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Developing professional identity through authentic learning experiences

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This study proposes a simulation approach of designing authentic learning experiences with an attempt to develop students' professional identity and capacity. The approach provides students with guaranteed exposures to professional roles and practices along with interventions from the instructor and practicing engineers through the simulation of a typical design project in civil engineering consulting firms. Students are required to develop designs collaboratively in teams for an on-going housing project based on the actual information and constraints of the site. A survey was administered to students about their professional identity development as well as the learning experiences. It was found that the approach created a sense of real-world experiences and had a positive impact on students' professional identity development. This study offers a new approach of providing authentic learning experiences that are more relevant and meaningful to students' future profession as well as more integrated with the academic curriculum while being less influenced by external, uncontrollable factors such as company or logistics arrangements.

Keywords: authentic learning, capstone course, professional identity development

Introduction

To prepare students with competencies and professional dispositions to work in complex workplace becomes increasingly important to higher education institutions. Students need to develop confidence in undertaking the disciplinary approach, understanding professional roles and work cultures, and identifying themselves as part of the professional community. These aspects are all parts of the professional identity development process.

Professional identity is also found to be a key motivating factor for students to persist in their university study. Specifically, engineering identity is also an important driver for students to pursue engineering as their career (Meyers, Matthew, Pawley, Silliman, & Smith, 2012; Tonso, 2006). It has been well recognised that professional identity cannot be solely developed through lectures and that the involvement in the discourse and practice of professionals in the community is essential (Allie et al., 2009).

One viable way to build professional identity is therefore to bring students to authentic and real-world working experiences, which will help them make sense of the knowledge and skills acquired in the university. Internships or work placements are often used to achieve this purpose. However, students' experiences during internships are majorly influenced by the company. The actual exposure to the professional engineering work is not guaranteed though the environment is truly authentic (Jonassen, Strobel, & Lee, 2006). Another constraint is that there are a limited number of internship opportunities, typically one or two, in the whole curriculum. The experiences are often not well connected to the contents in the academic courses.

This study proposes a simulation approach, which provides authentic design experiences through a simulation of real-life work in civil engineering consulting firms. The approach has been implemented in a compulsory capstone project course for final year civil engineering students in one of the research-intensive universities in Hong Kong. The decision of testing this approach in a capstone project course is based on the nature of capstone, which is about enabling students to integrate the subject knowledge and skills that they acquired in earlier years into a united whole in order to tackle an independent inquiry (Keith, Wong, & Li, 2014). Capstone courses therefore provide an ideal platform for the provision of authentic learning experiences which often involve various inter-related aspects associated with a profession.

Students following the approach are required to form multi-disciplinary teams specialised in different engineering aspects, with a structure similar to that in a design company. With the assistance of a team of practicing engineers as facilitators and professional advisors, students need to visit the construction site, identify site information, collect design constraints from government departments, perform impact assessments to understand the environmental and traffic issues, and finally come up with the foundation and structural design of the infrastructure.

By providing systematic simulated experiences and timely interventions, the approach allows students to integrate their knowledge and skills acquired in the first two and half years of the curriculum and apply them in a practical and professional sense. This study attempts to address two questions: (1) do the simulated design projects and environments provide students with a sense of real-world experiences? and (2) what is the impact of these experiences on students' identity development in civil engineering?

Identity Development through authentic design experiences

Engineering identity has been conceptualised as consisting of two broad constructs: the academic identity and the engineering aspirations. Academic identity indicates the extent to what students perceive themselves as performing well in their academic subjects while engineering aspirations mean the extent to which they see the work of engineers as desirable (Capobianco, French, & Diefes-Du, 2012). To identify oneself with engineering and perceive one's career in the engineering field are found as essential components that can reflect one's engineering aspirations (Meyers et al., 2012). Identity development has been conceptualised as an on-going, shifting, and dynamic process (Hatmaker, 2012). The acquisition of knowledge and skills in the specific field, though important, is only a part of the efforts to acquire the professional identity. Apart from that, students also need to develop ways to define themselves as professionals (Sutherland & Markauskaite, 2012).

There are two main groups of theories on engineering identity development (Dehing, Baartman, & Jochems, 2011). One group of theories emphasises the importance of social embedding and the surrounding communities. A typical example is the professional apprenticeship, aiming at mentoring students with the way of thinking as practising professionals (Sullivan, 2004; Wenger, 1998). The second group of theories frames the identity acquisition as the process in which individuals actively experiment with professional roles (Dehing et al., 2011; Ibarra, 1999). This can be achieved through students observing role models, experimenting with the provisional professional role, and evaluating these experiments through reflection and external feedback.

