Building Support Tools to Connect Novice Designers with Professional Coaches

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ABSTRACT
Creativity support tools help learners undertake creative work, such as facilitating coaching by creative professionals. How might we design creativity support tools that increase learners' access to coaching by creative professionals? This study took place in an extracurricular project-based learning program where students were co-located, and met professional coaches face-to-face once a week but otherwise communicated online. To test an online creativity support tool called the Loft and investigate coach-student communication we collected data from 47 interviews, online log data and field observations. We found that (a) explicit help-seeking was rare outside of meetings, (b) help from professionals was highly-valued but not sought out, and (c) online systems could surface learner struggles and trigger help-giving. Our findings suggested that online creativity platforms can support professional coaching through: (1) structured virtual updates (2) coach thanking, (3) Computer-Supported Group Critique, (4) disclosure of expertise, and (5) help-seeking training.

Author Keywords
Help-seeking, novice teams, coaching, mentoring, networked learning

ACM Classification Keywords
H.5.3 [Group & Organization Interfaces]: Computer-supported cooperative work, Web-based interaction

INTRODUCTION
Learning to do creative work is challenging. Creativity entails individual creating something they have never created before [1]. A vital component in supporting learners in creative endeavors is to foster help-giving and receiving with those who have relevant experience – peers, teachers, and coaches. While teachers and peers are on-hand within creative support environments at schools and universities, connecting creative professionals (who have relevant experience) to learners is far more challenging because of issues of proximity, scheduling, and differing expectations. Creativity support tools can help connect learners with creative professionals, and draw upon their expertise.

Creative support tools offer the chance for more learners to have a higher level of support for the same educational resources. While MOOCs have successfully increased access to educational resources, such as bringing lectures to large numbers of learners [26], learners undertaking creative tasks also need support through collaboration and connection with those with relevant expertise. The history of educational technology shows that increased access does not necessarily increase learning. Bain argues that despite promises of "dramatic improvement in teaching and learning for all students" and the largely successful efforts to bring about 1:1 student-to-computer ratio in schools, the movement "failed to demonstrate attributable, scalable and sustainable learning effects in education" (p. 7) [2]. Rather, what is important is for creativity support tools is to promote successful educational practices for creative learners.

Two such effective educational practices include project-based learning [4] and receiving help from an expert human coach [16]. Pedagogical approaches, such as project-based learning, recommend building longer term help-giving and -seeking relationships between learners and expert human coaches, as the coach can give higher quality help if they have knowledge of the project [4, 5, 32].

In this study we look to build on existing literature on creative support tools by focusing on the interactions between students and professionals acting as project coaches. We believe that this is an important area to pursue as professionals can bring valued expertise to learners, but are a different type of stakeholder with different set of motivations than teachers or peers. As such this brings a different set of considerations when designing creativity support. Following this, we ask h*ow might we create online tools that support help-giving and -seeking practices between learners and professional expert coaches in project-based creative learning environments?*

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BACKGROUND

Orchestrating Project-based Learning Environments

Project-based learning (PBL) is a resource-intensive educational approach [5, 6]. Learners work in teams to create an original solution to a problem. The solution takes the form of "advice or a product that answer a - research or practice - question" (p. 62) [16]. Project-based learning is an organizing principle for the design of learning environments [4], and gives educators the chance to challenge learners with authentic problems to encourage experience and modes of thinking aligned with real-world creative work [27]. Teams are paired with coaches who help the team throughout the project. One challenge of scaling project-based learning environments is building capacity in educational institutions [4]. In this work we examine the challenges and propose solutions for building creativity support tools that foster connections between learners and coaches who are paired together over the course of a project.

Coaching

Receiving help from an expert coach is one of the most powerful educational interventions [3]. In educational institutions, teachers traditionally play the role of help-giver. Creativity support tools offer the chance to include professional coaches who typically cannot be included in educational institutions [9, 28]. By professional coaches we mean industry professionals who are not the primary educator in a given learning environment. That is, professionals whose expertise is relevant to the project team (e.g. user researcher or product designer), rather than those whose primary job is to work as a coach in industry. Tapping into a network of professional with relevant industry experience can widen the pool of expertise available in learning environments. Professional coaches have expertise that peers and many teachers do not. It is important to note that professional coaches are different from teachers, in that they don't hold power through grades, or other performance reviews. Rather, coaches provide help when prompted through routine meetings or learner-initiated help-seeking. Coaching is a form of "on demand" and "adaptive" education, helping a learner complete a project that may otherwise be too hard [32]. Coaches and learners meet to review work, and create a plan for future work [32]. In recent years a number of innovative pre-professional educational programs for creative work that provide learners with expert coaches have emerged. Examples include robotics competitions and civic innovation clubs [15].

Help Tools

A number of other approaches have used technology to create more effective pedagogical help-giving approaches, such as peer formative feedback and cognitive tutors. In peer formative feedback similar-status learners consider and comment on the work of their peers in order to improve work and increase learning [30]. While socio-technical systems have been shown to gather valued feedback [11], and improve learning [8], peers by definition have limited knowledge in comparison to professionals. Likewise, cognitive tutors provide step-level feedback and have shown to produce learning gains rivaling that of one-on-one human coaching across many domains that do not initially seem well-defined [31]. However, cognitive tutors are unable to support learners in many aspects of creative work, such as when it is not possible to predict the activities that learners will undertake, such as in non-specific goal tasks [32].

