Strategies for developing effective communication skills in Engineering students

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Structured abstract

BACKGROUND
Effective oral and written communication skills are two of the most frequently ranked graduate competencies that fall short of engineering employer expectations around the globe.

PURPOSE
The Schools' Technology Project (STP), a 4th year engineering service-learning project for credit points at Monash University has successfully run for 42 semesters. The project is coordinated by the Faculty of Education and has been specifically designed to build engineering student capacity and confidence in a wide range of professional skills; including oral and written communication. The author has presented some of the successful student learning and skill based outcomes at a number of conferences. Question time following the presentations has consisted generally of 'how' do you get students to think/act the way they do? This paper has been written to provide some of the details, thinking and research behind the 'how' and 'why' of the organisation and implementation of the STP and the components of the assessment tasks that have contributed to the successful development of the students' oral and written communication skills.

DESIGN/METHOD
The assessment tasks, running of the elective and student roles have changed considerably over time to keep abreast with the requirements of industry and to give the students an 'engineer' identity. This paper is a phenomenological description of some of the project's specific considerations, learning strategies and tasks and the associated research and thinking behind them leading to the development of student confidence and competence in communication. A mixed method approach has been used to collect and analyse formal and informal opinions and data from written assessment tasks, unit-evaluation response, emails and feedback sessions from the 322 students enrolled in the STP from 2010-2012.

RESULTS
Nearly half of the engineering students enrolled in STP from 2010-2012 were unaware of the importance that employers of engineering graduates place on effective communication skills, or other professional skills and therefore they do not actively and consciously work on developing these skills during their degree. Students believe that choice, ownership, hands-on experience and knowledge of how people learn and communicate in the STP provides them with the necessary skills and gives them a distinct advantage over other graduates in obtaining (and retaining) employment in the engineering workplace.

CONCLUSIONS
Effective oral and written communication skills are teachable and learnable. Many of the strategies and assessment tasks outlined in this paper can be modified and used in existing technically based engineering units to develop the oral and written communication skills to assist students prepare for and successfully transition into the workplace.

KEYWORDS
Communication; strategies

The role of communication in Engineering practice

Effective technical and non-technical communication, as a two-way process, is paramount to an engineer's success (Vest, 2005). Research suggests that experienced and novice engineers spend around 60% of their working day in direct communication with other people; the majority of this interaction is orally based - informal face to face, on site, in meetings, in training sessions, over the phone, etc. (Trevelyan, 2012). Darling and Dannels' (2003) 'Report on the Role of Oral Communication in the Workplace' indicated that practising engineers deemed message construction (being concise, clear and logical) to be the most important oral communication skill to have in the workplace. Interaction with others was a close second (interpersonal skills, teamwork, negotiation, asking and answering questions), followed by public speaking skills and delivery (confidence, preparation, etc.).

Studies by Keane and Gibson (1999) and Male et al.(2010) highlight that the written communication skills required by engineers extend beyond just that of technical report writing; Writing emails and memos, reviewing documents, preparing agendas and writing minutes, constructing letters, proposals and tender documents and developing instruction manuals are key activities in an engineer's work schedule. Poorly constructed and written communication in the workplace leads to misinterpretation, inefficiency and time wastage, adversely affecting problem resolution (Riemer, 2007). Effective communicators know their audience, and they speak and write with a purpose. They know upfront whether they want to convince, inform, identify a problem or open up a discussion and they structure their conversations and writing accordingly. They are able to identify and clarify key pieces of information in complex ideas and translate them appropriately into words, graphics, metaphors or physical models that can be meaningfully understood by the audience they are communicating with (Ford, 2004).

Oral and written communication skills in the workplace are inherently social and interactive (Keyton et al., 2013). Both are teachable and learnable skills (Chan & Fishbein, 2009; Missingham, 2006), yet they are the skills that feature most frequently as being deficient in engineering graduates in surveys in Australia and around the world (Ashman, Scrutton, Stringer, Mullinger, & Willison, 2008; Male, Bush, & Chapman, 2010; May & Strong, 2011; Nair, Patil, & Mertova, 2009; Siller, Rosales, Haines, & Benally, 2009). Despite this, the emphasis on developing communication skills in many engineering courses is still limited to the one-way delivery of discipline-specific information through technical writing and the occasional formal oral presentation, supported by text and images on a screen.

