

Making It: Institutionalizing Collaborative Innovation in Public Higher Education

McCarthy, Seán^a; Barnes, Audrey^b; Holland, S. Keith^c; Lewis, Erica^d; Ludwig, Patrice^e; Swayne, Nick^f

^aSchool of Writing, Rhetoric & Technical Communication, James Madison University, USA, ^bSchool of Art, Design, and Art History, James Madison University, USA, ^cDepartment of Engineering, James Madison University, USA, ^dSchool of Nursing, James Madison University, USA, ^eDepartment of Biology, James Madison University, USA, ^f4-VA, James Madison University, USA.

Abstract

This descriptive case study provides a broad overview of JMU X-Labs, an academic maker space (in other words, a teaching lab with fabrication and digital production technologies) that hosts team-taught, project-driven multidisciplinary courses. The JMU X-Labs serves the students and faculty of James Madison University, a mid-sized, public, and undergraduate-focused university in the United States. The narrative proceeds from two different but overlapping points of view: how courses at JMU X-Labs are designed and taught; and how administration of JMU X-Labs supports them. The authors refer to specific courses, pedagogical methods, and problem-solving strategies to illustrate the narrative, and they argue throughout that pedagogy and administration are indelibly intertwined in how the organization operates. Gesturing to the broad applicability and transferability of the JMU X-Labs model, the authors mark some of areas of further research that would benefit a more robust understanding of how the organization operates and grows. Finally, the authors speculate how the dynamics of this young and growing organization may answer some core and difficult questions pertaining to innovation in higher education.

Keywords: *Innovation; Learning for Employment; Maker Spaces; Pedagogy; Multidisciplinary; Educational Strategies*

1. Introduction

On the first day of class at JMU X-Labs, Jamie didn't quite know what to expect. She had heard from other students that the course she had signed up for, "The Virginia Drones Project," offered practical experience working with unmanned aerial vehicles. The subject matter seemed exciting, and this kind of course was difficult to come by elsewhere on campus. With little-to-no expertise in the area, however, and not recognizing many faces around the room, Jamie felt anxious. A biology major, she had previously worked with one of the faculty members (albeit, in a different context: an advanced ecology course) who recommended she take this experimental class. Seeing him there helped her feel more at ease.

Although he didn't show it, Jamie's professor, Paul, was also nervous. It was his first time teaching in this space, and his first time co-teaching with faculty from other disciplines. He was used to working in labs, but this place was different. A former TV station situated on the edge of campus, JMU X-Labs comprised a series of connected, open-plan spaces that converged around a double-height room with a large garage door. Short-throw projectors beamed onto three walls, and a telepresence robot sat charging in the corner. Scribbled-on whiteboards on wheels were scattered throughout this main space, and a large yellow cart stuffed with what looked like kids' arts and crafts supplies took up one corner. In the space to the left of the garage door, a handful of unrecognizable, yet expensive looking machines flanked the walls. The sound of 3D printers working hummed in the background.

The above scene synthesizes the experiences of a student and a faculty member who have worked at JMU X-Labs, a shared academic maker space, which is an educational laboratory equipped with fabrication and digital technologies (Ludwig, Nagel, & Lewis, 2017). Located in James Madison University (JMU), an undergraduate-focused, public university in Virginia, JMU X-Labs has become a recognized hub of innovation and multidisciplinary teaching and research on its home campus, and it has begun to attract state and even national recognition for its commitment to forward-thinking undergraduate-focused education. This short, descriptive case study will provide a broad overview of JMU X-Labs from two different but overlapping perspectives: how courses at JMU X-Labs are designed and taught, and how the JMU X-Labs administration supports those classes. Combined, these viewpoints will provide a sketch of an on-campus organization that is successfully fostering a culture of innovation in a mid-sized, public, and undergraduate-focused university in the United States (US).

