Engendering resilience in classroom group work projects

Kenneth E. Igbo[a, b] and Karola von Baggo[b].
Faculty of Engineering and Industrial Sciences[a], Faculty of Information and Communication Technology[b], Swinburne University of Technology, PO Box 218 Hawthorn VIC 3122
Corresponding Author Email: kigbo@swin.edu.au

Structured abstract

BACKGROUND
Group-based assessments, where students are required to work cooperatively towards an assessable learning outcome, is increasingly becoming a vital part of engineering education pedagogy. Such collaborative learning environment proffers unique opportunities for students to shoulder a broad range of responsibilities, including managing risks, resolving conflicting interests and regulating both self and other group members' behaviour in order to achieve group goals. However, students' self-reports of their group work experiences are fraught with issues relating to the difficulties university students face with regards to managing their group work processes (Bacon et al., 1999; Chapman et al., 2006; Myer, 2012). The focus of this research, therefore, is on how university students working in collaborative learning groups make use of structured group process plan (GPP) in order to explore and/or address potential threats and opportunities within their group work dynamics.

PURPOSE
This study examines students' reflections on the usefulness of structured GPP in addressing both anticipated and unforeseen situations that arose in the course of their group work projects

DESIGN/METHOD
GPPs and group evaluation reports (GERs) of students' group work experiences, which formed part of the assessable components in the unit, were employed for data collection purposes. Data analysis was conducted using both inductive and abductive analytics based on the grounded theory method (Glaser & Strauss, 1967). Although issues and categories were allowed to emerge from data, these were later interpreted through the lens of both emerged and deductively identified factors

RESULTS
Our results showed that the GPP provided a means for students to explore technical, communicative and social skill-sets required for all the group assessment components. In addition, students appropriated the GPP in exploring group diversities, and how those differences pose both threats and opportunities for their group dynamics. Most importantly, the GPP captured individual work-study commitments, periods of high workload in this unit, as well as possible clashes between due dates in this unit and periods of high workload in other units. Overall, students noted that the GPP allowed for pre-emptive decision-making long before issues became imminent.

CONCLUSIONS
This paper presents a concrete application of the GPP, which proved particularly useful for addressing both anticipated and unforeseen situations in classroom group work projects. Its findings underscore the need to shift our focus towards ways to engineer resilience in classroom work groups. This shift in focus is based on the assumption that all student groups will likely experience challenging situations regardless of the methods used in forming the groups.

KEYWORDS
Group Process Plan, Resilience, Usability, Engineering & ICT Education

Introduction

The increasing number of assessment components that require higher education students to work collaboratively has necessitated efforts to improve the effectiveness of classroom group work processes. However, the literature on classroom work groups, particularly from the group formation perspective, offers opinions that differ widely regarding the potential benefits of different group selection methods. Popular views on the group selection debate appear to suggest that allowing students to self-select their own group members offers more advantages over instructor-assigned strategies (Chapman, Meuter, Toy and Wright, 2006; Myers, 2012). In spite of the growing popularity of this view, studies that refute such arguments have also been reported in the literature. For example, Feichtner and Davis (1985) posit that students who worked in the instructor-assigned groups are more likely to have positive experience with their group learning.

Regrettably, such inconclusive debate leaves the teacher with little or no direction on how to improve the effectiveness of group work assessments as vehicles for supporting active learning and nurturing requisite soft skills. After a preliminary investigation of student work groups formed using four different group selection methods, the authors concluded that, all student groups are likely to experience issues that could have been fixed easily (with the benefit of hindsight) regardless of the method used in generating the groups. This insight sparked a shift in thinking from a focus on group selection methods that offer more advantages to interventions that could support classroom work groups to successfully regulate their group work processes in spite of deficiencies that might be present in their group dynamics. Thus, we posit that it is more imperative to ascertain the mechanisms that make classroom groups resilient and to focus on supporting such mechanisms, rather than continuing on a never-ending trajectory about which group selection method offers more advantages.

In this paper, we share our efforts aimed at supporting classroom work groups to develop the ability to regulate their group work processes using a structured group process plan (GPP). Our focus is on how students used the GPP in addressing both anticipated and surprising situations that arose in the course of their group work projects. The overall goal is to delineate requisite mechanisms and/or skills that are useful for engineering resilient work groups; that is, a set of dynamic mechanisms and enabling conditions that support classroom work groups to cope effectively amid adversity. Dynamic mechanism represents models that support both pre-emptive decision-making and continuing adaptation of plan to suit prevailing conditions.