The focus of this paper is to provide 'the how and why' behind the design and organisation of the Schools' Technology Project (STP) and the components of the assessment tasks that have contributed to the successful development of the oral and written communication skills of final year engineering students. Many of the ideas presented in this paper can be modified and incorporated into existing technically based engineering units – so "the social and technical are inextricably intertwined" (Trevelyan, 2009).

The Schools' Technology Project

The STP is a service-learning elective, for credit points, offered to 4th year students from all departments at Monash University's Clayton Campus. The project is coordinated by the Faculty of Education and has been specifically designed to build engineering student capacity and confidence in a wide range of professional skill competencies including communication and interpersonal skills, problem-solving and life-long learning while consolidating student understanding of a number of basic engineering principles. The elective has run for 42 semesters with approximately 1,300 engineering students and 30,000 primary and secondary students and their teachers from 250 State, Catholic and Independent schools benefitting from the project.

Service-learning is a pedagogical practice that deliberately integrates community service activities with educational objectives. Students engage in meaningful learning through applied, project-based learning, drawing on multiple knowledge sources: academic, student

knowledge and experience, and community knowledge. They use what they learn in the classroom to solve real-life problems. They not only learn the practical applications of their studies, they become actively contributing citizens and community members through the service they perform (Furco, 1996; Hurd, 2008). Service participation has significant positive effects on academic performance, leadership (oral communication skills, interpersonal skills, cooperative and collaborative skills), academic and social self-efficacy and can build coping strategies (confronting problems rather than avoiding them and feeling comfortable in unfamiliar surroundings) (Astin & Sax, 1998; Simonet, 2008).

The STP students attend six hours of workshops and complete two assignments before taking on the responsibility of planning, organising and teaching a STEM-based (Science, Technology, Engineering and Maths) project in a primary or secondary school. The projects are typically 12+ hours in length, spread over six weeks and are specifically designed by the STP students to ensure that the learning outcomes achieved by the school students meet the goals negotiated between the STP students, their client (supervising teacher) and the STP coordinator during a briefing meeting. Examples of STP projects include understanding the concepts needed to design and construct trebuchets, pushcarts and models of bridges and working prosthetic limbs. The teachers provide regular guidance and constructive feedback to the engineering students on how to improve their presentation, listening, questioning, leadership, problem-solving and organisational skills throughout the project and in return their classes receive innovative, hands-on learning sessions from young enthusiastic engineering 'experts'. The teachers also see how engineering work and principles provide tangible links for their students to better understand and appreciate many of the science and maths concepts outlined in the National Curriculum.

A detailed explanation and findings of how the school placement component of the STP operates and develops confidence and competency in oral communication can be found in 'Preparing the Global Engineer: How learning to teach in a Service-Learning Project Develops Effective Communication Skills in Engineering Students' (Bowering, 2013). This paper will concentrate on the other elements of the course designed to build communication skill awareness and capacity.

Strategies to create identity, context and understanding of what employers of engineering graduates are looking for:

The philosophy underpinning the STP is that students learn best when:

- they are active participants in and have ownership of their own learning,
- their learning is purposeful and challenging, when they are willing to take risks, and they are provided with opportunities to apply their new understandings to authentic tasks,
- they feel part of a productive learning community; where ideas and opinions are shared and questions asked,
- they can effectively evaluate their own learning, act on constructive feedback and recognise how they can transfer their learning from the classroom to the engineering workplace (Bransford, Brown, & Cocking, 2000; Lieb & Goodlad, 2005; Merriam, 2001).

One of the goals for the first STP workshop is for the students to begin to identify themselves as engineers. In order for them to successfully 'sell' themselves and their ideas as engineers in the classroom, in an interview or in the workplace, they must 'know' themselves as engineers – what they stand for, what motivates them, what assumptions they make and what values they hold. The first activity is designed to facilitate the building of their engineering identity and requires the students to look at two images. The first image, in black and white, is of a simple land drilling rig, the second image, in colour, is of a large offshore production platform lit up at night. The students are required to decide which picture they think provides the best metaphor of engineering for them. Once they have decided they are required to move to the side of the room where their chosen image is displayed. There they

introduce themselves to someone they have not met before and discuss the reasons behind their image choice. Each side of the room then explains their thinking to the other side. Students who choose the land drilling rig as the best metaphor usually focus on the adage of keeping things simple, whereas the students who chose the offshore production platform tend to see engineering as exciting, complex and multidisciplinary. The activity is repeated using two very different pictures; an open, empty tool box and a clear, swimming jellyfish. Engineers needing to be flexible, transparent, organised and aware of environmental concerns are some of the reasons given for the metaphor preferences for the second set of pictures.

