Formative feedback in *Digital Lofts*: Learning environments for real world innovation

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ABSTRACT

Civic innovators design real-world solutions to societal problems. Teaching civic innovation presents serious challenges in *classroom orchestration* because facilitators must manage a complex learning environment (which may include community partners, open-ended problems and long time scales) and cannot rely on traditional classroom orchestration techniques (such as fixed schedules, pre-selected topics and simplified problems). Here we consider how *digital lofts--online learning environments for civic innovation* might overcome orchestration challenges through the use of badges, cases, crowd-feedback, semi-automatically created instruction, self-assessment triggered group instruction, social media, and credentialing. Together these features create three types of feedback loops: a crowd critique loop in which learners receive formative feedback on their innovation work from a broader community, a case development loop in which examples of student work are semi-automatically created to provide instruction, and a learner-driven instructional loop, in which self-assessments determine which group instruction is provided. Researching and developing digital lofts will help us to understand how to support real-world innovation across design disciplines such as engineering, policy, writing and even science; and result in technologies for disseminating and scaling civic innovation education more broadly.

Keywords

Digital lofts, feedback, civic innovation, online learning environments

1. INTRODUCTION

Many of the challenges facing our society such as global warming, poverty, and illiteracy are *political* problems that cannot be solved through engineering alone. For example, to create environmentally sustainable cities we would have to train engineers to redesign the land, water, energy and information systems of the city. And while we do train engineers to design membrane filtration-, renewable energy-, and mass transit-systems, we do not teach them about changing economic policy to promote conservation, energy initiatives to discourage fossil fuel use, or zoning rules to encourage mass transit. We do teach engineers about complex mechanical systems and how to communicate effectively as a team, but we don't teach them that sustainable infrastructure might also require changes in policy. Even when we do teach them about policy, we don't teach them how to change it, and even if they did know how to change it, they can't change it alone, leaving us with engineers who are at the mercy of policy problems, not ones that can solve them. In short, good technology and bad policy means no impact (Easterday, 2012).

To overcome societal challenges, we must train ***civic innovators*** who can identify, design and engineer solutions to societal problems. Civic innovators must be able to develop, modify, and implement ideas while navigating ambiguous problem contexts, overcoming setbacks, and persisting through uncertainty in their community. To become civic innovators, learners must gain experience identifying and tackling complex, ill-structured design challenges that are not easily solved within a fixed time frame. Civic innovation education is thus a kind of *service learning* that "...integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities..." (ETR Associates, 2012). However, unlike other forms of service learning, civic innovation focuses on *design*--whereas service learning might ask students to pick up trash in a riverbed to motivate learning about ecology, civic innovation might ask students to pick up trash in a riverbed to motivate learning about ecology in order to identify, design, and engineer solutions to reduce environmental pollution.

But embedding learning in real-world activities makes civic innovation difficult to teach: individual mentoring can be effective but expensive; extra-curricular environments provide flexibility but insufficient guidance; and classroom instruction is too rigid and time-bound for solving complex societal problems. Embedding learning in real-world activities creates a serious challenge of ***classroom orchestration.*** Classroom orchestration (Dillenbourg & Jermann, 2010) involves satisfying the constraints of curriculum, assessment, time, energy, space, etc. required to promote learning in a given context. Embedding learning in the real-world increases the orchestration challenge because orchestration techniques that work in the classroom (such as using simple problems, making students complete assignments at the same pace) can't be used when learners are working on real-world problems. Adding community clients and professional design mentors only makes orchestration more challenging.

New cyberlearning technologies, such as web 2.0, social media, reputation systems, and crowdsourcing offer new ways to orchestrate learning environments for civic innovation. Just as we create instructional *lab*s to teach science, the purpose of this project is to develop instructional *lofts* to teach innovation. Our research question is: ***how might we create Digital Lofts: on-line, learning platforms for teaching civic innovation that overcome the orchestration challenge?***

Knowing how to design digital lofts that overcomes the orchestration challenge will allow us to amplify teaching resources to make civic innovation education feasible. Design principles for Digital Lofts would allow us to overcome orchestration challenge not just for civic innovation education, but for project-based learning environments as well, allowing us to design learning environments that are more sustainable, more easily scaled to new contexts, and more like real life.

