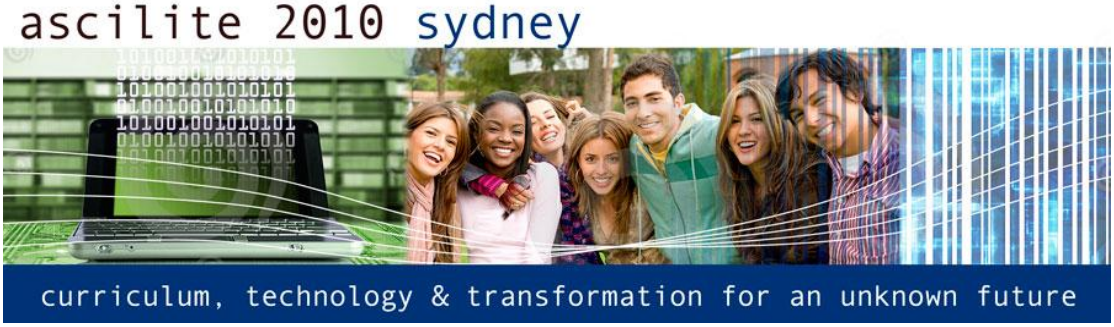

Constructionist principles in online teacher professional development: Robotics and hands-on activities in the Classroom

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This report explores the first iteration of a teacher professional development Courselet grounded in constructionist theory and activities. A design-based research approach guided this continuing examination of online teacher professional development (oTPD) activities within an educator social networking site. The topic of the oTPD was "Robotics and Hands-on Learning in the Classroom" for teachers interested in integrating constructionist LEGO robotics-based pedagogies. The Courselet engaged teachers in just-in-time, ongoing TPD utilizing Web 2.0 tools. Key findings of the first delivery of the oTPD Courselet point to flexible access, sharing of resources, teacher discussions, and support for constructionist pedagogical activities as the PD value for participants. Findings support the potential for an ongoing online community of practice around classroom robotics. The approach taken in this oTPD Courselet continues to inform a model of oTPD delivery within a social networking enabled environment. Further research is needed to determine the transfer of oTPD to classroom practice.

Keywords: constructionist, LEGO robotics, online teacher PD, oTPD, courselet

Introduction

Tell me, and I will forget.
Show me, and I may remember.
Involve me, and I will understand.
- Confucius, 450 B.C.

Education is in a transition from the Information Age to the Social Media Age. Digital media literacy continues to rise in importance as a key skill in almost every profession (New Media Consortium, 2010). Social media technologies are becoming pervasive in work environments, and knowledge of their development and use is becoming increasingly important. In classrooms, new media technologies underscore every part of students' lives as tools for social networking, online collaboration, and media sharing are all rapidly maturing and becoming accessible online (Hovorka & Rees, 2009).

Educators in the emerging Social Media Technology Age are charged with the task of creating learning activities that include these new technologies, although few have any formal training in digital and social media (Whitehouse, Reynolds, & Caperton, 2009). This problem is further compounded by the fact that new information technologies and processes are emerging faster than they can be integrated into course material and textbooks, so even newly graduated teachers are sorely behind in their knowledge of the technologies in which they are expected to be skilled practitioners. As a result, teacher professional development (TPD) that focuses on the integration of these new technologies into their teaching practice is critically needed. Additionally, access to timely, ongoing, and relevant professional development opportunities to meet these kinds of needs is a persistent challenge. Online teacher professional development (oTPD) has the potential of fulfilling both of these needs in this emerging Social Media Technology Age (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Herrington, Herrington, Hoban, & Reid, 2009; Vrasidas & Glass, 2004).

The literature has identified a critical need for research into accessible and high quality oTPD implementations (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009). Although these types of programs are becoming increasingly popular, very little research is being conducted to explore their effectiveness (Borko, Whitcomb, & Liston, 2009; Whitehouse, Breit, McCloskey, Ketelhut, & Dede, 2006). Desimone (2009) reports a recent consensus on the critical features of professional development for teachers that lead to increased knowledge and skills and improved practice. These features include content focus, active learning, coherence, duration, and collective participation; of these features, content focus and how students learn that content was considered the most influential for teacher professional development success. The oTPD implementation described in this paper encompassed all these essential features.

