Reflection for social learning: a humanitarian engineering case study

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Structured abstract

PURPOSE
Teachers, students, nurses and managers use reflection activities to affect deeper cognitive learning and personal growth. People that engage in reflection can be thought of as *reflexive,* and the literature shows that interactions by reflexive actors in the broader society will result in social learning and change. Here I present my experience as a humanitarian engineer in an Engineers Without Borders (EWB) partnership, where I assisted a Mechanics teacher to reflect and improve his teaching. I intend to show that his ability to reflect may have broader implications for social and community development beyond the individual level. I recommend that practising engineers and engineering teachers leverage this knowledge to improve outcomes in engineering study and work.

METHOD
Data was collected primarily from entries in the teacher's reflective journal. A cue-card provided the framework for journal-writing, and a structured peer / mentor feedback form was used intermittently to add structure to entries. The data from the teacher's journal entries was interpreted for qualitative changes in reflective structure.

RESULTS
Four major phases of learning and growth occurred over a twelve-month period. He: (1) Recognised his strengths and capabilities by drawing on past experiences. (2) Gained a sense of self-awareness and recognised his perceptions about teaching and learning. (3) Gained a critical understanding of the assumptions, attitudes and beliefs underlying approaches to learning. (4) Developed a deeper relational understanding and ownership of his role within the external context.

CONCLUSIONS
I conclude that reflection can help people recognise their existing strengths, critically analyse past experience, question underlying beliefs and attitudes, and acknowledge and challenge their roles in context. This helps to not only improve their professional work and grow personally, but by extension, should also result in social learning. I propose a research agenda to examine other case studies to see how reflection at the individual level contributes to the wider community. I recommend that practising engineers and engineering students use reflection in their work and study given the benefits already shown; and moreover, I encourage engineers to facilitate others' reflection to drive autonomous community development and positive social change.

KEYWORDS
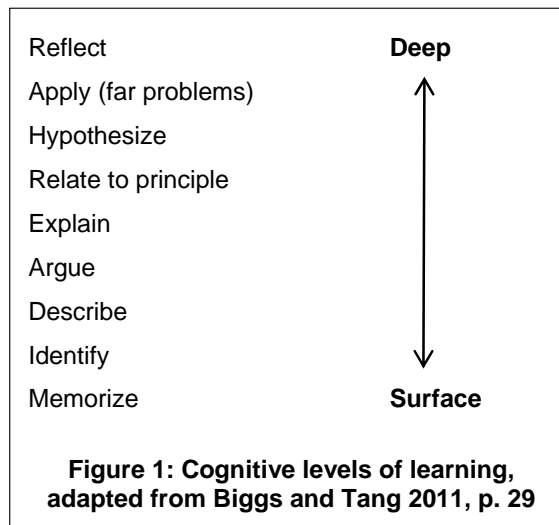Reflection, reflective practice, social learning, community development, capacity-building, humanitarian engineering

Introduction

Teaching researchers recognise that 'deep' student learning occurs when they engage in reflection activities (Figure 1) (Biggs & Tang, 2011). The benefits of reflection for an individual (such as students, teachers, nurses, and managers) are well described. It ranges from improving one's professional practice, to a broader role of reflection in understanding and interacting with one's surrounds. Dye (2011, p. 217) suggests reflection is "action on... thinking as part of a cycle of improvement", whilst other authors such as Morrison (1996) suggest that reflection results in broader attitudinal changes, empowerment, and political awareness. Supporting the idea that reflection plays a broader role in society, the social science literature describes that reflection activities in Brazil were thought to be behind the empowerment of Brazilians in the process of democratic reform in the 1970's (Freire, 1974/2005), According to the literature, individuals engaging in reflection can affect the broader community because 'reflexive actors' in society contribute to social learning (Eckersley, 2004). They can, through interaction with others:

> "change their understanding of, and therefore their relationship to, their external environment (including other social actors) in ways that may transform their understanding of their own interests and identities" (Eckersley, 2004, p. 35)

Indeed, through reflection, people 'create' social knowledge, since participants find out how to provide solutions to questions which never before have been posed (Freire & Faundez, 1989). In general, however, there are few empirical studies that describe how people who reflect give rise to social change.