The HCI community has created many tools that support help-seeking and -giving in multiple contexts. Prior work has demonstrated that online help-seeking tools can assist learners sourcing relevant examples of others' work. For example, Blueprint, an interface that provides sample code to programmers, was shown to help users write code [6]. Other web-based technical support tools, such as LemonAid, assist learners with finding help through asking them to select elements of a task that they are confused about and connect them with answers to frequently asked questions [7]. This work provides help by tailoring search to specific needs. Other tools, such as Aardvark, have been created to pinpoint specific people within the user's network who can answer questions [18]. However, these systems either cannot help learners outside a narrow domain, and so cannot be adaptive to the vicissitudes of creative projects, or take into account that learners don't always seek help as they don't know to or feel comfortable asking for help.

Help-Seeking

Tools can connect learners to currently untapped expertise. Individuals are often willing to provide help when they know they have relevant and rare knowledge to contribute [22]. To enlist professional coaches creativity support tools must support (academic) help-seeking and -giving.

Help-seeking is defined by Nelson-Le Gall [14] as having the following stages in which individuals:

1. **Recognize the Need for Help:** by realizing that their available resources are insufficient to achieve a task.
2. **Decide to Seek Help:** which may *not* occur. For example they may decide the costs of help-seeking are too high (e.g. loss of face), which is affected by the availability of online channels and self-esteem [20].
3. **Choose Type of Help Sought:** such as advice on how to conduct user testing on an educational design.
4. **Identify and Select Helpers:** including both person or informational resources [25] that can provide help.
5. **Enlist Helper:** by persuading the helper to provide help, a form of "social problem solving" [14].
6. **Evaluate Responses:** by judging the success of the help-seeking. May result in further help-seeking.

Nelson-Le Gall's framework gives an overview of help-seeking. Work from Hrastinski [19] shows that experienced peer coaches often find it hard to gauge learner expertise, and as a result how to help them. If we are to integrate expert coaches in creative support environments, we need a more complete understanding of the help-seeking and -giving relationships.

DESIGN MOTIVATION

In this study we aimed to: (a) test a novel professional coach-learner communication tool, (b) investigate coach-learner interactions, (c) develop a model to describe what mechanisms affect help interactions, and (d) begin to develop design principles based upon this model to inform future creativity support tools. This work contributes to the design of creativity support tools that support coach-learner interactions in creative support environments.

To start we wanted to examine how the following set of established design principles succeeded or failed to support help-seeking (both on- and offline) in a creative project-based learning environment. In this environment learners were all co-located in the same physical design studio space, typically meeting coaches face-to-face once a week, but otherwise communicating with coaches online. As our goal was exploratory for the purpose of building theory, this implementation represents a minimally designed system:

a) Making Project Thinking Visible: Project Storyboards: Making learner thinking visible is an established way to support help-givers such as teachers [9]. Storyboards are templates that prompt learners to summarize key aspects of the project (e.g. the challenge, key stakeholders, context, proposed creative solution) to help educators and peers understand the learners project [21]. Software that organizes learner work allows educators to browse (e.g. [21]) and supports their ability to give feedback more frequently [12,13]. For example, Kolodner [21] used storyboarding software to help middle-school students share their vehicle design projects in a physical sciences class. Motivated *a) Design Canvas* (see Systems, next section).

b) Making Project Thinking Visible: Computer Supported Formative Feedback Routines: Feedback routines are another way to make learner thinking visible. Formative feedback is a powerful form of help that can assist with learning [16]. We define feedback as a specific form of help directed at specific work [16], especially when iterating on creative work. Giving learners the opportunity to pose questions to direct the help they want on work in progress can illicit a great deal of feedback [11]. Project teams of learners in educational institutions [11] and practitioners [10] value these feedback routines. One advantage of these socio-technical systems is that they can structure interactions and create a record that supports review by help-givers [17]. Motivated *b) Computer-Supported Group Critique* (see *Systems*, next section).

c) Making Plans and Actions Visible: Computer Supported Task Setting: A key role for coaches is to both monitor and suggest learner activities [32]. Understanding what learners are doing is an additional challenge for professional coaches who, unlike teachers, are rarely in the same location as learners. Regularly reflecting upon and setting project goals is a vital task in projects. Motivated the *c) Workbench* (see Systems, next section).

In this paper we focus on how these design principles might work with a coach-learner rather than teacher-learner or learner-learner relationship. While both coaches and teachers give help to learners, coaches are under less obligation to ensure work is completed and do not have formal power over the learner in the form of grades and reports. We predicted that implementing these principles would lead to profitable coach-learner interactions.

