true for games that are, themselves, cognitively more complex. The current study presents an approach that adapts the abstraction of self-explanation prompts based on a player's performance.

The current study was conducted with 210 students in the 7th grade classrooms of two teachers in two different middle schools in the southeastern United States. In the navigation-only condition, players programmed their trajectories without any self-explanation prompts. In the navigation+abstract condition, these navigational challenges are paired with a self-explanation prompt that focuses on abstract connections between the navigational challenges and Newtonian relationships. In the navigation+adaptive condition, the navigational challenges are paired with self-explanation prompts that adaptively increase from low abstraction (in which the prompts focus concretely on navigational moves) to high abstraction (in which the prompts focus more abstractly on the navigational challenges in terms of overarching Newtonian relationships).

The results demonstrate that students in this condition (a) scored significantly higher on the post-test than students whose self-explanation prompts were not adaptively adjusted and were always abstract and (b) scored higher, but not significantly so, than students who did not receive the self-explanation functionality. Analyses of gameplay metrics suggest that trade-offs in terms of progress through the game may explain some aspects of these posttest comparisons. Analyses also demonstrate that both self-explanation conditions significantly outperformed the navigation-only comparison condition on a gameplay metric that suggests deeper model-based thinking and KI. These hypothesized differences parallel the distinctions between model-based reasoning and constraint-based thinking reported by Parnafes and diSessa (2004). Future research should explore extending the adaptive self-explanation functionality beyond the current platform into a broader range of digital platforms targeting KI.

Study 4. Orchestration supports for knowledge integration in a blended learning community curriculum for Grade 12 Biology

Alisa Acosta and Jim Slotta

Our work is grounded in a pedagogical model of learning communities called *Knowledge Community and Inquiry* (KCI; Slotta, 2014), wherein students work as individuals, small groups and a whole class to generate a shared community knowledge base and to use that knowledge base as a resource for subsequent inquiry activities. An important aspect of KCI is the design of curricular *scripts* (Fischer, Kollar, Stegmann, & Wecker, 2013) which specify the activity sequences, materials, student groupings, and technology elements that serve to guide the inquiry toward particular learning goals. *Orchestration* refers to the enactment of the script, binding it to the local context of learners, classrooms, curriculum, and instructor, and giving it concrete form in terms of materials, activities and interactions amongst participants (Tchounikine, 2013).

In collaboration with a high school biology teacher, we co-designed and implemented a KCI curriculum and corresponding technology environment called *CKBiology* within two sections of a Grade 12 Biology course. Students contributed to a shared community knowledge base in three ways: 1) By providing written explanations for various terms or concepts, 2) by identifying relationships between pairs of terms or concepts, and 3) by peer-reviewing explanations that had been written by other students. The concepts were presented in a concept map, with links representing the identified relationships, and concepts with completed explanations appearing in blue, uncompleted explanations in grey, and 'incomplete' or 'incorrect' explanations (as a result of peer review) containing a yellow dot. This knowledge base captured the KI processes of adding and distinguishing ideas, and was projected at the front of the classroom as students were working, serving as an orchestration support for both students and the teacher. This allowed gaps or disagreements in the knowledge base to become visually prominent, leading to impromptu class discussions, negotiations, and improvement. Through these activities, we argue that the teacher led the students to develop collective KI within the overall knowledge base.

The knowledge base then served as a resource for subsequent "review challenge" activities. In the first review challenge activity, students chose an area of specialization (i.e. immunology, endocrinology, nephrology, neurology) and worked within these specialist groups to solve a series of challenge problems. For each student, we generated a recommendation score based on the quantity (i.e. # of explanations written) and quality (i.e. # of negative peer reviews received) of their contributions to the knowledge base for each area of specialization. In the second review challenge activity, students formed jigsaw groups containing one representative from each specialization. Playing the role of medical practitioners, the groups integrated their diverse expertise in order to diagnose a virtual patient with ambiguous symptoms. Students were guided through this activity via a series of questions in the CKBiology platform, which included ordering the appropriate lab tests, negotiating and explaining the reasoning behind their diagnoses, and identifying possible treatment options—thereby integrating the knowledge they had acquired over the course of the unit. The poster will illustrate how KCI builds on KI to strengthen community learning.

