Board 26: What Features of the Problem Solving Studio Most Impact the Students' Experience?

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Doctoral studies in Science Education. Specifically in informal settings and through the application of problem based and project based learning.

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What features of the Problem Solving Studio are most impactful for the engineering students' experience?

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Introduction: This is a works in progress research paper. More than a decade ago, the Wallace H. Coulter Department of Biomedical Engineering at Georgia Technology and Emory University began to implement and test a new way to teach engineering called the Problem Solving Studio (PSS). PSS was first implemented in a sophomore-level engineering course whose primary goal was to teach students model-based reasoning and engineering estimation skills [1]. Prior to the creation of PSS, the course was taught using a traditional lecture-based approach, similar to the way the vast majority of technical engineering courses are taught [2][3]. The instructor who created PSS was motivated to do so because he realized that the students were not cognitively engaging with learning the course concepts and skills. PSS was intentionally structured to create a much more interactive experience than is typically experienced in traditional engineering courses. Student teams of two were formed (aka dyads) for the entire semester. These teams were challenged each class period to collectively solve complex analytical engineering problems together [2]. Students were required to work with one another to not only solve the problems they were assigned, but also to help each other master model-based reasoning and engineering estimation skills. PSS is a marked change from what students expect to do, or are used to doing, in the engineering classroom. We wanted to examine, therefore, students' experiences with working in the PSS. Our research question was: What features of the Problem Solving Studio are most impactful in students' learning experience? The results of this study have helped us identify what students perceive as the key features and characteristics of PSS and the impact of PSS on their learning.

Methodology: A qualitative study was conducted in a sophomore-level biomedical engineering course, entitled "Conservation Principles of Biomedical Engineering", that used the PSS learning environment. The course was taught in multiple sections. The researchers invited students from one of these sections to be interviewed. A total of 13 students volunteered. The researchers used Seidman's phenomenological interview approach to interview each participant three times over a period of three weeks the semester after they had taken the course. This interview approach was conducted to allow for analysis that is more robust; interviews can be analyzed from a thematic or narrative perspective. For this study, we analyzed the results of the third interview, which focused on the impact of the course on their learning, including how much of their learning they were able to transfer to other settings. Evidence of transferring could include using concepts from this course in other engineering courses, or in other engineering situations, or even in everyday non-engineering activities. Interviews were transcribed and analyzed using an interpretive phenomenological approach in order to understand how students experienced the problem-solving studio. Two researchers independently created themes about student experiences in PSS, and then themes were compared between researchers. Differences were discussed and negotiated until both researchers agreed with final themes.

Results: Three themes were identified: 1). Transferring of knowledge to other courses, 2). Real-world application, and 3). Team work as part of engineering. Themes are defined below:
Transfer: how knowledge from this course is applied in another course.

Real-world application: students explaining how features from this course also apply to problems in their everyday lives.
Team work: students recognizing how working in dyads applies to careers in engineering.

The Table below displays student quotes from the three developed themes.

Theme	Student quotes		
Transfer	*Yeah, I find that to biochemistry I, there are like certain types of problems, you know, I knew I needed to draw like the base of the sugar that I was doing a diagram of and then I had to go in, you know, connect to the certain way so like you can kind of just apply a method no matter like if you're working with like different base pairs of DNA when you're drawing out like molecular diagrams and I mean it's the same thing as what we did in 2210 when there's like certain stuff you need to label in each problem, certain words and key phrases they need to see for like points and stuff. So, yeah, you can kind of, I kind of like pull that over.*	*I'm trying to think of what classes. Yeah. I would say so. In the other problem-solving class that I'm in, like PSS type class, it's pretty similar in the way things are handled and stuff. We all do our homework together, that kind of stuff. So yeah.*	*I used it I'm trying to remember what class I used it this summer. I definitely used it in my class this summer where I was doing like degree of freedom and I was trying to figure out it might have actually been one of his 3520 class.* *So 3520 you had a partner and we would work through problems together, and I definitely used the mindset from 2210 where you think about like you try to solve something on your own and if you can't figure it out then you can talk to your partner and then if neither of you can figure out, then you can try to talk to other people around in the class.*
Real-World Application	*I guess like if anything the fact that it was like kind of group based was good at least for me because it just got me working with other people more. And I guess that's kind of applicable to like to wanting to do product design because you're always going to be working with like a team when you're doing design. Yeah. And you know you have designers, you have like manufacturers, you have engineers and so like I think it is good to have classes that are like group based like this was because like in the design*	*I feel like PSS is much more like industry to me because you, they usually like give you a problem at least I've only been working for like 3 months, but there will be like a problem and you'll work with other people to try to figure out a solution to it so it definitely feels like an industry way of thinking.*	*Yeah. It's definitely like the way of thinking where you like collaborate with people at your table. You definitely use that in the real world and I've used that at work like you like try to figure out some on your own but then you can talk to your peers as well and go off of each other to build on their ideas and your ideas.*

	firm really, for a design firm medical device company you will be working with like different sectors and different types of people so that's applicable I guess.		
Team work	*But it was also, stands out because of like how they do problem solving studio, how it's not just a lecture, and how you work in teams and you're actually like able to actively collaborate. So, I mean I have other classes and I've had other classes that, you know, you're in groups and you're like doing projects but this is a little different because you're doing like problems. And it stands out because of it's group aspect and also material was challenging and different.*	*Yeah. So I'm like one of those people who's very aware of my own strengths and weaknesses and stuff like that so when I work with a team I usually can kind of figure out where I fit in with that and can help everyone at the same -- we all worked together in that sense. But with the second one, I mean, like my partner rarely showed up so we never really got into a groove at all and then that made it hard because if you have no, like, if you never see them then you can't really -- I don't know -- adjust in any ways. And then I guess that's most of it. I don't know. I just -- I like working in teams because it's more -- there's more -- I mean, this is kind of a silly -- there's more brains. The chances of someone knowing how to do something are better, figuring it out, and like bouncing ideas off each other.*	*I feel like it definitely helped because you would work through a problem and then like if we got stuck sometimes we would like figure it out. We'd both go through the same like thinking process together. We wouldn't, it wouldn't be like one person doing the whole thing. Yeah.*

Discussion: These findings help us understand the impact of the problem-solving studio on its students. These impacts extend beyond just the technical content that was taught in the course (e.g. model-based reasoning and estimation). The PSS environment was designed to be a cognitive apprenticeship where, to the extent possible, students work together to solve problems co-constructively, because this is expected to lead to better learning [4]. But an outcome may be that their experience in PSS shapes their perceptions of knowledge transfer or teamwork in engineering, or how they practice engineering. As a result, we find that these students are able to transfer knowledge from PSS to other areas of their lives. We speculate that PSS may help students transfer not just the cognitive skills they learned from the course, such as model-based reasoning and engineering estimation skills, but also the interpersonal skills that they developed in PSS, which may affect their ability to collaborate with others in their future places of work. Broader impact: Overall, the findings suggest that learning environments that are highly interactive in nature, such as PSS, may promote learning not only of the technical content but also the professional skills that are critical for engineers in order to be able to work well together to solve complex analytical engineering problems. Future work should include an examination of how well PSS can be adapted and scaled to other engineering courses and university contexts.

References

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