Reflect   **Deep**

Apply (far problems)

Hypothesize

Relate to principle

Explain

Argue

Describe

Identify

Memorize   **Surface**

**Figure 1: Cognitive levels of learning,
adapted from Biggs and Tang 2011, p. 29**

Humanitarian engineering is the "application of engineering and technology for the benefit of disadvantaged communities" (Engineers Without Borders, 2013), and its ideals reside in concepts of community development, which was described by the UN in 1948 as "a process designed to create conditions of economic and social progress for the whole community with its active participation and fullest possible reliance upon the community's initiative". Engineers involved in humanitarian projects already use many approaches that are based on learning themes such as capacity-building and participatory development (Eade, 1997), story-telling (Ramsey, 2005), strengths-based approaches (Mathie, 2006), monitoring and evaluation (Earl, Carden, & Smutylo, 2001), Training for Transformation (Hope & Timmel, 1984), appreciative learning and action research (Kemmis & McTaggart, 1988), and Learning Organisations (Bawden, 1994). Learning activities such as reflection have not yet formally been described in humanitarian engineering literature, but they have the potential to improve outcomes of all types of engineering practice.

Development partnerships with Engineers Without Borders Australia
Engineers Without Borders Australia (EWB) is a member-based not-for-profit organisation with ten years' experience in creating systemic change through humanitarian engineering. They work in partnership with other community organisations to address a lack of access to basic human needs such as clean water, sanitation and hygiene, energy and engineering education. They also educate and train Australian students, engineers and the wider community on issues including sustainable development, appropriate technology, poverty and humanitarian engineering. Since 2006, EWB has supported a Development Partnerships program, placing volunteers with community-based organisations to assist with technical capacity-building projects. EWB Development Partnerships work with community partners in Australia and overseas to facilitate meaningful and lasting change. In these programs, engineering volunteers use engineering knowledge and resources to bridge self-identified gaps in access to community health, wellbeing and opportunity (Engineers Without Borders Australia, 2013).

A partnership between EWB and the Sri Lankan School of Prosthetics and Orthotics (SLSPO) was established in 2010. SLSPO is a not-for-profit training centre that trains Prosthetist and Orthotist Technologists for the artificial limbs and braces medical industry. The SLSPO Prosthetist and Orthotist program is offered to between six to twenty secondary school graduates per year that work towards a certificate to prescribe, manufacture and fit artificial limbs and braces for disabled people. In most cases, students selected for the course will display high academic results in business or science majors. The course takes three years, with theory subjects such as Mathematics, Mechanics, Materials Science, Computer Studies and Manufacturing Basics taught in the first year. Biomechanics, Manufacturing, Prosthetics, Orthotics, Fitting and a Clinical Internship follow in subsequent years. Graduates of SLSPO are employed in hospitals and clinics to care for a wide range of patients, including those with war disabilities, amputation (for example, from diabetes and road accidents), and congenital disabilities.

Objective

This paper presents my experience as a humanitarian engineer in an Engineers Without Borders (EWB) partnership in Sri Lanka with SLSPO in 2011, where I assisted a first-time Mechanics teacher to (1) reflect and improve his teaching practice, (2) develop the Mathematics, Mechanics and Materials Science curriculum and (3) teach the course subjects. I intend to show that his improved ability to reflect may have broader implications for social and community development beyond the individual level. I recommend practising engineers and engineering teachers leverage this knowledge to improve outcomes in engineering study and work.

Methods

Data was primarily collected from entries in the teacher's reflective journal, which incorporated written critical reflections on class experiences on an approximately weekly basis. The journal consisted of mostly 'reflection-on-practice' after each lecture (Ghaye, 2011, p. 6), containing the teacher's own thoughts, teaching experiences, and future actions, and was written in a 'free-writing' style. A framework for journal-writing was developed through using a cue-card adapted from Rolfe, Freshwater, and Jasper (2001) (Table 1).

A structured peer / mentor feedback form was used intermittently to stimulate reflection, which included prompters under six headings of Organisation, Presentation, Content, Interaction With Students, Activities, and General Observations. Video footage of classes was used at times alongside the cue card to stimulate reflection.

