The Supercourse: a case-study in Collaboration, Cross-Disciplinarity, and Mixed Reality Prototyping in Higher Education

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The Supercourse is a university-level class that brings together five different academic programs to build collaborative prototypes exploring mixed reality projects. The course also includes content around entrepreneurship in the mixed-reality context, and works within a larger student-driven entrepreneurship program at the university. Survey results from three years of running the course are presented, with key lessons suggesting the most important focus should be on collaborative and communications skills-development above and beyond the domain-specific mixed reality curriculum.

INTRODUCTION

The Supercourse brings together students from five different university degree-programs to develop mixed reality prototypes, in collaborative teams, using a elements of design thinking and lean startup methodologies. The class exists within the context of a larger university initiative around student-driven entrepreneurship called "Zone Learning", and in addition to its' stand-alone goals in mixed-reality technologies, serves as a primer for students to develop their skills in collaboration, practical project definition, production, pitching, documentation, prototyping, and user validation. That class has run for two years, and incorporates undergraduates from Computer Science, New Media, and Media Production degrees, as well as graduate students in Media Production and in Digital Media. Students self-select into teams, research a general topic of interest, develop a problem-statement/pain-point, identify their target users, develop iterative prototypes, create a video-demo, a poster-demo, branding materials, and present their project to industry in a demo-day.

BACKGROUND

Mixed reality projects merge real and virtual worlds along a continuum (Milgram and Kishino, 1994) that includes augmented reality, virtual reality, and even the Internet of Things (Fisher, 2003). Developing these projects can require cross-disciplinary skillsets (Newman et al,2007) from software programming, hardware engineering, experience or industrial design, business experience, to rich media production; however, the university typically teaches these disciplines in separate departments, with few chances for students to collaborate across schools (Kreber,2008).

In the Canadian context, major reviews emphasize the importance of greater collaboration across skillsets to encourage innovation in the digital media sector (Ontario Media Development Corporation, 2011; Ontario Ministry of Research and Innovation, 2008; Kitagawa, 2008). Within the university system, however, each of these skillsets are often taught in a separate department. While studies of higher education have long identified collaborative skills as a priority (Bleich, 1995; Chickering, 1987), the traditional university/department model has been slow to change. While discipline-focused specialist knowledge remains important (Jacobs, 2014), collaborative project-based learning provides an opportunity to ground work in real-world issues (Schlecty 2001), integrate learning from many courses, and encourages student-driven learning (Ansell, 1998; Light, 2001; Donnelly & Fitzmaurice, 2005).

Within the concept of project-based learning, the principles of iteration, prototyping, and a tolerance for experimentation (with the possibility of useful failures) (Brown, 2008; Lim, 2008; Maurya, 2012) are all features discussed in the literature of innovation, but rarely supported through standard higher-education structures. In a typical classroom students hand in assignments and receive grades, with few opportunities to refactor, rework, or restructure their work. The ideas of iteration, of building in order to learn, and then re-build, or throw away, or refine, require a different grading environment as well as different mindset on the part of students and lecturers.

CONTEXT AND ZONE LEARNING

Ryerson University is a mid-sized university offering over 100 undergraduate and graduate programs from the heart of Canada's largest city Toronto. In recent years, the university's Master Plan has evolved to prioritize experiential learning, innovation, and entrepreneurship as key differentiators for the institution. The university has a successful digital media accelerator program (ranked #1 in in the world according to the University Business Incubator index) (UBI Global, 2018). The administration has committed to extending this success into an ecosystem of earlier-stage and/or domain-specific incubators ("Zones") throughout the university. The intention is support intrinsically-motivated entrepreneurial projects within the university context – for example, the Transmedia Zone supports ideation and prototyping for content-and-technology projects; the Design Fabrication Zone works with advanced manufacturing techniques; the Fashion Zone incubates fashion-related startups. In all, there are nine Zones at the university. The goals of the Zone system are to support student innovation, an entrepreneurial mindset outside of traditional departments such as Business and Engineering, and the development of collaborative skills. There are a host of programs in the university aimed at supporting student before, during, and after their Zone experiences, from startup-skills workshops, business plan consulting, micro-funding opportunities, pitch development sessions, and student networking events. The Supercourse works as one of the precursor programs, with the hope that student teams will go on to apply to a Zone or to become further involved in research and development in mixed reality projects.