2. BACKGROUND

Advantages of civic innovation learning communities

What do civic innovation learning environments look like? Civic innovation learning communities: (a) have pro-public missions, (b) teach learners how to design solutions to real problems, (c) are led by learners and supported by faculty and professional experts, and (d) extend nationally through a network of chapters. For example, in *GlobeMed,* students work on international health challenges. In *Engineers for a Sustainable World,* students work on projects that promote environmental, economic, and social sustainability. It is important to stress the pro-public mission of these learning communities. Learners are tackling problems that require them to address societal challenges and to understand policy issues. For example, by tackling the problem of energy sustainability, students are forced to consider the environmental, economic and legal policies that constrain the effectiveness of technological interventions. For this project, we consider *Design for America*, which provides an ideal model of a learning community for civic innovation.

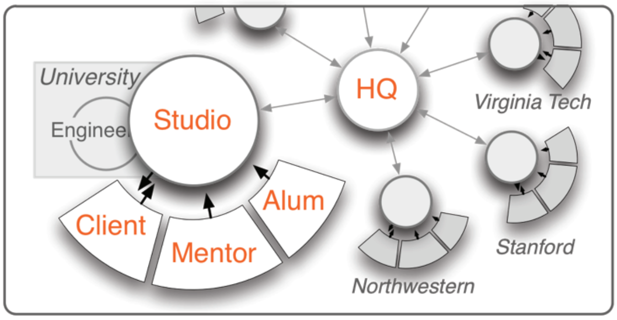

Figure 1*. Design for America's community of practice. The 14 studios are hosted on University campuses and interact with, but do not replace the existing curricula. Studios incorporate local clients, mentors and alumni and communicate directly with DFA Headquarters.*

Design for America (DFA) is a learner-directed, extracurricular service-learning environment that is succeeding at developing civic innovators. Universities host on-campus DFA studios in which student teams work on self-selected civic innovation projects throughout the academic year, applying the skills and expertise they've gained through academic coursework (Figure 1 & 2). Student teams identify challenges in healthcare, environment, and education in their local community such as reducing hospital-acquired infections and reducing water waste in cafeterias. They work with organizational partners to: understand stakeholder needs, ideate, prototype, test, and implement solutions. During the annual 4-day *Leadership Studio*, experienced student leaders train new student leaders in studio management and leadership.

Design for America was conceived by co-author Gerber during the 2008 presidential election to engage university students in solving civic issues using human-centered design. As an assistant professor of design, Gerber joined student co-founders Mert Iseri, Yuri Malina, and Hannah Chung, to start the first studio at Northwestern University. Currently, there are 14 studios hosted by universities throughout the country (including Stanford, Virginia Tech, and Northwestern) involving 1800 students (58% women), aged 18-30 from over 60 majors, working on over 50 projects; 15 faculty mentors; and 80 professional mentors. And the number of studios is expected to grow to 30 by 2015. In just four years, DFA has produced two start-ups that have raised over $1.5 million in funding. DFA has been featured in Fast Company, Oprah, and the Chicago Tribune.

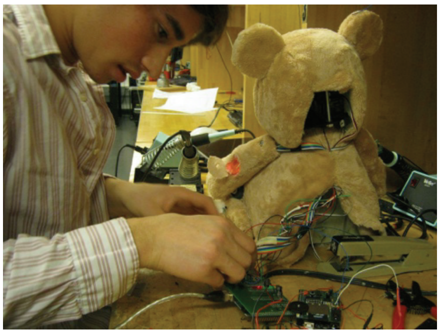

Figure 2*: Design for America students learn civic innovation through projects that require designing, building, and implementing solutions.*

Findings from surveys, daily diaries, interviews, and observations suggest that DFA students develop confidence in their ability to act as civic innovators through successful task completion, social persuasion, and vicarious learning in communities of practice with clients, peers, industry professionals, and faculty. Furthermore, students attribute achievement of learning outcomes outlined by the Accreditation Board for Engineering and Technology including identifying, formulating, and solving problems; functioning on a multidisciplinary team; communicating effectively; and knowledge of contemporary issues to their participation in Design for America. (Gerber, Marie Olson, & Komarek, 2012); (ABET Engineering Accreditation Commission, 2011).

