[WIP] Instructor Perspectives on the use of Educational Software in Core Undergraduate Science and Engineering Courses

Sarah Kaczynski, Tufts University

Sarah is a PhD student studying STEM Education at Tufts University. Her research focuses on the design, development, use, and assessment of educational technologies in undergraduate science and engineering courses. She works with Professor Milo Koretsky to support, maintain, and develop tools for teaching and learning, including the Concept Warehouse and a collection of virtual labs.

Sandra Walter Huffman, Tufts University

Sandy is a postdoctoral scholar at Tufts University working on Engineering Education research. She is interested in student modeling practices, knowledge practices, and sense-making activities in undergraduate engineering courses. She looks at the ways traditional classroom contexts influence student problem-solving methodologies, and ways task design and facilitation strategies can help students practice authentic engineering. She received her undergraduate and masters degrees in the Department of Mechanical Engineering at MIT, focusing in product design for emerging markets and engineering education research, accordingly. Her interdisciplinary PhD, also based in the Department of Mechanical Engineering at MIT, centered the sociocultural ways students engage with technical engineering material and suggested directions for a more integrated, authentic approach to helping students develop technical modeling practices that utilize course material in unfamiliar contexts.

[WIP] Instructor Perspectives on the use of Educational Software in Core Undergraduate Science and Engineering Courses

Introduction & Background

Software, including that which is specifically designed for teaching and learning (educational software), has become increasingly prevalent in education at all levels. Previous work has studied various educational software and their effects on learning, though little has been done to study instructors' perspectives on their use of educational software. This is especially true for those teaching beyond the K-12 level. K-12 research has shown that teachers' use of educational software is influenced by their instructional goals and beliefs about what makes technology use in the classroom effective [1], as well as constraints such as time and resources [2]. Similar work in higher education suggests that instructor beliefs about the role of technology are related to their philosophies of innovation in teaching [3]. Given the rapid integration of AI into classroom learning, this work is increasingly urgent and responds to a call for a greater focus on instructor perspectives on such technologies, including how they affect assessment [4].

Activity Theory [5], which provides a framework for investigating the relationships between people and things, including mediating tools [6], has been used in the field of human-computer interaction (HCI) [7]. More specifically, it has been used in both K-12 and higher education contexts as a lens through which to analyze perspectives on the use of technology within the *system* of education and understand the various components that affect perception and use of various tools [8], [9]. This body of work suggests a complex combination of goals, communities, and available tools affect how educators integrate technology, including educational software, into their practices. Figure 1 shows an example of an activity system including educational software. The examples for each component are non-exhaustive.

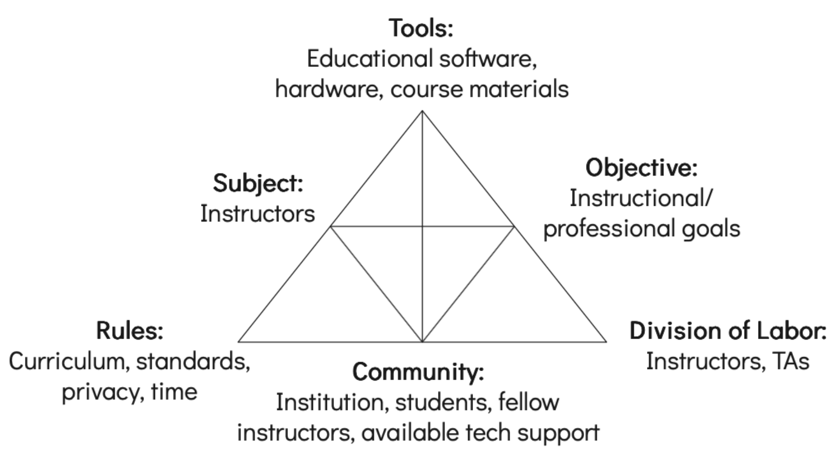

Fig. 1: An example of an activity system within education

This work-in-progress paper shares preliminary findings from an interview study of instructors from a range of backgrounds, institutions, and departments. It outlines gaps between how instructors describe their existing and desired educational software by focusing on questions designed to elicit creative and open-ended ideas for ideal tools that might not currently exist. These gaps and imagined software are contextualized by the activity systems that the instructors are situated in, similar to the figure above. Instructors' responses align with previous work in their uncovering of instructors' multifaceted reasoning in choosing educational software. Notably, they also provide insight into how instructors think about and with AI, both in terms of incorporation into their classrooms and as a tool for imagining novel educational software solutions.