The activity is followed by a class discussion analysing its purpose e.g. as an icebreaker, to begin to identify their own engineering values, as an opportunity for everyone to explain their ideas out loud to an audience. The very different interpretations of the same images by a relatively homogenous group provides a good introduction to the idea that people value and see things differently; considering others' perspectives plays an important role especially when working in a multicultural, multidisciplinary workplace. Downey et.al (2006) defines globally competent engineers as those who possess "the knowledge, ability, and predisposition to work effectively with people who define problems differently than they do." The importance of really listening to the needs and requirements of a client/colleague and asking of pertinent questions to understand their priorities and values is introduced at this point. It is critical that the students comprehend the significance of listening to others' perspectives before they meet with their client (supervising teacher) for the first time. Unlike most university assignments, where the focus is on the end product, their supervising teachers' focus for the STP projects is more on the learning processes leading to the end product. The students also discuss how the actual running of each activity contributes to its purpose being achieved e.g. physically moving to their picture of choice meant they couldn't 'sit on the fence' and wait to hear what others thought, discussing their idea with one person first before sharing it with the rest of the class gave many of the students the confidence to speak, knowing that their idea had already been 'checked' by another.

The second activity in workshop 1 requires the students to write a one or two sentence description of what a mechanical/civil/material (depending on their specific discipline) engineer does. This 'simple' task has many students perplexed as they grapple with providing a comprehensive answer. Research by Matusovich, Streveler, & Miller (2009) suggests that 3 out of 10 senior engineering students are unsure of what it means to be an engineer. Is it any wonder then, that the general public doesn't appreciate/understand the work of engineers? *"A lack of understanding of engineering careers has been shown to be a contributing factor to departure from engineering before and after earning undergraduate degrees" (Winters, 2012).* As lecturers, we need to be more conscientious about making explicit links between technical and non-technical knowledge and skills gained in the classroom and possible applications in industry.

The students are then asked to work with a student from a discipline different from their own to generate a list of the generic skills/attributes required to be a successful engineer. The lists are then compiled into one list on the board, and the class discusses which skills/attributes they believe are also important for effective teachers to have. Once the students recognise that successful engineers and effective teachers require the same generic skill set (the ability problem-solve, manage time, people, risk and resources, motivate, communicate, collaborate, analyse, evaluate, etc.) they begin to see how learning to teach can assist them in their future careers. This step provides the motivation they need to make the most of the elective as they can see how learning to teach will help them to become more effective engineers (Bransford et al., 2000).

> *"I found myself at the end of my degree questioning if the engineering profession was right for me. This was the result of years of hard, non-stimulating subjects, none of which I chose to do. STP allowed me to re-gain confidence in myself, gave me a new perspective and re-ignited my interested in the engineering profession. This was the direct result of going out and*

> *getting involved in something that was stimulating, hands-on, enjoyable and very rewarding."* (Part of an email sent to an Engineering Course Co-ordinator one year after the student entered the workforce)
>
> *"The teaching program provides an effective vehicle that grows confidence and pride with which the STP students are able to discuss their group's work and achievements and articulate what they have learnt in return. They have also demonstrated a strong community focus, an important part of the ethos of the profession.*
>
> *The program covers a number of the Stage One competencies that underpin engineering degrees and develops key skills that are highly desired by industry - communication, team work, influence skills, leadership and problem-solving. As a result the students' employability skills are significantly developed."* (Glenda Graham, General Manager Engineers Australia, Victoria Division, 2013)

There are five assessment tasks for the elective. The first two tasks are completed in the first three weeks of the semester and are 'assessment for learning tasks' (Black, Harrison, Lee, Marshall, & William, 2003). They are designed to give the individual students a feel for where their thinking/skill levels currently lie and motivates them to make the most of the learning opportunities provided to them during the elective (Loughran, 2012). The tasks also provide the STP coordinator with the information needed to appropriately modify the course content and type of feedback given to the overall cohort and individual students. Both tasks, are in the form of Journal Entries; encouraging the students to write in a less formal genre than is typically expected of them during their engineering degrees. They are required to write in the first person, for a mentor, and express their personal views. The students' views are not judged or assessed because part of the purpose for their writing is to encourage the start of ongoing, two-way conversations with the elective coordinator. Assessment instead is based on the quality of the examples they use to support their views and on their ability to write logical, comprehensible, concise responses.