Design for America's civic innovation model follows many recommendations of the learning sciences for improving motivation and transfer such as using real world problems that require design of meaningful products with social relevance. DFA encourages students to work on authentic problems (Shaffer & Resnick, 1999) to motivate learning and transfer. Students identify and select projects and self-direct the innovation and discovery process including observation, idea generation, prototyping, and testing (Kolodner, Crismond, Gray, Holbrook, & Puntambekar, 1998); (Puntambekar & Kolodner, 2005). By trying to apply their knowledge to a problem, students come to understand what they know and when they need more information (Edelson, 2001). Like service learning (Furco, 1996), DFA increases civic awareness, interest in the real needs of people, and contemporary issues by focusing on innovating solutions to local community challenges (Gerber et al., 2012).

Unlike traditional classrooms, Design for America's community of practice (Figure 1) expands beyond the physical boundaries of the student community to include experienced, local professionals, local clients and community members, as well as beyond the temporal boundaries of student life as learners continue to participate in projects as alumni. Students' involvement in a community of practice (Lave & Wenger, 1991) includes engaging with peer mentors, professionals and faculty in a non-evaluative environment over an extended timeframe. Communities of practice foster innovation self-efficacy (i.e., learners' belief in their ability to innovate, (Gerber et al., 2012) and such beliefs influence goal setting, effort, persistence, learning and attribution of failure (Bandura, 1997); (Deci & Ryan, 1987); (Ryan & Deci, 2000). Students select real world challenges (Shaffer & Resnick, 1999) that are personally meaningful, build and test solutions to problems, and share their work with the community through review sessions (Papert & Harel, 1991); (Papert, 1980); (Resnick, 2009); (Kolodner, Owensby, & Guzdial, 2004). Because DFA projects are extracurricular, they conclude when ideas are implemented, rather than when the academic term ends.

Orchestration challenges in civic innovation learning communities

While learning environments for civic innovation have many potential advantages, they also face many challenges. Civic innovation teachers face serious orchestration challenges because they have to teach many different project teams, with different levels of expertise, working on different problems for different community clients. The orchestration challenge makes civic innovation difficult to teach well.

Like many extra-curricular organizations, DFA students often suffer from a lack of guidance. Our needs analysis of Design for America found that, unsurprisingly, learners would benefit from more scaffolding and feedback on the innovation process including: (a) planning and conducting research on their project challenge; (b) using initial research to inform proposed solutions; (c) selecting and conducting appropriate design activities for their project challenge; and (d) discounting initial solutions if these solutions prove not to be viable. While DFA has been very successful at attracting learners, these learners report that frustrations from lack of progress makes them question their commitment to the work they are undertaking. And while leaders (student facilitators) experienced in project work and trained at the DFA leadership studio require less support, they find helping other students very challenging. In interviews, these student leaders asked for more granular 'how to' guides from DFA headquarters.

DFA students also often struggle to access available resources that could help them in their projects. While students are aware that they can reach out to experts within the DFA network generally, they struggled to identify specific individuals or instructional resources that can help them. Learners often fail to ask for support from more experienced members of the community because they don't know whom or for what to ask. Similarly, learners find it challenging to locate helpful instruction. They report floundering for long periods of time trying to find resources and as well as not knowing where to start looking.

In fact, these issues are challenges in project-based learning and criticisms of minimally guided instruction in general. Without sufficient guidance, learners become lost, confused and frustrated, which can lead to misconceptions (Kirschner, Sweller, & Clark, 2006); (Hardiman, Pollatsek, & Well, 1986); (Brown & Campione, 1996). Furthermore, students often need to develop additional help-seeking skills in order to learn effectively (Gall, 1981; Pintrich, 2004); (Ryan, Pintrich, & Midgley, 2001). Learning science provides myriad ways to offer guidance such as providing explanations, worked examples, process worksheets, prompts, (and many more) (Scardamalia, Bereiter, & Steinbach, 1984); (Reiser, 2004); (Edelson, Gordin, & Pea, 1999); (Puntambekar & Kolodner, 2005); (Kolodner et al., 2004).

Note that we do not wish to re-litigate the discovery vs. direct instructional debate here--achieving the proper balance between providing and withholding assistance (a.k.a the assistance dilemma) remains a fundamental and enduring question in the learning sciences (Koedinger & Aleven, 2007). Our point is merely that civic innovation facilitators cannot effectively deliver *any* instructional model (constructionist, direct, or otherwise) because they cannot effectively orchestrate learning at DFA studios. In other words, we cannot answer the fundamental questions about civic innovation without addressing orchestration.

