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Novice versus Advanced Undergraduate Computing Students' Engagement in Collaboration in an Online Flipped Classroom

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Abstract: This paper explores students' engagement in collaborative learning activities within two data science courses (one introductory and one advanced) taught synchronously online during the 2020-2021 academic year. Here, we draw on a multidimensional perspective of student engagement to understand novice and advanced computing students' collaborative learning practices and propose instructional design elements informed by students' unique needs and the limitations of the virtual format.

Introduction & Rationale

Considering the mass shift to online learning due to the Covid-19 pandemic, instructors of undergraduate students have been tasked with adapting their course material and instructional practice to be appropriate for remote instruction. For disciplines in which peer and instructor interaction are paramount in the development of industry-authentic interpersonal 'soft' skills, the constraints of online learning formats have proven to be a barrier to student engagement. Computing is one such discipline that experiences these tensions.

There is furthermore an increasingly widespread view that flipped classroom approaches engage students in developing these interpersonal skills and practices through active student participation and interaction (e.g., Bishop & Verleger). The flipped classroom model allows students to use class time to engage in iterative problem-solving, collective sense-making, and critical thinking through collaboration with classmates and instructor support. In our prior work, we identified a set of instructional design factors which the literature showed to be effective for flipped classroom implementations (Mithun & Luo, 2020; Mithun et al., 2021).

In this research, we consider how computing students engage in online small group collaborative learning activities in an introductory data science fundamentals course and an advanced database design and management course. We use a multidimensional (Fredericks et al., 2004; Sinatra et al., 2015) and sociocultural (Danish & Gresalfi, 2018) framework of student engagement to understand the behavioral, cognitive, and emotional aspects of students' engagement intersected with their social engagement in collaborative learning settings. We then use these insights in conjunction with instructor observations to identify how the current instructional design for each course can be revised to better suit the unique needs of each group of students. We pose the following questions:

1. How do novice and advanced undergraduate students behaviorally, cognitively, and emotionally engage during peer collaborative activities in an online data science course?
2. How does understanding students' engagement enable instructional design modification?

Methods

A variety of data sources were used to analyze undergraduate students' experiences in the introductory database fundamentals course (n = 21) and the advanced database design and management course (n=12). Students completed an end-of-semester (EoS) survey designed by the authors and a collaborator with expertise in student engagement as multidimensional (see Humburg, 2020). Students also completed university-mandated course/instructor evaluations and participated in an informal focus group facilitated by a third-party evaluator. Novice students additionally responded to weekly exit-ticket check-ins; each week's survey featured a new question about students' experiences within the context of the course, school more broadly, and/or their personal lives.

Quantitative data from the EoS engagement survey was segmented based on the target dimension of engagement, individual versus collaborative setting, and course enrollment. Basic statistical descriptives and comparisons were calculated across all segments in addition to student course/instructor evaluation data. We then ran significance tests across courses for each dimension of engagement and the individual/collective ownership items. We additionally coded all qualitative data (i.e., focus group reports, exit-ticket survey responses, instructor observations, and responses to open-ended text-based survey questions) using two coding schemes.

Findings & Discussion

Our analysis revealed that novice students were confronted with several barriers to engagement in small group collaborative settings which we seek to address in the next implementation of this course. First, we recognize that

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students' lack of behavioral engagement could be attributed to a lack of instructional mechanisms for maintaining individual accountability in group settings. Gaps in cognitive engagement were frequently linked to students not understanding the value of collaborations for their learning and thus, a lack of motivation to participate. Furthermore, novice students struggled to develop meaningful relationships with their peers throughout the semester – a phenomenon students attributed to the inconsistent and random group assignment and lead to a lack of group regulatory interactions.

Thus, we propose the following tweaks to novice students' instruction: (1) negotiating longer-term group assignments during class rather than relying on random weekly assignment, (2) introducing low-stakes 'peer/group evaluations' to more effectively identify and respond to moments of labor imbalance in groups, (3) requiring that in-class work is submitted to the instructor to allow for monitoring of individual students contributions, and (4) increasing transparency around the 'point' and value of collaborative learning activities for each content area.

For seniors, small group collaborative settings enabled the sharing of diverse ideas and perspectives; they recognized that collaborative activities aided in developing interpersonal skills authentic to those they will need after graduation. However, students cited frustrations around the lack of connection between concepts addressed in individual versus group settings. Thus, we take a similar approach as described above and plan to explicitly mention target concepts and practices for each given activity to draw connections between the multiple learning objectives. We also plan to review the current curriculum to better align the core concepts and learning objectives between individual and group activities.

We additionally suggest that student groups could benefit from the integration of mechanisms during large group discussions to make participation be perceived as less 'high stakes.' To do this, we hope to design discussion spaces where contribution is both more accessible and less intimidating for students. We anticipate better incorporating multimodal means of participation (the chat, reactions, polls, asynchronous feedback, collaborative whiteboards etc.) into group discussions to enable students to choose the mode of participation that is most comfortable for them as opposed to not engaging entirely. These approaches to increasing multimodal participation would prove particularly valuable for identifying students' misconceptions as they arise, opening interactional opportunities for group regulation and negotiation, leverage synchronous online tools in instruction as an asset rather than a limitation.

To conclude, we affirm that there is no 'one size fits all' instructional design solution for collaborative learning activities in computing and data science education, but that the students' unique barriers, perceived objectives, and learning preferences be considered in conjunction with affordances of the learning environment to inform theoretically grounded yet context and audience-appropriate instruction.

References

Bishop, J., & Verleger, M. (2013). Testing the flipped classroom with model-eliciting activities and video lectures in a mid-level undergraduate engineering course. 2013 IEEE Frontiers in Education Conference (FIE), 161–163.

Danish, J. A., & Gresalfi, M. (2018). Cognitive and Sociocultural Perspectives on Learning: Tensions and Synergy in the Learning Sciences. In Danish, Joshua A., and Melissa Gresalfi. "Cognitive and sociocultural perspective on learning: Tensions and synergy in the learning sciences." International handbook of the learning sciences (pp. 34–43).

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. Review of Educational Research, 74(1), 59–109.

Humburg, M. (2020, June). Engagement in Motion: How the Body Mediates Social and Emotional Engagement With Science Learning. https://doi.org/10.22318/icls2020.1039

Mithun, S., & Luo, X. (2020). Design and Evaluate the Factors for Flipped Classrooms for Data Management Courses. 2020 IEEE Frontiers in Education Conference (FIE), 1–8. https://doi.org/10.1109/FIE44824.2020.9274201

Mithun, S., Vickery, M., & Luo, X. (2021). Evaluating Factors for Effective Flipped Classroom Instruction in an Advanced Data Management Course. Proceedings for the 2021 Frontiers in Education Conference, 9.

Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The Challenges of Defining and Measuring Student Engagement in Science. Educational Psychologist, 50(1).