SYSTEM

We implemented the design principles described above using an exploratory online creativity support platform, the Loft, designed to support project-based learning environments. The Loft platform currently has over 1000 active users. To support creative learners, the Loft attempts to distribute the pedagogical tasks associated with project work (e.g. critiquing and help-seeking) amongst learners, while maintaining the depth of practice, thus reducing the orchestration challenge faced by educators. To support communication between coaches and learners we created the Loft Project Page that included the following features:

a) Design Canvas (Project Storyboard): the Design Canvas is an online page that outlines the key aspects of the project, created to help make learners thinking visible (influenced by the Business Model Canvas [24] and Storyboards [21]). The page is available to browse by all members of the program. Based upon reviewing project-based learning literature, the research teams own expertise in teaching and researching, and expert review, we selected ten key aspects for the teams to define. These aspects were: a 'How can we' statement (framed the creative challenge the team were solving), Team (expertise), Context, Partners and Stakeholders, Users, Design Process they were applying, Project Goals, User Experience (how the team envisage users interacting with their solution), Potential Solutions (descriptions of the creative solutions being considered), and Testing (testing plan or results).

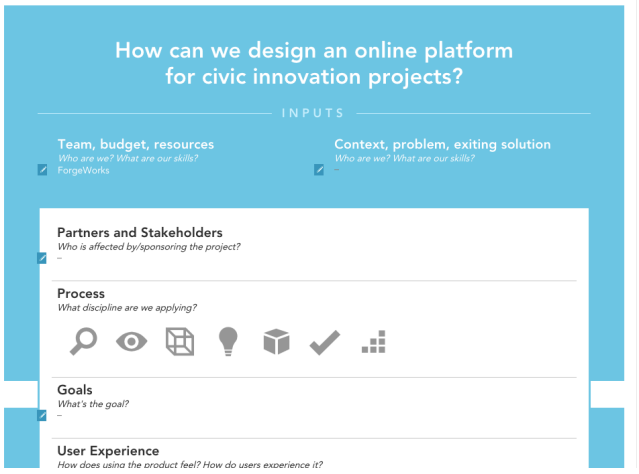

Figure 1: Design Canvas

b) Computer-Supported Group Critique: Computer-Supported Group Critique is a facilitated routine and system designed to give learners project feedback and make

learner thinking visible. The critique system includes: (a) a write-first script (those giving feedback write their feedback into a system during a short presentation, and before a following verbal feedback session); (b) question prompts written by the project team; (c) written comments; (d) public, near-immediate, threaded commenting; and (e) anonymous up- and down-voting [11]. The critique interface contained question prompts (prepared by the team) relating to the presenting design team's work. Each question prompt allowed threaded commenting (depth of 1 reply) that was public to everyone in the program. Participants could up or down vote the comments of others.

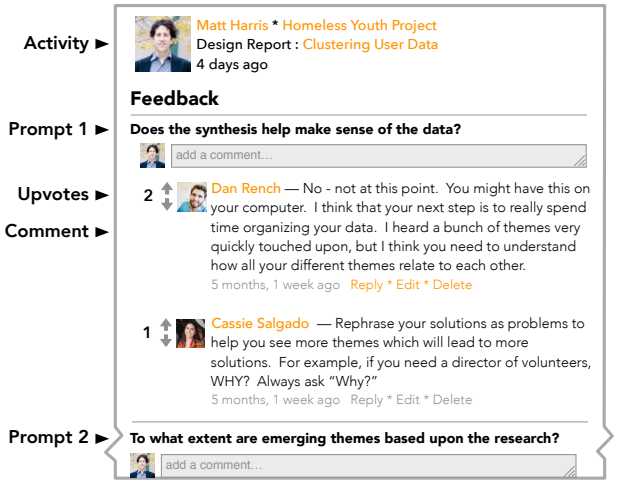

Figure 2: Computer Supported Group Critique

c) Workbench: A space for teams to post high-level goals ["Initiatives"] paired with short-term goals ["Tasks"]. For each task, learners could outline the location, owner, and due date for each task. Coaches could view these goals to understand the team's activities.

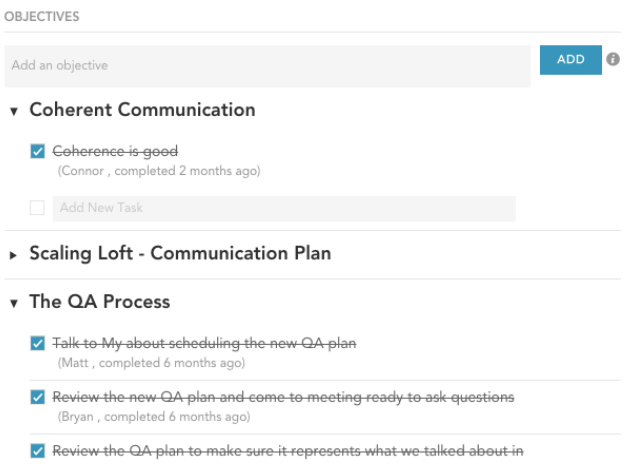

Figure 3: Workbench

METHODS

This study is part of a larger design-based research initiative to design creativity support tools to teach design to students throughout the US. The purpose of this stage was to create a working model that supported coach-learner interactions. To this end we conducted an observational study to investigate the context and how learners and coaches responded to the tool. In this section we describe the research *setting*, the *intervention*, and the *data collection* and *analysis* we conducted throughout the study.

