Motivated Interactions with Digital Games in a Science Center

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Abstract: There is untapped value in adopting motivation theories to inform the design of educational technology. Achievement goal theory explains why students whose primary aim is to learn and understand (mastery goal) think and act differently from those who focus mostly on competition (performance goal). We use self-reports to identify students with different motivational patterns and video analyses to understand how learners' motivational profiles relate to their interactions with a digital science game with hands-on features.

Introduction

Decades of research point to the crucial role of motivation in students' engagement and learning, suggesting that deep and continuous learning does not depend only on amount of engagement but reason for engagement (Schunk, Pintrich & Meece, 2007). For example, learners can be motivated by their desire for content mastery, for personal progress, and for outperforming others. Using a mixed-methods approach, we look at how motivation relates to visitors' interactions with digital games in a collaborative science center setting. Specifically, our research question is as follow: How are learners' motivational profiles related to how they interact with each other and with digital media artifacts in the science center?

Though research on motivational theories and their applications to education has generated thousands of journal articles, there is relatively little empirical evidence about whether these theories also hold up in educational technology settings. We highlight the achievement goal theory (Dweck & Leggett, 1988) of motivation to offer researchers, educators, and designers useful and theoretically-grounded constructs that can be empirically studied in digital media learning contexts. Achievement goals reflect both the reasons why an individual is motivated, as well as the standard against which they judge their success—and these reasons have different cognitive, affective, and behavioral implications. Researchers have distinguished two achievement goal orientations toward learning: mastery and performance. A mastery goal focuses on developing and mastering skills and knowledge whereas a performance goal focuses on appearing competent such as by outperforming others or by avoiding appearing incompetent (Anderman & Wolters, 2006). Empirical evidence suggests that adopting mastery goals has positive effects, including increased cognitive engagement in learning, deeper cognitive strategies, and greater interest in the task (Dweck & Leggett, 1988). The literature for performance goals has been less clear, with research indicating that the important distinction is whether students adopt the approach form of focusing on appearing highly competent or the avoid form of focusing on not appearing to be the least competent in a group. Furthermore, these goals can be complementary, as a learner can be both high in mastery and performance-approach goals. Much of the research on achievement goals has been conducted in classrooms or research labs, and we extend this work by examining implications of such goals in the context of an out-of-school digital media environment.

Study Design and Analyses

Task: Heat Pump Game

The heat pump exhibit used in this study is part of a larger exhibition about energy of the future at the Norwegian Museum of Science and Technology. The exhibition resembles a carnival with game booths about sources of energy such as sun, wind, and ocean waves. The heat pump game, designed and produced by our research lab, teaches students about energy transfer and the relation among pressure, condensation, evaporation, and temperature. Players learn about the general function of a heat pump—that it moves heat from inside to outside and vice versa—on the start screen before being shown a screen of the zoomed-in heat pump with details of its inner workings. Players are challenged to keep the house temperature consistently warm throughout the year by operating the heat pump through physically rotating a metal crank using the appropriate speed and direction. Two metal handprints on the table change temperature to align with the movement of heat in the simulation. As such, students operate the heat pump compressor using the physical crank to heat up or cool down the house as the heat pump's inner workings dynamically move in real time on the screen. The result screen following the game shows the percentage of time the house stayed within the desirable zone of warmth as well as the amount of energy saved.

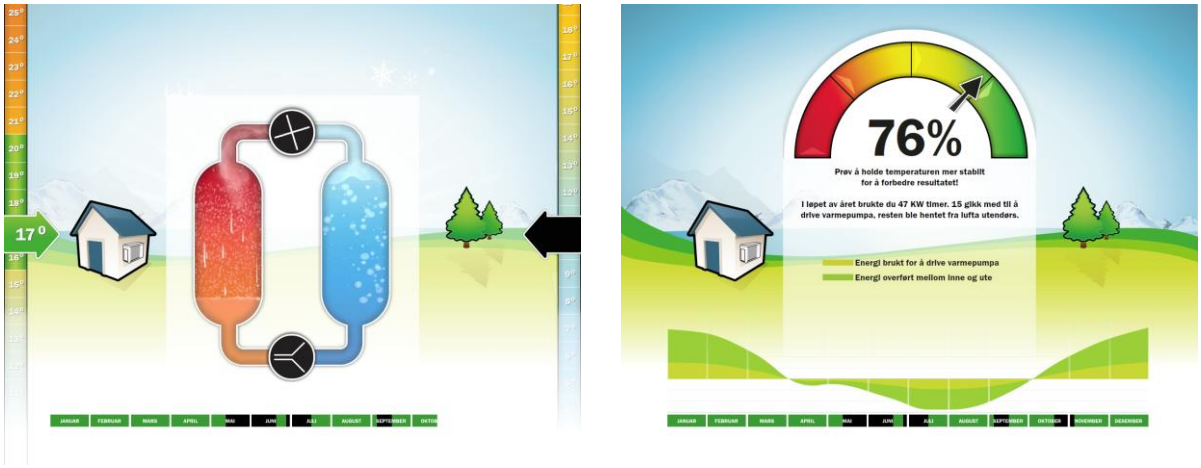

Figure 1. Screenshots of the heat pump game during the play (left) and of the results screen at the end (right).

Preliminary Analyses

For our heat pump game, we administered self-report measures of achievement goals to identify high school students with different motivational profiles, as indicated by their reported levels of mastery, performance-approach, and performance-avoid goals. The self-report items that measured mastery, performance-approach, and performance-avoid goal orientations were adapted from the Patterns of Adaptive Learning Survey (www.umich.edu/~pals/manuals.html). All three goal orientation constructs were scored on a 7-point Likert scale ranging from 1 (not at all true for me) to 7 (very true for me). Mastery goals focused on learning and understanding (e.g., "My goal is to learn as much as I can"); performance-approach goals focused on demonstrating ability and outperforming others (e.g., "My goal is to look smarter than other students"); and performance- avoid goals focused on not looking dumb (e.g., "My goal is to avoid looking like I can't understand the material"). Individual items in the specific goal constructs were averaged to create a final score from 1-7. This allowed us to select students of different motivational types, during a classroom field trip, for video-based analysis of their interactions with the exhibit to complement the quantitative accounts of their motivation. Our preliminary analyses show differences in the ways students attend to different parts of the screens such as the temperature meter, the scientific simulation, and the point screen. These choices are related to their motivation as well as levels of higher-order thinking, help-seeking behaviors, and responses to questions that press for deeper understanding.

Implications: Theoretical and Practical

Our research illustrates how the same event may have entirely different impacts on motivation and learning depending on the goals students bring to an activity. In doing so, we extend the current theoretical literature on achievement goals by providing specific examples of the process by which this may happen in the context of game-based learning. On a practical level, understanding how certain game elements afford different types of interaction for students with different motivations can provide insights about how to design game environments that promote adaptive motivation and effective learning.

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Acknowledgements

This research was conducted as part of the Mixed Reality Interactions across Contexts of Learning (MIRACLE) project, funded by the Research Council of Norway. The authors would like to thank the CHANGE research group in the Department of Educational Research and InterMedia for their feedback on earlier versions of this paper.