The research reported in this paper is part of an ongoing design-based program of research centered on the development, design, and evaluation of "Courselets," a delivery model for online teacher professional development using content-focused instructional packages and involving about 10 hours of teacher interaction time delivered within a social networking site (Ostashewski, 2010; Ostashewski & Reid, 2010). Online social networking is a new way for teachers to access PD, and Courselets have the potential to provide learning opportunities that are both inexpensive and scaleable. Providing teacher PD within a social networking site allows an increased teacher familiarity with social networking tools. Using online forums, blogs, video, and other social media embedded in the oTPD delivery can provide an opportunity for authentic teacher online learning experiences. The online learning experiences designed into Courselets are therefore dually valuable to teachers; firstly providing an opportunity to learn online using new communication technology tools, and secondly to have the access to specialized TPD at a distance.

The benefits of online learning are clearly applicable to teacher professional development where the access to high quality online teacher professional development has been identified as critically important (Borko, 2004). Today's teachers must be adaptive experts and lifelong learners, continually seeking and developing knowledge and skills, rather than working to acquire a core set of skills to be used for an entire career (Whitehouse, Reynolds, & Caperton, 2009). Similarly, research into oTPD needs to seek new ways that teachers' learning needs can be met, to identify opportunities for developing online communities to support learning (Oliver & Brook, 2002), and to extend the knowledge of the field of oTPD in order to create models that are effective for 21st century PD.

The advantages of utilizing an online social networking framework as a delivery platform for oTPD are threefold.

First, the online delivery platform supports and encourages teachers to learn together, while allowing them to retain control over their time, space, presence, activity level, identity, and relationships (Anderson, 2006). Increasingly, the demands on teachers' time and lack of control over their PD activities results in one-time, PD workshop sessions that are well documented to have little transfer to classroom practice (Borko, 2004). However, the delivery of PD through online social networking allows teachers to control their access and participation in relevant activities.

Second, it promotes the development of a network of relationships, which teachers can access to support their classroom teaching practices beyond their more formal oTPD activities.

Third, the delivery of professional development via a social networking site provides teachers with firsthand experiential learning about online technologies using tools such as blogs, forums, video and file sharing. The opportunity to actively engage with online tools for the purpose of creating online lesson plans and sharing them with other teachers to support their learning - an example of constructionist pedagogy in practice - provides teachers with an authentic experience of how online technologies can be used in their own classrooms.

The context

In 2009, an online Educators Community, www.2Learn2Gether.ca, was established by a not-for-profit organization in order to provide support for Alberta educators in a collaborative online environment. The community was based on social networking software customized to provide members with tools commonly found in social media sites like Facebook and Ning, or learning management systems like Moodle. Participant interactions in the online community involved user-created groups and forums, personal and group blogs, event calendars, and member messages. Learning opportunities included access to professional development videos, file uploading and sharing, and online teacher professional development Courselets.

The 2Learn2Gether.ca community proved to be successful as evidenced by a growing membership of over 1000 educators in its first year. The Courselet delivery model was piloted, which resulted in the development of a learner management system within the social networking software framework (Ostashewski & Reid, 2010). Ongoing evaluation and research around the use of this oTPD delivery format continues, and investigations are currently exploring a range of fully online, videoconference supported, and face-to-face blended delivery options.

A particular Courselet titled "Robotics and Hands-on Activities in the Classroom" was intended to provide teachers with an exemplar in two distinct forms: as a group of learning activities demonstrating constructionist pedagogy in action (i.e., the instructional design of the Courselet was based on constructionism), and through the instructional materials themselves, which presented Lego robotics activities structured for a constructionist learning environment, including presentation of the content and manner of implementation in the classroom. In other words, not only did the participating teachers experience the constructionist approach, they learned about constructionist pedagogy and how to incorporate it into their own classroom teaching practices. This result is in line with the recommendations of other studies (Alimisis, 2008; Alimisis, Moro, Arlegui, Pina, Frangou, & Papanikolaou, 2007; Bers, Ponte, Juelich, Viera, & Schenker, 2002; Stager, 2009), which found that engaging teachers in robotics training activities resulted in the integration of computer-based robotics into the classroom and the transformation of classroom environments towards constructivist learning. The activities in the Robotics and Hands-on Activities in the Classroom Courselet engaged participants with the constructionist literature, encouraged them to discuss and evaluate content-focused online resources, and participate in constructionist activities by sharing their reflections on the challenges of its application in their classroom. The final product was an online lesson plan utilizing the discussions and constructions of these PD activities. Seen through the lens of constructionist theory and emerging models of instructional design, the robotics Courselet provided an opportunity for participants to experience and reflect on a new strategy to add to their "instructional toolkit" or teaching repertoire. Within the constructionist paradigm of the robotics Courselet, participants formed new relationships with knowledge, something that Kafai and Resnick (1996) argue is as important as forming new representations of knowledge.