2. Teaching and Pedagogy at JMU X-Labs

Established in 2013, JMU X-Labs developed out of a process of trial and error and has grown considerably during that period. The authors (faculty and administrators who have taught and steered the direction of JMU X-Labs over the past four years) have all contributed their expertise to a variety of programming at JMU X-Labs, most notably the multidisciplinary and problem-based learning courses that form the core enterprise of the organization. In this course model, a multidisciplinary group of faculty designs and delivers a course to students from across the disciplines who develop solutions to complex societal, technological, or environmental issues, often referred to by design theorists as “wicked problems” (Rittel and Webber, 1977). Projects are often sponsored by clients who are trying to solve or respond to these issues in one way or another. These collaborators can be on-campus organizations, companies in the private sector, or organizations within the government and public sectors. Further, the faculty or clients may connect students to mentors in industry or elsewhere who have technical or problem specific expertise. These experts help guide the students’ research trajectories, and also frequently advise the faculty. For certain courses, industry experts become adjunct faculty and co-teach the course, often using telepresence technologies to do so.

Table 1. List of JMU X-Labs Courses and Disciplines Involved

Year	Course Name	Disciplines Involved
2015,2016, 2017	Medical Innovations	Engineering; Nursing; Biology
2016, 2017, 2018	The Virginia Drones Project	Biology; Industrial Design; Engineering; Physics; Writing; Computer Science; UAV Entrepreneurs
2017	AR/VR (Augmented Reality & Virtual Reality)	Computer Science; Computer Information Systems; Industrial Design; Media Arts; Communications; Theater and Dance
2017, 2018	Fueled (food truck)	Integrated Science & Technology; Biology; Engineering
2017, 2018	Hacking for Defense	Computer Information Systems; Engineering; International Affairs; Nursing; Writing
2017	Hacking for Diplomacy	Engineering; International Affairs; Sociology; Intelligence Analysis; Communications; Writing
2018	Autonomous Vehicles	Computer Science; Engineering; Integrated Science & Technology
2018	Blockchain	Integrated Science & Technology; Manufacturing; Information & Knowledge Management
2018	Political Discourse and Political Process	Political Science, International Relations, History, Justice Studies

As the titles to the courses in the above table indicate, courses at JMU X-Labs differ from standard courses in that they are structured around specific problems or ideas rather than content areas (such as biology, or physics). The emphasis on project-based learning and emerging technology is a powerful driver that attracts students’ attention and participation. However, interest alone is insufficient to attain a balanced mix of disciplines for each cohort, because it is unusual for students in the US university system to take courses outside their chosen major or minor, beyond core general education requirements. Thus, to ensure effective recruitment, each member of the teaching team uses a course listing within their department’s major to enroll a small number of students (<12). As a result, a JMU X-Labs course is actually a network of courses that provides credit to students in their chosen major but that meets concurrently, is co-located in a single space, and shares a common

syllabus. These three-to-six credit courses (meaning students meet for three or six hours a week) are generally scheduled in the evenings to allow for greater faculty participation and to accommodate most students' schedules.

Given their networked character and problem-based focus, learning objectives vary from course to course. Some offerings, such as "The Virginia Drones Project," have a number of objectives that extend across all participating sections, but that also contain specific nested objectives that are tailored to particular disciplinary groups. Other courses, such as "Medical Innovations," have objectives that span across all participating sections (Nagel, Lewis, Ludwig, 2016). Similarly, deliverables are largely predicated on the needs of the client/community partner, and so change from course to course. Often, they are technological solutions to specific problems. Two of our unmanned aerial vehicle-specific offerings, to illustrate, have developed attachments to drones to safely find and eradicate landmines in rural areas that were formerly theaters of war. Sometimes, however, solutions are intangible and are better characterized as services. A team working with a cybersecurity company in the "Hacking for Diplomacy" course created an assessment tool that informs intelligence analysts about the technical characteristics of emerging cybersecurity threats. Although the final product was a website, this project was essentially a service designed to help analysts determine the nature and characteristics of a cybersecurity outbreak.

