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Preparing General Technology Teachers in China for New Roles and Responsibilities

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Abstract: This paper discussesthe conceptualization, implementation and initial findings of a professional learning program (PLP) which used LEGO® robotics as one of the tools for teaching general technology (GT) in China's secondary schools. The program encouraged teachers to design learning environments that can be realistic, authentic, engaging and fun. 100 general technology teachers from high schools in 30 provinces of China participated. The program aimed to transform teacher classroom practice, change their beliefs and attitudes, allow teachers to reflect deeply on what they do and in turn to provide their students with meaningful learning. Preliminary findings indicate that these teachers had a huge capacity for change. They were open-minded and absorbed new ways of learning and teaching. They became designers who developed innovative models of learning which incorporatedlearning processes that effectively used LEGO® robotics as one of the more creative tools for teaching GT.

Keywords: Professional development, general technology teachers, LEGO®, constructivism, robotics

1. Introduction

The study reported in this paper outlines an initiative where a joint education project was undertaken between China and Australia. The project involved the professional development of one hundred high school general technology (GT) teachers from all provinces in China. This initiative was supported by the Ministry of Education (MoE), a local business (in China) and the LEGO® foundation in Denmark. An Australian University led the project. The key objective of the project was to enable general technology teachers to implement an innovative curriculum that was student-centred and promoted creativity and problem-solving. Because GT was only made compulsory for schools in China in 2010, no graduates from normal universities had been trained previously to teach general technology specifically, therefore, a strong group of specialised teachers is urgently needed to play a key role in fostering and developing new skills and innovative approaches to facilitate the science and technology attainments of China's youth.

2. Conceptualization of GT Teachers' Professional Learning in China

2.1. What research tells us

Research increasingly has informed us that the continued professional development of teachers is key to improving the quality of education. Experience in many countries strongly indicates that many educational reforms rely on teacher learning and improved instructional practices in class to enhance student learning [1]. Numerous studies and reports have recommended changes to teacher education to better prepare them to cope with 21st Century students [2]. Due to recent New Curriculum reforms in China, in-service teachers urgently need to engage in an "effective" kind of professional learning, if the newly introduced educational reforms are to have an impact on student learning. Lawless and Pellegrino [3]

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argue that introducing teachers to new technologies for teaching and learning can support a change in teaching practices. The Professional Learning Program (PLP)which is the focus of this paper demonstrates not only how to use technology, but also shows teacher participants how technologies can support instructional goals. The ultimate aim would be to achieve a degree of change in teacher mindset.

2.2. Theoretical Framework

The design of the general technology Professional Learning Program (PLP) adopted the key principles as proposed by Desimone [4]. She contends that these principles are characteristics of professional development which play a critical part in increasing teacher knowledge and skills,in improving their practice, and, which hold promise for increasing student achievement. The principles included the following.

- *Content focus:* the most influential feature – the PLP focused on the GT syllabus for this project
- *Active learning:* opportunities for teachers to engage – throughout the PLP, GT teachers had ample opportunity to engage whereby they designed challenges, discussed, evaluated, reflected and shared their knowledge online.
- *Coherence:* the consistency of school, district and state reforms and policies with what is taught in the PLP – this project was sponsored by the Ministry of Education with industry support and policy messages to teachers were consistent throughout.
- *Duration:* PD activities require sufficient time and had to span over a semester – the PLP was conducted intensively over five days, followed by implementation in schools and follow-up workshops after twelve months.
- *Collective participation:* participation of teachers from the same school or department – in the PLP teachers were grouped according to provinces and engaged in multiple forms of interaction and discourse including extensive group work and online discussion forums.

In addition, four pedagogical approaches [5] were adopted. Firstly, the program was underpinned by the theory of constructivism where human learning is constructed. Learners build new knowledge upon the foundation of previous ones. No matter if they are correct or incorrect, despite having the same learning experience with somebody else, each learner constructs individual meanings. Secondly, the notion of Papert's [6] constructionism– learning by doing --was incorporated. The learner in a constructionist environment builds things on their own, preferably a tangible object that they can both touch and find meaningful. Thirdly, learning by design facilitated collaborative learning in teams whereby students engage to design activities and reflect on their experiences. Fourthly, cooperative inquiry, which involves -- contextual inquiry, participatory design and technology immersion – allowed for teacher exposure to LEGO® robotics which for many teachers in China was their first experience. The PLP placed heavy emphasis on pedagogy. It was not sufficient for teachers to merely engage in exciting activities, work with well-developed curricular materials, and interact with one another in constructive and positive ways. The PLP aimed to have teachers return to their classrooms with clear teaching methods and means to assess their students' learning processes.