INTENDED LEARNING OUTCOMES

The goal of the class is to meet the following formal learning outcomes:

- Gain the ability to Analyze, Explain and Experiment with developing technologies and social practices in the field of mobile, mixed-reality and Big Data.
- Design, Create, and Revise an original mobile/mixed-reality prototype in a collaborative group context, following best practices in productive, professional, equitable, and inclusive group dynamics
- Critically Appraise and Constructively Criticize peer work using social, technical, artistic, and design criteria in small groups

In practice, the main outcome for the class is to give students experience in working in collaborative teams across disciplines. These skills are important for mixed reality products and services, as human-centered design, design thinking, solid business practices, and cutting-edge technology are all involved in the process; to truly innovate, teams will need highly developed collaborative skills. And, within the typical university degree program, there are few, if any, opportunities to work with students from other departments. A secondary goal is to give students the networking contacts as well as the confidence to make use of our Zone Learning initiatives. Again, to pitch a successful intrinsically-motivated entrepreneurial project in the technology space, teams need expertise in many areas. In our experience, students typically only know students from their own degree-programs (and often, only from their own year). University activities such as sports-teams give students the chance to socialize, but entirely outside of the professional domain: they don't get an opportunity to see the academic skills or domain-knowledge of their team-mates. A credit-course provides a chance to work intensely with a small group of students from other disciplines, as well as the chance to see, interact with, and critique the work of a larger group across the class.

COURSE DESIGN

The course is structured with a lecture component followed by team-meetings and peer-review sessions each week. The professors work closely with each team, rotating through so that teams get the benefit of multiple points of view. Peer presentations and feedback-sessions are incorporated into the class, to allow for students to learn from advice given to other projects (in a workshopping model) as well as to provide for a wider array of feedback opportunities and a greater chance for teams to practice giving pitches.

Course content includes not only subject-material for mixed reality technologies, but also for group dynamics and for a design-thinking and learn-startup method of research, ideation, prototyping, and validation.

Individual as well as group deliverables are used to scaffold modern approaches to opportunity-identification and iterative design, albeit in an abbreviated form suitable for a single-semester/single-credit course. Phase One focuses on Idea Generation, with graded work around a literature review, a pain-point/problem summary, group brainstorming, and agreed-upon project approach. Phase Two focuses on prototyping, with a paper prototype, a functional prototype, and user/peer feedback. Phase Three deliverables include a two-part final-project, with a fully-featured version due one week before the end of the class. This gives the team one week to get (and submit) testing and validation from their chosen users, and to make a second iteration of changes to their final project. Phase Four is for documentation and evaluation, and includes a high-production-value video-demo, a poster, and a live demo-day for their peers as well as invited industry and academic partners. Each student must also submit a formal peer/self-evaluation describing their own contributions to the project, a narrative of the contribution of their peers, and reflect on challenges and successes for the course. Graduate students enrolled in the class have an additional deliverable in the form of a design-fiction visioning exercise.

Note that all readings are front-loaded in the syllabus, with the latter part of the course focusing strictly on the group project.

The course culminates in a showcase demo-day, a three-hour session in which representatives from industry (including Apple, Google, and IBM), student peers, and senior members of the academic community circulate and hear pitches from teams. The format is a science-fair style, with each team presenting from a table with screens, posters, physical models, etc.

SAMPLE PROJECTS

Over the two iterations of the course 34 mixed reality projects were developed. Teams built functional prototypes along with demo videos, posters, websites, and a social media presence. The following are selected example projects produced during the class.

