An Iterative Course Design Project to Improve Preservice Physics Teacher Preparation for Teaching With Technology

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Abstract: This study reports on an iterative course design project to improve a junior level preservice physics teacher preparation course on technology and teaching. The course design used TPACK (Technological Pedagogical Content Knowledge) as the grounding education theory. The course was taken from a predominately modeling and laboratory-skills focused course to a project-based technology and pedagogy focused course. This poster describes the stages of the course design project, the difficulties encountered, and reflects on lessons learned.

Introduction

Technology has become ubiquitous in PK-12 classrooms. Ninety-seven percent of teachers have at least one computer in their classroom and 93% of these computers have internet access (Grey et. al., 2010). The predominance of effectively used technology is less clear. In a five-year study of new science teachers' technology use, Bang and Luft concluded that, "The uses of technology by beginning science teachers in this study were relatively limited, in that teachers used technology for assisting traditional teaching and learning and not necessarily for implementing reform-based teaching practices" (Yücel, 2014). Some studies in this area have suggested that teachers do not use technology because they lack the necessary Technological Pedagogical Content Knowledge (Ferreira et. al., 2013; Jang & Chen, 2010; Hechter et. al., 2012; Hechter & Vermette, 2013).

Teachers have many areas of knowledge that all play a role in teaching; they have content knowledge (e.g. the physics and mathematics, CK), pedagogical knowledge (e.g. group work and Socratic questioning, PK), and technological knowledge (e.g. Excel or Probe-computer interfaces, TK). In addition to these basic areas, overlap exists between these areas where teachers integrate their knowledge (Mishra & Koehler, 2006). TPACK states that it is necessary for a teacher to have integrated these areas to teach well with technology in the context of their course, i.e. they need TPACK knowledge not just PK, CK, and TK. This is similar to the concept of pedagogical content knowledge (PCK) being necessary for good physics teaching and not just content or pedagogy alone, but it acknowledges that instruction with technology necessitates additional areas of knowledge (Mishra & Koehler, 2006). Here we present the iterative course design process used to reinvent a technology and teaching course for third year preservice high school physics teachers.

The design process

Table 1 provides a brief display of the course as it went through redesign. The course was originally taught with modeling instruction to reinforce preservice teachers' content knowledge and lab-skills. The course goals were: "to improve preservice teacher candidates content knowledge and lab skills". The course was redesigned, using TPACK to guide the design, so that each technology was grounded in at least two pedagogies and physics concepts. The new course also included a wider range of technologies such as excel, videos, webpages, and simulations, and the course goals were changed to "prepare teacher candidates to create and implement student centered, hands on, discovery/inquiry-oriented labs and activities".

In the new design, each unit began with teacher candidates completing an example activity designed by the course instructor. The preservice teachers then designed their own activity for the following week's class. That week the activities were tested in class and each activity was peer reviewed for accuracy of the physics, clarity of instruction and content, and expected learning outcomes. For the third week, teacher candidates reworked their project based on this feedback and a new unit was started in class.

Redesign 1 to modify the curriculum around TPACK went well. However, the course instructor (one of the authors) noted that some teacher candidates did not work on the course material with the expected level of seriousness and interest and some teacher candidates showed little motivation to rework/improve their activities. When the preservice teachers were questioned about this, three issues were identified: 1. The activities were not actually going to be used so it, "did not matter"; 2. Preservice teachers felt that they would learn when they were on the job teaching; 3. Much of the instructor feedback given on the activities was to improve the scaffolding of the activity to address how the activity would "create" student knowledge. The preservice teachers were not cognizant of the difficulties in achieving student learning and therefore less accepting of the feedback.

To address these three issues, the curriculum was modified again into the 3rd design in the right most columns of Table 1. The Modeling Labs and Smart Phone Labs were combined into one larger project. Not only were preservice teachers required to design a hands-on inquiry lab, they would teach with their created inquiry lab in one of the sections of lab for a general education physics course at Illinois State University. To discourage the replication of their own introductory labs, a new technology - IoLab sensors - was chosen for the lab.

Results from this new course were encouraging. The preservice teachers got needed teaching experience, and the issues seen around lack of enthusiasm to edit the designed activities were mitigated. Also, feedback from the general education physics students showed that, from their perspectives, the preservice teachers' labs were as good as the traditional labs for this course in terms of their learning (measured by a subset of questions from two concept inventories widely used in physics education – the FMCE and TUGK) and their ranking of the instruction and their assessment of the lab tasks (measured with surveys designed by the authors for this project). Thus, completing the preservice teachers' inquiry labs instead of the traditional course lab used for this physic topic was not detrimental to the students taking the general education course.

Table 1: The Course Redesign

Original Course: Modeling Focused		Redesign 1: Technology Driven Projects focused on TPACK and Curriculum Design		Redesign 2: Adds the requirement that they teach w/ their designed activity in a real hands-on lab section	
Unit	Weeks	Unit	Weeks	Unit	Weeks
Modeling 1-D motion constant velocity	1	Excel for Teaching Physics	1 & 2	Excel for Teaching Physics	1 & 2
Modeling 1-D motion with acceleration	2	Phet Simulations	3 & 4	Phet Simulations	3 & 4
Modeling 2-D motion with TRACKER	3 & 4	Modeling Hands-on Labs	5 – 7	Design and Teach with IoLab	5 – 9
Modeling Friction and Forces	5 & 6	Smart Phone Motion (Apps for Labs)	8 & 9		
Rewrite a "Cook-book" lab to be modeling	7 & 8	Project Based Learning	10 -12	Project Based Learning	10 -12
Modeling Light and 1 other lab (flexible depending on interest)	9 - 12	YouTube Video Learning Project	13 & 14	YouTube Video Learning Project	13 & 14
Capstone Advance Lab	13 - 16	Webpage Design	16	Webpage Design	16

Implications and conclusions

We reported on the design process of a technology and teaching course for third year preservice high school physics teachers. The first redesign was completed using TPACK as its grounding theory; it changed the course from modeling-heavy to include many more technologies and pedagogies. This new unit-based course was effective; however, some preservice teachers wanted/needed more teaching relevant activities and experiences to help them understand the pedagogies presented and motivate them in designing classroom activities. A second redesign was completed to allow for these needs. By requiring preservice teachers to teach with their created curriculum, the issues seen in Redesign 1 were resolved. The biggest issue encountered in the course of this project from an instructional standpoint was timing. However, while this new course design does require significant instructor time to provide proper feedback and assistance, experience indicates that allowing the preservice teachers to create labs and teach introductory classes with their labs is feasible and worth the effort.

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