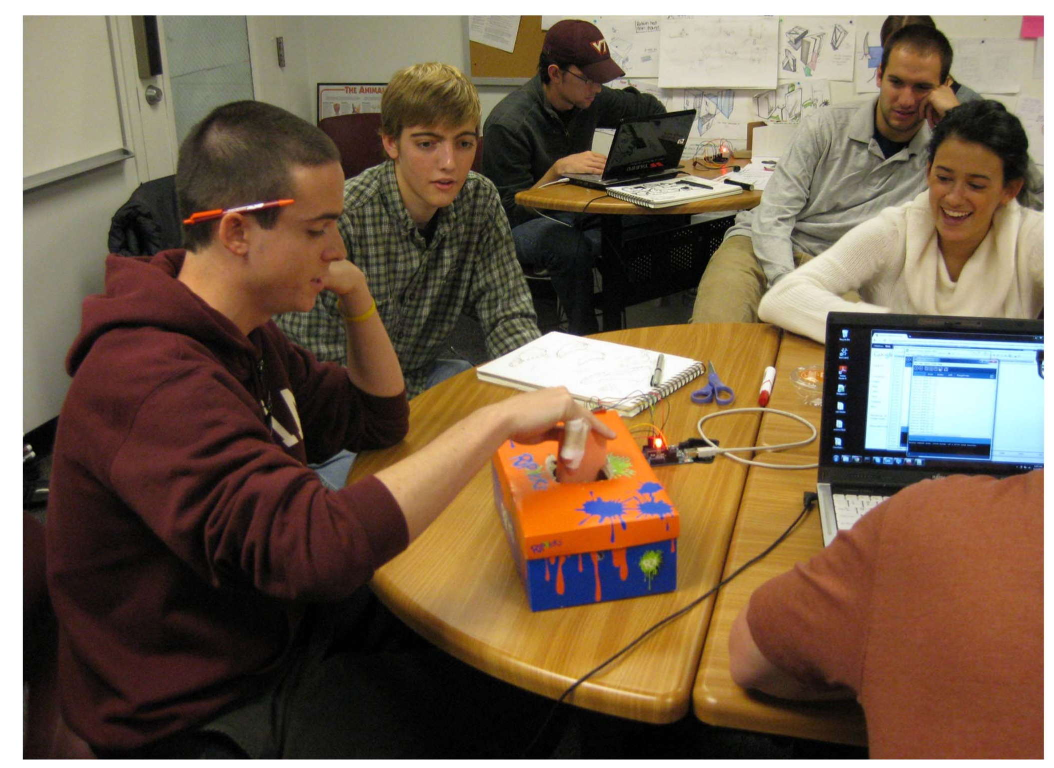
Example of user-friendly datasheets.

A student demonstrating his team's toy after the prototyping exercise. In pervasive computing, computing and sensing elements are seamlessly integrated with everyday objects.

Execution

Discipline-based workshops woven throughout the course achieve better integrated teams than workshops front-loaded at the beginning of the semester.

Self-managed teaming approaches can result in higher order thinking and behavior in collaborative design environments. However, too little structure results in insecure students (especially engineers, who are often extremely uncomfortable with uncertainty), conflict-ridden teams, and stalled design projects.



Instead of focusing on the outcome of a built product, instructors can act as facilitators and help students self-manage and work across disciplines.

Major Issues to Resolve

Now that we have formalized our pedagogical innovation into a workable model and developed several workshop modules, we plan to implement the workshops into other educational contexts. After teaching the course again in Fall 2011, we plan to work with two other universities to test the model in other interdisciplinary settings in Spring 2012. We would like to discuss ways to develop our model for adaptation in terms of instruction, student engagement, and assessment.

Discussion

Our experiences have shown that self-managed teaming balanced with guidance and role modeling of integrative collaboration improves both professional competence and innovation. To facilitate these activities, we have developed discipline-specific, hands-on activities co-led by faculty and students.

Assessment: Students' grades are based upon participation, an integrated product document and a presentation to venture capitalists. Feedback from both the instructors and the external evaluators has been excellent, and one team won the top prize in a local entrepreneurship competition.

Pedagogical assessment: Our surveys indicate that team satisfaction is improved in the workshop courses and that uncertainty avoidance levels, while pronounced in engineering students, is not significantly different across disciplines by the end of the semester. From observational data, we see patterns of positive effects of instructors role-modeling interdisciplinary collaboration and superior interdisciplinary student engagement in courses with hands-on workshops.

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