TEAMWORK FOR ENGINEERING STUDENTS: IMPROVING SKILLS THROUGH EXPERIENTIAL TEACHING MODULES

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Abstract – *Motivated by a perceived deficiency in teamwork skills of graduating engineering students, a series of six teamwork training modules are being designed for each of the students' first six academic terms. A careful pilot-revise-implement design cycle has resulted in the development of a number of variations of each module, catering to different disciplines' needs for integration with the curriculum.*

The project is at its midpoint, having designed, delivered, and revised the first three modules: an introduction to teamwork, communication in teams, and team conflict. The fourth module - giving and receiving feedback in teams - was piloted in early 2017. The last two remaining modules are envisioned to cover teamwork topics at a more advanced level.

So far, all modules have been delivered in host courses with instructors receptive to the need for teamwork training. It is observed that the modules' success and long term sustainability depend on their ability to easily integrate with or wrap around existing course activities.

Keywords: Teamwork Training, Active Learning, Blended Learning, Undergraduate.

1. INTRODUCTION

The ability to work effectively in teams is widely recognized as an important professional skill. Accordingly, teamwork is prescribed by the CEAB as one of the twelve attributes that engineering students must have developed upon graduation [2]. Yet, teamwork skills are rarely explicitly taught in most engineering curricula. While engineering students are certainly given multiple opportunities to work in teams and thus expected to develop teamwork skills through 'practice', this is hardly a substitute for those skills' planned instruction and assessment. The issue is even more pressing for institutions in light of the new CEAB requirements which place an expectation for rigorous continuous improvement of the instruction and assessment of each graduate attribute [2].

In 2014, the IDEAs Clinic [12] in the Faculty of Engineering at the University of Waterloo established a "teamwork working group" tasked with investigating the sources and quality of teamwork skills instruction to engineering students and developing a plan for more comprehensive and explicit teaching of those skills throughout the curriculum. The working group was first made up of engineering faculty and staff members who joined largely on a volunteer basis. The group was later joined by representatives from the Centre for Teaching Excellence and the Student Success Office. The latter brought on significant expertise in the subject matter, based on their extensive experience developing academic programming for the Student Leadership Certificate at our university.

The group tasked itself with creating six teamwork modules to be offered to undergraduate engineering students in their first six academic terms from first to third year (as depicted in Fig. 1); the capstone design project would then serve as a setting where developed teamwork skills could be applied in a semi-authentic context and assessed in a summative way. This approach is based on several existing institutional examples of teamwork instructional modules developed to supplement existing engineering curricula [10].

We have previously described the development and assessment of the first two modules [4] and more recently provided a detailed look into the inner workings of the teamwork working group [6]. As of the time of writing of this paper, we have developed, implemented, and tested the first four modules and are in the process of designing the final two. In the following sections, we describe in detail the general module design philosophy, development process, and assessment methodology, and provide a description of each of the four modules developed so far. We conclude with a general reflection on the challenges and accomplishments experienced by the team and highlight future steps.

Fig. 1. The six planned teamwork modules

2. DESIGN AND EVALUATION

2.1 Design

Each module is designed collaboratively by members of the teamwork working group using a standardized design cycle that takes into account students' teamwork needs (where applicable), educational best practices, and a framework of teamwork competencies based on the literature on teams. Each module follows a consistent structure that includes opportunities for student reflection and self-assessment at the beginning and end of the module, instruction on applicable teamwork theories or skills, and experiential activities through which students apply what they have learned in a team setting. While the structure of the modules is standardized, the teaching and learning approaches to deliver their content is developed with flexibility in mind. This supports easier adoption into different course environments and team settings, facilitating integration across faculty curricula.

Once a module has been developed, it is then piloted in selected host courses in collaboration with the host course instructors. The course instructors, students, module developers and other members of the teamwork working group are all engaged in a significant feedback process in order to capture the module experience and its perceived and real value. Feedback is then reviewed in the measurement stage. Measurement outcomes are used to not only improve on module design and delivery but also to gain faculty buy-in in future offerings. Additionally, key metrics are also utilized for CEAB accreditation purposes.

Once a module is piloted and its effectiveness measured a few times, its development moves to the integration stage. At this stage, members of the working group identify courses in each program that have an existing team project that may serve as long term hosts of

the module. Instructors of these courses are then approached with background information on the modules and assessment data to establish buy-in. Instructors who opt in to a particular module are then supported in customizing the module to integrate it in their course. At least in the first offering of the module post-integration, module developers will commonly support the instructor in its facilitation.