Authentic learning experiences embed the essence of both groups of theories. Six characteristics of authentic learning experiences have been identified, which include (1) a personal relevance to students; (2) a social context mirroring as much as possible the real-world practices; (3) sufficient autonomy for students to act independently; (4) appropriate scaffolding for students to develop professional thinking; (5) a complex, open and ill-defined problem; and (6) treating students as a real professional (McCune, 2009). Based on the above conceptualisation, whether or not a student is situated in the actual commercial firm is not the key to authentic learning experiences. The nature of the problem, the support from mentors as well as the social contexts are, instead, more important.

Internship experiences in fact often fail to conform to these requirements of authentic learning due to various constraints in the environments and the arrangements between the university and companies. There were often no clearly defined learning outcomes for the internship. Interns were in most cases exposed to a small part of the project without a full picture of the design experiences. According to Meyers and associates (2012), internships did not predict engineering identity because students with negative experiences were discouraged from becoming an engineer and that there were no interventions during the process.

Authentic learning experiences are indeed important but one should note that they also need to be supported by a clear connection between the experiences and theoretical knowledge as well as appropriate intervention from academic staff. Fitch's (2011) study well demonstrates this notion. Her study provides students with opportunities to work in consultancy teams among other students and develop communication strategies for real clients that include community groups in education, environment, aged-care, arts, youth and service sectors. The finding of her study shows that working with real clients on ambiguous projects may not automatically develop professional identity. On the contrary, some students felt frustrated by the constantly changing demands of real clients and were not able to see the relevance between the experience and their future professional work.

Regarding engineering students, there are a few empirical studies demonstrating the process of engineering students developing engineering identity during authentic learning experiences (Case, Kotta, & Mogashana, 2007; Dehing et al., 2011). The building of a learning community related to a chemical engineering course and its impact on engineering identity development has been studied in Case et al. (2007). The impact of workplace learning has been investigated in Dehing et al (2011). More research studies are needed on the relationship between simulated experiences in courses and students' identity development. It would be meaningful to study whether well-designed simulation experiences in courses within the formal curriculum can provide a sense of real-world practices and help build engineering identity. Such a study will open up new possibilities in curriculum design.

Design of the course

The simulation approach was implemented in a two-credit capstone design course for final year civil engineering students. The course was offered to students during their final semester of the undergraduate study. In previous offerings, the course was mainly delivered through lectures. Students were required to submit a design report at the end of the course. In this new trial, the course has been completely revamped. The entire course could be seen as a full simulation of the real-life workplace in civil engineering consulting firms. Students were required to form multi-disciplinary teams specialised in different engineering aspects, including environmental, geotechnical, transportation, and structural. This type of team structure is commonly adopted in a real-world design project. A team of five practicing engineers was appointed as guest lecturers who acted as the facilitators and professional advisors to student teams. Students worked in teams to acquire necessary information, formulate design solution, and work out the method to implement the solution.

The main task for students was a housing project located in an area of approximately 67,000m^2. This was in fact a real on-going civil project in the city. Students were required to visit the site and develop their designs based on the actual information and constraints of the site. It was proposed that the existing structure would be demolished and redeveloped for public housing. The site and the existing buildings were located on a slope so that extensive site information must be obtained for developing a sound design plan. Students were also asked to obtain information from relevant government units, following the same procedure a real team of engineers would undertake in a design project. Due to the complexity involved in this real-life project, a large amount of coordination was required among students in their sub-teams responsible for different engineering areas.

To enhance the authentic learning experiences in the course, students were also required to solve an emerging problem in a hypothetical scenario at a certain stage, typically around four to five weeks after the project started. The scenario presented to students represented a sudden change in the site condition. The scenario deployed in this pilot study was that the construction site was flooded due to heavy rains and students needed to formulate emergency plans within a short period of time. Students were not informed of the sudden change in advance and only had a limited time to solve the problem. A brief report was required.

There were four assessment components, including the attendance at the site visit, the scenario-based problem solving module introduced above, project reports (a sub-team report focusing on one area of the project and a final integrated report), and a project presentation. All components were assessed based on rubrics except for the attendance. The requirement for the project report followed the standard format of a consultancy report. For the final integrated report, the consistency among the assumptions and parameters of sub-teams was one of the scoring criteria, aiming to facilitate coordination among different engineering areas. Students were asked to address both laymen and technical advisors in their presentations. The practicing engineers as well as the course instructor were on the panel to raise questions to students about their design.