Journal Entry 1 asks the students to:

1. Read Nair et al.'s (2009) 'Re-engineering graduate skills - a case study'. A study of the 2007 Monash University survey of employers' satisfaction levels of their Engineering graduates.
    a. Identify the purpose of the paper and the intended audience. The students are reassured that the findings are typical for similar surveys conducted throughout the world, and certainly not unique to Monash or Engineering.
    b. Respond to the paper, stating whether they agree/disagree or are surprised with the survey findings and back up their statements with relevant, personal examples from their studies or work experience.
2. Conduct an informal (not assessed) audit of their current professional skill levels.
3. Identify three professional skills that they will specifically work on developing over the semester and the measures they propose using to evaluate how successful they are in meeting their goals. Students are encouraged to use the SMART (Specific, Measurable, Attainable, Relevant, and have a Time-frame) approach to goal setting (Latham & Locke, 1991).

Analysis of student responses from 2010 to 2012 (322 students) indicated that nearly half (48%) of the students had been unaware of the value that employers placed on professional skills. Most assumed that their technical skills, based on their subject selections and results at University, would be more than adequate for them to secure and thrive in their first engineering job.

> *"I was under the impression that the best person for the job was always the person who was the most technically able, this article has broadened my understanding of the credentials that are required by employers."* (Journal Entry 1 response, semester 1, 2012)

Students need to be made aware of perspective employer expectations by the beginning of their third year of their undergraduate degrees so that they can consciously and actively work on developing the broader skill set required by employers (Crebert, Bates, Bell, Patrick,

& Cragnolini, 2004). A large number of students have indicated that the table provided to them to assist with auditing their existing professional skills has been very useful, particularly when they were preparing for job interviews. The table consists of three columns. The first column lists the professional skills identified by employers of engineers as being most important. Specific components making up each skill set is also included e.g. knowing and catering for one's audience, using specific appropriate examples (models, analogies, graphs etc.) to illustrate a point etc. are included in the oral communication section. The second column is where students record 'interview worthy' examples to demonstrate their competencies in each skill set, while the third column is provided for students to record possible situations and opportunities for them to actively seek out/use to further enhance each of their skill sets.

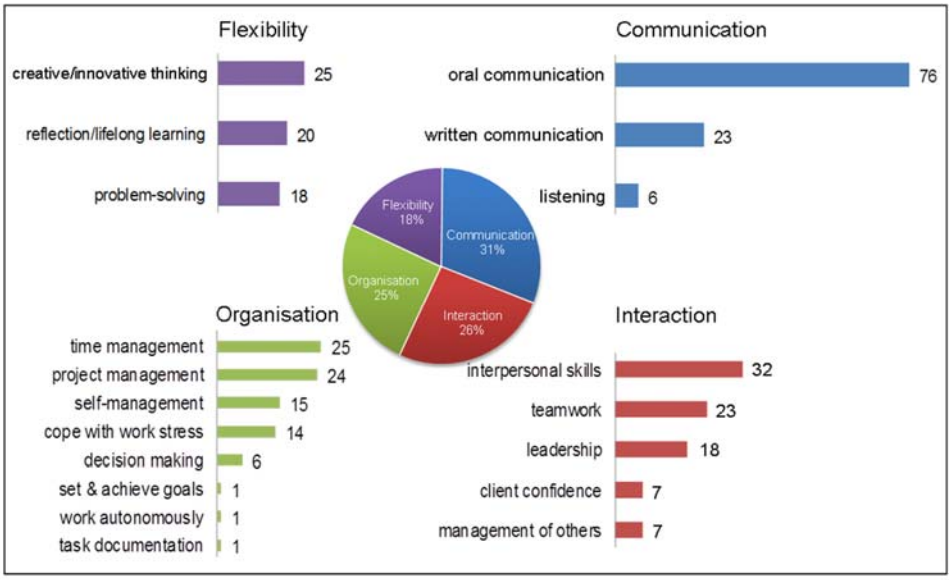

Fig. 1 The professional skills identified by STP students as the ones they most needed to work on developing

