Role-play learning tool to enhance student's view of industry operation complexity

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Introduction

Universities are expected to produce graduates that are able to effectively engage in the professional environment. The debate around how to promote professional graduate attributes and prepare work-ready graduates has been recurrent in higher education literature (Litchfield, Frawley, & Nettleton, 2010; Moore & Morton, 2017; Spanjaard, Hall, & Stegemann, 2018). It is generally accepted that engineering higher education programs must provide students with the necessary technical skills, and at the same time develop all the professional skills such as communication and teamwork, to prepare them to work in the industry environment. Less common is the reference to the need to expose the students to the industry structure with their diversity of roles, specific responsibilities and interdependencies. However, successful adaptation to the work environment can be greatly facilitated if students get the chance to understand the complexity of an industry work environment before having to participate in it in a placement or first job.

Approaches to leverage the adequate level of industry readiness have involved a variety of in-class activities such as demonstration, debate and experiential collaborative exercises (Bedwell, Fiore, & Salas, 2014), problem-based learning (Davis & Miller, 1996), and role-play (Duchatelet, Gijbels, Bursens, Donche, & Spooren, 2019).

A role-play is an active learning activity in which students engage in a realistic scenario to develop cognitive, affective and behavioural awareness in a supported environment. It can also foster student's engagement and establish explicit connections between content, which may enhance the retention of information and the application of the knowledge in different contexts (Pavey & Donoghue, 2003). A role-play is therefore, an appropriate tool to foster the development of interpersonal and professional skills while consolidating the scientific and technical content of an engineering course. The application of role-playing in higher education has been done in multiple fields of study (Ahmad, Shafie, & Latif, 2010; Chan, 2012; Rao & Stupans, 2012), to stimulate professional skills such as communication and professional attitude.

Role-playing is especially valuable to promote higher order learning objectives such as creation, evaluation and analysis (Shapiro & Leopold, 2012). Therefore, it is an adequate tool to consolidate knowledge acquired in earlier stages of the study program or of the course in which the role-play is embedded.

Role plays are also adequate tools to promote students' awareness of situations happening in reality within the work environment (Kilgour, Reynaud, Northcote, & Shields, 2015). This becomes even more impactful when industry members participate in the role-play, acting as they do in real life.

Motivation and objective

This study assessed the impact of using a role-play simulation of a water utility to develop professional skills relevant to water engineering. The situation used for the simulation was based on a real-life scenario that a bulk water supply authority in South East Queensland (Seqwater) faced recently, and was presented by a member of Seqwater to the students using real data collected at that time. The scenario consisted of the detection of undesirable compounds reaching a key SEQ water treatment plant after a localised heavy rain event

upstream. The students had to formulate a solution to avoid or minimise surpassing the Australian Drinking Water Guideline health limits and to mitigate the consequences for costumers.

The role-play aimed at exposing the students to different roles involved in decision making within Seqwater (corresponding to the roles they incarnated during the role-play), and allowing them to interact with members of the industry, which mentored each group in the decision making simulation. The activity was designed to foster communication and interpersonal skills while applying the technical knowledge and engineering skills developed in the course, as each of the team characters was essential to develop a solution to the case study.

The learning objectives of the role-play were:

- Promote awareness of industry professional environment;
- Engagement with a real-life scenario to bridge the classroom theory and the real-world;
- Development of professional and interpersonal skills.

The motivation for this study came from the identification of a need to expose the students of the Master of Engineering - Urban Water to the mode of operation of a typical water industry, in preparation for the industry placement taking place in the following year and/or a first job in the industry after that, since the cohort is vastly comprised of recently graduated bachelors with little or no work experience. It is hypothesised that an interactive learning approach, in direct contact with industry professionals and using real scenarios, improves student's engagement and the development of professional skills.

By using a real-life scenario, with real data, this activity aims at bridging the gap between textbook knowledge and application on a day-to-day position in industry (Litchfield et al., 2010). Students also have the opportunity to interact with industry members, which not only makes the scenario more realistic, as it helps retaining knowledge through engaging into empathetic and social feelings (Pavey & Donoghue, 2003).