Group Formation and Assessment

Traditionally, students are either assigned randomly to groups or required to self-select their own group members based on varied selection metrics, including but not limited to students who share similar motivation or expected outcome, students who share past social relationships or friendships, and on students' stated preferences (Colbeck, Campbell, & Bjorklund, 2000; Delson, 2001). Recently, more sophisticated tools and selection metrics are being employed to engineer student groups using an array of instruments relating to student teamwork profile (Borges, Dias & Cuhna, 2009), personality variables (Bradley & Herbert, 1997), learning style (Kyprianidou, Demetriadis, Tsiatsos & Pombortsis, 2011), etc. Although these tools are useful for generating heterogeneous groups with complementary skillsets, there are a few concerns around their conceptualisation and implementation. Firstly, majority of the tools focus on 'who/what the student is' rather than on 'what the student does' (see Biggs, 1999). Secondly, the underpinning concepts are very mechanistic in nature and appear to presume that student groups would work well once their attributes are correctly matched. Thirdly, most of the tools are not easily replicable without extensive programming; hence, poses a barrier to their adoption and implementation in other classroom contexts.

In parallel, an increase in the frequency of reports relating to free riding in classroom group work projects has resulted in research into strategies for re-distributing group marks in line with team member contributions (e.g., Goldfinch & Raeside, 1990). One implication of this research is the use of self-assessment and peer-assessment tools to enforce accountability in classroom group work projects (Lejk & Wyvill, 2001). Besides social relationship bias and reciprocity that could undermine the idea of fair distribution of marks, mark variation across group members can work against group collaborative processes in unanticipated ways. Anecdotal evidence suggests that students who obtained highest scores for individual contribution are not necessarily the ones that engaged more with group-centred learning activities or developed the intended transversal skills. A not-so-far-fetched evidence is exemplified in actions of students, who hijacked group assessments for a number of reasons, not the least of which is a belief that no other team member could produce satisfactory work. This practice is commonly known as the “lone wolf” phenomenon (see Feldman-Barr, Dixon & Gassenheimer, 2005). Thus, groups may, inadvertently, engage in counter-productive behaviours as each team member strives for the highest score obtainable in a project at the detriment of group-centred learning and team skill development.

Why resilience?

Investigations of how people cope with complexity in high risk systems – such as nuclear power plants, health care and aviation systems – have revealed how human decision-makers actively devise defences to guard against potential paths to failure, compensate for unacceptable conditions and gaps in knowledge, and create conditions necessary to address potential surprises (Hollnagel, Woods & Levenson, 2006; Woods, Dekker, Cook, Johannesen & Sarter, 2010). In order to demonstrate such resilience capabilities within classroom work groups, students must develop four crucial abilities: the ability to anticipate long-term threats and opportunities; the ability to monitor short-term developments and threats around their group work processes; the ability to respond effectively to both expected and unexpected situations; and the ability to learn from past events (Hollnagel, Woods & Levenson, 2006). These are the four cornerstones – anticipating, monitoring, responding and learning – on which the notion of resilience engineering is founded. Thus, classroom work groups can be said to be resilient if they can adjust their functioning prior to, during and following escalating demands and unexpected changes to their work plans or group member behaviour, and still be able to sustain acceptable group performance (Hollnagel, Woods & Levenson, 2006).

The underlying assumption that drives the resilience perspective is that all human adaptive systems are seldom trouble-free, mainly due to their inherent complexity as well as gaps in fitness between expectations and reality (Hollnagel, Nemeth & Dekker, 2008). Thus, miscalibrations – when coupled with inherent complexity of engineered systems – easily open adaptive mechanisms to factors that generate mal-adaptive processes (Igbo, Higgins, Dunstall & Bruce, 2013). This process is mostly evident when there is a significant variation between intended plan and real situations (Woods et al., 2010). Hence, having the right static mechanisms alone is not sufficient to ensure positive adaption (Igbo et al., 2013). The challenge therefore is to ensure that enabling conditions, which mostly lead to acceptable outcomes, can be created and sustained.