Many JMU X-Labs classes are invested in finding new applications for emerging technologies or to respond to wicked problems that are difficult to approach, let alone solve. Consequently, it is important to articulate clearly what exactly the students are expected to produce within the sixteen-week arc of the semester. In nearly all instances, the deliverables produced by our classes are prototypes of final products rather than projects that are ends in themselves. Essentially, prototyping is a rough sketch or articulation that should only cost enough time and effort to generate valuable feedback to further iterate an idea (Brown, 2008). The prototyping process in our courses is fast and iterative, and in the early stages of development prototypes are designed with simple materials, such as paper, cardboard, and wire. As the semester evolves so do the quality, sophistication, and specificity of the materials, but the final projects produced by teams are generally prototype solutions. Although not ready for market, these deliverables serve two very important functions: 1. They demonstrate student learning of the concepts taught in the class and the quality of the team's response to their partner/client's needs. 2. For the client, these prototypes provide potential responses to the problem under consideration that may be worth seeking funding for further development.

Prototyping is a key part of design thinking, which along with ethical reasoning and communication, forms three pillars of instruction common to many JMU X-Lab courses. These pillars serve to provide a solid "operating system" upon which to build a common experience for all the participating students, regardless of discipline. Design thinking is a

problem-finding and problem-solving method that occurs as an iterative process through the following actions: empathize, define, ideate, prototype, and test (d.School, 2010). These actions parallel the scientific process (observe, formulate hypotheses, develop predictions, test, refine) and the creative process (research, ideate, develop, revise). This method enables students and faculty across disciplines to rely on a recognizable framework and to develop a common language for communicating process and ideas. Some classes, particularly those with students from disciplines that traditionally do not define themselves as “creative,” have used the book *Creative Confidence* (Kelley & Kelley, 2013) to ground their understanding of design thinking.

Teaching ethical reasoning within the context of our project-driven, multidisciplinary courses provides a framework for students to weigh the risks and benefits of their prototype designs. Featured in the syllabi of many JMU X-Lab courses are texts such as the story of Henrietta Lacks (Skloot, 2010) and “The Eight Key Questions” (Madison Collaborative, 2013), a method of ethical reasoning designed for undergraduate instruction by faculty at our university. Some courses also include reflective assignments or questions on the final exam that further assess students’ ability to reason ethically as they develop creativity skills and build their projects. Students in the “Medical Innovations” course have completed the Survey of Ethical Reasoning pre/post course and have found increased confidence in their ability to ethically reason following a creative course with deliberate ethics instruction (Personal Communication Allison Ames, 2017).

Finally, written and oral communication practices are woven throughout all courses. Students develop oral presentation skills throughout the semester to better understand the problems they are trying to solve and to articulate the prototypes they develop to various audiences, including faculty, collaborating partners, and the general public. Writing, which we understand as a fundamentally multimedia practice, is an integral aspect of the communication instruction throughout the course. Students use a variety of technologies to write in these courses. Messaging systems such as Slack coordinate team efforts; collaboration-based technologies such as Google Docs enable students to complete collaborative writing assignments throughout the course. Furthermore, most JMU X-Labs classes publish a publicly-accessible course website and social media feeds where students document their research journeys for a general audience using a variety of media and genres. These public-facing representations of the course serve a number of functions: to document the research process; to teach students how to articulate their research for diverse audiences via the worldwide web; as an archive for students for professional development purposes; and as a publicity tool to market the outcomes of the course with campus, local, regional, and national media (McCarthy et al. 2016).

Currently, we are collecting data on many of the JMU X-Lab courses to better understand student learning outcomes. Based on course and instructor surveys and personal feedback,

we can informally report that outcomes of JMU X-Labs courses align well with recommendations from the Association for American Colleges and Universities to promote skills sought by employers, such as: critical thinking; complex problem solving; written and oral communication; application of knowledge and skills in real-world settings; and the location, organization, and evaluation of information from multiple sources (Hart Research Associates, 2013). Furthermore, the success of JMU X-Labs is reflected in increasing interest from industry and public-sector organizations that wish to partner with our classes, both to work on wicked problems these organizations face, as well as to forge a recruitment pipeline for students who have participated in JMU X-Labs courses.