Constructionism learning theory

The theoretical framework and literature that informed the design of the oTPD robotics Courselet activities and content is based on Seymour Papert's (1991) constructionism learning theory. Numerous definitions of constructionism are found in the literature, but one of the simplest is the following: "constructionism boils down to demanding that everything be understood by being constructed." (Papert & Harel, 1991, p. 2) Hands-on learning, learning by doing, and learning through constructive play or gaming are other

descriptions of the application of constructionism and provide insight into the use of this teaching and learning theory. According to Papert and Harel (1991),

> Constructionism--the N word as opposed to the V word--shares constructivism's connotation of learning as "building knowledge structures" irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe. (Papert & Harel, 1991, p. 1)

According to constructionism theory, tools, digital media, artifact construction, and reflective discourse on the artifact are the basis of new knowledge construction. Similarly, the Social Media web provides a framework where learners are equipped with a constantly expanding array of online digital tools allowing them to construct and share their digital artifacts instantly with others around the world, a feat that Papert and others probably considered impossible 30 years ago.

Application to education

An application of constructionist learning is found in K-12 classrooms and occurs using LEGO educational manipulatives and robotics technology. Advances in the field of robotics combined with the initiative of the construction toy manufacturer, LEGO, has resulted in a unique partnership that has made its way out of research labs and into K-to-12 classrooms (Chambers, Carbonaro, & Rex, 2007). The design and construction of LEGO robot systems in a problem-solving context is an application of constructionist theory that is proliferating worldwide under the umbrella of the annual First LEGO League (FLL) international competition. The FLL competition and field kit presents a real-life series of engineering problems, which teams of students work to design a solution for using the programmable device and software, in order to have students concretize their understanding of the topic while solving competition tasks. An example of FLL field kit and competition involved the construction of a Lego robotic Land Rover vehicle, of the type used by NASA in their mission to Mars.

A significant boost to the use of educational robotics application in the classroom was realized upon the development of computer programming and physical manipulative construction kits. LEGO has organized classroom activity kits and materials to support science and engineering classroom activities for the K-12 classrooms (Carbonaro, Murray, & Chambers, 2007; Stager, 2009). The kit includes exploring levers, pulleys, and simple event programming. As an educational tool, LEGO robotics allows students to learn in an active environment while constructing physical objects and experiencing concepts in meaningful ways (Chambers, Carbonaro, & Rex, 2007). These activities provide students with an opportunity to use robotics to stimulate learning and problem solving and provide an experience that demonstrates how computer technology extends beyond the desktop computer. Young learners have an opportunity to act as mini-scientists and inventors whose creative work in building and testing solutions develops their own knowledge structures and epistemologies for understanding how the world works (Whitehouse, Reynolds, & Caperton, 2009).

In closing this discussion of how the constructionist theory is applied in education, Andersen's (2005) comment, in his review of Japanese students involved in LEGO robotics, eloquently summarizes the student competencies developed in the constructionist learning environments: "This way of organising and structuring education also enhances "flow", "creative thought", "collaboration" and "action competence" – all crucial, not just for individuals but also for institutions, companies and whole societies, to prosper and develop in the 21st Century." (pp. 13-14) Computational environments are stimulating workplaces that support new ways of thinking and learning by engaging the user in the design and creation of useful artifacts with an array of powerful tools. The educational innovations discussed support the following four tenets of constructionism as a learning theory identified by Bers, Ponte, Juelich, Viera, & Schenker (2002):

i. Learning occurs by designing meaningful projects and sharing them in a community,
ii. Manipulation of objects helps concrete thinking about abstract phenomena,
iii. Powerful ideas come from different realms of knowledge,
iv. And Self-reflective practice and discourse with others is crucial.

