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Attitude and Challenges in Collaborative Learning among Engineering Students

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ABSTRACT

CONTEXT

Research in engineering education reached momentum during the first decade of the 21st century in response to the demand to produce quality graduates. For educational institutions to stay competitive, there is the need to explore and adapt new teaching and learning strategies through rigorous research and innovation in engineering education. As Mohd-Yusof et al. (2015) reported, such initiatives will prepare engineering students in coming up with forward-looking and cutting-edge initiatives, develop new designs, products, and services, and deliver to serve the communities and innovate continually to support the industries.

PURPOSE OR GOAL

The study aims to document the attitudes and challenges of engineering students regarding collaborative learning. It also aims to explore the relationship of students' socio-demographic profiles such as gender, age, civil status, and degree program to their attitudes and challenges to collaborative learning.

APPROACH OR METHODOLOGY/METHODS

Mixed-methods research was used in the study. For the quantitative part, descriptive-inferential statistics was used to describe the participants' attitudes and challenges. To triangulate the quantitative findings, qualitative design, particularly thematic analysis was used.

ACTUAL OR ANTICIPATED OUTCOMES

Institutions may benefit from the findings since educational stakeholders may have a comprehensive understanding of students' attitudes and challenges in collaborative learning which will help them tailor and apply a more responsive and inclusive pedagogy.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Participants have a positive attitude toward collaborative learning. They also experience challenges, which stem from group conflict, the pacing of the learning process, and objectivity in the assessment of students' learning. This emphasizes the need among engineering educators to be ready for various challenges when using collaborative learning. As regards participants' socio-demographic profile, only age and degree program were associated with participants' challenges in collaborative learning.

KEYWORDS

Collaborative learning, attitudes, challenges

Introduction

Given that professional engineers themselves work with one another and with professionals in various domains, collaboration is an important aspect of engineering education. Though early implementation of collaborative learning encountered resistance from both educators and students as it precisely opposes the traditional teacher-centered learning experiences and its efficacy was doubted (e.g., Seidel & Godfrey, 2005; Atman et al., 2010; D'Souza & Wood, 2003; Taylor, 2011; Virga et al., 2014; Howard, 2015; Allan, 2016; Pearsons, 2010), its efficiency and effectiveness in students' academic performance, relationship with peers and faculty, and attitude toward tertiary learning experience have been validated in over 20 years of empirical data (e.g., Dass et al., 2021; Koehn, 1995; Lin, 2015; Yee & Yoo, 2018; Seemiller & Grace, 2017; Thacker, 2016; Desai & Lele, 2017; Alford et al., 2014). Indeed, implementing collaborative learning without considering the scholarly empirical-based approach can be costly as well as disruptive and detrimental to students' learning. Engineering educators need to be cautious in implementing collaborative learning for it will bring positive and negative impacts on students. What is needed is the use of the strategy as backed up by sound and deeply rooted educational principles and empirical data from further studies. Engaging in collaborative learning research can lead to further improvements in implementation, which in turn can result in a virtuous research cycle.

In the New Zealand context alone, this topic has not yet been fully explored. Much of the studies surveyed were done in the American, European, Indian, and Arab settings. It is of significant interest to explore how engineering students in New Zealand educational institutions perceive collaborative learning in their classes. This is in relation to what Torres and Santos (2021) mentioned New Zealand has a diverse society in a globalized milieu and many people from the Pacific and Asia have decided to pursue education in the country.

The present study aims to describe the attitudes and challenges in collaborative learning among engineering students at the Southern Institute of Technology (SIT). In particular, it determined the students' socio-demographic characteristics in terms of gender, age, civil status, and degree program. Finally, it determined the significant difference in students' attitudes and challenges in collaborative learning when grouped based on their socio-demographic profile.