Choosing their own goals to work towards during the semester provides a differentiated, relevant curriculum for all students and gives them ownership of their learning. Students from 2010-2012 set goals in 19 different professional skill sets, with nearly a third of the students setting at least one communication based goal (see figure 1). Developing oral communication skills was the most frequently selected goal, nominated by 23% of students, though their specific focus varied. For example, one student with a non-English speaking background wanted to be able to explain concepts and give instructions clearly and fluently, without the need to repeat or rephrase himself, while another student, who was more competent and confident in his existing oral communication skills, wanted to be able to have genuine, meaningful dialogue with his students. Knowing the individual student's goals assists the STP coordinator to decide which school/supervising teacher to place each student with and guides the type of feedback and advice given to them. The student with the goal to speak fluently and coherently was placed with a very multicultural class and was encouraged to use visual aids, demonstrations and models to help his students both see and hear what he was saying. It was also suggested that he ran through complex explanations and instructions multiple times before presenting them to his class, either with friends or out loud to himself, so he could hear when he paused, stumbled or became stuck. Whereas the student who wanted to effectively converse with his students was placed with a small group of students, in an after-hours project to design, build and race solar powered cars. He was encouraged to pay attention to their body language, not to interrupt their speaking and hold off any judgements/assumptions until they had finished explaining their ideas and to give himself (and others in the room) time to digest questions/statements before responding/ requesting others to respond.

Understanding how people learn

The focus of the second workshop is on how people learn. The students individually explore what they enjoy learning about (e.g. different cultures, cooking, fluid dynamics) and why, and what they struggle to learn and why. They are then asked to reflect on a particular lecture/tutorial/practical class where they felt they had learned a lot and one class that confused them and consider why. This is followed by a class discussion identifying common factors that encourage or hinder learning. The hinder learning list is always at least twice as long as the encouraging learning list. What it does highlight to the students though, is that they already know a lot about what to do and what not to do when they begin planning and preparing for their teaching sessions. This leads very nicely into an introduction to the constructivist theory of learning, in particular the importance of recognising prior knowledge and scaffolding new learning on this. Learning style preference theories are also covered in the second workshop, in particular Fleming's VARK (Visual, Auditory, Read/wRite and Kinaesthetic) and Felder Silverman's Index of Learning Styles. The concepts covered in this workshop are consolidated and 'Ah-ha' moments occur when the students begin working on their second Journal Entry responses.

Journal Entry two requires the students to:

1. Complete two on line learning styles questionnaires ("Felder Silveman Index of Learning Styles Questionnaire," ; "VARK Questionnaire,") and assess whether they agree or not with their results (and why) and identify strategies that they can use to make the most of their learning style preferences to help them achieve the goals they set for themselves in Journal Entry 1, in their future studies and work.
2. Use the resources provided on STP website to identify characteristics in other people that may give clues as to their learning style preferences.
3. Outline strategies to consider using when working/communicating with people, especially those with learning style preferences different to their own.

To remind the students that knowing and catering for ones' audience is an important aspect of effective communication, they are provided with the learning styles preference profile of the STP coordinator and encouraged to take this into consideration when constructing their responses. As the STP coordinator has a very strong preference for visual learning and a very low preference for Read/wRite the students are encouraged to respond in formats other than text e.g. point form, flow charts, tables and annotated diagrams, where appropriate. Thinking and practising presenting information in a less wordy form can also be useful in the engineering workplace where the reader may be time poor or not proficient in reading English.

Many students report that understanding how they and others learn has helped them to become better communicators, more effective leaders and constructive members of teams as well as assisting them to be more productive learners.

> *"The concepts I have been introduced to branch far beyond teaching, they will help become a better engineer. Explaining things to managers, co-workers and contractors will be far simpler now that I can implement multiple learning styles into my explanations. My presentations will be more focused and the key concepts better projected. Not only should all engineering students take this class, I think that all lecturers should take it as well to remind them that every person learns differently and that lectures must be tailored to take this into account."* (Open comment Unit evaluation response, Semester 1, 2012)