3. Administration at JMU X-Labs

Administrative structures that support JMU X-Labs are important to acknowledge and explain. Without these structures, the courses described above would not function—the administrative scaffolding should therefore be viewed as integral to their pedagogical success. To illustrate, a JMU X-Labs course is actually a network of concurrently-running classes, as discussed above. This was made possible by adapting the regular scheduling of courses to the needs of this multidisciplinary style of teaching. Without this administrative “hack” (or adaptation), the classes that we describe above would not exist in the same way.

Equally important is the relationship between JMU X-Labs and the rest of the university. The JMU X-Labs reports directly to the university provost rather than to a specific department or academic unit. This reporting structure is significant because multidisciplinary courses are well regarded and even sought after in some disciplines but are often considered extra-curricular in terms of logistics, departmental culture, and curricular requirements. Reporting directly to the university provost has the effect of creating an “agnostic” space within the university where alternative forms of teaching, learning, research, and innovation can take place without disrupting disciplinary or departmental norms.

Routine issues, such as procurement of supplies, are complicated at JMU X-Labs. With up to eight active and unique courses underway in a typical semester, JMU X-Labs staff purchases might include virtual reality headsets, cell phones, sheep’s blood, brewing supplies, sensors, and even a golf cart (for use in the class in autonomous vehicle design in 2018). These purchases require research prior to purchase and then maintenance once they become part of the lab’s stock. JMU X-Labs is a team of six administrative and technical staffwork for the in a part-time capacity. Technical experts research and maintain the various technologies and work with students during open lab hours. The administrative team handles the considerable logistics of running the lab, as well as managing finances, calendars, promotion, website design and a wealth of other duties, including the design,

organization, and promotion of events such as conferences and end-of-semester presentations.

Several faculty who regularly teach at JMU X-Labs have become part of the core structure of the organization—another way that pedagogy and administration intertwine at JMU X-Labs. They weigh in on course development, as well as initiate and execute research projects based on the courses taught in the lab. Often, they will solicit industry and community partners to take part in courses to work with students as either clients or mentors. Finally, as JMU X-Labs projects continue to be successful and become better known, several of its faculty and administrators have started a small but promising consultancy arm of the organization to bring design- and multidisciplinary-based innovation practices to other organizations.

4. Conclusion

Although we are already at work on research that examines student learning outcomes, there is clearly a need for research into JMU X-Labs in other areas of inquiry. Pedagogically, how do we recruit students who will succeed in these innovation-driven classes (Mayhew and Selznick, 2016), and how do we train faculty to work in teams and teach students technologies the faculty often don't yet fully understand themselves? Institutionally, how do we broker relationships between departments and faculty to staff JMU X-Labs courses, and how is that labor accounted for and rewarded? An organization such as ours depends on a network of partners both on and off campus: how is that network developed and sustained, and what are the tangible benefits for everyone involved?

These and other questions animate the group of faculty and administrators who are affiliated with JMU X-Labs. Hugely positive anecdotal evidence propels us to design studies to answer them, as such research will enable us to validate what we do and improve upon it, and hopefully provide resources to others to help them adapt JMU X-Labs' model to other institutional settings. Moreover, we believe that the relatively young and emergent culture that has built around JMU X-Labs begins to answer some broader questions about the popular, yet vexed issue of innovation in higher education. As Berger and Milem (2000) argue, student learning is largely ignored in discourses surrounding change making in higher education. JMU X-Labs, in contrast, is successful *because* student learning is its primary focus. Denning and Dunham (2010) observe that many bids for innovation fail because organizations are focused on external exemplars rather than the needs and capacities of the organization itself. JMU X-Labs emerged out of the particular (and peculiar) specificity of its host institution. In the process, it has hacked into existence a vibrant culture of innovation that may look at home in elite institutions such as Stanford and MIT, but is largely nonexistent in public education (at the undergraduate level, at

least). “Making it,” we find, is about understanding, engaging, and transforming what is right in front of us, not peering longingly at greener, faraway hills.

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