Methodology

Research Design

Given the nature of the current investigation, it employed the mixed-methods research design. Several scholars (e.g., Creswell, 1994; Hurmerinta-Peltomaki & Nummela, 2006; Jick, 1979; Parkhe, 1993; Tashakkori & Teddlie, 2003) as noted by Rouzies (2013) have proposed mixed-methods to overcome the limitations of using these methods individually. Mixed methods research is a type of research that combine elements of qualitative and quantitative approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, and inference techniques) for the purpose of wider understanding or corroboration (Johnson, Onwuegbuzie, & Turrner, 2007). For the quantitative part, descriptive and inferential statistics were used. Thematic analysis through coding was done for the qualitative part.

Participants

Thirty-six students from SIT pursuing Bachelor of Engineering Technology and Graduate Diploma in Engineering Technology participated in the study. The majority (19 or 52.8%) of the participants were domestic students, while the remaining (17 or 47.2%) were classified as international students. Nearly all the participants (28 or 80%) reported that earning an engineering-related degree was their first choice. With regard to participants' preparation for pursuing an engineering degree, almost three-fourths of the participants reported that they were moderately prepared (14 or 38.9%) and prepared (12 or 33) to accomplish academic-related tasks in engineering.

Instruments

A survey Questionnaire for participants was used as the main data collection tool for this study. The Survey Questionnaire is a researcher-made instrument that consists of three parts. Part 1 is for the participants' socio-demographic profile, while Part 2 and Part 3 were for the participants' attitudes and challenges to collaborative learning, respectively. Items in the last two parts of the survey questionnaire were based on previous studies on collaborative learning and tailored in such a way that they fit the present study.

For the validation of the researcher-made survey questionnaire, the expertise of a qualitative researcher and college professor was sought. This is to ensure that the questions asked from the participants captured the needed data for the study. After having presented the survey questionnaire to the validator, revisions based on the validator's suggestions were incorporated. After the questions had been revised, the survey questionnaire was pilot tested on 10 non-participants to address the possible concerns that each question would have before it had been finally administered to actual participants.

Data Collection Procedure

Data gathering commenced after the research instruments had been drafted, validated and pilot tested. Tabulation, analysis, and reporting of data were done through the assistance of a statistician for the quantitative part and three inter-coders for the qualitative part. The final stage was the packaging of the report for presentation and then later for publication.

Data Analysis

To analyse the quantitative data collected, descriptive statistics such as frequency count, percentage, mean and standard deviation were used. For inferential statistics, One-way ANOVA specifically Welch's Test was used. Qualitative data were analysed through thematic analysis as suggested by Smith et al. (2009). The thematic analysis aims to reach the concepts and themes that can explain the collected data, gather similar data within the framework of specific concepts and themes, and discuss them in a manner the reader can comprehend. Verbal responses in the questionnaire were extracted without annotations. Then, the data were sorted digitally for content analysis. After grouping responses based on commonality, recurrence, initial codes, sub-themes, and themes had been prepared. The final version of the summary of the qualitative data was done after a thorough discussion among the inter-coders.

Results and Discussion

Participants' Socio-Demographic Profile

Presented in Table 1 are the participants' socio-demographic profiles such as gender, age, civil status, and degree program. In terms of gender, an overwhelming majority (32 or 88.9%) of the respondents were males and the remaining (4 or 11.1%) were females. As regards participants' age, more than one-fourth (11 or 30.6%) belong to ages 21-25, followed by those who belong to 16 to 20 (9 or 25%), 26 to 30 (7 or 19.4%), 36 and above (6 or 16.7%), and 31 to 35 (3 or 8.3%) age brackets. In terms of civil status, the majority were single (25 or 69.4%) were single and more than one-fourth were married (11 or 30.6%). Finally, regarding a degree program, almost half (16 or 44.4%) were enrolled in Bachelor of Engineering Technology (Mechanical), more than one-fourth (13 or 36.1%) were enrolled in Bachelor of Engineering Technology (Civil) and the remaining were pursuing Graduate Diploma in Engineering Technology (Civil = 5 or 13.9%; Mechanical = 2 or 5.6%).