The need for new orchestration technologies

In a typical classroom, orchestration is relatively easy. But the traditional classroom approaches to orchestration don't work for civic innovation. For example, to make classroom teaching easier, we often give students identical, simplified problems (in the words of one DFA student: "well-defined problems on a platter.") We use schedules that keep learners moving at the same pace so we can teach the same skills and knowledge to the whole class. This is an easy way to orchestrate groups of learners when we have a limited set of teaching resources.

Unfortunately, when we use simplified, artificial problems, we don't give students a chance to practice the skills for coping with design complexity we want them to learn. We also destroy the motivational benefits that come from working on real world problems. For example, if we want students to practice "scoping," (i.e., identifying important but tractable problems to solve) then we need to give them ill-defined problems that can be scoped in different ways and that may not fit neatly into the academic calendar. If we want them to practice communicating with clients, then we must accept unclear and changing project goals. If we want to take advantage of students' intrinsic motivation to address real world problems on topics they feel are important, then we must accept a certain level idiosyncrasy of projects. But once we start letting different groups work on different, more complex problems, at different speeds, working with clients in the community, and so on, it becomes almost impossible for a single teacher to orchestrate learning in a productive way.

Could technology help teacher orchestrate civic innovation learning environments? Existing online learning management platforms do not address the orchestration problem. Many of the most popular general-purpose online platforms assume a classroom model and are designed for distributing online books or lectures, such as academic platforms like the Open Learning Initiative (Lovett, Meyer, & Thille, 2008), MIT Opencourseware (Massachusetts Institute of Technology, 2012), and Coursera (Severance, 2012), which do not help us orchestrate design projects. Other technologies provide no pedagogical help but rather tools for managing files and conversations, such as Blackboard (Blackboard Inc., 2012), Canvas (Canvas, 2012), Lore (Lore, 2012), and Sakai (Sakai Foundation, 2012). Some technologies for orchestration focus on only small portions of the challenge such as managing a single activity (Dillenbourg & Jermann, 2010). And while there has been great progress in technologies for orchestrating scientific inquiry (Peters & Slotta, 2010), such as BioKIDS (Songer, 2006), BGuILE (Reiser et al., 2001); (Sandoval & Reiser, 2004), Inquiry Island (White et al., 2002), KIE (Bell, Davis, & Linn, 1995), and WISE (Slotta, 2004), these platforms are not appropriate for teaching civic innovation.

Solving the orchestration challenge is not simply another application of technology to teaching, it is absolutely essential for creating the civic innovation learning environments urgently needed to prepare learners for the societal challenges that await them.

3. TECHNOLOGICAL INNOVATION

Orchestration of civic innovation is difficult because there are too many moving pieces: different learners, with different abilities,

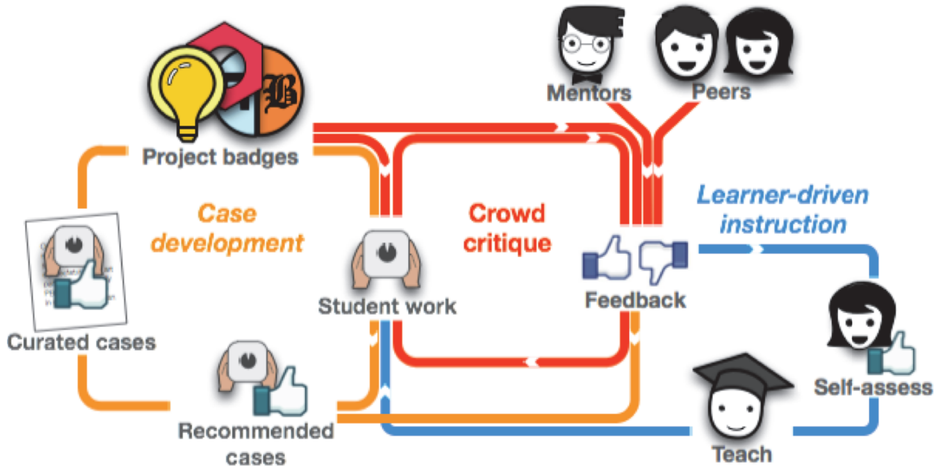

Figure 3. *Digital Lofts merge curriculum and data in three integrated feedback loops: the crowd-critique loop, the case development loop and the learner-driven instructional loop.*