Even thought in Papert's view (1999) constructionism is a theory of knowledge, his theory contributed important elements to the discussion of 21st Century education. Papert's (1991) comment about why teachers should choose the constructionist philosophy of teaching makes this point concisely: "This is not a decision about pedagogic theory, but a decision about what citizens of the future need to know." (Papert & Harel, 1991, p. viii)

Application and potential for distance education

Constructionism is the only knowledge framework that has been proposed that allows the full range of intellectual styles and preferences to each find a point of equilibrium during an instructional event (Papert, 1999). This approach holds enormous potential in the provision of opportunities for distance education to engage students of all ages in meaningful collaborative learning communities. In a knowledge industry such as education, the construction and sharing of knowledge within a networked community (Dron & Anderson, 2009) has particular relevance for distance and online education as an instructional approach for the design for learner-centered activities. In contrast to Piaget's constructivism, Papert's constructionism focuses on "learning how to learn", and on the importance of making things during the learning activity (Ackermann, 2001). In summary, constructionism as an instructional approach has the potential to support meaningful active learning artifacts to meet the needs of networked connectionist (Papert, 1992) distance education.

The potentials of the Learning 2.0 web, which requires a demand-pull rather than supply-push teaching and learning approach (Whitehouse, Reynolds, & Caperton, 2009), may in fact meet constructionist online learning challenges and needs.

> [W]e argue that digital media for teacher learning helps teachers think differently about content than they would with other media, and we believe that thinking differently will help lead educators to effective change in practice. (Whitehouse, Reynolds, & Caperton, 2009)

The goal of the teacher professional development reported in this paper is ultimately for students to be engaged in constructionist activities, though their teachers' authentic engagement in and construction of new knowledge. As such, this paper contributes to the existing literature on this emerging field of oTPD and distance education.

The study

This paper reports on a segment of an ongoing design-based research study focusing on the development and delivery of oTPD within a social networking framework. Design-based research is a constructive activity that allows researchers to produce and add to the foundation of educational technology theory and may contribute more than other types of research to this field (Wang & Hannafin, 2003). The goal of this type of research is to develop models of successful innovative solutions, as opposed to describing particular artifacts or programs. It has been argued that research of successful models oTPD is best served by a design-based research approach (Dede, Ketelhut, Whitehouse, Breit, &McCloskey, 2009).

An understanding of the outcomes of design-based research can be found by exploring a key component of the methodology. This key component is an iterative development - delivery - evaluate - redesign cycle. The cycle is the process by which a design-based research method is able to broadly explore the nature of a learning innovation and the complex system in which occurs. In this type of research the Design-based Research Collective (2003) identified the goal of evaluation as a tool with which an educational intervention is analyzed and then further refined. However the similarity of design-based research with evaluation research ends there. A design-based research program goes beyond perfecting a specific product or artifact to generate a model of a successful innovation (Design-based Research Collective, 2003) supported by design and implementation principles.

In this research study, the constructive activity of building an environment, structure, and processes needed

to deliver oTPD is grounded by both the literature and the ongoing evaluations that occur as part of the development and delivery activities in a design based research study. Design-based research blends empirical educational research with theory-driven design of educational environments and is an important research methodology for detailing when, why, and how innovative educational solutions work in practice (Design-based Research Collective, 2003). It is the innovations of this type of research process that we believe will help educators to understand the relationships among theory, designed innovation, and practice. To develop and disseminate a successful model of oTPD delivery using a social networking framework is the goal of this ongoing design-based research program.

Preliminary findings

The "Robotics and Hands-on Activities in the Classroom" online TPD Courselet was based on a constructionist design which provided learner engagement with the four tenets of constructionism (Bers, Ponte, Juelich, Viera, & Schenker, 2002). One early career teacher participant indicated that he was assigned to a teaching position where LEGO robotics was the focus. The oTPD Courselet provided critically needed resources, networking, and classroom applications that were not made available to him any other way. Without the timely and flexible access that the oTPD Courselet provided, the teacher reported that his students would have had much fewer opportunities to explore LEGO robotics activities.

The robotics Courselet was designed to make use of several social media technologies that are part of the social networking structure. Within the Courselet structure the following elements were available to teacher participants at the start of the oTPD Courselet:

i. a weekly activity guide,
ii. embedded videos,
iii. a discussion forum,
iv. a file sharing folder,
v. a group blog,
vi. a Courselet overview,
vii. an event calendar; and
viii. a list of Courselet participants.