Study 5. Cognitive processes and collaborative supports for knowledge integration among youth designing games for science learning

Camillia Matuk, Christopher Hovey, Talia Hurwich, and Juan Pablo Sarmiento

We explore youth's learning through their design of educational science games. Such games are unique learning opportunities because they require designers to integrate diverse areas of knowledge, including experience with games, an understanding of science, knowledge of effective pedagogical strategies, and a facility with the design process (c.f., Khaled et al., 2014). As with other complex, real-world problems, this task is best accomplished by a team of interdependent collaborators with distributed expertise, rather than through the equal roles typically assigned to students in traditional classroom settings. But what roles do learners take on in such situations? What is learned, and by whom? How is that learning supported by, and made visible in the game design process? We investigate these questions through our design and enactment of a youth workshop for designing games for science learning.

Our participants were eleven 7th grade youth from a public middle school in a large urban city in the eastern United States. Up to 4 facilitators were present on any given day, as well as two teachers from the students' school. In our 5-day long elective workshop, we tasked students with creating games to teach players about the measles virus. Their games were intended to accompany the comic book, *Carnival of Contagion* (worldofviruses.unl.edu, Diamond et al., 2012), which touches on the pathology and cultural history of the measles virus, and frames vaccination as a social responsibility. The first four days of the workshop took place at a university-based game studies center. Activities guided students in brainstorming design ideas from their reading of the comic, developing and play-testing prototypes, and refining their designs. On the final day, students exhibited their games and hosted a game jam for their peers at school.

Our workshop was informed by research suggesting that dispositions toward STEM develop best during playful, social interactions in which learners can express their ideas, goals, interests, and curiosities; engage in activities driven by shared purpose; and have opportunities to realize the personal relevance of STEM (e.g., Clegg & Kolodner, 2013). We also draw on principles for encouraging disciplinary engagement (Engle & Conant, 2002. Following these principles, we gave students interdependent roles (science wizard, play engineer, and concept artist) intended to help them express agency in their individual responsibilities, as well as to appreciate their peers' unique contributions to their shared goal (cf. Jiang, Shen & Smith, 2016). We also created end-of-day deliverable to encourage student accomplishment of key milestones in the design process. Finally, we created activities that addressed individual expert responsibilities, as well as ideas that crosscut roles and that addressed science game design (e.g., how to align learner and player mechanics), the design process (e.g., how to move from idea to prototype), and the social aspects necessary for productive collaboration (icebreakers, teambuilders).

Our data include field note observations, audio recordings of design activities, student interviews, facilitator reflections, iterations on students' game design artifacts, and responses to surveys. By drawing illustrative examples from our analyses, we describe how students learned to integrate their understanding of science and games throughout their design process. We document the challenge of facilitating this process given students' diverse starting points in their understanding of science, design, games, and pedagogy. Further we describe how different teams approached their interdependent roles, sometime successfully and sometimes not. The teams illuminate the challenges of building a culture of interdependence among learners who are used to school's traditional power structures.

This work adds to the larger program of research on KI by examining how interdependent collaborative learners make connections among their ideas and the contributions of others concerning science discipline ideas and game design. Future work might explore what aspects of KI are useful in such settings, and which might need to be elaborated or adapted.

Study 6. Extending the knowledge integration rubric to assess interdisciplinary understanding

Adi Kidron and Yael Kali

We expanded the KI rubric (Liu, Lee, Hofstetter, & Linn, 2008) to assess interdisciplinary understanding for undergraduate students studying a semester-long interdisciplinary course. The course was based on the Boundary Breaking for Interdisciplinary Learning (BBIL) model (Kidron & Kali, 2015). We used different learning technologies to design features (e.g., video-recorded lectures, collaborative documents, structured feedback