working on different (complex) design problems, at different speeds, with different community clients. We could solve the orchestration challenge by giving each project team it's own professional design teacher but doing so is costly. However, with new technologies like web 2.0, crowdsourcing, and social media, we may be able to reduce the orchestration challenge for teachers and give them additional resources to overcome it. Specifically: we can use web 2.0 to scaffold the innovation process and provide flipped, just-in-time instruction relevant to students' current goals; we can use crowd-feedback to provide learners with more frequent, higher quality feedback on their progress; we can use recommender systems to semi-automatically create case libraries of successful designs; and we can automatically monitor group progress so teachers can give the right instruction to the right group at the right time.

Design hypothesis. Our initial design hypothesis argues that we can teach civic innovation by using what we call ***Digital Lofts*** to overcome the orchestration challenge. Digital Lofts are online learning platforms for support learning in real world contexts that:

1. use badges to scaffold the innovation process,
2. provide a student-generated and curated case-library linked to badges to teach design,
3. use crowd-feedback to increase the frequency and quality of feedback,
4. use recommender systems to semi-automatically create case-based instructional material,
5. use self-assessment to trigger maximally relevant group instruction,
6. use social media to facilitate participation and support, and
7. use recognition and credentialing to facilitate help-seeking and connections to resources.

These features allow us to create a curriculum that dynamically adapts to the needs of the learner, that is, to merge curriculum and data. By merging curriculum+data, we can reduce the challenge of orchestrating civic innovation to a manageable level.

To understand how Lofts help us orchestrate civic innovation, we can think of Lofts as supporting 3 interrelated feedback loops: (a) **a crowd-critique loop** in which students receive feedback on their work through project critiques, (b) a **case development loop** in which student work is used to semi-automatically create case studies of successful and unsuccessful designs which are then used to teach design principles, and (c) a **learner-driven instructional loop** in which students' self assessments trigger face-to-face group instruction taught by facilitators (Figure 3).

The crowd-critique loop

Designers and engineers often organize their work according to an innovation process. Figure 4 shows the high level steps or goals of a simplified innovation process consistent with the processes used by leading design and engineering firms like IDEO and Cooper (Dubberly, 2005) by the Stanford *d.school* (Beckman & Barry, 2007) or defined in engineering education standards (Massachusetts Department of Education, 2006). In Figure 4, the first stage of design is to "focus" by identifying a potential topic to address such as "water conservation at universities." The second stage is to "immerse" or study the user-needs, constraints and technologies involved in the issue. The third stage is to "define" a specific problem that can be solved, such as "reduce water use in the college cafeteria by 30%." The fourth stage is to "ideate" by generating a wide range of potential solutions. The fifth stage is to "build" the design using sketches, prototypes and high-fidelity implementations that realize the design idea. The sixth stage is to "test" the design. Even in simplified models like that in Figure 4, the design process is applied in an iterative and non-linear manner.

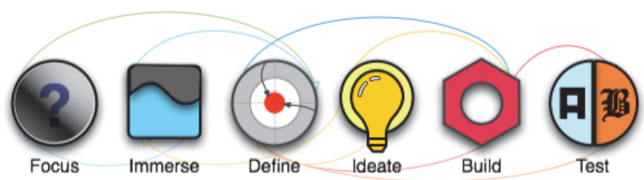

Figure 4. *Badges scaffold complex design processes for the novice into smaller, more manageable challenges and identify members who have passed the challenges as potential mentors.*

Design can be thought of as a process of learning (Beckman & Barry, 2007); (Owen, 1998). Designers construct new knowledge through observations that yield insights; insights support frameworks that inspire ideas that lead to innovative solutions (Beckman & Barry, 2007). Through this process, people construct knowledge (Dong, 2005), moving back and forth from the analytic phase of design, which focuses on finding and discovery, to the synthetic phase, which focuses on invention and making (Owen, 1998). Beckman and Barry (2007) describe knowledge creation through the design process as movement between concrete experiences and abstract conceptualization, reflective observation, and active experimentation. Inductive and deductive practices support the construction of new knowledge that designers use to shape the environment in ways that did not previously exist.

So how can teachers guide design groups working on different, complex problems? One of the most important ways to promote learning is to provide learners with scaffolding and feedback on their work.

