Designing Technology to Support Coaching in Informal Learning Environments

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ABSTRACT

While more informal learning environments offer many novice creative practitioners access to design education with more freedom and flexibility to decide what to work on and work at their own pace, providing novices regular, dedicated coaching that will be critical to their success may be more challenging in these environments. In my research, I am interested in studying how do coaches support novice creative practitioners in more informal learning environments to solve real-world, complex problems, what obstacles do coaches experience, and how might we design technology to support coaches in these environments. At this workshop, we hope to share our insights on coaches' strategies in supporting novices and obstacles they experience, and brainstorm innovative ideas with other researchers in the field on how we might design and build technology that can support coaching and learning in environments that are more self-directed, informal, and involves peer-to-peer learning.

CCS CONCEPTS

• **Human-centered computing** → **Computer supported cooperative work**.

KEYWORDS

Design Education, Informal Learning Environments, Coaching, Peer Coaching

INTRODUCTION

Novice creative practitioners struggle to solve real-world, complex problems that are poorly defined, have many possible solution paths, are highly domain-specific, and do not have one best answer [8, 12]. Real-world, complex problems are challenging for novices because they require novices to define the problem and understand needs of multiple stakeholders. Further, they must apply metacognitive skills like making effective plans to solve problems, monitoring progress, and evaluating whether they have achieved their goals [8, 13, 15, 16, 18].

One of the most effective ways to support novices to solve real-world, complex problems is for a dedicated coach to provide tailored support and guidance [3, 5, 11]. While definitions of coaching vary, we draw from the design and engineering education research communities to define coaching as a form of adaptive education that supports novices in learning cognitive and metacognitive strategies and processes that resemble those of experts to solve real-world, complex problems [3]. Commonly used in problem-based learning [6, 7], project-based learning (PBL)[4], and design education [13], coaching involves a range of activities including diagnosing novices' challenges, supporting novices in defining and achieving goals, modeling how to do certain tasks, and prompting novices to reflect [3, 4]. Even though formal environments like PBL and design education are often highly resourced, coaching is very time-consuming and labor-intensive. Coaches need to spend an extensive amount of time each week meeting with novices to monitor their progress, diagnose challenges they may be experiencing, and deliver assistance on a wide range of problem-solving content knowledge and skills like reflection, planning, and communication [13, 14].

But coaching might be even more challenging in more informal learning environments like extracurricular programs, makerspaces, and the workplace. These environments offer a much larger number of novices access to design education with the freedom and flexibility to work on any problems they like at their own pace, and have less expectation around their completion and investment [17]. For example, an entrepreneurship incubator can support hundreds of novice entrepreneurs but have only 3-5 dedicated coaches. While coaches may help novices scope their projects to some extent, novices choose problems that are of the most interest to them and work on their projects at their own pace. We might imagine coaching to be even more challenging because novices' projects may take much longer to complete, there is a much larger number of novices to support and monitor, and there is a wider range of domain expertise required to assist them.

Previously, researchers have designed and built a wide range of technologies to support coaches in monitoring, diagnosing, and assisting novices in formal learning environments [e.g., 10, 13, 19]. For example, novices fill in design canvases to externalize thinking on their project and help coaches diagnose potential design risks [13]. Novices use a "sprint log" to record the amount of time they spend on each of their tasks, helping coaches to monitor their progress [19]. To offload the work

required by coaches to assist, Kulkarni and colleagues built a platform to facilitate novices in giving each other feedback [10].

Yet we don't know what additional support coaches may require and how might technology support them in learning environments that are more informal. For example, while an extensive design canvas is effective at helping coaches diagnose novices' challenges, it may be too labor-intensive when coaches have hundreds of novices to support and all novices are working on different projects at different paces. Peer coaching systems also may not know which peers to pair up with in order for peer coaching to be effective when novices are working on different projects and in different stages of their problem-solving.

At the workshop, we will present two of our projects that help us understand coaching in informal learning environments and envision future technology that can support learning that is more self-directed, informal, and involves peer-to-peer coaching.