> *"A huge benefit I gained from STP is the knowledge of my learning strengths and weaknesses. By realising the learning mechanisms I responded strongest to, I was better able to prepare myself for the end of year exams. Knowing that I am a strongly visual and global learner I was able to capitalise on these methods by employing techniques I researched for Journal Entry 2 (JE2). Instead of becoming frustrated and beginning to doubt my ability to comprehend the material, I was able to recognise that the information was just not being presented in a way which I could effectively learn from. Quite often I used techniques learned in JE 2 to work around these situations – such as trying to understand where the concepts in question fitted into the bigger picture or by making visual*

representations of complex relationships. By 'visualising' these problems in ways that I could understand them better, I was often able to come to easier solutions than my non STP friends studying the same technical subjects." (Student comment, Written Report, Sem. 2, 2011)

The strong preference for active/kinaesthetic/visual learning styles amongst STP students (see Figures 2 and 3) helps validate the heavy emphasis on hands-on, experiential learning throughout the elective. The STP coordinator also uses the individual student results as a guide when provide feedback and suggestions so that the information is delivered in ways that suit their particular learning style preferences.

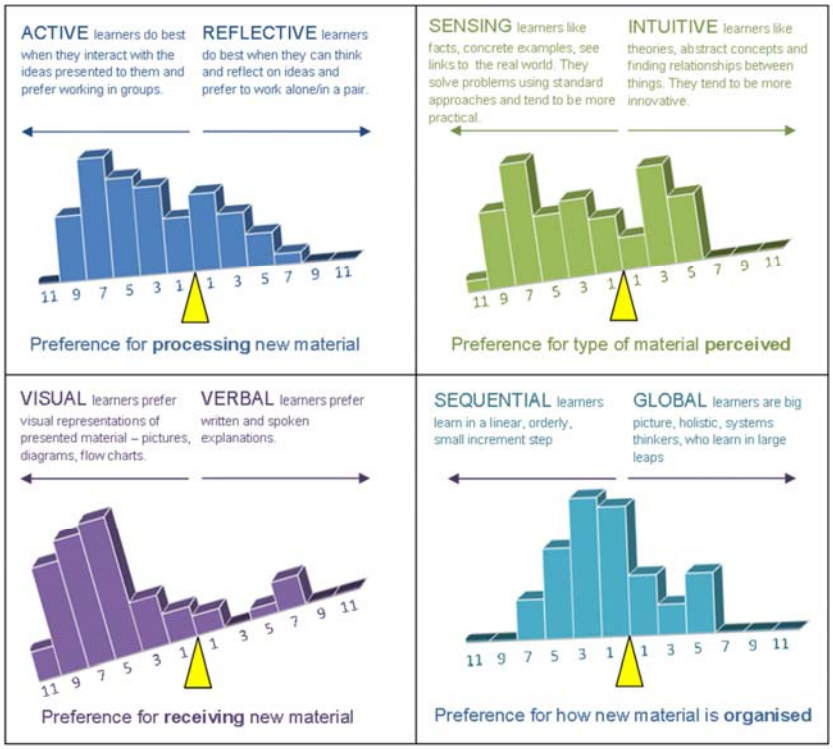

Fig. 2 Felder Silverman Index of Learning Style Preferences for STP students (322) 2010-2012

Fig. 3 VARK preferred learning style (by highest scoring option) STP students 2010-2012

Effective communication

Planning for effective teaching (communication), being an active listener, how to ask good questions, body language, being assertive and how to give and get constructive feedback are covered and demonstrated in Workshop 3. One of the keys to good communication is having confidence; knowing that you are well prepared and really understand what you will talk/write about. The STP has a dedicated space (the STP coordinator's office) in the Faculty of Education where students can plan aspects of their lessons, borrow equipment (such as magnets, batteries, straws, hydrogen powered cars, water rockets etc.) and ask for advice. The room has a comprehensive range of teaching resources, some created by former STP students (models, curriculum packages, written reports etc.) and others of a commercial nature for the students to refer to. Photos of previous STP students working in schools are on display providing visual reference points for ideas on how to present concepts. This space is a hive of activity during placements, with multiple students at a time borrowing equipment, testing and refining possible activities, exchanging ideas and experiences and practicing explaining concepts such as gravity and acceleration to a live, receptive audience. The space also provides the STP coordinator with the opportunity of having regular constructive, informal feedback sessions with individual students.