These four pedagogical approaches coupled with the critical principles of professional development guided the design and development of the PLP. The three phases below demonstrate the PLP cycle where teachers continuously engaged in professional discourse online and participated in the sharing of resources with other teachers across China, a resource sharing culture that was also foreign to the majority of the teachers. Essentially the PLP was a pedagogical approach to allow teachers to design learning environments to support new ways of teaching.

2.3. Design and Development of the PLP

In recent years, Chinese education reforms and teachers have become very mindful of innovative approaches. Chen [7] when discussing key issues in the implementation of general technology curriculum, believes that the ways to handle the problems are *learning by doing* and *doing for learning* to connect the curriculum with the students' daily life; integration with other subjects, integration of compulsory and optional modes and paying attention to the humanistic effects resulting from the integration. Chen also goes on to say that the curriculum needs to be the platform for students' innovation.

In line with these reforms the PLP in this study was therefore designed to immerse teachers ina constructivist-learning environment through hands-on engagement with LEGO®educational robotics. It was believed that through these experiencesteachers would be able to design and implement learning activities in general technology classrooms that were interesting, enjoyable and challenging. More importantly it would cultivate skills to creatively solve problems. Through this training, it was also hoped that teachers would acquire knowledge and skills to assume a leadership role in sharing this expertise with their peers in their local provinces. An online community was also created to facilitate interaction between teachers in China and experts in Australia.

The PLP included three Phases of implementation. *Phase 1 - five day training face-to-face:* teachers participated in hands-on workshops focussing on inquiry and project-based learning using LEGO® robotics. The teachers were expected to construct their own knowledge as they think technologically (using LEGO® robotics across subject areas) to investigate, design, produce, evaluate and reflect on their "design challenges". Throughout the five-day training sessions they engaged continuously in discussions both in class and online which focussed on the interplay between materials, systems and information in the tasks which they carried out in groups of four or five. By the third day teachers were required to design their own lessons within their teams. These lessons were then presented to the group and tried out in class. At the end of the PLP, each teacher was required to design at least three more lessons, which they will try out once they returned to their own schools. These lesson plans together with teacher self-reflections and notes for improvement were then uploaded onto a Learning Management System for sharing among all teachers.

Phase 2 - twelve months of lesson implementation in schools: teachers implemented their ideas in their classrooms, using some of the strategies derived in Phase 1. Throughout this time all teachers engaged in online discussions on a Moodle platform moderated by the project team.For the majority of the teachers their schools were then set up with access to LEGO®robotic kits and laboratories provided by the MoE (a partner in this project) in China as part of their curriculum renewal process.

*Phase 3: two-day follow-up workshop focusing on reflection and sharing.*This was the reporting and deep reflection phase.Teachers shared their experiences, ideas, lesson plans and resources face-to-face and online. An electronic repository was established with access for all teachers who participated.

3. Details of the Professional Learning Program

3.1. Participants

One hundred and forty GT teachers participated in Phase I of the PLP in July 2010. Three teachers from each province in China were nominated by the MOE to complete Phase 1 in Nanjing (2010) and Phase 3 in Beijing (2011). Phase 2 was completed at the teachers' schools.

3.2. Purpose

The aim of the PLP was to influence teacher mindsets to allow changes in teacher practice to have an impact on student learning outcomes in general technology. The program employed an innovative framework to prepare high school teachers to integrate robotics activities with their classroom teaching methods. The program provided guidelines to teachers through hands-on activities. Teachers were shown how to develop assessment procedures to assess design-based learning in the classroom, and to identify teaching approaches that effectively integrate robotics to support student learning.

3.3. Nature of teacher seminars and workshops

Teachers received all the materials, tools and support they need to become change agents in their own schools. During the training session teachers had every opportunity to practice new strategies in an informal setting with their group members. Peer evaluation of each other's work was a core part and at the end of each day there were reflection sessions where teachers had to work in groups and individually to upload what they felt they had learnt that day. All this material was then made available to all online.