During the course of a role-play, students were asked to contribute to discussion in the role of an assigned character, which corresponded to a role in the industry organisation. The mentors guided the discussion and encouraged the contribution of each of the students (and their characters) to find a solution to the problem presented in the case study. Their participation was assessed by the industry mentors, contributing to 5% of the final course mark.

The present study investigated the impact of the role play on the students in three aspects:

1. Awareness of critical aspects of the structure and professional environment in a real industry, namely the importance of individual team roles and team work in decision making;
2. Bridging the gap between academic learnings and their application in the real-world;
3. Contribution of the role-play learning activity to the development of professional and interpersonal skills (communication, argumentation, synthesis).

Approach

The cohort was composed of 17 students (domestic and international), the majority with chemical or environmental engineering background. Six professional mentors guided and challenged the students during the role-play. One mentor was from Queensland Health and five others were staff members of Seqwater with different roles in the organisation structure: two water quality specialists in water treatment and distribution system, one catchment water quality specialist, one planning engineer and one process engineer. The interaction with a

range of Seqwater staff members from different disciplines as well as a representative from Queensland Health showed to the students that the management of incidents is very much a team effort.

The activity took place in three phases:

1. Preparation:

The role-play was organised between the teaching team and the industry partner (Seqwater) to ensure the proposed challenge was feasible for the students.
Before the role-play, the students had access to different materials:

- The purpose of the role-play;
- A detailed introduction of the scenario including background materials, the challenge, and the team of professionals that would be involved with the activity;
- A detailed position description of the duties and responsibilities for each of the different roles that the students incarnated;
- Students were divided into four groups, with one mentor was assigned to each group;
- The roles were distributed just before the role play. A card with a brief introduction sentence was given to each student:

Water quality scientist: "Your Holy books are the Australian Drinking Water Guidelines, the Water Supply (Safety and Reliability) Act 2008 and the Public Health Act 2005. You will fight to make sure pathogen removal is not compromised."

Operation Process Engineer: "Each treatment has a maximum load capacity. You have to make sure the system will not breakdown."

Operation Manager: "Every drop of chemical counts! You have a specific budget to run the drinking water treatment plant and you have to stick to it."

Operation Manager Supply System: "You want as much water as possible in the supply network. Moving water around and bleeding tanks are not an option for you."

Customer Service Manager: "Your mission is to protect Seqwater's reputation and ensure community satisfaction."

- The assessment component: the total weighting assessment was 5% with 0.5% for peer assessment on contribution, communication and collaboration; 2.5% for mentor assessment on participation, communication, role incarnation and critical thinking; and 2% for presentation evaluation on the findings: 2%.

A detailed introduction to the scenario and expected activity were given at the beginning of the class, done by an industry member.

2. Actual role-play (approx. 2h):

Each group of students actively worked on the problem proposed under the supervision of an industry mentor. The mentors' role was to drive the discussion and stimulate the students to contribute to finding a solution to the problem while incarnating the attributed role. The mentor from Queensland Health was present and went to each table to stimulate the thinking regarding public health regulation ensuring each role kept in mind the importance of regulation compliance and its impact on human health.

3. Debriefing:

Each group of students presented their solution. The industry member presented final conclusions and remarks on the solution implemented in real life, and corresponding consequences, and linked with the students proposed solutions. Finally, the mentor from the Queensland Health concluded on the health issue related to this challenge and potential remediation solution if the regulation was not met.

To evaluate the outcome of the role-play activity, a survey was conducted among the students after participation in the role-play. Half of the questions were quantitative (using a 4-point Likert scale) and addressed student post role-play views associated with their interaction with the professionals, the hands-on experience with real life situations, the benefit of this exercise towards their professional life, and the assessment adequacy. The other half of the questions were semi-structured reflections on the impact of the activity on their perspective of their future professional life and team work, and overall opinion about the learning experience. The survey concluded with an open-ended question on suggestions for future editions.