"Being an international student, I have had a lot of self-doubts especially when it comes to communicating with people from different language and culture backgrounds. The school placement had given me a huge confident boost as it made me realize that I could actually

communicate efficiently and it was my lack of knowing how to prepare and lack of confidence in my head all along that was preventing me from doing it." (Written Report, Semester 2, 2011)

The students are required to email a copy of each of their lesson plans to their supervising teacher three days before each teaching session. The teachers provide timely, constructive feedback which allows the students to make any necessary alterations to their plans. The feedback from their client (supervising teacher) helps keep the STP students focussed and on track, and also allows the students to go into the schools with some confidence that at least the content they intend to cover will be appropriate. The STP coordinator is CC'd into each email that the students send to their clients so that feedback can be provided to them on their business email etiquette. It is quite astounding how many students start their emails with a 'Hey Rob' and use texting language and spelling.

Teaching young children (most STP students work with children aged 9 – 13 years old) is an excellent way of seeing how effective one's communication skills are. Children make it very obvious when what you are saying makes no sense, is boring or irrelevant; likewise you certainly know when you have the children engaged and wanting to know more. Children are also not embarrassed to ask for concepts to be re-explained multiple times. The STP students quickly learn that repeating information using the same language and examples will not work; they need to have thought about a range of different examples and ways of explaining them, during the planning stage if they are to be successful communicators. Throughout their teaching placements, the STP students receive regular formal and informal feedback from the children and their supervising teacher, from their STP colleagues and from the STP coordinator. The students are expected to reflect on this feedback and their experiences as part of their personal 'assessment for learning' (Stiggins, 2002). The students placements are 'graded' by their supervising teachers (and modified by the STP coordinator) via an online survey. The placement grades contribute 20% of the students' overall marks. The students are not assessed on their ability to teach per se, rather on their ability to engage with their clients and students, their organisation and professionalism and their ability to take advice on board.

The remaining assessment tasks

The final two assessment tasks, a Written Report and a Negotiated Task, are 'assessment of learning' tasks and are submitted at the end of the elective. The purpose of the written report is to provide a formal record of whom their client was, what they were asked to do and the steps they took to meet their brief. They need to provide evidence of the outcomes of their project for their students, client and school and reflect on what aspects of their project planning and management most contributed to these outcomes. The students rely on the information that they have kept in their professional journals (unassessed) to answer these sections. Each report also includes a section in which the students evaluate how successfully they met the three professional skill goals that they set for themselves at the start of the elective and which of the skills/strategies they used in the classroom could be effectively transferred into the workplace. The students are also asked to provide feedback as to which areas of the STP could be improved. The intended audience for the report is for future STP students.

The purpose of all activities and assignments is explicitly explored throughout the elective to reinforce the concept that effective engineers (and teachers) communicate and work with a clear purpose. Instead of always writing for an instructor and a grade and adhering to familiar mechanics and form that is the usual procedure throughout most of their degree (McCaffery, 2012) the STP students are required to write for a variety of purposes and audiences. Being able to identify and write for different nuances and audiences are essential skills that graduates need to navigate when they first enter into the workforce (Paretti, 2008).

The final assessment task, the Negotiated Task, gives the students the opportunity of designing and completing a task of *their choice*, based on two guiding principles. They must identify a particular audience and intended purpose for their work and their task must assist them in further enhancing at least one professional skill. Examples of the types of tasks

completed include: creating teaching packages for their supervising teachers/future STP students to use, a written performance review of their achievements in STP and half hour interview with the STP coordinator, developing a portfolio for use in interviews, constructing a 'communication for dummies' guide for graduate engineers etc. Initially most students are apprehensive about this task – but once they have seen some examples and start discussing specific ideas with the STP coordinator they get excited and inspired to do something that really interests them/is of value to them. What is particularly heartening to see are the number of students who construct amazing teaching models (such as a portable wind tunnel, solar air heater and water wheel), which they donate to STP for future students to use during their teaching placements.

Conclusion

The STP has been carefully designed to enhance the oral and written communication competencies and confidence in the engineering students. The students embrace the opportunity to have ownership and responsibility for their learning. Many of the example/strategies provided here can be easily tweaked and included in existing engineering units to enhance the communication skills of their engineers while working within a technical context.

References

Ashman, Peter J, Scrutton, Skye, Stringer, Dylan, Mullinger, Peter J, & Willison, John. (2008). Stakeholder perceptions of chemical engineering graduate attributes at the University of Adelaide. *Chemeca 2008: Towards a Sustainable Australasia*, 912.