Setting. The study took place at one location within the Design for America (DFA) network. DFA is an extracurricular program at 21 universities across the US [15], with 5 full-time members of staff, and 800 university student members who participate in teams each year. Learners work in project teams to identify local challenges and design products or services to meet these challenges. In the previous year, DFA received 127 offers to coach teams from creative professionals via their online interest form. However, they only engaged 9 of these coaches because the time it took staff to orchestrate the coach-learner relationship.

We conducted this research at one DFA site in which students undertook an intensive 6-week extra-curricular summer program located at a university design institute. All student teams worked within the same physical studio, and coaches typically came to the space for 2 hours each week for coaching sessions, but otherwise communicated with teams online. Students received no course credit or pay. An experienced undergraduate served as the program facilitator and was available 9am-5pm each day. This site was rare in the network, as the program engaged professional coaches, but had no full-time staff member orchestrating the program or the coach-learner relationship. However the lack of full-time teaching support made this site an ideal setting for studying how creativity support tools function with minimal orchestration.

In the DFA teams of 4-5 university students create solutions (products and services) that solve real-world social challenges selected by program developers. The project teams' challenges were animal rights in animal shelters, bed-bugs in low-income housing, and under-utilized school gardens in education. Teams are not restricted to a particular solution, rather are expected to create an original solution based on their investigations and understanding of the problem and context. The undergraduate program facilitator paired each team with 1-to-2 professional coaches and with a local non-profit client organization.

The undergraduate program facilitator coordinated weekly skills training workshops led by professional designers from the community for all design teams. Teams met (primarily face-to-face) with their coaches for two hours each week over the six-week period. Coaches also agreed to give an extra 2 hours per week in communicating (online) with teams as needs arose. Team members worked approximately 40 hours a week on their projects.

Participants. The study involved thirteen undergraduates between 19-23 years old at a private Midwestern university. Participants majored or double majored in engineering (10), social sciences (3), and humanities (2), and included 5

freshmen, 4 sophomores, 3 juniors, and 1 senior (54% female). Twelve of the 13 student participants had no formal training in design or similar creative fields. All participants used the Internet daily.

Coaches: The study involved 5 creative professional coaches who worked in the neighboring city to the research site (40-60 minutes travel time). Coaches were between 35-60 years old. All coaches had over 10 years of relevant professional experience (design research, product design, service design), and their primary job was in industry. Coaches also had a range of experience as adjunct professors (1, 3, 4, 6, and 11 years). None of these adjunct positions were at the university where the study took place. All coach participants used the Internet daily. Coaches were recruited by the student facilitator from a roster of volunteers from the program's interest form.

Intervention. We conducted a face-to-face demo of the Design Canvas and Workbench to each team of students for 30 minutes on the first day of the program. A researcher sat with the each team around a laptop, presented functionality, and answered questions.

Design Canvas. On the first day of the program and two days before both mid- and final- review presentations, one of the researchers advised teams to update the design canvas. They were also advised to have weekly conversations with their team to define and re-define the key categories as their project developed.

Computer-Supported Group Critique Sessions. The student facilitator ran critique sessions. Critique sessions involved all student participants, the student facilitator, and members of the design community (between 0-1 design professors and between 5-6 design undergraduates and graduate students). There was no expectation for the coaches to attend. Only one coach attended a critique session in-person during the first week. During weeks 4-6 the Loft sent out email notifications from the site to the coaches when feedback was given online.

Workbench. On the first day of the program a graduate student researchers advised teams that (a) they could use the Workbench to set and assign goals, and (b) the Workbench was one way to keep the coach up-to-date.

Data collection. We conducted observations and in-person interviews to understand what occurred within the environment (both off- and online). We observed the studio for 5 hours each week, taking notes on how the designers and coaches interacted with each other and the system. We kept in close contact with the student facilitator to understand the challenges the teams were facing.

We conducted 38 semi-structured individual face-to-face interviews (30-55 minutes) with students on their project work, experience interacting with coaches and use of the system. Each student was interviewed 3 times, other than one student who was interviewed twice. We conducted 9 semi-structured individual face-to-face interviews (45-65 minutes) with coaches on their coaching strategies, interactions with their team, and use of the system. Each coach was interviewed twice, other than one coach who was interviewed only once. We amended our protocol as themes emerged. An example theme was coaches monitoring team (non-)actions following coach advice. For part of each interview we returned to the online system to clarify responses and aid the recollection of the participants. We scheduled interviews with each student every 2 weeks for students, and each coach in the 2nd and 6th (final) week of the program.

We transcribed all interviews immediately following the interview, resulting in more than 800 pages of transcripts. We used the field notes, transcriptions, and data log to crosscheck emerging themes.

Analysis. We treated the design of the system as a *pre-structured case* [23], meaning we derived categories in our coding scheme based on existing theories (for help-process and systems motivation) and then added nuance to, amended and developed new categories as we analyzed the data. We analyzed the interview transcriptions for themes based around Nelson-Le Gall's help process [14], while also looking for other themes that might compliment or contradict this process. Analysis occurred during data collection, allowing us to alter our data collection to better capture emerging themes that we had not predicted. First level coding identified 550 instances of 27 codes describing how the system provided and failed to provide support. We then iterated between first level coding and open coding to cluster these codes into 17 conceptual categories pertinent to learner-coach communication. We formalized our findings as a process diagram (see *Figure 4*) with descriptive narrative. To refine our theory and resolve researcher disagreement we checked the model against our data and existing research.