Once the module has been successfully integrated in a course, it is then considered to be in maintenance stage. At this stage, the module is firmly embedded into the course and it is expected that all future offerings of the module will be delivered by the course instructor independently.

2.2 Evaluation

Measurement of effectiveness is a critical activity in the development of any training program. Accordingly, to evaluate the modules' effectiveness, Kirkpatrick's model of training evaluation [7] (Fig. 2), was chosen as a general assessment framework. The model has four levels, namely: *reaction*, *learning*, *behavior*, and *result*. Each teamwork module and the series of modules as a whole are evaluated according to this model and at each level.

Fig. 2 Kirkpatrick's model of training evaluation

2.2.1 Measuring Reaction. The first component in Kirkpatrick's model is *reaction*, which is the attendees' reception of the program. The criteria considered in evaluating this component in the context of each teamwork module are the module's environment (e.g. size of the room, lighting, sound quality, etc.), the quality of the presentation, and the module activities. In measuring reaction, the evaluator explores the degree to which the module's attendees enjoyed its various parts by asking questions such as "*please indicate the degree to which you enjoyed this workshop.*" or "*how was the quality of the presentation?*", typically on a 5-point Likert scale. Results have shown that more than 80% of the students have reacted positively to the modules.

2.2.2 Measuring Learning. The second component in Kirkpatrick's model is *learning*, defined as the degree to which the training program attendees meet the learning objectives of the program. To measure student learning of teamwork concepts we utilized Bloom's taxonomy of learning [1].

According to Bloom's taxonomy, learning occurs in three domains, namely: cognitive, affective, and psychomotor [1]. The psychomotor domain is concerned with the physical skills that the trainees learn and is thus not applicable to our teamwork modules.

The **cognitive** domain includes six levels of learning: remembering, understanding, applying, analyzing, evaluating, and creating. The process of cognitive learning starts by students remembering the main concepts. Once they remember concepts, they are expected to understand them at a deeper level, and be able to apply them in practice. *Remembering* and *understanding* of the modules' materials are evaluated through testing students before and after each module. The degree to which a module has helped students remember and understand teamwork concepts taught in it is thus measured by comparing student performance in those two tests. To measure students' ability to remember the material, at the beginning and conclusion of each module students are quizzed about the meaning of some of the concepts taught in the module (e.g. the definition of backup behavior). In order to measure understanding of teamwork concepts, students are prompted to identify, recognize, or explain these concepts in a given context. For instance, in the third module, students identify the source of conflict in a given conflict scenario.

Once students remember and understand a concept, they are then expected to progress to more advanced levels of learning - applying, analyzing, evaluating, and creating. Taking into consideration each module's content and host course, different forms of teamwork activities have been designed during which the students can *apply* concepts learned in the module, in practice. These activities are usually integrated with existing team projects in the course. For instance, in the case of the third

module, which includes instruction about team conflicts caused by personality differences, students are asked to complete the Myers-Briggs Type Inventory (MBTI), discuss their personality characteristics with their teammates, and identify potential conflicts that might arise as a result.

Various methods are also employed to evaluate the degree to which students can *analyze* and *evaluate* their own or their teammates' teamwork skills. Students evaluate their own and their team mates' performance based on the criteria taught in the modules using structured self- and team assessment surveys or through more open-ended reflection pieces.

In our modules, we expect students to achieve the learning objectives at all cognitive levels, except for at the "creating" level; reaching this level of expertise requires a significantly greater amount of time and practice opportunities than what we are able to offer during an academic term.

The **affective** domain of Bloom's taxonomy of learning is concerned with the attitudes of the students towards what they learn [8]. It is now common knowledge that students' attitudes and beliefs towards what they learn significantly affect the degree to which they value and use what they learn in practice. This domain has five levels, namely: receiving, responding, valuing, conceptualizing, and characterizing.

Receiving is the degree to which the students actively listen to the content and follow the lecture. *Responding* is the degree to which students are engaged in the lecture and are involved in the activities and discussions. We have typically measured both these levels through the instructors' own observations about how much students participated and were engaged in a teamwork module.

Valuing is attaching values to what one learns and finding relevance of the concepts to one's experiences. We measure valuing by asking students questions such as "*I would like to work in the teams where team members display backup behavior*" or "*I would like to learn more about other conflict resolution strategies*" (5-point Likert scale, strongly agree-strongly disagree).

