ABSTRACT
Learning progressions allow researchers to describe key milestones along a pathway of thinking about a topic or practice that ranges from beginner to advanced. For science practices, some progressions can be abstracted from specific content; others are connected to specific science understandings. This paper describes the application of learning progressions research to the design of Aquatitis, a middle school science game to support learning of science practices through simulated immersive experiences in which students engage in experimentation, modeling, and argumentation.

I. INTRODUCTION
Digital games can address a current need for teaching science practices in school, through immersive experiences and active learning with digital environments and tools. The Aquatitis research project considers how game design can be informed by learning progressions for science practices.

In Aquatitis, learners will take on the role of an ocean scientist who uses science practices of experimentation, modeling, and argumentation to investigate questions related to aquatic ecosystems. We aim to develop and scaffolded layers of science practices within the gameplay, and that way how learning progressions can be empirically derived from game data and be operationalized to inform the design of the game itself.

II. THEORETICAL FRAMEWORK
Performance of science tasks requires both understanding of core content and the ability to use science practices (NGSS Lead States, 2013). Research in learning progressions for science practices faces the challenge of differentiating student performance of practice from student learning of content knowledge (Schwartz et al., 2009; Berland 2010; Osborne et al., 2016). Some performances of practice are on par with knowledge, the practice itself, while learning can also require more sophisticated practice and use of more complex tools.

Another dimension in which students can demonstrate progression in science practices independently of science content relates to scaffolding. Initial tasks can be structured or simplified to be easier for the learner to complete. As the learner progresses in expertise, scaffolding is foiled so that the learner is more responsible for the cognitive choices involved in doing the task.

Learning progressions research resonates with how game designers think about progression in gameplay. Games can provide psychological immersive experiences in which players feel caught up in a virtual environment, through engaging situated learning, even on desktop or laptop screens (Dede et al. 2018). Games implement learning progressions through transitions from easier to more challenging levels (Koster, 2005), in order to achieve “flow” (Csikszentmihalyi, 1990), successful games seek to provide continuously challenging experiences within the narrow margin between boredom and frustration (Schell, 2015).

III. DESIGN
Aquatitis situates the learner as a researcher on an ocean-research ship, selecting and completing “jobs” that require the student to investigate aquatic ecosystems using a submarine to observe and collect data and samples at different underwater sites (Fig. 1), and shipboard tools to conduct experiments, construct models, and develop scientific arguments. Aquatitis focuses on the development of three core science practices for middle school students: experimentation, argumentation, and modeling. For each of these practices, we are designing the game with specific challenges for students to engage in learning progressions in two ways:

1. scaffolding of tasks that fades as students advance in levels of play and have more control over their engagement in science practices
2. opportunities to engage with more advanced tools at deeper levels of complexity as they progress in game challenges.

IV. PILOT TESTING AND NEXT STEPS
Through our fellow teacher program we recruited 18 teachers across the state of Wisconsin to engage their students in their own studies of ocean life using virtual simulation. These teachers are playing the game this spring, and some are also participating in a research study involving surveys of student understanding of science practices and student-think-aloud interviews during game play. Findings will support development of the full version of the game. Over the next two years, we will explore how embedded assessments within the game will be able to evaluate student learning of science practices and scientific reasoning, and be used by the game to identify learner types and provide personalized interventions that improve learning outcomes.

ACKNOWLEDGMENT
The project is funded by the National Science Foundation under grants DRL-1907384, DRL-1907394 and DRL-1907417. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.