RESULTS

Systems that connect learners with professional coaches must support complex help interactions that can break down in a number of ways. The first aim of the study was to build on existing models of help-seeking by extending these models to the realm of online creativity support tools. We found that help seeking interactions occurred primarily through two routes: (1) highly explicit help-seeking, and (2) unsolicited help giving in response to learner disclosure about their project, as well as by mixtures of the *two. We describe the process model and related evidence in this section*. The titles A)-Q) in italics correspond with *Figure 4*. Table 1 summarizes the Participant IDs (PIDs) across roles and teams.

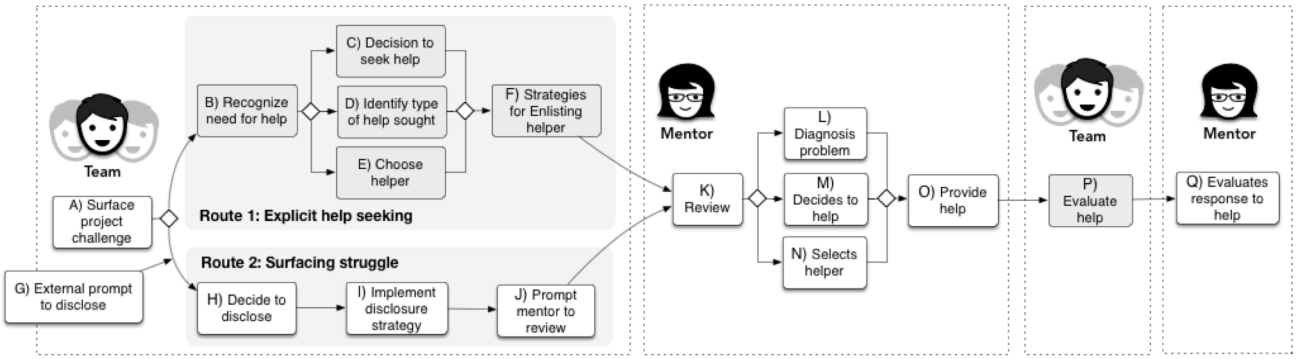

Figure 4: Help-seeking and –giving model

	Team 1	Team 2	Team 3
Challenge	under-utilized school gardens in education	Animal rights in animal shelters	bed-bugs in low-income housing
Student PIDs	11, 12, 13, 14	21, 22, 23, 24, 25	31, 32, 33, 34
Coach PIDs	41	42.1, 42.2	43.1, 43.2

Table 1: Summary of Participant IDs (PIDs)

(A) Surface project challenges (learners): As learners worked on their projects they would surface aspects of their project that they perceived needed attention. This was a different state than *awareness for need for help* described by Nelson-Le Gall's process [15]. Teams would work together and discuss these issues. For example, PID 22 reported on the discussion the team had when they realized older cats weren't reacting to their pet care device as expected: "*We've started to hit some bumps in the road … …I think there have been a lot of conversations we've had as a team there and we've just kind of been working through and trying to come up with a landing point that we all feel competent in.*" All teams reported having these types of discussions between two (PID 23) and five (PID 31) times a week.

Route 1: Explicit help-seeking

(B) Recognize need for help (learners): As expected, learners and coaches did not always agree that learners needed help. *Learner awareness for need for help* can be thought of as a learner generated prompt that they should seek help from a source outside of the team. Learners reported that outside of meetings they didn't need the coach's help (PID 11, 13, 14, 21, 22, 25, 32, 33). When discussing contacting coaches outside of the meeting PID 32 stated that: "*I feel just because we don't need it too much in the end.*" Conversely, coaches reported that learners were often not aware that they needed help (PID 41, 42.1 42.2, 43.1). As PID 42.1 states: "*they don't even always recognize that they need help.*"

(C) Decision to seek help (learners): While learners might recognize they need help, this does not guarantee that they will seek help [15]. The coaches perceived that learners were sometimes aware that they needed help, but found it difficult to ask (PID 41, 42.1, 42.2, 43.1). PID 43.1 reported "*I think [the learners]… …don't like to fail, they don't like to admit it.*" A number of learners stated that they didn't ask for help on an issue that the team had discussed and had differing views on (PID 11, 12, 22, 24, 25, 31, 32). Specifically, they felt that asking for help from the coaches could create divisions within the team. PID 22 described this situation: "*But I feel like I don't necessarily want to be asking for advice [from the coach] …because I feel like then it gets into this like debate where whoever presents the information in the best way or makes the most compelling or convincing argument kind of wins there… …it feels like an 'us' versus 'them' type situation".* The majority of learners also expressed that they were very comfortable reaching out to the coach outside of meetings (PID 13, 14, 21, 22, 23 25, 31, 34).

(D) Identify type of help sought & E) Identifying helpers (learners): Help-seekers have a sense of the type of help that they need, and who or what can help them. Both coaches (PID 41, 42.1, 43.1) and learners (PID 11, 12, 25, 31, 34) reported that learners struggled to articulate questions to coach. PID 41 (coach) noted: "*I want them to have more specific questions prepared but I know that like that's hard.*" (Coaches can however diagnose problems and give help based on these less complete questions, expanded upon in *L)* Coach *Diagnoses Problem*).