Other sources of data were taken from notes of discussions regarding the teacher's and my review of journal entries either on the same day or the next day after journal writing. Discussions were mostly a combination of 'reflection-on-practice', 'reflection-for-action' and 'reflection-with-action' (Ghaye, 2011, p. 6).

Data from the teacher's journal entries and discussions was interpreted to determine qualitative changes in reflective structure.

Table 1: Reflective journal 'cue-card', adapted from Rolfe et al. (2001).

Description level of action "What …"	Interpretation level of reflection "So what …does this tell me / teach me / mean about…"	Outcome level of reflection "Now what …do I need to do in order to…"
happened?	me?	improve things?
is the problem or difficulty?	others?	improve my performance?
is the reason for feeling bad or getting stuck?	the (classroom) environment?	improve others' performance?
was my role in the situation?	our relationships?	resolve the situation?
was I trying to achieve?	the model/theory I am using?	feel better?
actions did I take?	how I perceive (learning)?	… broader issue to be considered if this action is to be successful?
was the response of others?	… was going through my mind as I acted?	… might be the consequences of this?

Case study: EWB-SLSPO Partnership

Four major phases of learning and growth occurred over a twelve-month period.

1 Reflection to explore personal strengths
The teacher recalled various examples of successful and unsuccessful teaching and learning experiences as a student, and the behaviours displayed by teachers and students in these examples. He compared them to behaviours seen and tried as a parent, and identified personal strengths and improvement opportunities. He also identified pros and cons of the 'accumulation' teaching style (where the teacher 'pours' knowledge into students), which was at the time, predominant in the Sri Lankan education system.

2 Reflection to develop a wider view of self
Within eight weeks of teaching, he began to question his own teaching performance, such as his understanding of the contribution of the teacher's presentation to student learning, the teacher's role in creating a positive classroom environment, and his physical presence in the classroom:

> *"Before I only thought only about the contents of the lecture - how much you know about the subject and the content of your slides - if you have a story to match with the sequence of slides it's enough. But now, I feel the way you are going to present yourself is also more important. The way you are standing, walking, what you are talking about, and how to make sufficient and active participation in the lecture."*

> *"Also I found that having some kind of idea how I should be a good lecturer and what are the qualities of a good lecture that makes us more confident in teaching … rather than to try to do it without much knowledge or idea."*

The peer / mentor feedback form, together with the cue card, stimulated reflection, and he became aware of the potential to incorporate new learning components in classes:

> *"The feedback form arranges the topics in a much more organised and useful way. I found once I became used to doing lectures, it was a good reminder to think: 'What kind of aspects/criteria do we want to consider for an effective lecture?'"*

3 Reflection for awareness of beliefs and attitudes

After about eighteen weeks of teaching, he began to question deeper beliefs and attitudes to learning, including the role of students in helping teachers advance professionally:

> *"Learning how to teach is a never-ending lesson."*

> *"So what I tried to do was not to give [the students] things in another new way, but to combine things with their previous knowledge, polish their knowledge and make them discuss or express their idea about the points of the lesson. At the same time I took time to explain things where it applies closely to the prosthetics and orthotics sector."*

> *"Students tried to make things clearer by asking questions. They help us a lot in that way."*

The reflections at this stage showed a greater participation in, and ownership of the results of the teaching and learning process:

> *"When I reached the conclusion slide of the first session I found they were at the stage where I wanted them to be."*

> *"Overall, I found that students got a reasonable amount of deeper knowledge about the lesson, though it took more time than I expected."*

4 Reflection as a primer for transformational change

During the fourth stage, the teacher's reflections began to take on an experiential and transformational perspective. There were three emergent changes to reflections between twenty weeks and twelve months of teaching.