Method

Particpants

This study is part of an on-going research project started in 2012 and has since been conducted over three semesters at a university in Victoria. The reported data is based on the latest study of 56 students (50 males, 6 females) majoring in Engineering and Information Communication Technology (ICT). All were enrolled in a unit requiring a core design project that must be completed in small groups of three to five. The participants worked across 18 groups supervised by the same tutor in semester 1 of 2013. A wide range of group member selection methods was approved by the tutor (with the consent of the unit convener) in order

to facilitate cultural and disciplinary diversities, as well as groups with similar goals, motivations, learning style and work ethic.

Instruments

The GPP has four main sections: project overview, resources and responsibilities, communication and documentation, and work plan. The project overview section required groups to outline a brief description of the design they have decided to prototype and evaluate. The second section, resources and responsibilities, afforded groups the opportunity to explore skillsets within their team as well as gaps in knowledge for the selected design theme for the semester. It was assumed that awareness of individual skills within the groups will facilitate role allocation across group members. Communication and documentation section required groups to detail how they plan to manage communication channels as well as establishing contingency plans for potential breakdown in communication. Groups also explored various platforms for document sharing and version control. Lastly, the work plan section required a detailed description of how group plans will be executed, with tentative timelines aligned to the due dates for different components of the design assessment. Groups were also encouraged to consider potential risks to their work plans and perhaps possible mitigation strategies.

In addition, a detailed instrument sheet and assessment rubric was provided to support students to engage meaningfully with this exercise. In addition, a group evaluation report (GER) was conducted at the end of the semester to gain insight into issues that arose and how groups managed both expected and unexpected situations. Probes were used in the GER to elicit both qualitative and quantitative information on the challenges groups faced and how they were handled. Whilst the quantitative questions uses a likert-like scale to collect data on specific aspects of students' group work experiences, the qualitative probes were designed to accommodate other themes students deemed interesting in their group work experiences.

Procedure

Each group submitted their GPPs in week 4 of the semester. This was followed by an individual evaluation of their group work experiences in week 12 using a structured group evaluation report (GER). Whilst only GERs from individuals who volunteered by way of signing an informed consent are included in this study, the ethics approval allowed the use of group-based GPP, where at least one group member has given consent to be part of the study. The qualitative data was analysed thematically using mainly inductive and abductive analytics based on the grounded theory method (Glaser & Strauss, 1967). Although themes were allowed to emerge from data, they were later interpreted through the lens of both emerged and deductively identified factors.

Analysis

First, group evaluation reports from students that volunteered were collated, matched against their GPP and then de-identified. This allowed for establishment of links between how students made use of the GPP and their reflections of its usefulness in addressing both foreseen and unforeseen challenges. Second, the data set comprising the GPPs and GERs were analysed thematically to identify how students made use of the GPP as well as the enabling conditions that facilitated its usefulness. Third, the themes identified were then deductively linked to the four cornerstones of resilience – anticipating, monitoring, responding, and learning – to provide a broader explanation for mechanisms that allow classroom work groups to succeed amidst adversity. The quantitative data analysis is not included in this paper as it focused more on students' satisfaction with specific aspects of their group work experiences; therefore, do not provide beneficial information to support our argument in this paper.

Results

Provides a "big picture" perspective

Based on student responses, the GPP was very useful for providing an overall perspective regarding the requirements and deadlines for the different assessments items. It further supported the development of an early awareness of how all assessment components fit into the overall design project. Not surprisingly, 18 of 56 students (32%) commented on this important contribution of the GPP.

> *P061: The major benefit of our group process plan is that it outlined our key milestones. So we could set our own due date and work towards it.*
>
> *P081: The group process plan was made at the beginning of the semester, when none of us had a very clear clue of what would need to be done in the future. But as it went on, the guideline really showed its effect, it basically tells us what would come after, and then we would get prepared so we would not rush. The result of that is the quality of our work improved a lot than not having a plan first.*
>
> *P142: [The GPP] generated an early awareness of the kind of work the group would be working on throughout the semester and when each other would be busy throughout the semester, this really helped our group not to fall behind. It also provided me with a printed timeline to stick on the wall and look at to know where I was with everything.*

Facilitates communication and meeting scheduling

Further, the GPP proffered a platform for determining students' availability for both face-to-face and virtual meetings, as well as for planning out meeting times and communication channels throughout the semester. 12 out of 56 students (21%) acknowledged this contribution of the GPP in their responses.

