Research-practice partnerships and communities of practice for fostering better teaching and learning

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ABSTRACT

We report on how a college and university physics-based research-practice partnership (RPP) has flourished in the greater Montreal area. The RPP has fostered bringing discipline content knowledge AND pedagogical knowledge together to design effective instructional innovations. It has co-designed activities and built resources that engage students meaningfully with the physics content (including for waves, optics, and modern physics), and provide evidence of statistically significant learning gains. This partnership has informed the development of a community of practice, Supporting Active Learning & Technological Innovation in Studies of Education (SALTISE), which facilitated the knowledge mobilization. SALTISE infrastructure allows us to share with other instructors, using a peer-to-peer professional development approach. These resources include: 1) a repository of peer-generated teaching and learning materials on the SALTISE website, 2) peer mentoring and support, 3) monthly virtual meetings and information sharing, and 4) a free annual conference that brings together practitioners and researchers. We discuss how this model could be useful for the SPIE community.

Keywords: active learning, research-practice partnerships, community of practice, peer mentoring, education

1. INTRODUCTION

Science faculty in higher education are experts in their fields, i.e., they bring “content knowledge” into the lesson plan and/or in-class activity. Typically, however, they have little or no formal training in instruction and learning, i.e., “pedagogical knowledge.” Research tells us that instruction is most successful when both content knowledge and pedagogical knowledge are brought together into a harmony referred to as “pedagogical content knowledge” (PCK, [1]). Innovative instructional approaches, such as student-centered active learning (AL) instruction, arguably, are even more susceptible to requiring pedagogical knowledge and know-how because of the privileged role and importance they place on the practices of collaboration, reflection and discourse, both inside and outside of the classroom [2]. Thereby, this pedagogy involves the careful design of activities that engage students meaningfully in those practices, while also being focused on the content knowledge. While there is accumulating evidence suggesting AL approaches positively impact students' learning and students' motivation towards learning and retention of students in STEM-based programs [3-8], there is also reason to be alert to the challenges posed — i.e., to implement such evidence-based approaches productively, science faculty need to have support to acquire pedagogical knowledge and use it successfully. But how do they achieve this ambitious standard? One promising solution is the development of collaborations between the content knowledge experts (instructors / practitioners) and the pedagogical knowledge experts (educational researchers).

This paper reports on a possible model: a collaboration, framed as a research-practice partnership (RPP, [9]), which brought together a small group of college-level physics instructors and learning sciences researchers to form an enduring partnership that engages in the co-design of AL activities and the development of evidence-based resources, through iterative implementation cycles of design-based research [10]. This RPP furthered the impact of their efforts through the expansion

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into a community of practice. Thereby, they have developed a sustainable infrastructure for sharing instructional tools, resources, evidence-based best practices, and activities with a larger group of practitioners and educational researchers.

We start by describing this productive partnership using examples from collaborations that focused on co-designing AL instruction for a college-level course on waves, optics and modern physics. We explain how the RPP has co-designed activities and built resources that engage students meaningfully with the physics content and provide evidence of statistically significant learning gains. Then we report on how the work of this RPP informed the development of a community of practice, Supporting Active Learning & Technological Innovation in Studies of Education (SALTISE), which facilitated the knowledge mobilization. SALTISE infrastructure (https://www.saltise.ca) allows us to share with other physics instructors, and educators from other disciplines, using a peer-to-peer professional development approach. These resources include: 1) a repository of peer-generated teaching and learning materials on the SALTISE website, 2) peer mentoring and support, 3) monthly virtual meetings and information sharing, and 4) a free annual conference that brings together practitioners and researchers. Lastly, we will discuss how SALTISE might be a model for the SPIE Education and Outreach Committee and the ETOP community to consider the creation of a repository of teaching and outreach materials that can be shared among the SPIE membership.

2. PHYSICS EDUCATION-BASED RESEARCH-PRACTICE PARTNERSHIPS

The RPP at the center of this story is made up of a group of college physics teachers and education researchers, from three colleges in the province of Quebec, Canada. Quebec colleges, typically referred to as cégeps, are a unique post-secondary system. Compared to other parts of Canada, and elsewhere in North America, the cégep pre-university programs are equivalent to grade 12 and what is typically the first year of university. Students in the Science Programs take courses from the main science disciplines including physics. Typically, these students are highly motivated and focused on their studies to enter university, which is a competitive endeavor. At the same time, the instructors are typically disciplinary experts, most with Master degrees in their fields and many with Doctoral degrees, whose mandate is teaching and are not required to do research in their field.

This team of physics instructors and learning scientists began working together over 18 years ago as an RPP. A driving principle has been the bringing together of content and pedagogical knowledge which has been accomplished through a genuine collaboration with deep respect for the two epistemic traditions: (1) understanding the challenges of learning physics (promoting conceptual change); (2) investigating pedagogical principles that support and deepen learning (designing for learning). Using design-based research methodology, the team engaged in a co-design process that bridges across these boundaries to maintain a balance between content knowledge and pedagogical knowledge, while maintaining the rigor of research and the flexibility of adaptations associated with implementations. We believe our studies have yielded interventions that are both evidence-based and practice-tested, thereby, making them ready to be implemented and sustained in typical post-secondary science classrooms. Furthermore, the RPP co-design has brought to the foreground the importance of the practitioner's knowledge of implementation and valuing this knowledge as an emergent outcome of the PCK collaborations.