Table 1: Participants' socio-demographic profile

SOCIO-DEMOGRAPHIC PROFILE	Frequency	Percentage
Gender		

Male	32	88.9 %
Female	4	11.1 %
Age		
16-20	9	25.0 %
21-25	11	30.6 %
26-30	7	19.4 %
31-35	3	8.3 %
above 36	6	16.7 %
Civil Status		
Single	25	69.4 %
Married	11	30.6 %
Degree Program		
Bachelor of Engineering Technology (Civil)	13	36.1 %
Bachelor of Engineering Technology (Mechanical)	16	44.4 %
Graduate Diploma in Engineering Technology (Civil)	5	13.9 %
Graduate Diploma in Engineering Technology (Mechanical)	2	5.6 %

Attitudes toward collaborative learning

Summarized in Table 2 is the quantitative result of the participants' attitude toward collaborative learning. The average agreement on attitude towards collaborative learning ranges from 2.07 to 4.00. It has a mean of 3.15 and a standard deviation of 0.43. It can be seen from the figures that attitude ratings have skewed to the right distribution, i.e., the bulk of the respondents either agree or strongly agree on the premises on attitudes toward collaborative learning.

Looking at the individual ratings each statement obtained, it could be noted that statements on positive attitude as regards collaborative learning obtained higher mean scores compared with statements on negative attitude toward collaborative learning. In particular, the top three items include Statement 2 (*Collaborative learning can promote better understanding*, $\bar{X}$ = 3.50), Statement 8 (*I willingly participate in collaborative learning,* $\bar{X}$ = 3.44), and Statement 1 *(Collaborative learning can promote better understanding among students,* $\bar{X}$ = 3.39). The three statements that received low mean scores include Statement 11 (*Collaborative learning decreases my academic productivity*, $\bar{X}$ =2.08), Statement 9 (*I am hesitant to participate in collaborative learning activities*, $\bar{X}$=2.17), and Statement 15 (*Collaborative learning creates dispute among students*, $\bar{X}$ = 2.18). The foregoing results show that participants have a positive attitude toward the use of collaborative learning activities in their respective courses works. This corroborated Mohamad et al.'s (2020) findings that engineering students from a higher institution in Southern Peninsular Malaysia have a positive attitude toward collaborative learning.

Table 2: Attitudes toward collaborative Learning

	Mean	**SD**	**Verbal Description**
1. Collaborative learning can promote better understanding among students.	3.39	0.549	Strongly Agree
2. Collaborative learning develops students' social skills.	3.50	0.561	Strongly Agree
3. Collaborative learning develops students' personal skills.	3.22	0.637	Agree

4. Collaborative learning helps achieve a better classroom atmosphere.	3.22	0.681	Agree
5. Collaborative learning helps students to become critical thinkers.	3.14	0.683	Agree
6. Collaborative learning is cognitively beneficial to students	3.19	0.668	Agree
7. Collaborative learning is one of the useful teaching and learning techniques.	3.28	0.741	Strongly Agree
8. I willingly participate in collaborative learning activities	3.44	0.504	Strongly Agree
9. I am hesitant to participate in collaborative learning activities.	2.17	0.845	Disagree
10. Collaborative learning activities help me accomplish more learning tasks.	3.03	0.774	Agree
11. Collaborative learning activities decrease my academic productivity.	2.08	0.841	Disagree
12. Collaborative learning activities make the learning experience easier.	3.22	0.760	Agree
13. Collaborative learning activities make me more anxious as a student.	2.25	0.906	Disagree
14. Collaborative learning helps boost my confidence.	3.17	0.737	Agree
15. Collaborative learning creates disputes among students.	2.18	0.904	Disagree

Legend:
3.25 – 3.99 Strongly Agree
2.50 – 3.24 Agree
1.75 – 2.49 Disagree
1.00 – 1.74 Strongly Disagree

To triangulate the foregoing quantitative findings, participants' responses to the open-ended question that probes their attitude toward collaborative learning were coded to come up with themes and sub-themes which were summarized in Table 3. Two themes (i.e., positive and negative attitudes) emerged. For the positive attitude, the following sub-themes were identified: promotes better understanding among students, beneficial to international students, promotes better socialization and communication skills, gives everyone the chance to share ideas, and prepares students for industry work. The sub-themes for the negative attitudes include giving tutors the opportunities to be lazy, allowing others to freeload, and slowing down the teaching-learning process.