FIGURE 1
FOUR SUPERCOURSE PROJECTS

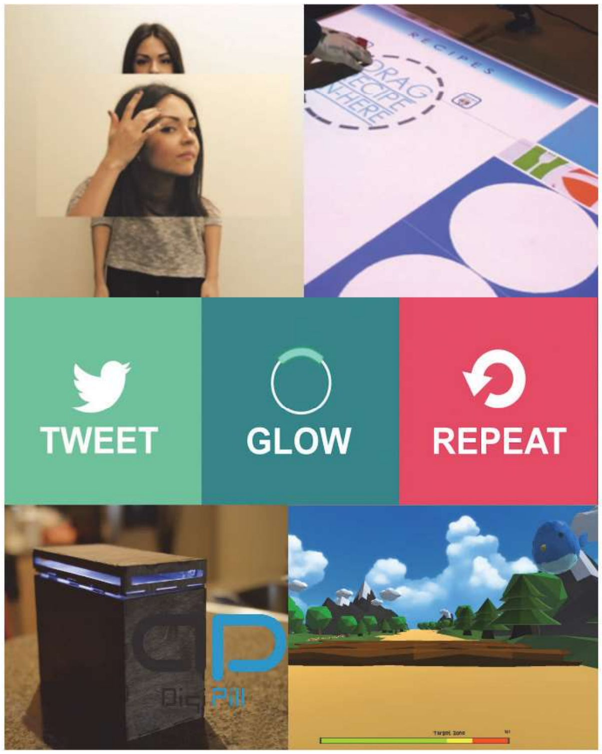


FIGURE 2
SUPERCOURSE SURVEY RESULTS

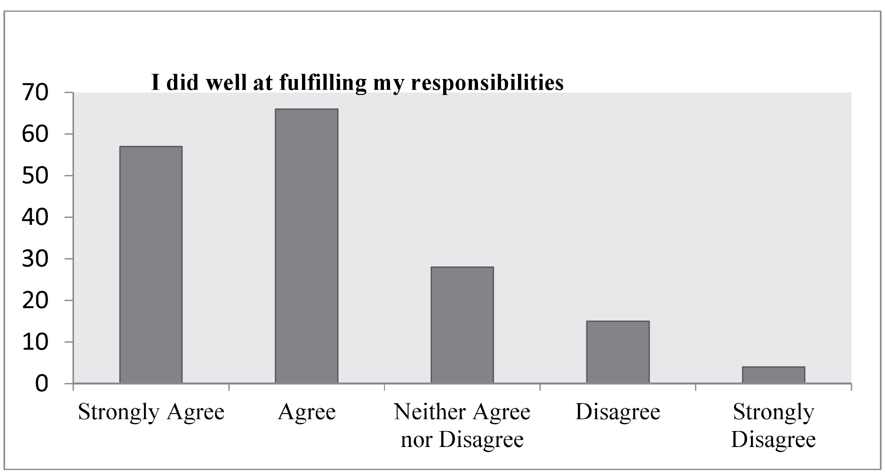


FIGURE 3
SUPERCOURSE SURVEY RESULTS

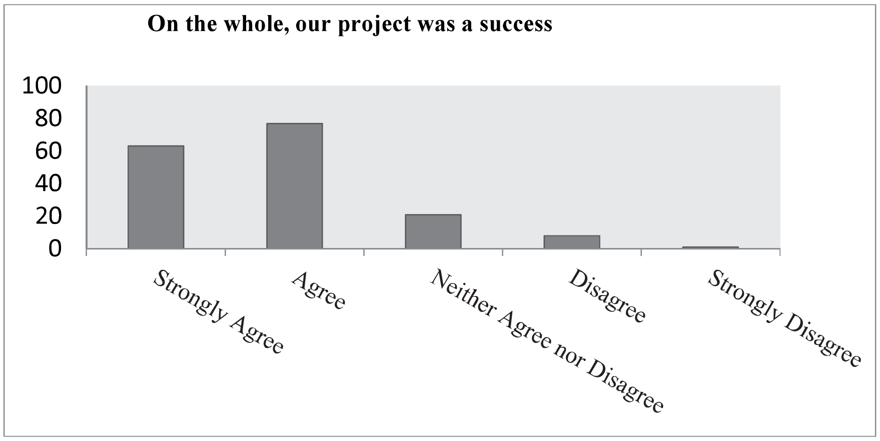
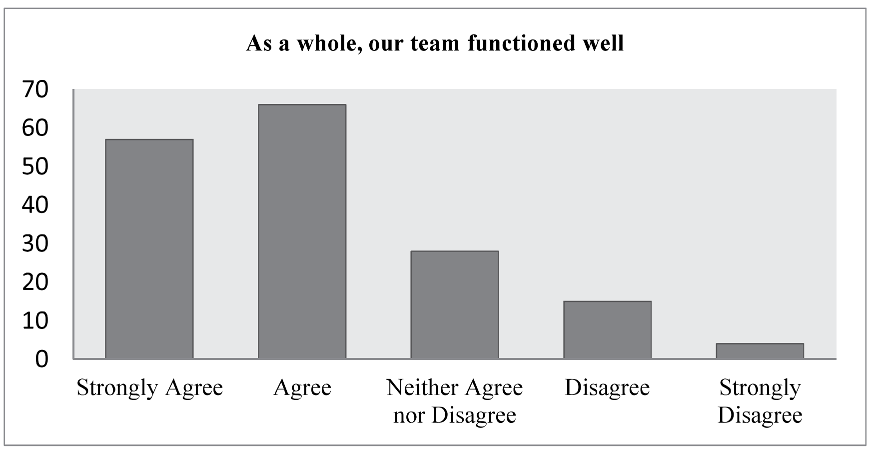