With their focus on promoting conceptual change and conducting a cross between physics education research (PER) and learning sciences research, this RPP designed and studied student-centered instructional approaches, collecting evidence of when and how such implementations were successful, and when they were not. Focused on increasing students' academic success, the team has investigated methods and conditions required to increase the success of active learning instruction and the innovations in learning spaces including: flipped classrooms [11], design of active learning spaces [12, 13], and digital learning spaces (e.g., myDALITE [14]). Recently, and specifically for a college-level physics courses on waves, optics and modern physics, the RPP has studied the role of peer feedback and learning by identifying errors [15, 16]; and, the types of support that enable greater self-regulation in inquiry based learning [17] and inquiry based laboratories [18]. These studies have produced empirical findings, but importantly, they have generated resources including guidelines and tools, soft (scaffolding templates) and hard (an online digital platform, myDALITE). Increasingly, these resources were shared with other practitioners, which led to the next step, building an infrastructure for supporting such activity and mobilizing the team's growing body of PCK knowledge and knowledge of implementation.

3. THE SALTISE COMMUNITY OF PRACTICE

The SALTISE community grew out of the RPP described above and joined forces with colleagues from two higher education institutions: like-minded physics instructors (practitioners) and education instructors (researchers) faculty from a local Montreal-based university and learning sciences faculty from a Toronto-based university. As pioneers in the emerging field of AL research and implementation, and aware of the challenges faced to mobilize pedagogical knowledge, typically approached as professional development, the group saw an opportunity to create a new approach consisting of peer-modeling and peer-to-peer support. Efforts aimed at bringing together faculty from across the Montreal post-secondary network have been tried previously (QEMSAP, [19]), but in this instance, the timing was right. Policy makers recognized the need for more evidence-based informed instruction, and they were ready to support a grant that proposed the development of an initiative that would allow the distribution of this growing body of knowledge at the same time as the building of a community. With local support among colleges and universities, and via various funding agencies, SALTISE formed and has sustained growth for over 12 years. SALTISE now has over 2000 members (teachers, researchers, pedagogical advisors, software developers, etc.) across colleges and universities, in English and French, mostly in the greater Montreal area, but with others from Quebec, Canada and internationally.

Classroom activities and additional resources are shared with instructors via the SALTISE website infrastructure. Labeled under "Teaching Resources," instructors can find guidance and scaffolds to support the implementation of "Approaches and Strategies" and "Active Learning Activities" to list two of the main categories. The former describes types of pedagogical scripts that are taken from the research and increasingly have evidence to support their efficacy. Specifically, the website characterizes these into the two aspects: approaches are macro-scripts such as flipped classroom, inquiry-based learning, problem-based learning, project-based learning; meanwhile, strategies are micro-scripts such as jigsaw, peer assessment, reflective writing, etc. The Active Learning Activities (ALA), on the other hand, are lesson plans (instructional scripts) collected from SALTISE practitioner members, instructors who have taken the plunge and designed AL instruction within their courses. These ALA are organized by discipline, instructional level, activity duration, class size, etc. SALTISE has devised a systematic method to document and communicate the pedagogical elements of these activities along with curating the content knowledge materials used. In addition, this systematic method includes a way of describing the ALA lesson workflows, which involves using a unique curriculum mapping tool, CourseFlow – developed by members of the RPP along with others from the community. This tool, and the SALTISE infrastructure system, are intended to help lower barriers to using and designing with PCK, allowing higher education faculty to "see" the structure of the pedagogical knowledge within AL activities. Lastly, the teaching resources section of the website hosts collections of these curated instructional course content materials, which provide lecture notes, videos. simulations, and so on, organized by discipline and instructional purpose.

As a community of practice, SALTISE provides peer mentoring and support to its membership. It has developed several programs to achieve such goals, including monthly webinars (virtual meetings and information sharing), *à-la-cart* workshops for small groups of faculty, and one-on-one tutorials. In addition, as with all communities of practice, there is the support and mentoring of novice members by more senior ones. SALTISE is no different, for instance, if an instructor who is new to using AL instruction wishes to explore and/or implement a specific strategy, they can be partnered with an experienced colleague. Under this arrangement, the novice can visit the experienced instructor's classroom, and receive personalized mentoring and advice. Activities and resources are shared between the mentor and mentee, and often are modified to suit the mentee's pedagogical needs. Finally, SALTISE has organized a free annual conference since 2012. This event brings together practitioners and researchers to share their respective findings. Over a two-day period, 60+ presentations are made by both classification of members. As such, empirical studies are scheduled within the same session as practitioner best practices. We believe that coming together in this manner is another form of RPP as all members of the community are given equal respect and blur the distinction that is typically represented in other knowledge transfer efforts.

4. CONCLUSIONS

We started this paper by focusing on the challenges faced by science faculty in higher education. While such individuals are experts in their fields, they have little or no formal training in instruction and learning. We referred to this as PCK and argued that innovations such as AL instruction required even more of this pedagogical knowledge. We also posited that collaborations between content knowledge experts and the pedagogical knowledge experts could be a remedy. We further

showed how we developed such a collaboration with an RPP that brought together physics faculty and learning science faculty who co-designed instructional interventions that are empirically tested, producing evidence of their efficacy, and are immediately applicable for use in classrooms. We then described how this RPP was successful and brought their findings into a community of practice, SALTISE. Then, explained what this community has done to create resources and tools to share the findings of practitioners and researchers working together. Our RPP experience and the peer-led professional development approach of the SALTISE community has generated qualitative evidence (growth of membership, participation in the annual conference, use of website materials) of their effectiveness as a model for supporting the transformation of instructional practices. In doing so, this model helps to overcome the challenge of embedding more pedagogical knowledge into their instruction (content knowledge) without going through formal training. SALTISE can also be a model for the SPIE Education and Outreach Committee and the ETOP community. In addition to the biannual ETOP conference, a repository of teaching and outreach materials, like how SALTISE documents and shares ALA on its website, should be available to all SPIE members. SPIE members can contribute to this repository and its content be shared among the membership.

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