Firstly, he critically analysed other teachers' classes, and made suggestions for more effective class conduct:

> *"At the end of the activity the teacher gave an illustration about how to write the briefing report…I found that the students weren't able to pay their full attention to the explanation, since students were excited about the activity…I wish we had more time to explain it, to emphasise to students that answering questions and writing the report were also very important and we were to assess them on it…One or more students should explain or repeat everything about the activity in their own words to the class and we should give them time and motivation to ask questions. They should confirm their understanding about the objectives of the practical."*

Secondly, he critically analysed difficult situations, proposing strategies for future activities:

> *"How can I tackle difficult questions in class? Definitely I don't need to know the answers for all questions immediately. But I should work out how to deal with this. 1. If it is not relevant to the lesson I can ask the student to ask it later. 2. If I can't identify if it is relevant is or not, I can write down the question on the white board or a piece of paper. 3. I can try it at break time if not after class. 4. If it is important I can discuss the answer at the next class."*

> *"Overall the course went well I think. It was a bit challenging to get them out of their shells and make them talk and make them more responsive. But doing this course gave me more experience and confidence to be ready for the next new batch. I improved the class environment, keeping eye contact and those kinds of things. But still I feel I want to reduce my talking and make them talk more. Time constraints were a critical factor for that."*

Thirdly, he considered his career in the context of an emerging disability services sector in Sri Lanka, and his role in challenging beliefs and attitudes of students towards disability:

> *"I have lots of questions to answer and lots of options to follow. But I want to find the perfect solution. I want to make a good enough decision which sets me on a proper path."*

> *"I want others to have a proper path, options to go where they want to go. A 'national action plan for people with disabilities' will help to do that. People with disabilities should be able to make up their mind and work out their own plans, goals. So I want to contribute to this. But it is not easy to try to work on this basis."*

> *"Being a teacher at this school I am in a position to develop the learning of our students about disability and the importance of their service for people with a disability. A module on disability studies will help these students to adopt their career with proper foundation knowledge about disability and meeting the needs of disabled people."*

There were noticeable changes in attitude of the following year's incoming students:

> *"One of the new students said the senior batch has a better vision about the prosthetist and orthotist career, they respect their profession and are willing to promote this idea to the next year levels too… Because of this change, the new students show us more of their talents, have more skills and I guess they might do more difference in the field."*

To summarise this last phase, the teacher's views transformed, from a teacher-student to a broader teacher-disability sector nexus; the students benefited from the teacher's improved teaching practice; and the teacher's role changed to a self-motivated agent of change for students.

Conclusion

I conclude that reflection helps people recognise their existing strengths, critically analyse past experience, and acknowledge and challenge their roles in context, so that they can better their professional work, understand their direction and actions, and grow personally. The outcomes show reflection is useful not only to improve teaching practice, but also as a tool for broader 'experiential and transformational' learning (Ghaye, 2011, p. 14), and in this way, people reach their own conclusions, and respond, improve, or adjust according to their needs and choices.

By extension, these new abilities resulting from reflective practice should also result in social learning. Although this case study alone cannot support this conclusion, this study adds to existing work by Freire and others showing that the outcomes from reflective practice will more likely than not empower individuals to create real social change. Reflexive people can 'assess assumptions implicit in beliefs' and 'challenge the validity of presumptions' (Mezirow, 1991), 'examine, analyse and make judgements about ideas on the basis of ethical, political and social values' (Reeves, 2010, p. 162), 'improve flexibility' (Ande, 2011), 'enhance human insight' and 'amplify success' (Ghaye, 2011, p. 20). Therefore, I propose a research agenda to examine other case studies and literature to determine (1) what contribution reflection (at the individual level) has at the wider community level for social learning and change; (2) what time frame is needed for social learning from reflective practice; and (3) what effect do environmental factors (such as organisational structure and access to resources) have on the research outcomes. Executing this research agenda will enhance the understanding of the potential for reflection to strengthen individual and collective performance.

This study concludes that reflection can be thought of as a specific tool that engineers can use to analyse their role and effectiveness in their own context. I recommend that more practising engineers and engineering students reflect as part of their work or study given the benefits already shown.

I also encourage engineers to *facilitate others' reflection* to drive autonomous community development and positive social change. This could be achieved by practising engineers that facilitate reflection of operations staff or stakeholders in engineering projects, or students that facilitate reflection of 'mock' clients. When clients and stakeholders can critically reflect on their own situations, then they are likely to bring about positive change to an engineering project – a change which is self-driven, rather than enforced or suggested by an external actor. A cue card may be used with these clients or stakeholders as a supplementary aid for their reflection.

In summary, the ability to reflect may have broader implications for social and community development beyond the individual level. Practising engineers and engineering teachers can leverage this knowledge about reflection to improve outcomes in engineering study and work.

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