> *P011: The plan helped us in scheduling meeting through out the semester such that the meeting during the heavy workload weeks were more frequently scheduled compare to moderately low workload weeks.*
>
> *P183: The group process plan set up our standardised group meeting time and that allowed us to always be able to meet up and make sure that everything was working well. This really helped up as a group*
>
> *P102: The group process plan contributed to the group's performance in that it gave us a guideline when & how we were going to communicate during the semester.*

Supports role designation and task allocation

In addition, the GPP captured technical competencies within the groups, which proved very useful in designating roles, task allocation based on expertise to successfully undertake each project component, team member background and requisite resources accessible to each team member. As expected, 19 of the 56 students (34%) reported on how the GPP was useful for identifying team member skills.

> *P011: Group process plan helped us in dividing the group activities and tasks into manageable chunks and the team leader was able to allocate group resources effectively. For example, while distributing the tasks of prototype design, the skills and background of group members were checked in order to allocate the tasks to appropriate candidates.*
>
> *P072: The group progress plan contributed a lot to our group performance by assisting us in deciding what task we would assign to each group member.*
>
> *P061: The GPP was the key document we followed in every task. Firstly, we identified our skills and resources, which made it easy to split our duties. Then we agreed upon group roles so we could have a clearer picture of our roles and responsibilities.*
>
> *P082: It worked quite well because we first checked what sort of skills each and every member has, after looking at the skills we came up with the decision that which group member should be given roles according to his skills, and by doing so it worked well and made us finish our work on time without facing any difficulty or problems*

Bolsters social bonds and peer-supported learning within groups

But, beyond identifying technical skills, some groups used the GPP to develop a shared understanding of their group dynamics along with other peripheral attributes (strengths, weaknesses and values) that reinforced social relationships within the group; and further assisted in allocating tasks and clarifying skills that needed to be learned or improved.

> *P093: One section that contributed greatly was the session where we shared our own unique values, feelings and personality. I believe this section positively influenced team dynamics and allowed us to come together as not just a project team, but friends*

> *P094: The process plan played a very important role in connecting all members and contributing to the group's performance. By defining characteristics of each member, we had opportunities to understand more about the people we were going to work with and know how to assign roles with respect to each member's strengths and weaknesses. In fact, the roles and responsibilities assigned were really appropriate for the team and helped maximize the productivity of our works*

> *P101: The most helpful part of group process plan was covering other group member's weaknesses. In my case I had problem with my English language skill. So I got help from other members with English speaking background.*

Facilitates workload management

Also, the GPP was used as an instrument for workload management as well as for anticipating and managing periods of high workload during the semester.

> *P011: Because of the group process plan the team members were able to check the current and future work load and plan accordingly.*

> *P041: Having our work planned out ahead of time allowed us to complete the larger tasks without clashes with our other homework, which was very helpful.*

> *P094: Having a Work Breakdown Structure helped us manage our time well. Because we have many assessment items to submit for this project, so it's important that we planned from the beginning for particular time during the semester. This method is very effective in determining whether the group is ahead or behind the schedule.*

> *P152: [The GPP] helped us save time, as we usually know what we had to do at a particular time, or which section each member needed to finish. We also allowed additional time for our plans in the event that unexpected circumstances occurred*

Serves as a risk management plan

Furthermore, some groups deployed the GPP to critically explore potential threats, opportunities and risk mitigation strategies. For example, a student noted:

> *P094: The gaps and risks analysis allowed us to list all potential threats that may affect our performance in terms of member's lacking skills or external factors. By identifying the mitigation strategies, we were more confident to deal with these issues and find the best way to mitigate their effects on our group's performance even in the worst circumstances.*

In a similar but more specific case, another student described a concrete strategy the group agreed upon for managing potential threats to their work documentation.