Research Setting

We choose to study coaching in a university incubator because of the growing number of incubators, the ill-defined nature of the problems novices at incubators tackle, and the often limited number of coaching resources available. University incubators are also an important context for novices to learn to innovate and solve real-world, complex problems [2]. Innovation incubators are also different from formal classrooms. Unlike in classrooms where instructors scope out projects for novices to work on, novices at innovation incubators choose and scope projects themselves. As a result, everyone is working on a different problem. Furthermore, unlike in classrooms where novices are expected to turn in their projects at the end of a semester, there are no organizational expectations on novices' investment and completion at informal settings like incubators [17]. As a result, novices can work on their projects for months or even years, and everyone is in different stages of their projects. Incubators

STUDY 1

In order to understand how do coaches support novices in informal learning environment. we built a coaching model that details coaching strategies coaches use, goals they aim to achieve, and novices' challenges that these strategies are employed to support. We first conducted an interaction analysis [1, 9] of video recordings of 24 1-to-many coaching sessions between three coaches and 30 novices to identify coaching strategies. Then, we conducted interviews and retrospective analysis with 3 coaches to understand novices' challenges which these strategies are employed to support and coaching goals. Based on this analysis, we built a model of 1-to-many coaching that details how coaches monitor, diagnose, and assist many novices simultaneously.

We found that, in more formal learning environments, coaches not only need to support novices' metacognitive skills like planning and reflection, but also need to support peer learning, provide

accountability, and mitigate novices' fear of failures. Because novices are working on different projects at different paces, they are often not aware of their peers' expertise and do not know the relevance between themselves and peers. As a result, they don't know which peers to seek help from and do not know how to effectively help their peers. Coaches use strategies like modeling for help-seeking, summarizing learning into applicable knowledge, and directing novices to relevant peers for help to support peer-learning. Furthermore, coaches utilize the presence of peers to hold novices accountable by publicly recording, announcing, and checking in on novices' goals and progress in front of their peers.

STUDY 2 (ONGOING)

After gaining an understanding of coaches' goals and strategies in informal learning environments (Study 1), we want to identify obstacles coaches experience in supporting novices and identify opportunities for future technology to support coaches in these environments. Based on our insights from study 1, we hypothesized what might be challenging about coaching and designed three prototypes to address these challenges: (1) an interface to automatically help novices check-in progress, reflect, and plan through templates and checklists; so that novices can to coaching sessions prepared and coaches can have more time to diagnose and assist during coaching sessions; (2) a dashboard that puts novices' progress and plans side by side to assist coaches in planning ahead and being deliberate about how to spend coaching time; (3) a system that records novices' progress and plans over time and pair up peers who can support each other automatically.

We iteratively tested and improved these prototypes with coaches. In each testing session, we asked coaches to think-a-loud on how they would use them, what did they like and dislike, and how might they improve them. We also tested the self check-in templates with students to see whether they were able to complete them and whether they perceived the templates as valuable. As we iterated, we discovered some important opportunities and tensions that future technologist should consider: (1) Templates and checklists are extremely valuable at helping novices communicate with coaches, be prepared for coaching sessions, and develop self-directed learning skills, however, novices may ignore the templates if there is nothing holding them accountable or act in a performative way which ends up wasting coaches' time in coaching sessions; (2) Detailed and nuanced information about novices' previous progress and plans are effective at helping coaches diagnose novices' challenges, but too much information from many novices may be overwhelming to coaches. Such information needs to surface reasons behind novices' actions and translate to actions coaches take in coaching sessions; (3) While pairing up novices to support each other could be valuable and effective, it is important that the system is capable of understanding the nuances behind novices' methods and experiences to make predictions on which peers to pair up, and facilitate novices in doing activities that encourage them to help each other to come up with ideas rather than rate on their efforts or outcomes.

REFERENCES

[1] Marcela Borge, Craig H. Ganoe, Shin-I Shih, and John M. Carroll. 2012. Patterns of team processes and breakdowns in information analysis tasks. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work (CSCW '12)*. Association for Computing Machinery, New York, NY, USA, 1105–1114. https://doi.org/10.1145/2145204.2145369

[2] Rodney Brooks, William Scott Green, R. Glenn Hubbard, Dipak C. Jain, Linda Katehi, George McLendon, James Plummer, Myron Roomkin, and Richard Newton. 2007. *Entrepreneurship in American Higher Education.* SSRN Scholarly Paper ID 1291290. Social Science Research Network, Rochester, NY. https://doi.org/10.2139/ssrn.1291290

[3] Allan Collins, John Seely Brown, and Susan E. Newman. 1989. Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In *Knowing, learning, and instruction: Essays in honor of Robert Glaser.* Lawrence Erlbaum Associates, Inc, Hillsdale, NJ, US, 453–494.