Learners were at times unaware of coach expertise, and reported discounting coach as a source for help. For example, learners in one team reported that their coach could not help them in testing their product, when in fact one of their coaches had 22 years experience in user product testing. Learners in another team perceived that their coaches could not help them with their educational intervention designed to train and bring a sense of trust in community housing affected by bed bugs, while their coach had 18 years experience as an educator and 12 years as a community organizer.

(F) Strategies for enlisting helper (learners): When asked most learners did not report using strategies for help seeking. Some learners (PID 11, 12, 23, 34) reported preparing questions for the coach before they met. In terms of the

channel for enlisting help, learners favored asking for help in meetings. They reported perceiving asynchronous forms of communication (email and Loft) as feeling "inefficient" as it would take too long to write an email and wait for a reply (PID 11, 12, 14, 25, 31).

P) Evaluation of help (learners): All learners reported that interactions with their coach(es) were helpful. They identified that meetings reduced the anxiety they were feeling [PID 11, 21 24, 25, 34], increased confidence they felt in their project because of coach expertise [PID 11, 12, 31, 32, 34], and helped the team to be motivated and "energized" (PID 22) after meetings (PID 23, 33, 25). Teams noted that they had a clear plan of action after coach meetings thanks to coach help, leading to the team being more effective (PID 13, 22, 23, 24, 31, 32, 34). As PID 12 stated "*after meeting with her we have like such a clear sense of like objectives and we have like her expert opinion on like what to do next, so we have like a lot of momentum*." Furthermore, learners reported that coaches helped them think through what they perceived as challenging and important decisions (PID 11, 12, 14, 21, 22, 25, 31, 32). As PID 32 notes "*sometimes when we have conflicting ideas… …and they'll help us like work through it. So yeah, the coaches have been pretty helpful with that.*"

Help Giving Process

(G) External prompting to disclosure: In meetings all coaches would prompt learners to talk about their project. As PID 42.2 (coach) stated: "*so they're [meetings] really about sitting down, getting an update, what happened between this time and last time? What today are your big burning issues? Where do you need help?*" Discussing how long coaches would ask questions for, PID 41 (coach) reported: *"So that I would say, me kind of driving it for the first I don't know maybe 45 minutes into an hour of just like "then what?", "then what?", "then what?"*. Coaches also encouraged learners to contact them outside of these meetings in two forms. Firstly, at the start of the program all coaches and teams agreed that teams should send out weekly "update emails". Secondly, coaches all encouraged their teams to contact them if they needed help. PID 42.2 (coach) explained he reiterated this each week as he "*never want[s] the team to be like they couldn't reach out to one of us if they needed something*". Learners all reported understanding there was an open invitation to contact their coaches.

(H) Decision to disclose (learners): Learners disclosed significant details about their projects in face-to-face meetings and in update emails. Learners by-and-large rejected the Design Canvas as a prompt for communicating their project with coaches. Teams filled out the Design Canvas on two occasions, in the first week, and in the final week. The Design Canvas was perceived as a summative communication device that felt "*final*" (PID 11, 21, 25, 31, 32, 34), and "*formal*" (PID 14). When discussing why they didn't use the Design Canvas PID 13 "*I feel like [our project] is like a work in progress like we're not fully sure…I want to like put something that's like definite*." This resulted in learners feeling unmotivated to regularly use the Design Canvas as a communication channel with their coaches.

Similarly, learners largely rejected the Workbench as a way to communicate with the coach. While all teams did use task lists to organize their work, they preferred to do so on paper (PID 11, 12, 13, 12, 22, 32, 33) and did not perceive value in the coach seeing what they did (PID 14, 23, 33).

(I) Implement disclosure strategy (learners): Once learners decided to communicate information about their project they would employ a certain strategy. In face-to-face coach meetings all learners stated that they would report on their recent activities and their current plans. As PID 23 states "*we catch her up on what we've been doing and then we kind of end our spiel with, "And this is what we have planned for today.*" In meetings learners would also sometimes prepare questions regarding what course of action to take (PID 12, 14, 22, 33, 34) and describe the pros and cons of different options they were considering. This report differs from how the how coaches describe meetings (as expanded upon in *Prompting Disclosure from coach*) as coaches reported that they were the chief drivers or face-to-face interactions (PID 41, 42.1, 42.2, 43.1) As expanded upon in *Coach Diagnosis* and *Coach Help Strategies*, this disclosure led to interactions that learners found useful (see *P) Learner Evaluates Help*).

Email and Loft disclosure differed from face-to-face disclosure. Teams sent coaches "update emails" 2 or 3 days after their weekly meeting. PID 25 described update emails as explaining "*what we've done this week, this is what we're going to do next week…. …for example like last week it would have been you know, we continued working on the heating and cooling element.*" Update emails would not include questions or descriptions of what the team was struggling with (PID 11, 12, 25, 31, 32, 34, 41, 42.1, 43.1). As PID 24 said the emails were "*more of a status update like I don't think we ever really ask questions to them like specific questions*." Rather, learners saw it as a way to keep the coaches aware of what they were doing (PID 11, 12, 13, 14, 22, 24, 25, 31, 33, 34). Analysis of teams update emails found 1 question pertaining to the project out of the 15 emails. As expanded in (*L) Coaches Decision to Help*, these emails did not trigger coach help giving. For Computer-Supported Group Critique teams also prepared 3-7 questions and associated files (e.g. personas, sketches) that they wanted feedback on (when prompted).