> *P102: In the GPP we said that we would upload the documents to blackboard file exchange and send an email to everyone else in the group saying what they did and with the version number of the document e.g. document names, which were annotated with the name/ID of the member who worked on the file. This provided a form of version control.*

Limits of the GPP's applicability

Despite the afore-mentioned uses of the GPP, it was found that not all students were excited about the usefulness of the GPP. Thus, the authors explored those negative responses in order to understand the limits of the GPP; more specifically, why it worked for some individuals/groups but not others. A key factor that emerged relates to student's inability to

deal with both expected and emergent situations. In response to whether the GPP contributed to their group work performance, some students noted the following:

> *P023: Not much, we tried to follow it but always people were busy with other assignments and project. So everything depended on the availability of the group members.*
>
> *P132: It didn't, just as I expected it wouldn't, I wrote that plan largely thinking of it as an ideal situation, however, the ideal was quite far from reality, we divided up the work as per the plan, but I still had to do a lot more in order to get it up to any kind of standard. I think even if I had made them stick to the plan, it wouldn't have gone that well, basically because most of the time, they tried to do as little as possible to complete the task*

Further investigations revealed that the GPP was hardly referenced after its initial conception. Although there is no clear reason why it was not used, the comments did highlight a very different team dynamics from the groups that used it.

> *P021: Once it was completed, it was never opened again. Work would be passed out at the meeting and then whatever my team member didn't do I would complete before due date*
>
> *P052: We never looked at it again. Other more pressing work meant that we often had to cancel meetings and do things last minute…*
>
> *P111: It is unlikely anyone else besides me ever referred back to the group process plan. I had to complete the tasks other people were assigned to in the plan on more than one occasion.*

Implications for Classroom Work Groups

Our results showed groups that critically explored potential paths to failure in their group processes were able to deal with similar challenges that other groups were not able to address. As evident in students' responses, group's ability to identify team member work-study commitments and periods of high workload in this unit – as well as possible clashes between due dates in this unit and periods of high workload in other units – informed their group work strategies. Thus, early awareness of risks and mitigation strategies placed proactive groups in a pre-emptive control mode while the reactive groups were forced to adopt a scrambled control mode (Bergstrom, Petersen & Dahlstrom, 2011).

These findings have several implications for supporting classroom work groups. First, static mechanisms that merely inform students on what to do are grossly inefficient for supporting classroom group work dynamics. It is through active engagement with such instruments that students develop critical analysis and risk management skills (McConnell & Sasse, 1999). Second, dynamic models such as the GPP do not automatically eradicate all issues related to group work. However, such models should sensitise students to potential paths to failure, and be able to support them to navigate unfamiliar terrains as demands on their skillsets escalate. This paper therefore advocates for a GPP model that not only allows students to pre-empt potential threats and opportunities around their group dynamics, but also serves as an active navigational tool – rather than a passive roadmap – for possible solutions and repertoire of strategies that could be deployed under both expected and unexpected situations.

Collectively, these findings underscore the need to shift our focus towards ways to support students to develop resilience abilities. In this light, current models for generating and assessing classroom work groups can be extended to include support mechanisms for developing "requisite imagination" (Adamski & Westrum, 2003) necessary for anticipating threats, identifying and monitoring early signs of degradation, responding to critical demands and unexpected changes, and learning from both past successes and failures (Hollnagel et al., 2006). By compensating for unacceptable conditions and maintaining readily deployable contingency plans, students are better positioned to "…resolve conflicts, cope with surprise,

work around obstacles, close gaps between plans and real situations," (Woods et al., 2010), and thereby more readily deal with unanticipated adverse situations.

Future research should focus on incentives that would entice students to engage more actively with the GPP throughout the semester. Our preliminary results suggest a need for an assessable mid-semester review in order to get students re-evaluate how well the GPP model developed at the start of the semester fits with evolved group dynamics and thereby inform the nature of adjustments that is required to sustain intended performance. With regards to limitations, this research could be limited by the fact that its data are based on assessable materials; hence, students might have been swayed to respond either affirmatively or negatively about their group work experiences. Although this paper draws on diverse student group-work projects conducted over three semesters, it is possible that the generality of our findings may be constrained by the specific nature of assessments that students were required to complete in that semester. Again, it is possible that the theoretical lens (resilience engineering) through which this study is investigated may have influenced the interpretation of its findings. As a check, it is suggested that other theoretical approaches be deployed to investigate ways to support spontaneous and proactive adaptations in classroom group work processes.