The Loft's crowd-critique loop scaffolds the design process and provides feedback using project critiques. The crowd-critique loop starts with **project badges** (like girl scout badges) that break the complex design process into a series of manageable mini-challenges (Figure 4). For example, for the *focus* badge, learners have to scope an important but tractable issue such as *hospital acquired infections*; for the *immerse* badge, learners have to conduct user-research on their target population to better understand their needs. In the second step of the crowd-critique loop, learners use the resources attached to each badge to help them solve the challenge--each badge is linked to *flipped* (*blended)* instructional material (Khan, 2012); (Lovett et al., 2008) that includes resources, principles, and examples that can help the learners solve the design challenge. For example, the "build" badge for a web design project might include a video lecture on writing html, an interactive javascript tutorial, on-line readings about web-design principles, or examples of the different stages of creating a well-designed website In the final step of the crowd-critique loop, (after students have worked on a badge and submitted their work to the Loft), the Loft solicits feedback on students' work from professional design mentors and peers who have previously completed the badge. The mentors and peers use the badge assessment rubrics to provide feedback to students.

The widespread use of badges in online games has led to a surge of interest in badges for learning (Duncan, 2011). However, civic innovation students are already intrinsically motivated to work on real world design problems, so it doesn't make sense to use badges as extrinsic rewards that might decrease motivation (Deci, Koestner, & Ryan, 1999) and encourage gaming the system (Kraut & Resnick, 2012). So instead, Lofts use badges to scaffold the design process and communicate learning goals, which should increase learning (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010).

Combining flipped instruction with face-to-face teaching can be more effective than face-to-face teaching or online-only teaching alone (Scheines, Leinhardt, Smith, & Cho, 2005); (Lovett et al., 2008). Our flipped instructional material will use a guided-experiential learning approach shown to improve learning outcomes relative to traditional project-based learning (Velmahos et al., 2004); (Clark, 2004/2008).

Providing high quality feedback to learners is one of the most effective ways to increase learning (Hattie, 2009); (Hattie & Timperley, 2007); (Ambrose et al., 2010). The Loft provides learners with two underutilized sources of feedback: professional mentors and peers. Giving peers well-designed assessment rubrics can make their feedback as effective as instructor feedback (Sadler & Good, 2006). The Loft thus uses ***crowd-feedback*** to increase the frequency and quality of feedback available to learners.

But what if students refuse to submit work or mentors and peers refuse to review it (Kraut & Resnick, 2012)? Our needs analysis found that DFA students are hungry for feedback on their project and very willing to submit work to get this feedback. Professional design mentors are also very willing to provide this feedback assuming that students 'drive' the process by providing them with well-prepared material from their design process (which the badges help students to do).

The case development loop

Developing useful learning resources can be a challenging task especially with design teams that may all be pursuing different directions at different times--how can cyberlearning technologies help produce effective and engaging learning resources?

Our needs analysis found that DFA students prefer to share design lessons through stories about how they created their designs and how well those designs worked. In the learning sciences, this falls under the heading of *case-based reasoning,* where each story describes an example or case of a design that worked (or didn't work) along with an explanation of the key features that led the result, in which context, and so on. Teaching effectively with cases has been well studied in several forms, including learning from cases (Kolodner, 1993; 1997), analogies (Gentner, Loewenstein, & Thompson, 2003), and worked-examples (Ward & Sweller, 1990; Salden, Aleven, Renkl, & Schwonke, 2009).

Unfortunately, DFA students' learning from cases suffers many limitations: (a) it is done informally, so knowledge of particular cases is not spread widely; (b) students do not effectively teach with cases, sometimes hiding illustrative mistakes, promote their projects rather than teaching, and failing to highlight the key design lesson or principle; and (c) students do not present contrasting cases that would allow learners to understand the deep features and the context of applicability of a case. Such knowledge sharing is typical of large distributed organizations (Argote, 1999).

Furthermore, it is difficult to create case-based teaching material both in terms of creating a useful library of cases and in creating ways for learners to find the appropriate case when needed (Kolodner, 1997).