The weekly activity guide presented links and participant expectations for each week of Courselet activities. Instructions and links to external articles and websites, as well as internal Courselet videos were described in each of the weekly activity guides. Courselet videos included instructional segments on tools found within the Courselet, such as "how to post a blog" as well as external LEGO robot exemplars found on YouTube. Weekly discussions were initiated by the instructor in the Courselet discussion forum and the instructor moderated ongoing threads that supported the TPD activities of each week. The file sharing folder allowed PDF documents, such as step-by-step "how to" guides to be available for participants, as well as made it possible for participants to upload images that demonstrated a completed LEGO robot constructed as part of one week's activities. The group blog, which allows for posting a blog and then further threaded comments connected to that blog, was used by the instructor to have the participants track their own professional growth and challenges during the oTPD activities. The value of both the discussions and the blog postings, participants commented, appears to revolve around the sharing of resources and teaching strategies using these resources. The social networking framework in which the Courselet was delivered, by default, lends itself to the sharing of information, contributing to the overall value to teachers of this type of oTPD delivery.

Numerous participants reported that this was their first PD experience with LEGO robotics and the experience provided a much needed technology support activity for their teaching practice. Participants also reported that the resources and discussions around the implementation of LEGO robotics activities in their classroom provided them with sorely needed pedagogical strategies. For example, one task within the Courselet involved identifying and discussing the building challenges that are inherent in LEGO robotics activities. The discussions surrounding this activity provided considerable insight to implementation strategies for the teachers in their specific teaching context. In this way, the Courselet provided valued

opportunities for teachers to discuss strategies for LEGO robotics as well as the constructionist learning pedagogy.

Following the four tenets of constructionism as instructional design guideposts for the oTPD Courselet seems to have provided timely access and resources to support new teacher classroom activities.

Findings of the first delivery of this Courselet indicate considerable value for participants in two areas: the manner in which the oTPD experience was delivered, and the content of the Courselet. The theme of flexibility of access to the Courselet materials is one key finding reported. As part of the Courselet participants were pointed to online resources and provided with opportunity to dialogue with experienced LEGO robotics teachers on a flexible schedule over a period of eight weeks. Teachers reported the flexibility of the timeline of the Courselet and the activities within the Courselet were very important success factors as they often struggled with finding time to access PD activities during teaching. Participant feedback regarding the delivery of the Courselet within a social networking framework indicated that while some participants were very familiar with the web 2.0 toolset and used it daily in their teaching practice, for other teachers it was new and required time to learn how to navigate and use the tools. Both groups of teachers reported that there was value in the social network delivery framework.

The second key finding was that the content of the Courselet supported TPD learning effectively. Outlining objectives and scaffolding of learning for teachers by providing all of the materials at the beginning of the Courselet was reported to assist teachers in knowing how to manage their progress through the activities. Instructional video segments and PDF materials supporting interactions, such as blog posting or lesson plan development, provided participants with the needed asynchronous support. Access to new resources identified in the materials and in forum discussions was reported as very valuable for classroom application of LEGO activities. Networking with other teachers who were integrating LEGO robotic activities and sharing experiences within this community allowed teachers to develop relationships that continued beyond the Courselet activities. This networking with an extended LEGO robotics community was evidenced in two ways: teacher participants asked to have continued access to the Courselet artifacts and discussion space, and several participants volunteered to be involved in the 2010 FLL competition as coaches or volunteers reportedly due in part to their Courselet participation.

In conclusion, the robotics oTPD Courselet provided an opportunity for teacher participants to experience, reflect, and plan an implementation of a "new" constructionist pedagogical strategy for their instructional toolkit. Through the exposure and experience of constructionist activities such as building robots, guided reflective blogs, sharing resources and classroom implementation ideas through forum postings, and construction of a digital artifact (online lesson plan), the constructionist PD design was demonstrated to be an effective method of oTPD. Findings support the development of a new online teacher community that has potential to continue to exist for the purpose of providing ongoing access to materials and participants anytime and anywhere needed. The delivery of technology oTPD activities delivered within a social networking software community appears to hold promise for further support of LEGO robotics technologies in the classroom, with the potential of developing a mature robotics community as identified in Ostashewski and Reid's (2009) IME Community of Learners.

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