FIGURE 4
SUPERCOURSE SURVEY RESULTS



Echo is a digitally-enabled "magic mirror", which uses a Kinect and a projector to add user-specific features to the morning bathroom routine. Three sample applications included a gamified toothbrushing experience for kids, a controllable zoom effect for shaving or makeup-application, and information-update widgets for traffic and weather. Kitchen Byte used an overhead camera and projection system to provide augmented-reality cooking instructions, including automated pre-heating timers and step-by-step instructions projected onto the stove and work-surface. Crowdlet is a Bluetooth-enabled LED bracelet that can be remotely controlled by Twitter hashtags, location-sensing, and musician/event administrators. The wearable allows for realtime audience-interaction and feedback in large crowds, music concerts, or sporting events.

DigiPill is a digitally-enabled pill-case, synched with a smartphone app. The app provides visual confirmation of the medication one is supposed to take, provides information about side-effects, and transmits a signal to the pill-case that causes the correct pill-compartment to glow when user has to take their medication. Jump In combines an Arduino Uno-based heart-rate monitor with a Kinect game that uses a proven interval-training regimen in a user-tracking exercise game for kids.

STUDENT FEEDBACK AND COURSE OUTCOMES

Students from both sessions of the course filled out self/peer evaluation forms via a non-anonymous Google Form. The form asked students to reflect on what their project, how their specific responsibilities, and how each of their team-mates performed. There were also additional questions on what value they found in the class, improvements for future iterations, and thoughts on entrepreneurship before and after the course. Removal of repeated submissions gave a dataset of 167 survey responses combined across the two years of the course. We divided the entries into qualitative and quantitative responses and did analysis within Google Sheets and Excel. The quantitative data used a five-point Likert scale anchored by "strongly agree"/"strongly disagree" to assess if they felt their project a success, if their team functioned well, if they personally fulfilled their responsibilities, and before/after classifications of themselves as entrepreneurial. These results are summarized in figures 2-6.

FIGURE 5
ADDITIONAL SUPERCOURSE SURVEY RESULTS

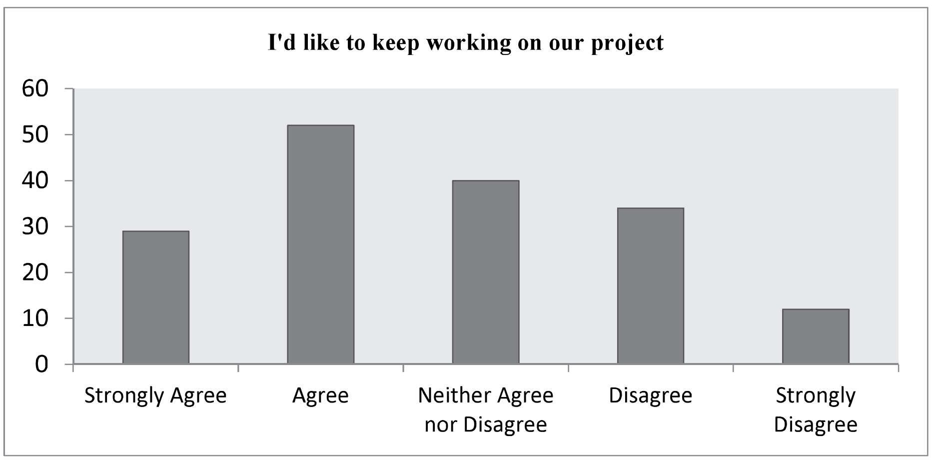
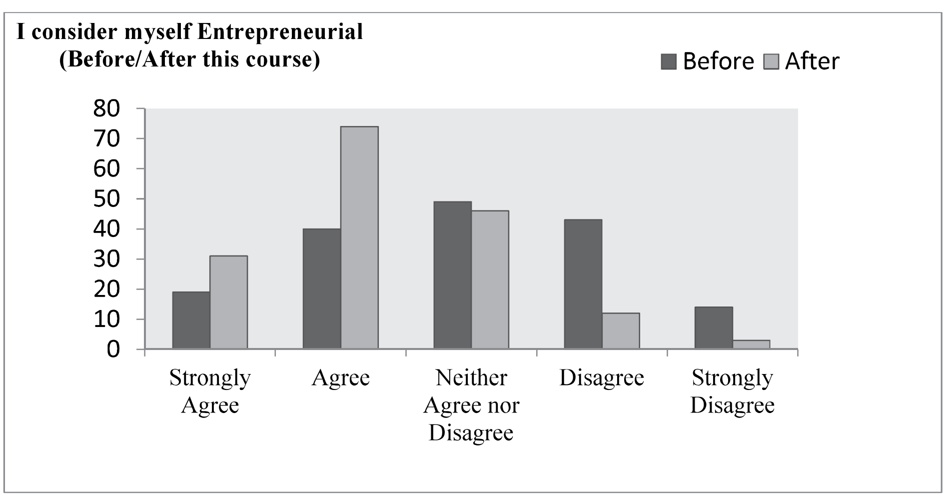