Astin, Alexander W, & Sax, Linda J. (1998). How undergraduates are affected by service participation. *Journal of College Student Development, 39*, 251-263.

Black, Paul, Harrison, Chris, Lee, Clara, Marshall, Bethan, & William, Dylan. (2003). *Assessment for Learning-Putting it into practice*: Open University Press.

Bowering, Robyne. (2013). *Invited Paper-Preparing the Global Engineer: How learning to teach in a Service-Learning Project Develops Effective Communication Skills in Engineering Students*. Paper presented at the American Society for Engineering Education International Forum Atlanta, USA.

Bransford, John D, Brown, Ann L, & Cocking, Rodney R. (2000). *How People Learn*: National Academy Press Washington, DC.

Chan, Adrian DC, & Fishbein, Jonathan. (2009). A global engineer for the global community. *The Journal of Policy Engagement, 1*(2), 4-9.

Crebert, Gay, Bates, Merrelyn, Bell, Barry, Patrick, Carol-Joy, & Cragnolini, Vanda. (2004). Developing generic skills at university, during work placement and in employment: graduates' perceptions. *Higher Education Research & Development, 23*(2), 147-165.

Felder Silveman Index of Learning Styles Questionnaire.). from http://www.engr.ncsu.edu/learningstyles/ilsweb.html

Ford, J Dyke. (2004). Knowledge transfer across disciplines: Tracking rhetorical strategies from a technical communication classroom to an engineering classroom. *Professional Communication, IEEE Transactions on, 47*(4), 301-315.

Furco, Andrew. (1996). Service-learning: A balanced approach to experiential education. *Expanding boundaries: Serving and learning, 1*, 1-6.

Hurd, Clayton A. (2008). Is service-learning effective?: A look at current research. *Service Learning: Perspectives and Applications*, 1-11.

Latham, Gary P, & Locke, Edwin A. (1991). Self-regulation through goal setting. *Organizational behavior and human decision processes, 50*(2), 212-247.

Lieb, Stephen, & Goodlad, John. (2005). Principles of adult learning: Best Practice Resources.

Loughran, John. (2012). *What expert teachers do: Enhancing professional knowledge for classroom practice*: Routledge.

Male, SA, Bush, MB, & Chapman, ES. (2010). Perceptions of competency deficiencies in engineering graduates. *Australasian Journal of Engineering Education, 16*(1), 55-67.

May, Elizabeth, & Strong, David S. (2011). Is engineering education delivering what industry requires. *Proceedings of the Canadian Engineering Education Association*.

Merriam, Sharan B. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. *New directions for adult and continuing education, 2001*(89), 3-14.

Missingham, Dorthy. (2006). The integration of professional communication skills into engineering education.
Nair, Chenicheri Sid, Patil, Arun, & Mertova, Patricie. (2009). Re-engineering graduate skills–a case study. *European Journal of Engineering Education, 34*(2), 131-139.
Riemer, Marc J. (2007). Communication Skills for the 21st century Engineer. *Global J. of Engng. Educ, 11*(1).
Siller, Thomas J, Rosales, Alma, Haines, John, & Benally, Aaron. (2009). Development of undergraduate students' professional skills. *Journal of Professional Issues in Engineering Education and Practice, 135*(3), 102-108.
Simonet, Dan. (2008). Service-learning and academic success: The links to retention research. *Minnesota Campus Compact*, 1-13.
Stiggins, Richard J. (2002). Assessment crisis: The absence of assessment for learning. *Phi Delta Kappan, 83*(10), 758-765.
Trevelyan, James. (2009). *Steps Toward a Better Model of Engineering Practice.* Paper presented at the Research in Engineering Education Symposium, Cairns, Queensland, Australia.
Trevelyan, James. (2012). *Why Do Attempts at Engineering Education Reform Consistently Fall Short?* Paper presented at the Profession of Engineering Education: Advancing Teaching, Research and Careers, The: 23rd Annual Conference of the Australasian Association for Engineering Education 2012.
VARK Questionnaire.). from http://www.vark-learn.com/english/page.asp?p=questionnaire
Vest, Charles M. (2005). Educating engineers for 2020 and beyond. *Educating the Engineer of, 2020*, 160-169.
Winters, Katherine E. (2012). *Career Goals and Actions of Early Career Engineering Graduates.* Virginia Polytechnic Institute and State University.

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