To more explicitly reveal the types of educational software that undergraduate science and engineering instructors want, which can in turn better inform educational software developers and researchers of possible avenues of work, this paper focuses on responses to the question: *If you could magically create a piece (or suite) of learning software, what would that consist of in terms of design, functionality, etc.? How would this software support you in your goals for teaching and learning?* These responses were analyzed with the goal of answering the following research questions:

1. What gaps exist between available and desired educational software?
2. How do instructors imagine their ideal educational software and what features does it contain?

Methods

Participants in this study were recruited through professional connections and email lists for professional societies. They were first asked to fill out a Qualtrics survey to screen for eligibility. In order to be eligible, potential participants must:

- Currently be teaching (or taught within the past year) at least one core undergraduate science or engineering course
- Use at least one piece of educational software in their current/previous class(es)
    - *Examples of Educational Software:* Learning Management Systems (LMSs) (i.e. Canvas, Blackboard, Moodle, etc.), virtual lab simulations, interactive textbooks, etc.

Eligible instructors were contacted via email with a link to schedule an interview. This work-in-progress study includes five participants from five different universities who had taught/were currently teaching courses in chemical engineering, computer science, and physics.

Author 1 conducted semi-structured interviews over Zoom. Once consent was obtained, video and audio recording started. Participants were asked about their background, including information about their teaching and other responsibilities, their course(s), and their career goals. They were then asked about the technology they use in their instructional practices, especially educational software. Finally, participants were invited to imagine their ideal piece or suite of educational software and share what that would look like and how it would help them achieve their goals. Each interview concluded by inviting participants to share more thoughts on earlier points of discussion and/or bring up new ideas that weren't previously discussed. To protect the identities of the individuals who participated in this study, their names, workplaces, and other identifying information have been anonymized.

Transcripts were automatically generated by Zoom then converted into .csv files by a Python-based utility [10], and each .csv file was added to an Excel workbook. Author 1, who has a background in computer science, education IT, STEM education research, and classroom teaching, began the familiarization process by watching/listening to the video/audio recordings and correcting the transcripts as necessary to ensure accuracy. She then reviewed each transcript multiple times while taking notes on initial ideas, potential codes, quotes that stood out, etc. For the subset of instructors included in this work-in-progress, codes were applied to each instructor utterance. This resulted in 32 codes for responses to the question: *If you could magically create a piece (or suite) of learning software, what would that consist of in terms of design, functionality, etc.? How would this software support you in your goals for teaching and learning?* These codes were then grouped into 9 themes, which were refined across transcripts.Two of the themes are explored below.

Findings

Across the 5 interviews analyzed in this work-in-progress paper, we found a dichotomy in instructor responses. Some instructors seemed satisfied with (or perhaps constrained to) existing educational software, though others leaned heavily on generative AI as both a feature of imagined educational software and as a tool to more creatively imagine new educational software to bring to life.

Some Instructors Mostly Satisfied with Existing Educational Software

Two out of the five instructors reported a general satisfaction with existing tools. Mateo, who teaches Physics, stated that his ideal collection of educational software,

> "...already exists, it's the Google Features. It has everything in it. You can embed everything within everything. It is easy to use, there's a lot of answers online about how to use it. And it gives you all the information you want, or it gives you ways to access the information you want in a way that, based on how I talked about what my goals are in my course, I think supports my teaching and my students' learning, all throughout."

Mateo's response reveals the value he places on integration between features, as well as the community support available for them. Despite his general satisfaction, he later stated that the one feature he would like that wasn't available within the Google suite was software for polling students during class. However, because "Poll Everywhere exists…" he doesn't "feel like [he] need[s] to magically create something new." Here, Mateo demonstrates comfort with "making do” within the constraints of his existing activity system because he can support his teaching and learning goals.