(J) Prompt coach to review (learners) & K) Review (coach): Help-givers need to have some prompt to review information, and once prompted can decide whether or not to review. Coaches all reported that they would always review anything that teams disclosed. In the final three weeks of the course when coaches received email notifications to review team Computer-Supported Group Critique (CSGC) online PID 42.1, 42.2, 43.1, and 43.2 reviewed every critique. Coaches also browsed Loft without the team prompting (PID 42.1, 42.2, 43.1, 43.2). However, away

from the meetings coaches did not view it as their responsibility to seek out information about the project. PID 41 stated: "*my role is a responsive one… …if they need me I will respond because that's kind of what I signed up with them… I definitely won't, I mean, you know, seek it out.*"

(L) Diagnoses problem and *(M) Decides to help (coach)*: In theory it is not always certain that help-givers will always give help. For example, helpers might decide that they don't have time to help. In meetings coaches diagnosed a range of problems, such as: (a) teams being emotionally "down" (b) lack of clarity around goals (all coaches).

When reviewing team disclosure on the Loft, participants had mixed reactions to the different channels (see Table 1). Coaches reported that reviewing the Design Canvas did not help with diagnosis, or trigger help giving (PID 41, 42.1, 43.1). When discussing the Design Canvas PID 41 reported "*I mean, this is sort of like what we did on day one... …I mean there's nothing here that's like, I need to know. Sort of like, a little bit basic.*". Likewise, on reviewing the Workbench coaches noted that while it gave them more detail about the project (PID 42.1, 43.1), it didn't give the type of information that the coach would be looking for to give help (PID 41, 42.1, 43.1). Furthermore, PID 42.1 also noted that she wouldn't know if her help was needed as if teams didn't use the Workbench daily it would be out of date: "*So it feels like it's outdated. Just because they move so quickly… …every day they have different stuff*".

Communication Channel	Team Use	Coach Use
Design Canvas	Limited use as it felt too "final" and "formal" for the to use regularly.	Did not trigger help interactions as felt too "basic", even when up-to-date.
Computer Supported Group Critique	Generated questions each week around areas they wanted help on.	When prompted by the system gave team help either on line, or followed up during face-to-face meeting.
Workbench	Limited as no perceived value of coach seeing specific goals.	No use due to lack of team use. Coaches felt information was "outdated".
Update email	Sent weekly emails but rarely included questions or details of team struggles or decisions	Did not trigger coach replies. Emails viewed as "non-actionable".

Table 2: Summary of communication channel use

Update emails also failed to trigger coach help-giving. No coach reported responding to these emails by giving the team help. Referring to one email PID 43.2 said: "*It was not specific questions. It was here we put up some new things interesting your thoughts, but no it was more of a passive role [for him], I felt.*" Similarly PID 41 (coach) noted: *"They sent me that email and I was kind of like, it just wasn't an email that even been merited to response. I was so busy I was like "okay, great to know". But if they had added a question I would have totally responded. But it was like a non-actionable".*

(N) Selects helper (coach): While coaches mostly reported only their own help-giving activities, they also reported considering others who could help their team. Coaches who worked in pairs reported that they would were aware of their partners expertise, and so they took over help-giving accordingly (PID 43.1, 43.2, 42.1, 42.2). As PID 43.2 said: "*[PID 43.1] and I seem to work just very comfortably… ….if she is strong in that area, I could kind of sit back and let her be strong in that area. And if I have something to offer to your show probably reciprocate so there were certain areas that I was more engaged.*" There was also evidence that coaches were ready to connect their teams with other experts. PID 42.1 and 42.2 offered to connect their team with professional contacts they had should the team want to create a higher fidelity prototype.

(O) Provide help (coach strategies for help): Coaches reported using a range of strategies. In meetings coaches: (a) encouraged teams by praising their project and progress (PID 41, 42.1, 43.1, 43.2), (b) stated choices teams had to help decision making (PID 41, 42.1, 42.2), and (c) helped teams organize and prioritize all the tasks they need to do (all coaches). While doing this coaches also reported that they had an opinion of what they thought the team should do (PID 41, 42.1, 42.2). Throughout the session coaches entered into a dialogue with the learners and expressed "working through it with the teams" (PID 43.2). All coaches reported spending time reaching a consensus with the teams over project plans.

Outside of meetings coaches also gave help on the Computer-Supported Group Critique. Between weeks 4-6 (after automated email notifications were implemented) PID 42.1, 42.2, 43.1, and 43.2 all commented on the system after having seen team questions and peer comments.

(Q) Evaluates response to help (coach): Coaches monitored the help they gave learners. In meetings coaches would ask questions to see if teams had followed their advice (PID 41, 42.1). Coaches reported feeling good about help that was appreciated and improved the project (PID 41, 42.1, 42.2, 43.1). PID 41 (coach) reported on advice she gave a team to recruit teachers to test their educational design: "*They were like "That's a good idea" and then they did it and they were like "Yeah, that was great, everyone signed up" So I was like "Yes"... .. but also like [the help] moved them along and I felt like great about that.*" The coaches also recognized that they have limited power with learners in persuading them to follow the advice. As a result when coaches saw teams not following their advice they stopped persuading them and recalibrated their advice.