Conceptualizing is a level of affective learning in which one formulates what one has learnt based on personal views. At this level, students are expected to have clear beliefs and a concrete stance as to why something is valuable, and come up with a personalized plan on how to apply it in practice. We measure the degree to which students conceptualize modules through questions such as "*I believe displaying backup behavior in a team makes the team more cohesive*" or "*I will initiate displaying backup behavior in future teamwork*" (5-point Likert scale, strongly agree-strongly disagree).

Finally, *characterizing* - the most advanced level of affective learning objectives - is the degree to which one believes in what one has learnt and adapts it into one's behavior. Students are not expected to obtain this level of

learning within the academic term; characterizing a skill into one's behaviour requires significant exposure and practice. However, we have asked questions such "*I already have some plans in mind about how I am going to approach conflict resolution in my future teamwork*" (5-point Likert scale, strongly agree-strongly disagree) to understand the degree to which students are likely to integrate what they have learned into their behavior.

2.2.3 Measuring Behaviour. The third component in the Kirkpatrick model is *behavior*, which is the degree to which behavior is changed as the result of the training program. Our target is improved student performance in capstone design project teams. To measure students' current behavior in capstone projects, fourth year students who had not participated in the teamwork modules were surveyed and prompted to identify current problems that they face in their teams and their perceived level of expertise in teamwork skills. In a few years, the same survey will be run with students who will have participated in the teamwork modules. Behavioural change will thus be measured by comparing survey results between the two groups.

2.2.4 Measuring Results. The fourth component of the Kirkpatrick's model is the *results* (of the behavioural change discussed above). Short-term and long-term results for the training program have been identified. Short-term target results are improved self- and team assessment measures in the capstone project teams, as well as more effective teams, fewer ineffective teams (i.e. teams who fail to work together), and fewer students' teamwork-related complaints to the instructors. The long-term target result is improved student performance on team-related criteria in co-op positions and full-time employment.

3. THE FIRST FOUR MODULES

3.1 Module 1 - Team Membership Skills

The first teamwork module was developed and pilot-tested in early 2015. Its goal was to have students learn, discuss and experience the difference between teams and groups, Tuckman's stages of team development [11], characteristics of effective teams, and time management skills. The module was initially delivered in the fall 2015 term by a graduate teaching assistant (hired expressly for this purpose) to over 800 first-year students in their first academic term. It was envisioned as a 90-120 minute team activity where students constructed "forts" and competed for the "best fort". Pre- and post- module survey feedback was collected from the participating students to assess the first two levels of Kirkpatrick's model: reaction and learning. A full description of the module and a detailed analysis of the student feedback

from that first offering is provided in [4]. Students indicated that they did not see the activity as being authentic, with many commenting that it was childish. Additionally, issues were observed with having a graduate student, with whom the participating students were unfamiliar, as the facilitator of the session. In response to these identified issues, the module was redesigned in the summer of 2016 in time to launch for the new incoming class in fall of 2016.

The redesigned module maintains a focus on team membership, but the goals were slightly adjusted. In the new format, students develop basic team membership skills including developing a sense of team orientation, leadership skills, and backup behavior [9]. The new module incorporates short instructional pieces – consisting of short videos that introduce module concepts – that wrap around an existing term project in a host course. Students complete a short quiz to demonstrate remembering and understanding of the video concepts and produce the two practical outputs of the module: a project Gantt chart and a team contract. The new design requires less in-class time and no longer necessitates a graduate teaching assistant to facilitate the sessions, greatly improving the long-term viability of the module.

The redesigned module was piloted in the summer 2016 term to a class of approximately 150 students. In fall 2016, the module was further delivered to approximately 450 students in 3 programs. An additional 2 programs (~300 students) had already integrated the use of both Gantt charts and team contracts into courses in their first term, and thus did not require this module.