A separate survey was conducted amongst the industry mentors after participating on the role-play, including qualitative and quantitative questions (on a 4-point Likert scale) that addressed their post-role play views associated with the effectiveness of the role play in contributing to improve the students' professional skills, the material provided before the activity and the students' preparedness for this challenge. A final suggestion for future editions of this activity was asked at the end of the survey.

Results and Discussion

Quantitative analysis of the impact of the study was limited by the reduced number of students enrolled, but the surveys provided valuable qualitative feedback, particularly through the comments made by students and mentors in the open-ended comments and suggestions part of the surveys. One of the open-ended comments from a mentor was "*being able to integrate these industry experts into the different student teams to act as mentors and provide support also worked very well, with not only the students benefiting from this but also the Seqwater and Queensland Health staff*". Although not statistically supported, the quantitative questions revealed that students overall valued the interaction with the professionals in the role-play, the hand-on experience with real case situations, and considered the activity both useful and enjoyable (98% of the answers to these questions were agree or strongly agree). Similarly, the quantitative questions revealed that mentors overall valued the effectiveness of the role-play to improve the student's professional skills (100% of the received answers to this question were agree); and that the students were technically prepared to take the challenge proposed (60% of the received answers to this question were agree).

A Master of Engineering is, by definition, an applied program, designed to prepare graduates for various functions in industry. The link with industry is a strong component of the UQ's Master of Urban Water Engineering, and in many of its courses (e.g. within the course where this study took place, WATR7109 – Drinking Water) the students have several opportunities to be exposed to the industry, e.g. through field trips, guest lecturers from water-related engineering companies, problem-based learning with authentic industrial data, etc. Nevertheless, the students don't have the chance to experience the feeling of being embedded in the professional environment before the industry placement in the second year or even before their first job after graduation. The workplace environment is markedly distinct from an academic environment, not only because real situations are sometimes unexpected and often more complex than theoretical cases, but also because the structure and ultimate objectives of an industrial organisation are in essence different from those of an education organisation. The structure around decision making used in this role-play scenario is a good example that highlights the relevance and responsibility of individual roles and their cooperation towards a common objective in an industry.

Real-life scenario to bridge the classroom theory and the real-world:

The role-play activity in this study offered the students the opportunity to engage in a realistic scenario that mimics the decision-making process in Seqwater, thus giving them a taste of how it is to work in an industry team. Students commented that they appreciated the opportunity "*to face real problems*" and "*to apply their theoretical learnings to a real-life problem*". Indeed, with the participation of industry members as mentors, the students had the chance to bridge the gap between the knowledge learnt in an academic environment and the real

world. The mentors agreed that "*this exercise appeared to help students link the technical learnings from the course together*".

But the greatest add-on of this type of learning activity is that, beyond the technical learning, the whole set-up (role-play, real case scenario and industry mentors) allows students to experience feelings (e.g. the weight of responsibility for a decision with implications in public health) that otherwise they don't have the chance to experience before the end of the program. One of the student's comments was: *"coming up with different options for approaches to solve engineering problems and assessing those problems by experienced staff was very good. It was very important to know the practical limitations of our solutions."* Another said *"role-playing activities help highlight that multiple factors (some of which non engineering related) contribute to decision making."* It is anticipated that the awareness raised by the role-play of what it is working in a water treatment and distribution utility stimulates the students to further develop their professional skills during the rest of the Master.

One of the objectives of this role-play was to apply the theory learnt during the semester to a real-case challenge. This is an important and challenging objective as often students have difficulties in transposing their knowledge to real-life situations. By promoting this critical thinking, the students will be more prepared for their future professional life/experience. One of the student's comments was: "*[my biggest learning was] how to face real-case problem*". Another said "*[this activity] helped me to bridge what I have learned and the industry requirements*".

According to mentors, the role-play was effective to bridging the gap between theory and real-life. One of the mentor's comments was: "*I think at least some of the students realised through the scenario how the skills they learnt through the course could be applied in practice*".

