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Supporting Computational Fluency: Clowder, a New Scratch Project Analyzer

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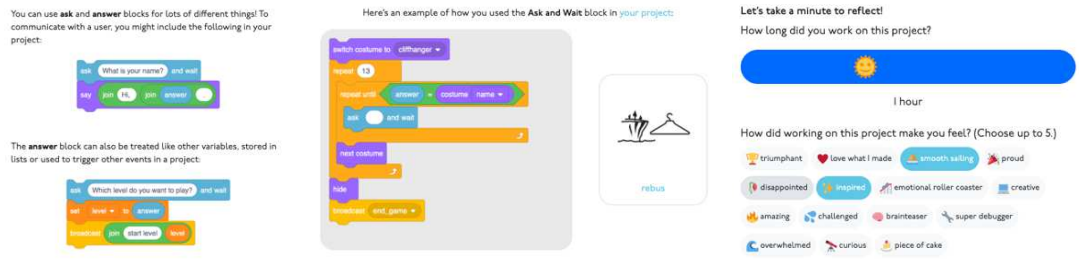
Abstract: Reflecting on programming projects can help learners deepen understandings of how they have marshaled computational concepts in service of their own ideas. We introduce Clowder: a tool to help learners examine their Scratch projects.

Introduction

Feedback from analysis tools can offer opportunities for learners to reflect on their programming projects and further develop computational fluency (Moreno-León et al., 2017). These tools often focus on the presence/absence of code constructs as evidence of learner understanding of concepts and practices, de-emphasizing other aspects of project process. We designed a new tool, Clowder, for Getting Unstuck, an online professional learning experience for K–12 teachers about Scratch, a block-based programming language. In July 2020, participants were emailed 10 daily prompts encouraging exploration of a concept (e.g., "Create a project that uses broadcasting blocks"). 298 participants made at least one project, for a total of 2,219 projects. Once projects were shared to online community studios, participants could use Clowder. Given a username, Clowder returns pages about participants' individual projects, highlighting project excerpts and offering interactive reflection elements (see Figure 1). 198 (66%) participants' pages were visited at least once, and across all ten days, pages averaged 168 visits. Of the 131 participants that completed the exit survey, 87 (66%) found Clowder helpful, 8 (6%) found it not helpful, and 35 (27%) did not use it.

Figure 1

The prompt overview (a), schema-satisfying code excerpt (b), and interactive reporting (c)



(a) (b) (c)

Highlighting the "why": Prompt overview and project excerpt

Explicit identification of computational concepts can be valuable for learners' ability to transfer knowledge to other contexts (Franklin et al., 2016). Each project page begins with an overview that includes the prompt, a description of the computational concept, and examples of the concept in practice. The learner is then presented with an excerpt from their project and its associated sprite or backdrop. The displayed excerpt satisfies an underlying schema—a detailed specification for what elements Clowder should search for in the learner's project. Only 115 projects (5.2%) did not meet schema requirements. The code excerpt invites the learner to closely examine their use of a particular block, and we hoped to offer an opportunity to read and reflect on programming concepts in the context of their intentions. Some participants encountered an error message ("We couldn't find an example in your code!") instead, because their project did not validate against the schema. Sometimes, this error message appeared because the schema did not anticipate all appropriate responses, or because of a bug in Clowder. One participant who saw the error message reported subsequently feeling "a little shy of using the tool." Other participants did not understand why their project did not satisfy the schema. What should a learner see if their project is not aligned with the schema? One option was to omit mention of an error, mitigating the risk of discouragement, but error messages can be useful signals. We designed the message to indicate that although Clowder was unable to show a code excerpt, this could have been an issue with the tool *or* with the project.

Making process visible: Interactive time and emotion reflection

Developing computational fluency can require attending to less-visible aspects of process, such as time and emotions (Plucker et al., 2004). On the project page, learners can record how much time they worked on their project, using a slider (zero minutes to more than three hours). 131 participants filled out the time tracker at least once, and 33 participants filled out the time tracker more than five times. The minimum reported time was five minutes; the maximum was more than 3 hours. Across 396 projects, participants reported averages of 96 minutes. Learners could also choose up to five emotions from a set of 15. 115 participants filled out the emotion tracker at least once, 37 participants reported emotions at least five times, and all emotion options were used at least once. The most frequent emotions reported were "love what I made," "creative," "inspired," "challenged," and "proud." There is a delicate balance to strike, though, between signaling what can be possible and what should occur. Time spent does not always correlate with output, and we wanted to avoid setting expectations of spending as much time as possible. In this opt-in learning experience, participants wrote about balancing Scratch projects with work and family obligations during the COVID-19 pandemic. There are also many ways to describe emotions, from open-ended text boxes to comprehensive drop-down lists. By displaying positive *and* negative emotions, we hoped to indicate that projects may involve both emotional highs and lows. However, one participant noted, "I found the emojicons did not express the range of my experience, and that was frustrating."

Emphasizing the social: Project excerpts and collective statistics

Multiple examples can help learners see beyond a single model (Atkinson et al., 2000), but the large online studios can be difficult to navigate. After the interactive reflections, Clowder displays schema-validating excerpts from five other projects, followed by collective statistics. For example, on Day 7, learners saw the number of projects shared that day (196 projects), words written in projects' "Notes and Credits" (14,375 words), and comments (865 comments). By highlighting collective efforts, we aspired to signal the importance of reflection while minimizing points of comparison. One participant wrote, "Seeing all the examples from other participants showed me there are no bounds to creativity. I can do it too." We considered the number of examples, because seeing too many could feel overwhelming, but too few could limit learners' imagination. We also considered whose excerpts to show and to whom, given the range of participants' prior Scratch experience. Clowder displays five random projects, and learners can click to view five new projects.

Future directions

At the close of the learning experience, one participant wrote, "I really got a lot out of [Clowder], thinking about my own project and seeing what others had done with the same prompt." Analysis tools can serve as opportunities for learners to develop ideas grounded in their interests and the facility to bring those ideas into being. Future work could examine how different error messages, different ways of highlighting process, and different examples of projects *might* constrain or support learners' ideas.

References

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