FIGURE 6
ADDITIONAL SUPERCOURSE SURVEY RESULTS



The qualitative data was organized, grouped, and coded according to emergent patterns. For the question "What were the biggest challenges your team faced?" we found the following grouped responses across 179 entries:

30% of responses described challenges with scheduling. Students had different schedules and classes across departments, lived on opposite ends of the city, or had complex work schedules.. Some teams used online tools, but typically these were general purpose social media tools (Facebook), or voice-chat (Skype). Individuals reported general dissatisfaction with these tools. One team used the online project/teamwork platform Slack, with positive results.

A further 30% of responses described the challenge of communication. These included describing team-mates not responding to messages in a timely fashion (and thus delaying dependent deliverables from other team-mates), and members staying out of communication and simply showing up at the end with their own piece of the project completed.

22% of responses dealt with a culture-clash between various departments or individuals. Some of the fine-arts students were categorized as "shy", some of the computer science students as poor communicators, and in general stereotypes of arts/design vs engineering or business students were described.

31% of responses mentioned challenges with specific individuals in a team. The free-rider problem (Brooks, 2003), in which some team-members underperform yet benefit from the efforts of their team-mates, was cited as a specific issue in several teams. Others reported issues around anger management, "bossy" or domineering behaviour, and differences in approach between graduate students (who tended to take leadership roles, and/or took the course more seriously and with more attention) and undergrads (who may have been younger, less experienced, and been carrying a higher course-load). Some responses included a discussion of how teams resolved the problems, citing the occurrence as a valuable learning opportunity.

Only 7% of responses described difficulties with the details of their actual project as their biggest challenge. Issues cited included hardware failures, problems with specific APIs, or problems with an overall approach or design constraint. Several respondents suggested that their project-specific challenges were appropriate independent learning opportunities rather than challenges.

We asked a further two qualitative free-text questions: "What did you learn from doing this project? Be as specific or as broad as you like", and "What was your favourite part about this course"." We grouped and coded the answers to these questions into a single category measuring positive outcomes, resulting in 267 responses.

45% of responses described gaining experience with and a positive appreciation for "collaboration skills". Students cited a newfound understanding of the importance of timely communication, why formal scheduling/deadlines were important to a working team, and suggested they now understood how different points of view lead to a more interesting product. Others discussed how they came to value working in a group; one engineer noted that a media-student was great at pitching the project – a skill the engineer didn't have, didn't prioritize, yet truly valued during the end-of-class showcase event. Students discussed issues in bad group dynamics or in dealing with conflict, and how they came to resolve these issues over the course of working together. Many comments specifically noted how impressed they were with what a team could product from varied skillset/backgrounds, as something significantly more accomplished than what any could do on their own. Some students also expressed pride in their team's ability to overcome communication or personal issues to pull together, creating something the whole team appreciated.

19% listed "professional skills" as a key learning. These included personal time management; appreciation for (or growing their own abilities in) leadership; risk management when dealing with the codebase, feature-creep, or a deadline; learning how to pitch ideas or projects; how to work in asymmetrical situations (ie: experienced grad students vs undergrad, or expertise in non-overlapping domains); and iterative approaches to projects.