Settings

In the spring semester (i.e., from February to May, 2014) of 2013-14, 151 students in a university in Hong Kong were enrolled in the course. All students were in their final semester (i.e., the second semester of their third year) of the civil engineering undergraduate study. Since internship is a compulsory component in the civil engineering curriculum in this university, all students had at least one internship experience before taking the course.

The survey items were adapted from the relevant items measuring engineering self-efficacy, engineering intrinsic interest value, identification with engineering, and engineering career in the study of Jones and associates (2010). The original study regarded engineering as a broad discipline while this study specified the characteristics of civil engineering in each item. For example, 'I like engineering' was adapted to 'I enjoy designing and building things'. The items were firstly drafted by the first author and then reviewed by the second author. Disagreements between the two authors were resolved through a number of discussions. A small-scale pilot study was then conducted with five civil engineering students who were asked to complete the questionnaire and subsequently invited to comment on and make suggestions to the items.

The final version of the pretest covered four items on self-efficacy in civil engineering (e.g. "I am clear about the procedure of delivering a civil engineering design project."); two items on intrinsic value (e.g. "I find that civil engineering is an interesting subject.")'; four items on self-identification with civil engineering (e.g. "I feel happy when I am able to make important civil engineering decisions."), and three items for career plans in civil engineering (e.g. "I plan to have my career in civil engineering.").

The post-test contained the same items in the pretest and also involved five questions on students' experience in the course. Examples were "The course helped me form a clear picture of the design experience." and "The course enabled me to act like a civil engineer." All items adopted a 7-point Likert scale (1 – strongly disagree, 7 – strongly agree). In addition, students were asked to select the components they found most useful in the course. The posttest also included two open-ended items aiming to elicit students' suggestions to improve the learning experiences and their lessons learned from the course.

Pre-test and post-test were administered to all students enrolled in the capstone course at the beginning and the end of the semester. The internal reliability of each construct was examined by Cronbach's α as the internal consistency score for the four constructs in both the pre-test and post-test. All of these values exceeded .70, which is considered as meeting an adequate internal consistency in social sciences study (Nunnally & Bernstein, 1994).

Results

Among the 151 students enrolled in the course, 142 students completed the pre-test and 146 students completed the posttest. The matched sample size was 139, representing 92% of the total class size. The values of relevant items were averaged to represent a construct. Through paired sample t-test, it was found that students indicated higher level of self-efficacy in civil engineering, higher self-identification with civil engineering, and a stronger desire in having a career in civil engineering. There was no statistical difference in their intrinsic value to civil engineering. Table 1 shows a summary of the results.

The course components perceived as most useful by students were "working in a team" (111 votes), "the design experiences" (96 votes), and "handling real-site situations" (82 votes). "Site visit" and "interaction with professional engineers" were components with relatively fewer votes (i.e., 32 votes each). Table 2 shows a summary.

Table 1: Results of the Paired Sample T-test

Construct	Pretest[a]		Posttest[a]	
	Mean	*SD*	*Mean*	*SD*
Self-efficacy in civil engineering**	4.376	0.920	5.106	0.743
Intrinsic value to civil engineering	5.338	1.013	5.468	1.020
Identification with civil engineering*	5.475	0.938	5.662	0.801
Career plan in civil engineering**	5.486	1.000	5.824	0.862

**p<0.01; *p<0.05

[a]Scale: 1-7, 1 - strongly disagree; 7 - strongly agree

Table 2: Components perceived as most useful by students

Component	Number of Votes[a]
Working in a team	111
The design experience	96
Handling real-site situations	82
Self-directed problem-solving	53
Group meetings	47
Lectures	42
Project presentation and discussion	34
Site visit	32
Interaction (or meeting) with professional engineers	32

[a]Students could choose as many components as appropriate.

Regarding students' course experiences, 87% of the students agreed that the course enabled them to act like a civil engineer and 86% agreed that the course provided a clear picture of the design experience. The percentage of students who agreed that the course provided an opportunity to integrate the civil engineering knowledge and skills acquired before the course was 85%. The means and standard deviations of the items on the course experiences can be found in Table 3.