Similarly, Danielle, a Chemical Engineering instructor, said that “I honestly have a good system, and I'm pretty happy with it. I do… I mean, there's things I wish were tweaked, like, really little tweaks.” She then suggested that she wished that Gradescope had “...a more complicated rubric tool that did more great, like, grid-style rubrics, so you could do, like, reports and stuff.” Here, despite her confidence in reaching her instructional goals within the constraints of her current activity system, Danielle shares a desire for more advanced features that could allow her to expand the boundaries of her teaching practice.

In both of these examples, instructors suggest that they are satisfied with existing general-purpose and educational software. However, given the opportunity to imagine a potentially better tool, their response was to combine or add features to existing solutions. This highlights the value that some instructors place on integration between features and consolidation to a minimal number of platforms. Further, it shows that some instructors experience a general alignment between their instructional goals and the tools that they have available to reach them.

Imagining Ideal Solutions with Generative AI

Other instructors offered more imaginative software solutions, all of which included some discussion of generative AI either as a central feature or existing tool to be improved upon. Cody, a Computer Science instructor who brought up generative AI extensively throughout his interview, said that he would ideally want a “better, more social gen-AI.” He hypothesized a groupchat-based AI platform, in which students could engage with each other and an LLM. However, Cody expressed concern that such a tool would have to prove itself more helpful than existing commercially available products for students to choose to engage with it, saying “And I think if the tool is better than existing tools, then students will use it. I think if it's not better than existing tools, then students won't use it, and they'll just use their own whatever… external service that they sign up for.” He also highlighted the role of cultural values and norms in choosing and interacting with generative AI tools, citing “a kind of culturally [...] individualistic or efficiency-oriented, time-oriented mindset.” He said that he feels

> “like that gets in the way of things like, oh, actually it'd be kind of fun to have a group chat where AI is part of that group chat… but I can also see how other people are thinking about things, and how they're feeling about things… but that would be such a different, like, mindset versus, like, the efficiency or the individualism cultural value that I think is embedded into the [...] way Gen AI tools are designed right now, yeah. So I think that'd be the biggest one, because then if they had that, and that product was better, just in terms of getting you better answers, in terms of giving you a better experience, I think students would use it.”

Here, Cody demonstrates that his perception of educational software's usefulness is informed by how students engage with it, not just what it is like for him to navigate as an instructor. He also reveals how he values social connection within education. In Cody's case, the community (students) and rules (cultural norms, time constraints) provide constraints for what kind of educational software Cody feels like he could implement within his current activity system. However, his novel idea of a social AI-based platform for education pushes the boundaries of some of those constraints, providing a potential to create a different activity system that better aligns with his goals for his students' learning.

Justin, who teaches Chemical Engineering, expressed a desire to shift towards a different way of assessing students' learning: through one-on-one interviews that would allow him to gain a better picture of students' understanding. He considered a possible AI-based solution that could help him conduct those assessments at a large scale without the barrier of time constraints. He suggested that he could have his students "sit in front of a Zoom screen and, you know, basically, you know, have, like, a chatbot or an AI bot kind of prompt and have these interviews as, you know, ' me.'" Besides lacking the "human connection" that he would want in that kind of assessment, he also expressed a wariness of using AI in assessment, for fear of what he called "a feedback loop of stupidity," in which students submit AI generated content that is then assessed by AI. Justin later suggested that, while he didn't see a generative-AI-based tool as being exactly what he wanted, it could serve as a good approximation for the type of assessment activities he had in mind. Justin demonstrates a desire for substantial systemic change, at least surrounding assessment in an engineering classroom and, while a generative AI-based educational software does not completely align with his goals for human connection, it helps him envision a change in assessment practices while navigating existing time/logistic constraints that come with teaching large classes. Here, we see Justin considering generative AI as both a potential tool, and as a means for imagining educational software that aligns with his goals for teaching and learning.