3.4. Training teachers for 21st century students

The project team recognised that there will be substantial need for teacher professional growth for effective implementation of the new GT syllabus post training. This growth requires significant change to teacher practice and beliefs. In designing the program it was important to ensure that the participants would ultimately be able to demonstrate some of these characteristics as depicted by Kalantzis and Cope [8]. If teachers are to return to their schools as change agents then the teacher has to be:

- purposeful learning designers, rather than (just) a curriculum implementer.
- able to "let go", allowing learners to take more responsibility fro their own learning.
- collaborative, sharing their learning designs online, reusing and adapting others' learning designs and jointly writing learning designs in teams, peer reviewing others' learning designs, team teaching in classes – developing a professional culture of mutual support and sharing.
- able to provide opportunities for students to critically self-assess and reflect upon their learning.

Besides these qualities, we also needed to be mindful that when GT teachers implement their new teaching strategies in class, for them their problems are amplified because of the demands of using robotics in class. In addition to preparing their GT lessons, they have to manage laboratories with hundreds of pieces of equipment, work with timetable constraints and manage large classes.

4. Why Robotics?

Studies have shown that robotics can have inter-disciplinary potential to enhance cognition in a range of ways. Research on the cognitive skills development associated with technology has established that use of robotics helps improve students' problem solving skills, critical thinking, collaboration and communication [9]. Maud [10] discovered through extensive use of robotics-based lessons that students were simultaneously developing knowledge in mathematics and science and being required to vocalise problems and solutions. Working with technology-based processes of design also encouraged peer-tutoring, self-reflection and self-directed learning.

5. Preliminary Findings and Observations

Despite the constraints that the teachers had to work with in their local situation, the preliminary findings from teacher reflections and classroom observations strongly indicate that for professional learning to have a flow on effect on students in the classroom, teachers need to buy in first. That is the training sessionsand subsequent support must have the ability to have an impact on the teachers for them to be able to change their mindset and for them to subsequently change their teaching practices. As one teacher put it:

> *When we started on the first day we were not confident to speak up publicly and did not feel that we were learning very much. However, by the third day all teachers in each team or group were actively engaged in all activities, presentations and discussions. We realised that for us to be good teachers we need to be able to see the classroom activities from the students' perspective. First we need to learn ourselves just like being a student and then and only then can we be better teachers who teach these students to be active learners.*

From an initial analysis of focus group interviews, surveys, reflective statements, videos and lesson plans, it was evident that teachers realized that the activities which they engaged in actually mirrored what designers and engineers seeking to solve problems would be doing to produce new knowledge. In this way teachers deepened their understanding of how LEGO® robotics can be used to teach GT and not merely teach to the textbook or for students to sit examinations. Teachers consistently indicated that during the training they had learnt to recognise what kinds of experiences actually facilitated their learning and in turn their students' learning.

In order to ensure replicability of this model throughout China, the project's materials have been carefully aligned with the general technology curriculum standards in China. It is the aim of the MoE to train as many teachers as possible within a short period of time. This project is hopeful that professional educators of tomorrow will not be people who simply enact received systems, standards, organisational structures and professional ethics. [2]. To date, preliminary findings confirm that the teachers who have undergone training

are now using, adapting and envisioning models of instructional design that are flexible, adaptive and based on innovative instructional methods as well as creative use of LEGO® robotics and other materials.

Finally, another important observation is that teacher learning is influenced by participation in a community. With the extensive amount of time spent on discussions and reflective activities, which the teachers were initially uncomfortable with, their learning has surely been enhanced by interactions that encouraged them to articulate their views, challenge those of others and to come to better understandings as a community. When these teachers were supported by appropriate technology, design processes and teaching strategies,they feltempoweredto create, adapt and share content more easily.Evidence for changes in teacher attitudes and beliefs can be found in the teachers' reflective notes, in focus group discussions and in the multitude of new lesson plans generated as a result this intervention. The PLP also succeeded in changing teachers' awareness of what was worth assessing e.g., using assessment rubrics to evaluate the entire design and challenge process and not just teaching to the textbook and for producing the outcome alone.

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