References

Adamski, A. & Westrum, R. (2003). Requisite imagination. The fine art of anticipating what might go wrong. In E. Hollnagel (Ed.), *Handbook of cognitive task design* (pp. 193-220). Mahwah, NJ: Lawrence Erlbaum Associates.

Bacon, D. R., Stewart, K. A. & Silver, W. A. (1999). Lessons from the best and worst student team experiences: How a teacher can make a difference. *Journal of Management Education, 23(5),* 467-488.

Bergstrom, J., Petersen, K., & Dahlstrom, N. (2011). Securing Organisational Resilience in Escalating Situations: Development of Skills for Crisis and Disaster Management. *Fourth International Symposium on Resilience Engineering*, June 8-10, 2011, Sophia Antipolis, France.

Biggs, J.B. (1999). What the student does: teaching for enhanced learning. *Higher Education Research & Development, 18(1)*, 57 – 75.

Borges, J., Dias, T. G., & Cuhna, J. F. (2009). A new group-formation method for student projects. *European Journal of Engineering Education, 34(6)*, 573-585.

Bradley, J. H., & Herbert, F. J. (1997). The effect of personality on team performance. *Journal of Management Development*, *16*, 337-353.

Chapman, K. J., Meuter, M., Toy, D., & Wright, L. (2006). Can't we pick our own groups? The influence of group selection method on group dynamics and outcomes. *Journal of Management Education, 30(4),* 557-569.

Colbeck, C. L., Campbell, S. E., & Bjorklund, S. A. (2000). Grouping in the dark. *Journal of Higher Education, 71(1),* 60.

Delson, N. J. (2001). Increasing team motivation in engineering design courses. *International Journal of Engineering Education, 17 (4,5)*, 359-366.

Feichtner, S. B., & Davis, E. A. (1985). Why some groups fail: A survey of students' experiences with learning groups. *Organizational Behavior Teaching Review, 9(4),* 77-88.

Feldman-Barr, T., Dixon, T. A., & Gassenheimer, J. B. (2005). Exploring the lone wolf phenomenon in student teams. *Journal of Marketing Education, 27,* 80-91.

Glaser, B. G. & Strauss, A. L. (1967) The discovery of grounded theory: strategies for qualitative research. Chicago, IL: Aldine.

Goldfinch, J., & Raeside, R. (1990). Development of peer assessment technique for obtaining individual marks on a group project. *Assessment and Evaluation in Higher Education, 15(3),* 210-225.

Hollnagel, E., Nemeth, C. P., & Dekker, S. (2008). *Remaining Sensitive to the Possibility of Failure (Vol1)*. Aldershot, UK: Ashgate.

Hollnagel, E., Woods, D. D., & Levenson, N. G. (Eds.)(2006). *Resilience Engineering: Concepts and Precepts* (pp. 347-358). London, UK: Ashgate.

Igbo, K. E., Higgins, P. G., Dunstall, S., & Bruce, P. J. (2013). Regulating interactions across multiple centres of control: An airline operations control perspective. *Fifth International Symposium on Resilience Engineering*, June 24-27, 2013, Soesterberg, the Netherlands.

Kyprianidou, M., Demetriadis, S., Tsiatsos, T., & Pombortsis, A. (2012). Group formation based on learning styles: can it improve students' teamwork? *Education Technology Research Development, 60,* 83-110.

Lejk, M., & Wyvill, M. (2001). Peer assessment of Contributions to a Group Project: a comparison of holistic and category-based approaches. *Assessment and Evaluation in Higher Education, 26 (1),* 19-39.

McConnell, C. A., & Sasse, C. M. (1999). An anticipatory case for managing teams and team projects. *Issues in accounting Education, 14(1)*, 22-47.

Muller, T. E. (1989). Assigning students to groups for class projects: an exploratory test of two methods. *Decision Sciences Journal, 20(3),* 623-634.

Myers, S. A. (2012). Students' perceptions of classroom group work as a function of group member selection. *Communication Teacher, 26*, 50-64.

Woods, D. D., Dekker, S., Cook, R., Johannesen, L., & Sarter, N. (2010). *Behind human error (2nd ed.)*. London, UK: Ashgate.

Copyright statement