In one particular implementation of this module (Mechatronics Engineering), the students were required to watch the 3 online videos and complete a team contract for a major 2-day design activity. Those same students then created another team contract and a project Gantt chart for their final 6-week course project. The students were given a template for the team contracts to prompt them to come to an agreement about team structure (leadership structure and decision-making processes), meeting procedures and frequency, goals of the project, and backup behaviour (how the team would handle member accountability and assist teammates struggling with their tasks). Team contracts were required for both projects, and carried a small amount of grades to ensure teams took them seriously. Gantt charts formed part of their final project planning report which was submitted about half-way through the project, and graded as part of this report. Team contracts were well received by students and taken seriously by all groups. However, in focus groups at the conclusion of the term, students admitted they did not refer back to their contracts during the duration of the project (though it is possible this sample of teams did not have troublesome group members). The project was scaffolded carefully with TA design reviews, incremental reports, formal and informal presentations,

etc., to ensure students made continued progress. In this environment, Gantt charts were largely a linear table of work leading up to a deliverable/check-in, and so were potentially less useful than for large, complex projects. However, early exposure to Gantt charts in first year is valuable, especially as students prepare for their first co-operative work terms. Students typically recognize how important project management is project success, especially in later years of their program.

3.2 Module 2 - Communication Skills

The goal of the second module (previously described in [4]) is for students to develop communication skills and strategies including effectively exchanging complex information amongst multidisciplinary team members and coordinating the exchange of communication. This module focuses on four main skills/strategies, including tailoring a message to its audience, asking strategic questions and learning the difference between open and closed questions, listening actively while paying attention to body language, and summarizing and paraphrasing a message to ensure no mistakes were made while listening.

In this module, students work in teams of six, broken into three pairs. Each team has two “builders” that are given a pile of Lego pieces, two “directors” that are given a picture of a Lego structure, and two “runners” who form the communication channel between directors and builders. Teams have ten minutes to recreate the Lego structure given to the directors without direct communication between directors and builders. It has been observed that this activity is challenging for students; typically fewer than half of the teams are able to build the complete structure. Following this activity, the facilitator debriefs the students, presents the four skills/strategies mentioned above, and then the students swap roles and do the activity again.

Establishing student buy-in can be difficult as communication may appear a trivial topic. In addition, the activity in this module is not an authentic engineering experience (though students do enjoy it). To establish buy-in, before the Lego activity begins students are prompted to answer a typical behavioural interview question on communicating complicated material to someone else. Pilot-testing of the module have shown that linking the module objectives to co-op interviews is crucial in capturing students’ attention. Further buy-in is established when the module facilitated by a regular instructor.

This module carries no grades in the host course, though it has found a permanent home in the introductory labs which take place in the first week of the students’ second academic term. It has thus the feeling of an ice breaker activity, nicely fitting in the first week of the term, as students come back from winter holidays or from their first co-op term.

3.3 Module 3 - Introduction to Conflict Management

This module introduces students to different types of conflict - task, process, and relationship - and strategies to help mitigate or resolve personal conflict. Students learn when and why these different types of conflicts occur, when they are productive versus destructive to a team, and how differences among team members’ needs and perspectives may lead to conflict. A large component of this module includes time to learn and reflect on various strategies aimed at reducing or solving relationship conflict. By the end of the session, students are expected to be able to understand when and why different types of conflict might occur, recognize differences among team members’ needs and perspectives, and implement individual strategies aimed at mitigating or resolving conflict amongst their team members.

The session was piloted during the fall 2016 term in a class of 120 students, working in teams of four. Prior to the session, students were asked to watch a series of short videos which described the different types of conflict teams often encounter. Students were asked to complete a Myers-Briggs Type Inventory (MBTI) self-assessment tool online and watch an additional video which explained Myers-Briggs personality types. While a strong majority of the students completed the MBTI prior to the session, unfortunately, many of the students did not watch the videos introducing them to the types of conflict. During the session, the teams came together to share the results of their MBTI and discuss areas of potential conflict based on each member’s personality type. Each student was then given a list of conflict resolution strategies, asked to reflect on the discussion they had just had with their teammates, and complete a brief write-up discussing the personalized conflict resolution strategies that they could implement to help mitigate or resolve any potential future conflicts. (This document can be submitted as a deliverable for the course if desired and can be used as a binding document to help manage team conflict.) Finally, a series of questions prompting students to reflect on their teamwork processes, any new insights gained, and the strategies they implemented to mitigate or resolve team conflict, was included as a section of each team’s final report. The module created space and opportunity for those students who may not have previously addressed existing team issues or challenges to feel more comfortable bringing these up. Some students who were introverted, asserted that they had previously felt unheard by their team. For example, in some cases the majority of team members were extroverted and had a propensity to ‘think out loud’, while the introverted team members preferred to think independently before contributing. Given these prompts and points of comparison, students were able to engage in rich discussions with their team

mates and come to recognize differences and areas of sensitivity for their team members.