Rachel, another Chemical Engineering instructor, expressed a desire for a tool that could generate homework and exam problems. She shared a dissatisfaction with textbook problems, saying that "they have errors, or problems, or they're confusing." She then talked about how she has pivoted to writing her own questions but that it is a time-consuming process. She shared how she had previously sought out AI-based options for problem generation, but that "It was not great" and that she hasn't "had great success with getting something that's accurate." Rachel did talk about how she sometimes uses AI to get *inspiration* for questions, but that it still does not suffice as a problem generation resource, "at least for the stuff [she's] teaching." Unlike the previous two instructors, Rachel did not imagine generative AI as being central to her idea of ideal educational software. She *had* previously considered it as a resource – just not one that was able to provide the content she needed with the expediency that she desired.

These instructors' responses suggest that they experience tension between various elements of their existing activity systems and their instructional goals. Technological innovation through their ideas of "ideal" educational software might help them reduce that tension by changing that component of systems. This group of instructors shares a common thread of considering AI in their potential solutions; it provides ways for them to think beyond constraints such as time, student comfort, and instructor availability while also being a potential *feature* of their imagined software. Though these instructors demonstrate higher levels of tension in their activity systems, they consider more novel educational software solutions.

Discussion

In this paper, we focus on instructor responses to the final question in the interview protocol, an invitation to imagine and share their ideas of "ideal" educational software according to their goals for teaching and learning. Collectively, their responses suggest that there are many factors that affect the kinds of educational software that instructors use and would like to use. Student learning, expediency of course content generation, desire to share community-focused learning tools, and aspiration to shift from traditional assessment methods stand out as examples of influences on instructors' perspectives on educational software.

Notably, generative AI came up in responses from the three instructors who did not explicitly state that they were satisfied with current educational software offerings. These instructors shared ideas on the potential for AI to help them achieve their instructional goals but also expressed concern about its effects on learning and uncertainty about its ability to accurately complete tasks.

RQ1: How do instructors imagine their ideal educational software and what features does it contain?

When invited to share their ideas of what their ideal educational software would look like, barring such constraints as time/cost to develop, some instructors tended to lean on existing software and physical tools as inspiration. However, others embraced generative AI as a means for creating, or at least "approximating" desired educational software; while the question itself opened up their thinking about novel software, knowledge of generative AI seemed to serve as a way of expanding their consideration for what could be possible.

The instructors who did not leverage generative AI in imagining ideal software suggested features of novel educational software by combining or enhancing features of existing tools. Those who did include generative AI in their imagined software, on the other hand, suggested more innovative features. Instructors suggested features such as AI-enabled group chats for students where they can interact with both the AI and each other, as well as AI-based interviews as a new way of assessment. The instructors' desire for these features, alongside their instructional goals and openness towards new technologies, align with Kopcha, et al.'s work [3], which used Activity Theory to group instructors into "profiles" based on their attitudes towards/adoption of technology in the classroom.

RQ2: What gaps exist between available and desired educational software?

Instructors' ideas for their ideal educational software illustrate the gaps that they perceive between available and desired educational software. These "gaps" are not *necessarily* pieces of software that don't exist, but rather features that might exist across multiple products or that instructors feel would improve existing software, as well as software that, at least to the knowledge of these instructors, does not exist.

Preliminary analysis of a subset of instructors included in this study reveals that some of these gaps are: virtual polling that integrates into existing software/ecosystems, more advanced/customizable rubric/grading tools, improved question generation software, social generative AI-enabled chatbots, and tools for conducting interview-based assessments. These gaps reflect constraints in instructors' existing activity systems, such as time and labor resources, as well as the goals and values they have in their teaching practices. This phenomenon aligns with findings from investigations of instructor perspectives of educational software in the K-12 space [1][2].

Implications for Instructors

The findings from this subset of data, which will be further explored in a longer paper, suggest that instructors experience varying levels of tension between their existing and ideal activity systems, which affects their satisfaction with the existing educational software available to them, as well as their creativity in imagining novel educational software. For instructors in search of innovative educational software, generative AI can serve both as a potential component of such software and a tool for expanding ideas of what software is possible to create.