Promote awareness of industry professional environment:

The students appreciated the opportunity to have good quality contact time with the industry professionals: *"[the direct contact with members of the industry] is very important since they can impart their expertise and knowledge on how to handle real case situations*" and "*the mentors have helped to critically think in the right path to find an adequate solution for the problem*".

However, the team players did not incarnate their roles as expected, perhaps because they were too focused on solving the engineering problem. One of the industry mentors found that: "*None of the students were fighting for the roles of the role play, they shared the specific knowledge of their cards with their team mates and didn't really embrace the specific mind set of the characters. I did ask quite pointed questions of team members specific to their role in the incident and most of the time they appears paralysed to make a decision and not wanting to own the specific role."* One student also suggested that: "more discussion of the individual roles we were supposed to play is needed. My group seemed to forget half way through their role as our focus was solely on finding a solution to the scenario."

This aspect should be improved in future editions of the learning activity.

Development of professional skills:

The variety of roles included in this role play gave the students the opportunity to view situations under different perspectives, an approach towards constructivist learning (Kilgour et al., 2015). It gave them a more realistic perspective to work as a team in an industrial environment and in particular within a decision making process under a somewhat stressful situation. Being aware that one answer will not fit all is an import aspect of the learning process as well as the fact that often in industry projects compromising is important. One of the students reflected on this and said: "*before the role playing, I thought work in a team is to contribute to one target and team members have some positions to achieve the target. After this role-play, I found that working in a team is really complicated. Members have different positions and need to balance all parts of the project.*" Still regarding the importance to understand the contributions of different roles in an organisation, another student mentioned: "*each member has different concerns which will greatly affect the decision*".

Other interpersonal skills that the role-play seemed to have contributed to were argumentation or negotiation (one student commented that "*It teaches the need for negotiation and that even though someone else's perspective is different to yours, it does not mean it is incorrect"*), and communication within an interdisciplinary environment ("*the biggest learning experience was communicate in an interdisciplinary team*"). Overall, by fostering a professional attitude and interpersonal skills, this activity contributed to develop student's maturity in a supported environment.

Assessment and student's level of preparedness:

The assessment and feedback to students was led by the industry members and completed by the academic team. It was extremely useful to involve the industry members in the assessment, as they have a better sensitivity to assess the professional skills targeted in this study. From the mentors perspective the preparedness of the students to tackle this challenge was overall sufficient, even if "*some students seemed prepared while others needed assistance to start brainstorming ideas*."

According to the mentors, the role-play was effective in contributing to improve the students' professional skills such as communication, team membership/leadership, critical thinking, interdisciplinary. However, "*the scenario wasn't of long enough duration to really build these skills*."

Also, a mentor highlighted that "[*I think] the exercise and exercise planning went well and it was a fantastic example of how to turn all that knowledge that has been taught and use it on an actual worked example, the concept was great, I'm just not sure my team read or absorbed sufficient information, or felt confident in expressing it in a small closed group working environment. Maybe this was too much of an evolution and they needed to work through a catchment monitoring event, water treatment plant process optimisation or event and a piped water event to understand the elements before bringing it all together under one big scenario, however that is how the real world of water supply is, and therefore I still support the exercise design and parameters."*

Conclusions and future recommendations

Despite the limited number of students, the response to the qualitative questions of the surveys evidenced that the role-play learning activity was very well received. It seemed to help the students apply their theoretical knowledge to real-life scenarios, and to develop their professional and interpersonal skills.

The surveys gave valuable feedback on how to improve this activity. For future editions, the teaching team will prepare better the students for their individual role and reinforce the incarnation of the role throughout the activity:

1. Providing more practical examples of what it means to be in each of the positions described, in respect to all the others (e.g., expectations, responsibilities, priorities, etc.);
2. Taking a break in the middle of the role-play to refocus the group with the aid of the cards given at the beginning of the activity;
3. Ask the students to write a short reflective essay about what they learned about the different roles in the water industry.

By doing so, it will help the students to be better prepared and incarnate more the individual roles, which will contribute to a better understanding of different positions in a water industry and their interdependencies.

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