Table 3: Students' ratings on the course experiences

Item on the course experiences	Mean[a]	SD
The course provided an opportunity to integrate the civil engineering knowledge and skills I learned before the course.	5.528	0.926
…helped me form a clear picture of the design experience.	5.500	0.977
…increased my interest in designing and building things.	5.308	1.007
…enabled me to act like a civil engineer.	5.541	0.872
…enhanced my determination to be an engineer.	5.397	0.921

[a]Scale: 1-7, 1 - strongly disagree; 7- strongly agree

Among the 146 students who completed the post-test, 80 students provided suggestions to improve the design experiences in the course. Most of the suggestions focused on the support and scaffolding to students, for example, more lectures on the theories (by 15 students) and more guidance on the project (by 14 students). In addition, students also indicated the lessons learned from the course. Specifically, 96 students have indicated the areas they would like to improve based on their experiences in the course. The areas that have been frequently mentioned included design knowledge and skills (by 16 students), technical knowledge (by 15 students), and real-life design exposures (by 11 students).

Discussion

The pilot run of the course has demonstrated that simulated experiences can provide students with a sense of real-world experiences. Students indicated higher self-efficacy, better identification with civil engineering, and a stronger desire to pursue a career in civil engineering at the end of the course than they did in the beginning. The intrinsic value to civil engineering remained the same high level, which indicated that these students were interested in civil engineering and also maintained their existing level of intrinsic value to civil engineering throughout the course.

It was noted that students' self-efficacy in civil engineering was relatively low (averagely at 4.4 on a 7-point scale) in the pretest even if they all had internship experiences prior to the course and were in the final semester of their undergraduate study. This result is consistent with the arguments made earlier in the previous section that an internship may not necessarily provide students with the confidence in their professional knowledge and skills. After the course, the self-efficacy level raised to 5.1 on average along a 7-point scale. As discussed in Ibarra (1999), an opportunity for the students to experiment with the professional role can be more relevant and useful for developing the professional knowledge.

Students' ratings on the course experience (refer to Table 3) showed that the course has provided a sense of real-world environment. To be specific, more than 80% of the students agreed that the course provided a clear picture of the design experience and also enabled them to act like a civil engineer. Students' evaluation to the authenticity of the setting and their roles is important since it is essential to authentic learning experiences (McCune, 2009). The means of all the five items evaluating course experiences were above 5.3 along a 7-point scale.

A majority of the students perceived working in a team, the design experience, and handling real-site situations as the most useful components. The design of these components in the course has been following a real civil engineering design project. Working in a team was more related to the social embedding and communities as described in Sullivan (2004) and Wenger (1998). The design experience and handling real-site situations enabled students to actively experiment with their simulated professional roles (Dehing et al., 2011; Ibarra, 1999). These two aspects created a favourable environment for students' professional identity development.

The suggestions given by the students were mostly related to the support and guidance to their learning, which indicated the importance of scaffolding in authentic learning, as emphasised in McCune (2009) and Fitch (2011). An interesting phenomenon was that students suggested having more lectures in the course whereas the lectures as a course component were not perceived to be as useful as some of the other items. These two seemingly contradictory results in fact provided some insights to students' readiness in a problem-based learning environment. On one hand, students realised that they needed more professional knowledge as they started to get engaged in the problem-solving process. On the other hand, they were probably not fully ready for the problem-based learning environment because they still expected most information to be provided in lectures. The initiatives to actively seek information and learn in a self-directed manner were not in place. The lack of such initiatives could also be observed from the lower number of votes by students on the usefulness of the component "interaction (or meeting) with professional engineers".

Overall speaking, the evaluation results are encouraging with regard to the effectiveness of the authentic learning experiences in developing engineering identity. It should be noted that the study has a number of limitations. Data were collected from only one cohort of students. The pilot study should be replicated with more cohorts of students to study the effectiveness of the approach. The study is also subject to the potential bias from maturation. Participants at their final year of study could naturally become more competent in their profession and have a higher level of identification regardless of the intervention. Qualitative data should be collected from students to cross-validate the results in the next stage of the study.

Conclusion

Authentic learning created through simulated experiences is found to have a positive impact on civil engineering students' self-efficacy and professional identity development. The study also shows the value of simulated experiences in creating a sense of real-world engagement and professional practice. Students' suggestions on having more lectures and guidance on the project affirm the importance of scaffolding as emphasised in the literature. Meanwhile, these suggestions also shed light on the readiness of students in a problem-based learning environment.

The implication of the present study to curriculum development in higher education is significant since simulated design projects may become an important component in more senior years of a curriculum, during which students can integrate their knowledge and skills acquired in the early stage for the development of professional identity and be better prepared for entering the professional world. Although the present study is situated in the discipline of civil engineering, the approach of providing authentic experiences through capstone projects would be relevant to some other disciplines that also value professional identity and problem-solving skills.

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