DISCUSSION

In this study we have sought to illuminate ways to build successful creativity support tools that encourage interactions between learners and professional coaches.

	Feature	Description	Rationale	Evidence
1	Structured Virtual 'Update' Routine	Teams regularly write short report in structured form that prompts disclosure about current challenges and decisions.	Prompts that lead teams to disclose questions and information about project challenges elicit more coach help. Could make help more timely (addresses Route 2).	Learners *were* capable of disclosing information about their project that triggered help giving. **See *(J) Prompt coach to review (learners) & K)* Review *(coach)*.** They were also prepared to write emails, that served limited purpose, but the coaches did review. See ***(H) Decide to disclose***
2	Computer-Support Group Critique (CSGC)	See Systems Description.	The team generated questions and peer feedback could trigger coach help-giving when they reviewed this disclosure. Coaches reviewed.	Once coaches were made aware of CSCG they reviewed it, gave help on the system, and used this to inform help given in meetings. **See *(J) Prompt coach to review (learners) & K) Review (coach)***
3	Explicit Expertise Disclosure	Coach platform profiles that list expertise, and introduction routine.	The system and related routines should support learners in relating the tasks they are taking on with the expertise of the coach.	Teams struggled to know who they could use their coaches, and were often unaware of their expertise. **See *(D) Identify type of help sought & E) Identifying helpers (learners)***
4	Coach thanking & help-review (routine & functionality)	System prompts team to report successful help to coach. Teams inform coaches of result of coach help - system notifies coach.	Coaches monitored the results of their advice, and reported a positive emotional response when their advice was useful.	Coaches monitored the success or their help, and *were* motivated by knowing their help was successful. **See *(Q) Evaluates response to help (coach)***
5	Help-seeking instruction	Teams are provided with written instruction on how to work with coaches, including how to prepare for meetings, how to generate questions, and peer examples of questions that trigger help.	Preparation for meetings could significantly improve the quality and quantity of questions for the coach. Furthermore, seeing examples of peers asking for questions could help teams feel more comfortable about help seeking.	Teams struggled explaining the help they wanted. This led to coaches spending a significant amount of time asking questions about their project. Furthermore, some coaches reported teams as unwilling to initiate help seeking. **See *(B) Recognize need for help (learners), (C) Decision to seek help (learners)*.** Coaches wanted more specific questions from teams. **See *(D) Identify type of help sought & E) Identifying helpers (learners)***

Table 3: Suggested directions for future creativity support tools for connecting professionals and students

Most importantly, through this study we found that:

- *Explicit help-seeking outside of face-to-face meetings was ineffective*. Learners face significant barriers to effective help-seeking, especially outside of a face-to-face meeting with coaches. Specifically, learners' greatest challenges were diagnosing the need for help, overcoming the perceived shame of asking for help, formulating help requests, and recognizing that help-givers have relevant expertise. This explains the seemingly paradoxical situation of students reporting that they value coach interactions highly, but do not seek any coach interactions outside of face-to-face meetings. Without coach guidance they did not communicate in ways that triggered coach help-giving. Furthermore, existing online tools did not sufficiently overcome these barriers, even tools designed specifically for project-based learning.
- *Online systems can promote help-giving by surfacing problems and notifying* coaches. When learners used the online peer-critique systems (which automatically notified coaches), coaches were able to diagnose problems from the critique questions written by teams, discussion which triggered help-giving. This shows that prompts for online disclosure can promote help-giving by coaches. It demonstrates how social-technical systems can expand the possible help-seeking routes. These routines need to support student disclose that triggers coach help giving. Such disclosure could include highlighting important team decisions, as well as current team struggles.

The model suggests a number of features that future designs and research might pursue. We present descriptions for these features, rationales, and evidence related to our findings in *Table 3*.

Limitations

The participants in this study were undergraduates, so the issues that arise may differ across age groups. Some of the data in this study was taken from self-reporting from ongoing use. Advantages of this approach include collecting both reflective and in situ data; disadvantages include biases from self-report [29]. As an observational study, the causal relationships remain speculative. However, as a theory building exercise, this study provided us with a richer model of the help-giving and help-seeking between learners and coaches that offers detailed and plausible explanations for how and when different systems can support critique.

CONCLUSION

We examined how creativity support tools might allow us to incorporate professional coaches – a currently untapped resource – to provide help. This study contributes to our understanding of creativity support tools in three ways. First, we tested a novel online creativity support platform for student-professional coach interactions. Second, we extended existing help-seeking models by developing a new model that: (1) identifies the challenges learners face in explicit help-seeking that actually arise in creativity support tools, (2) shows how online critique can surfacing problems. Third based on this model, we suggested principles for creativity support tools that scaffold help-seeking that future work might pursue.

Using an existing creativity support tool, this model shows how a range social and software factors influence the help-giving and -seeking process and interventions that can be applied to creativity support environments to support the coach-learner relationship.

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