[4] Debra M. Gilbuena, Benjamin U. Sherrett, Edith S. Gummer, Audrey B. Champagne, and Milo D. Koretsky. 2015. Feedback on Professional Skills as Enculturation into Communities of Practice. *Journal of Engineering Education* 104, 1 (2015), 7–34. https://doi.org/10.1002/jee.20061 _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/jee.20061.

[5] Cindy E. Hmelo-Silver. 2004. Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review* 16, 3 (Sept. 2004), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

[6] Cindy E. Hmelo-Silver and Howard S. Barrows. 2006. Goals and Strategies of a Problem-based Learning Facilitator. *Interdisciplinary Journal of Problem-Based Learning* 1, 1 (May 2006). https://doi.org/10.7771/1541-5015.1004

[7] Cindy E. Hmelo-Silver and Howard S. Barrows. 2008. Facilitating Collaborative Knowledge Building. *Cognition and Instruction* 26, 1 (Jan. 2008), 48–94. https://doi.org/10.1080/07370000701798495 Publisher: Routledge _eprint: https://doi.org/10.1080/07370000701798495.

[8] David H. Jonassen and Woei Hung. 2008. All Problems are Not Equal: Implications for Problem-Based Learning. *Interdisciplinary Journal of Problem-Based Learning* 2, 2 (Oct. 2008). https://doi.org/10.7771/1541-5015.1080

[9] Brigitte Jordan and Austin Henderson. 1995. Interaction Analysis: Foundations and Practice. *Journal of the Learning Sciences* 4, 1 (Jan. 1995), 39–103. https://doi.org/10.1207/s15327809jls0401_2 Publisher: Routledge _eprint: https://doi.org/10.1207/s15327809jls0401_2.

[10] Chinmay Kulkarni, Michael S. Bernstein, and Scott Klemmer. 2015. PeerStudio: Rapid peer feedback emphasizes revision and improves performance. In *L@S 2015 - 2nd ACM Conference on Learning at Scale.* Association for Computing Machinery, Inc, New York, NY, USA, 75–84. https://doi.org/10.1145/2724660.2724670

[11] Jingyan Lu, Susan Bridges, and Cindy E. Hmelo-Silver. 2014. Problem-based learning. In *The Cambridge Handbook of the Learning Sciences, Second Edition.* https://doi.org/10.1017/CBO9781139519526.019

[12] Collin F Lynch, Kevin D Ashley, Vincent Aleven, and Niels Pinkwart. 2006. Defining "Ill-Defined Domains"; A literature survey. (2006), 10.

[13] Daniel Rees Lewis, Jamie Gorson, Leesha Maliakal, Spencer Carlson, Elizabeth Gerber, Matthew Easterday, and Christopher Riesbeck. 2018. Planning to Iterate: Supporting Iterative Practices for Real-world Ill-structured Problem-solving. Presented at the 13th International Conference of the Learning Sciences, London, 2018.

[14] Daniel Rees Lewis, Emily Harburg, Elizabeth Gerber, and Matthew Easterday. 2015. Building Support Tools to Connect Novice Designers with Professional Coaches. In *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition.* ACM, Glasgow United Kingdom, 43–52. https://doi.org/10.1145/2757226.2757248

[15] Horst W. J. Rittel and Melvin M. Webber. 1973. Dilemmas in a General Theory of Planning. *Policy Sciences* 4, 2 (1973), 155–169. https://www.jstor.org/stable/4531523 Publisher: Springer.

[16] Donald A. Schon. 1987. Teaching artistry through reflection in action.

[17] Richard A. Schwier. 2010. Focusing Educational Technology Research on Informal Learning Environments. *Contemporary Educational Technology* 1, 1 (March 2010). https://doi.org/10.30935/cedtech/5965

[18] Herbert A. Simon. 1977. The Structure of Ill-Structured Problems. In *Models of Discovery: And Other Topics in the Methods of Science*, Herbert A. Simon (Ed.). Springer Netherlands, Dordrecht, 304–325. https://doi.org/10.1007/978-94-010-9521-1_17

[19] Haoqi Zhang, Matthew W. Easterday, Elizabeth M. Gerber, Daniel Rees Lewis, and Leesha Maliakal. 2017. Agile Research Studios: Orchestrating Communities of Practice to Advance Research Training. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. Association for Computing Machinery, New York, NY, USA, 220–232. https://doi.org/10.1145/2998181.2998199