Digital Lofts overcome this challenge through a case development loop. In the ***case development loop***, the Loft uses assessments of students' work to semi-automatically create *case libraries*--examples of student work that include reflections about what worked, what didn't, in what context. First, the crowd-feedback from the crowd-critique loop is used to recommend particularly successful and unsuccessful examples of each design step, producing sets of contrasting cases. Second, an instructional designer creates *curated cases* by selecting cases that best illustrate key design principles. The instructional designer then refines these cases. Finally, the contrasting cases are then presented as an instructional resources linked to each badge.

The crowd-feedback and badging systems of the Loft reduce the orchestration challenge of providing relevant and engaging instruction to a manageable level in several ways. First, the Loft continually collects student work from multiple campuses, so we get the initial material for the case library "for free" using crowdsourcing, or production of work by a distributed crowd of people (Von Ahn & Dabbish, 2004). Second, project critiques act as a *recommender system* (Kiesler, Kraut, Resnick, & Kittur, 2012) sorting student work into contrasting cases. Third, cases are already linked to particular phases of the design process through the badges, so we automatically generate index that links the case to the relevant goal the student is working on. After the Digital Loft has done the heavy-lifting of generating, recommending, and indexing cases, the instructional designers can make the final case selection. Instructional designers can also edit the cases to improve their quality (Puntambekar & Kolodner, 2005; Kolodner et al., 2004), and present related so to encourage case comparison thus improving the chances of transfer (Thompson, Gentner, & Loewenstein, 2000; Gentner et al., 2003).

The learner-driven instructional loop

One of the difficulties of teaching groups of students of varying abilities engaged in projects at differing stages is how to provide face-to-face group instruction in a relevant and timely manner. When should a facilitator lead a "user research" workshop if each group is at a different stage of the design process? While the Loft tailors feedback and instruction to each project team, there is still a need for group instruction taught by a knowledgeable facilitator.

In the ***learner-driven instruction loop***, students' self assessments of their abilities and interest in learning different design skills are collected and monitored by the Loft. When enough students indicate a desire to learn a certain skill set, facilitators are notified that there is an opportunity to teach a workshop on an in-demand topic. The learner-driven instructional loop begins after students complete a badge. At this point, the Loft reminds learners to update their "individual development plans" (Beausaert, Segers, & Gijselaers, 2011). An individual development plan (IDP) is a list of skills along with the learner's self-assessment of his current ability level and desire to learn that skill. As students take on new badge challenges, the skills necessary for completing that badge are added to their IDP. Once a given number of students at a DFA studio or classroom express an interest in learning a particular skill, facilitators are notified that they should conduct a particular workshop (and provided with a facilitator's guide for that workshop). Because these workshops are triggered by students' current interests, the workshops maximally target students' interests and needs. While students may not be perfectly accurate in their self-assessments, feedback from mentors and peers provide a reality check on the students' self-assessments (i.e., negative feedback from mentors will prompt students to reassess their skills).

People who implement career goal plans report greater success and satisfaction in their career (Ng, Eby, Sorensen, & Feldman, 2005), so IDPs for civic innovation should increase the success and satisfaction of novice civic innovators on their journey to become more successful designers.

4. CONCLUSION

The study of Digital Lofts will lead empirically-grounded principles for designing online environments for civic innovation education, contributing to number of research areas including digital badges, crowdsourcing, learning-by-cases, design-based learning, and online learning communities. Because many domains can be framed as design disciplines including engineering (making technologies), policy (creating government programs), English language arts (creating texts and speeches), and even science (creating research studies), principles for online innovation education apply to myriad disciplines. And by coordinating groups of learners and mentors throughout the design process, Digital Lofts blur the boundaries between informal and formal learning environments: making extra curricular environments more effective and classroom environments more like real life. This project seeks to lay a theoretical foundation for understanding the broader ecosystem of online, social, design-based learning environments.

More broadly, our goal is to create a widely adopted online learning environment that will support civic innovation training. The Digital Loft platform will be disseminated broadly, targeting use in the teaching, training, and learning of civic innovation. This will fill an urgent need for learning environments that educate civic innovators who can solve our greatest societal challenges. Foreseeable impacts on higher education and society include: increasing the number of graduates motivated and capable of broader societal impact, improved education, curricular changes, and support for future interventions. Successful output of this project will help to foster and support a culture of innovation in our future workforce. By developing a scalable, cost-effective, online platform for design-based learning across many disciplines (design, engineering, speaking, etc.) Digital Lofts have the potential to fundamentally transform online learning.

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