Implications for Developers and Researchers

The "gaps" between existing and ideal, imagined educational software expressed by instructors present potential projects for educational software developers and STEM Education researchers. The context of an instructor's activity system and the extent to which its elements align with the instructor's educational goals can be an avenue through which to explore the strengths and limitations of existing educational software. Further research outlining the tensions within existing activity systems and how they may be limiting pedagogical change, especially in assessment, can inform both researchers and developers. Characterizing the needs expressed by instructors can help developers better understand potential users, and inform the creation and testing of products that help support users in various activity systems.

Conclusions

This work-in-progress shares excerpts from interviews with five physics, computer science, and chemical engineering instructors. In their responses to a prompt to imagine their ideal educational software, two notable ways of thinking emerge: imagining improved versions and/or combinations of existing tools and leveraging generative AI to imagine new, innovative tools that align with instructional goals and push the boundaries of the constraints of their current activity systems. Further work is required to see if these patterns hold for a larger, more diverse group of instructors.

Future work for this study will include continued recruitment and data collection, with the goal of including transcripts from approximately 20 interviews with a more diverse group of science and engineering instructors. Qualitative coding methods will be used to analyze the entire corpus of data, consisting of more interviews and questions that give more insight into more components of instructors' activity systems. Through the lens of Activity Theory, that data will be used to provide more detailed context for the educational software that instructors use, why they use each specific tool, and suggested avenues for educational software development work.

Acknowledgements

We would like to thank the instructors who volunteered their time and shared their thoughts and experiences through these interviews. We would also like to thank the STEM Education community at Tufts, especially the Koretsky Group, for their helpful feedback and support for this work.

References

[1] D. S. Niederhauser and T. Stoddart, "Teachers' instructional perspectives and use of educational software," *Teaching and Teacher Education*, vol. 17, no. 1, pp. 15–31, Jan. 2001, doi: 10.1016/S0742-051X(00)00036-6.

[2] I. Karasavvidis, "Activity Theory as a conceptual framework for understanding teacher approaches to Information and Communication Technologies," *Computers & Education*, vol. 53, no. 2, pp. 436–444, Sep. 2009, doi: 10.1016/j.compedu.2009.03.003.

[3] T. J. Kopcha, L. P. Rieber, and B. B. Walker, "Understanding university faculty perceptions about innovation in teaching and technology," *Brit J Educational Tech*, vol. 47, no. 5, pp. 945–957, Sep. 2016, doi: 10.1111/bjet.12361.

[4] J. Watkins, "Pedagogical Responsibility in the Age of AI: Preservice Teachers' Reasoning About Automated Scoring Technologies," presented at the 19th International Conference of the Learning Sciences (ICLS) 2025, Jun. 2025, pp. 279–287. doi: 10.22318/icls2025.108486.

[5] Y. Engestrom, "Activity theory as a framework for analyzing and redesigning work," *Ergonomics*, vol. 43, no. 7, pp. 960–974, Jul. 2000, doi: 10.1080/001401300409143.

[6] B. A. Nardi, "Activity Theory and Human-Computer Interaction," in *Context and Consciousness*, B. A. Nardi, Ed., The MIT Press, 1995, pp. 4–7. doi: 10.7551/mitpress/2137.003.0005.

[7] V. Kaptelinin and B. A. Nardi, "Activity theory: basic concepts and applications," in *CHI '97 extended abstracts on Human factors in computing systems looking to the future - CHI '97*, Atlanta, Georgia: ACM Press, 1997, p. 158. doi: 10.1145/1120212.1120321.

[8] K. Isssroff and E. Scanlon, "Using technology in Higher Education: an Activity Theory perspective," *Computer Assisted Learning*, vol. 18, no. 1, pp. 77–83, Mar. 2002, doi: 10.1046/j.0266-4909.2001.00213.x.

[9] E. Murphy and M. A. Rodriguez-Manzanares, "Using activity theory and its principle of contradictions to guide research in educational technology," *AJET*, vol. 24, no. 4, Aug. 2008, doi: 10.14742/ajet.1203.

[10] kaczynskistufts, *kaczynskistufts/vtt-to-csv: VTT-to-CSV Converter*. (Jan. 22, 2026). Zenodo. doi: 10.5281/ZENODO.18332578.