3.4 Module 4 - Reinforcing Communication and Team Membership Skills

The purpose of this module is to reinforce team communication skills and to provide students with an opportunity to practice giving and receiving feedback. The module has been designed as an interactive session, where students observe the design artifacts of a team project and provide various types of feedback while also considering their verbal and nonverbal communication in the process. By the end of the session students are expected to be able to understand the value of seeking, giving, and receiving feedback for self, team, and as a professional; to apply communication skills that keep feedback from being personal, both as the giver and as the receiver of feedback; and to integrate various types of feedback to enhance their creative potential and interpersonal interactions when giving and receiving feedback in a team setting.

In the module, students are first exposed to a short presentation on the value and potential benefits of engaging in feedback for self-development, team functionality and as an important skillset for professional work. They are then introduced to a framework that encourages progression through three key feedback stages: *interpretation* (clarifying questions to expand understanding beyond what has been presented), *evaluation* (assessment of what has been presented), and *recommendation* (further information and ideas about what can be done to progress the design) [5]. Preliminary research suggests that students are either unable to move past clarification questions, or they move right to making recommendations, neglecting to take the time to fully understand the problem.

The module has so far been designed around existing course contexts where students work on design projects in teams (at beginner, intermediate, and capstone level). It was piloted during the winter 2017 term with three classes from different engineering disciplines with class sizes ranging from 40 to 140 students. While the module has been designed to be facilitated by the course instructor, during the pilot phase the sessions were run collaboratively with the module developers. Teams were paired and asked to post their designs on the wall. First, students reviewed the other team's design or solution on their own and marked the best components of the solution or any areas of questions or concerns through coloured dot stickers or a coloured marker. They then took turns asking questions about the designs, evaluating them, and making recommendation following the feedback process learned in class. Each team then came together to discuss the feedback provided to them and its effect on their next design steps. Feedback supported teams in their decision

making with regards to which design ideas were most promising. The setup also allowed students to provide feedback to their peers in a low risk environment. Each student then completed a giving and receiving feedback self-assessment to reflect on their behaviours and attitudes around feedback. Finally, a series of questions prompting students to reflect on the value and impact of the session on their final designs and teamwork processes were included in each team's final report.

It was observed that the module is most effective when the designs/ideas being critiqued are a component of a team project that exists within the course rather than a standalone opportunity to individually generate ideas and critique in a team setting. In addition, environmental factors (size of team groupings and classroom) can impact the activity considerably - student feedback to one of the sessions (where teams were put in groups of three) suggested that there was not enough time for each person to provide valuable feedback and that it was too loud and crowded with so many (roughly twelve) individuals present and trying to participate.

4. REFLECTION AND FUTURE WORK

Initially, each module was envisioned as a two-hour in-class workshop that would help develop identified teamwork-related skills through both exposure to the underlying theories as well as an experiential component where students could practice and reflect on these skills. It was expected that the activities performed would be engineering-relevant and would have some commonality across different programs, while allowing for some variation based on discipline; necessary for more senior years. It is interesting to reflect on how the series of modules has developed against these expectations.

The underlying philosophy has been maintained - each module introduces the underlying theory, involves active learning through an engineering-relevant activity, and encourages self-assessment and reflection. However, considerable flexibility has been shown with respect to the format of the modules; this has included variation in the overall time required and adaptations such as the use of blended models with the theory component delivered online. Much of this was driven originally by the absence of an identified curricular "home"; the modules have therefore been implemented based on the voluntary cooperation of many different instructors, each of whom had different needs and expectations in terms of both the timing of the module within the semester and class time available.

A second change resulted from the fact that many of the instructors who were willing to host the module in their courses were already assigning a group project. This provided an opportunity to re-imagine the workshops in terms of an existing project and improve student engagement by better integrating the module with the

course and aligning it with its respective engineering program. It also provides some direct value to the instructor in terms of enhancing the delivery of an existing course component.

While these changes have resulted in considerable additional effort, we believe they ultimately represent an improvement both from a pedagogical perspective, due to the better integration and alignment with the host course, but also from a sustainability perspective in terms of ensuring the continuity of the project; the latter benefit arises from the improved value of the module to the specific course and hence to the instructor of that course. We are continuing to monitor the modules through surveys and interactions with both students and instructors, as well as through the aforementioned study monitoring teamwork performance in capstone projects. These data and observations will continue to inform module development.