16.5% of responses mentioned the chance to work on a real-world project. One student suggested that their previous university courses were focused on the theoretical or hypothetical, and that this class allowed them to work on a real-life issues. Several responses praised the chance to develop a functional app or projects for their resume/portfolio. A further 19% of submissions listed "hard skills" they learned during the course such as Android development, Augmented Reality toolsets, wearables hardware, C#, and the Google Maps API or web-design skills.

DISCUSSION

In general, the survey-results show a positive appreciation to the course. Several respondents specifically described it as the best course they've taken at university, and multiple fourth-year graduating students described it as a great way to end their university career. It's interesting to note that that despite most students describing this class as the first time they've had an open-ended, self-driven project, as well as the first time exploring mixed realities, the biggest challenges were around communication and scheduling. According to the responses, the details of working within a focused group environment was something that their previous educational training hadn't prepared them for, despite it being the most common modality digital technologists will face in their future careers. The Supercourse as currently designed includes some instruction in how to go about modern iterative project-design, but was focused on providing the opportunity for group/collaborative work as well as on the details of mixed reality innovation. Student feedback suggests more explicit education in good group dynamics and communication strategies, as well as integrating a requirement for positive communication and meeting-attendance into the course grading schema should be a priority.

Project-work in a business-incubator or in a work setting allows teams to focus their attention and possibly their schedules on common meeting or work times; the multiple competing demands for full-time students taking a single project-based course doesn't have the same focus. When looking more deeply into the free-text responses, students felt prepared to self-teach API structures, and were able to take in the new creative technology approaches covered in the mixed-reality lectures and demos. The main area they felt the need for more instruction was in the dynamics of the team. When rating their own and their group's performance most teams were positive, although this may be an artifact of the self/peer evaluation forming a component of their grade for the class.

One of the goals for the course was to introduce students to the entrepreneurial culture in digital technology at the university. Figure 6 shows a very strong move towards self-identifying with the entrepreneurial mindset as a result of taking the course. From the 34 projects across the two course-iterations, six teams went on to develop their ideas or their team within university research labs or Zone entrepreneurship incubators. A further four continued work on the project in their graduate theses or major research projects. One additional project won a $25,000 investment immediately following the class. We have not tracked individual class-members who may have connected with University entrepreneurial programs apart from their Supercourse team.

NEXT STEPS

Survey data as well as feedback from university administration, and faculty colleagues have led to specific recommendation for the next iteration of the Supercourse.

1. Collaboration Training: Provide more specific training in group dynamics and collaboration. Clearer goals, expectations, and training should lead to better project outcomes, fewer conflicts, and better student satisfaction.
2. Regular Meetings during Class Time: allow for in-person weekly meetings between teams during classes. Scheduling between students is difficult to coordinate, and the only time that can be guaranteed for all students to be available is during class time. We should save at least 40 minutes of each class for team meetings.
3. Meeting Reports. Requiring meeting reports and attendance records from team meetings would allow us to better document individual contributions. Submission and attendance

should use an online tool that makes it easy for instructors/TA's to monitor. Reilly et al (1996) suggest that mere exposure to an evaluation tool can help with the free-rider issue; more regular and visible tracking of these issues may help even further.

4. Collaboration Tools: provide simple instruction in productivity and group-tracking tools such as Slack. Despite all being at the same physical university students operate as a more decentralized team (and thus can benefit from remote management and project tools).
5. Two-course cycle. Ideally, we could structure this program as two courses taken in consecutive terms. One course could focus on the technology, with the second on the collaborative process and the project itself. Realistically, this is likely to be difficult in a crowded curriculum across many departments. However, it may be possible to have, say, graduate students more properly prepped for the class with a pre-requisite seminar.

FUTURE PLANS

The course will run again in winter semesters, with specific modifications based on this analysis. We will implement the above changes, aware that it will be difficult to include these group-focused skill-development sessions in the midst of content-heavy lectures, demos, and discussions around mixed reality technologies. Ultimately, it may be during one-on-one sessions that the professors are able to give useful pointers about APIs, hardware, or relevant related projects to each individual team. This will remain a resource-heavy course in terms of demands on teaching staff; however, the overall student satisfaction and tangible outcomes seem to warrant continued development of the initiative. Future options for the Supercourse include inviting a wider cross-section of the university community into the course, and also exploring chances for inter-university collaboration internationally. The chance to give students specific experience in geographically-diverse and cross-cultural collaboration is interesting, with an attendant need for specific instruction, mentorship and support for the process. The potential of a "master-class" seminar for project team-leads will also be explored.

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