In the near future, the teamwork working group is engaged in the modules' development cycle on several fronts. First, the last two modules in the series - "conflict resolution" and "applying teamwork" - will be designed and piloted. Second, as the other modules continue to be offered across programs and cohorts, the content and delivery of each module will continue to be refined and adapted to suit varying course contexts, student needs, and instructor preferences. Third, host courses for each module, in each cohort and program, will be sought in order to maximize the number of undergraduate engineering students that get exposed to their content. This is a recurring challenge that is magnified by the large number of cohorts (due to the large number of engineering programs and the various co-op streams) and the lack of 'common' engineering classes for first-year students' in different disciplines.

A final thought also relates to the ongoing sustainability of the project. The current model, whereby representatives of the Student Success Office carry the bulk of the module design (and to some extent, facilitation) efforts, will not be feasible once all six modules have been designed. As it becomes clear that the modules' success and long term sustainability depend on their ability to easily integrate with or wrap around existing course activities, a lot of work remains to be done in the proper documentation of each module and in the design of handbooks that clearly describe how instructors can adapt the content of modules according to course structure and needs. While likely to solve the sustainability problem, this 'distributed' model of module delivery reduces consistency in the delivery of the modules within and between programs and poses challenges to the assessment of the teamwork graduate attribute. Thus, in the near future, the group will need to establish a long-term plan that balances the need for consistency in delivery and assessment with the need for adaptability to different program needs.

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References

- [1] L. W. Anderson and D. R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, New York: Longman, 2001.
- [2] Engineers Canada, *Accreditation Criteria and Procedures*, 2016. Available as of May 8, 2017 from <http://www.engineerscanada.ca/accreditation-resources>.
- [3] Google, *Design Sprint Methods*. Available as of November 21, 2016 from <https://developers.google.com/designsprint/downloads/DesignSprintMethods.pdf>
- [4] A. Hurst, E. Jobidon, A. Prier, T. Khaniyev, C. Rennick, R. Al-Hammoud, C. Hulls, J. Grove, S. Mohamed, S. Johnson and S. Bedi, "Towards a multi-disciplinary teamwork training series for undergraduate engineering students: Development and assessment of two first-year workshops,," in Proc. ASEE 123rd Annual Conference & Exposition (New Orleans, LA; June 2016), 18pp., 2016.
- [5] A. Hurst and O. G. Nespoli, "A two- dimensional typology for characterizing student peer and instructor feedback in capstone design project courses,," in Proc. ASEE 123rd Annual Conference & Exposition (New Orleans, LA; June 2016), New Orleans, 18pp., 2016.
- [6] A. Hurst, M. Mostafapour, R. Al-Hammoud, A. Prier, E. Jobidon, C. Rennick, J. Grove, E. Li and S. Bedi, "Practising what we preach: A multi-disciplinary team teaching multi-disciplinary teamwork,," in Proc. ASEE 124th Annual Conference and Exposition (Columbus, OH; June 2017), 16 pp., 2017.
- [7] D. Kirkpatrick, "Great ideas revisited. Techniques for evaluating training programs. Revisiting Kirkpatrick's four-level model," *Training and Development*, vol. 50, no. 1, pp. 54-59, 1996.
- [8] D. Krathwohl, B. Bloom and B. Masia, *Taxonomy of Educational Objectives Handbook II: Affective Domain (The Classification of Educational Goals)*, New York, NY: David McKay Company, 1956.
- [9] E. Salas, D. E. Sims and S. Burke, "Is there a "Big Five" in teamwork?," *Small Group Research*, vol. 36, no. 5, pp. 555-599, 2005.
- [10] L. J. Shuman, M. Besterfield-Sacre and J. McGourty, "The ABET "professional skills" - Can they be taught? Can they

- be assessed?," *Journal of Engineering Education*, vol. 94, no. 1, pp. 41-55, 2005.
- [11] B. W. Tuckman, "Developmental sequence in small groups," *Psychological Bulletin*, vol. 63, no. 6, pp. 384-399, 1965.
- [12] U. of Waterloo, "Engineering Ideas Clinic," University of Waterloo, [Online]. Available as of May 8, 2017 from <https://uwaterloo.ca/engineering-ideas-clinic/>.