Table 3: Summary of Participants' attitudes toward collaborative learning

Themes	Sub-themes	Sample Codes
Positive	Promotes better understanding among students	*Learning becomes easier because they can help and explain things that tutors do not know* (P19) *Very helpful when more than one does not understand* (P21) *Helps understand concepts when explained differently* (P34)
	Beneficial to international students	*Good for us in study especially for international students* (P3) *Collaborative learning gives chances to the students, especially international students* (P26)

		As a student from a different country, collaborative learning helps me understand and learn about other people in my class (P30)
	Promotes better socialization and communication skills	*Improves socialization* (P33)
	Gives everyone the chance to share his/her ideas	*Collaborative learning brings forth questions that normally aren't asked in classroom situations* (P7)
	Prepares students for industry work	*Collaborative learning prepares us for the industry* (P20)
Negative	Gives tutors the opportunity to be lazy	*Collaborative learning is used as an opportunity for tutors to be lazy and do other things that are not tutoring* (P32)
	Allows others to freeload	*Collaborative learning or group projects do not work because some members will put in more effort than others and results will change* (P35) *Efforts are not equal* (P36)
	Slows down the teaching-learning process	*I find that collaborative learning slows down the process. I would much rather be provided the material and go away and learn it by myself* (P31) *Too long* (P38)

Challenges to collaborative learning

Table 4 summarizes the participants' responses to the challenges of collaborative learning. Like the participants' ratings on the statements on attitude, it can be seen from the figures that challenges ratings have skewed to the right distribution. This implies that the bulk of the respondents either agree or strongly agree with the various statements on students' challenges in collaborative learning. Of the six statements, Statement 4 (Collaborative learning activities allow my classmates to freeload, and receive credit for a group's accomplishment without contributing substantially to it) and Statement 6 (Collaborative learning gives *my classmates* the opportunity to specialize in particular tasks and avoid others) obtained the highest mean score of 2.67, which was followed by Statement 5 (Collaborative learning gives *me* the opportunity to specialize in particular tasks and avoid others). This concurs with the observations of scholars on the various challenges of collaborative learning in undergraduate engineering programs. For, Seidel and Godfrey (2005), collaborative learning activities, if not carefully planned and evaluated, may enable students to freeload, and obtain credit for a team accomplishment without substantially contributing. In particular, students may find in collaborative learning activities the opportunity to specialize in specific tasks and get rid of others such as technical report preparation and CAD modeling a concern in which course outcomes are assessed at the team level, but skills are developed at the individual level.

Table 4: Challenges to collaborative Learning

	Mean	**SD**	**Verbal Description**
1. I am not fully equipped with the competencies to effectively and efficiently participate in collaborative learning activities.	2.06	0.715	Disagree
2. My classmates are not fully equipped with the competencies	2.17	0.737	Disagree
3. Collaborative learning activities *allow me* to freeload and receive credit for the group's accomplishment without contributing substantially to it.	2.25	0.937	Disagree

4. Collaborative learning activities *allow my classmates* to freeload and receive credit for the group's accomplishment without contributing substantially to it.	2.67	0.828	Agree
5. Collaborative learning *gives me* the opportunity to specialize in particular tasks and avoid others (e.g., CAD modeling, report writing).	2.53	0.696	Agree
6. Collaborative learning *gives my classmates* the opportunity to specialize in particular tasks and avoid others (e.g., CAD modeling, report writing).	2.67	0.828	Agree

Legend:
3.25 – 3.99 Strongly Agree
2.50 – 3.24 Agree
1.75 – 2.49 Disagree
1.00 – 1.74 Strongly Disagree

Responses to the open-ended questionnaire were coded to come up with themes and sub-theme on the participants' challenges in collaborative learning. Three themes were identified as the participants' challenges in collaborative learning. For them, the process may create group conflict, hinder the learning process, and lessen objectivity in the assessment of students' learning. The sub-themes and sample codes are presented in Table 5.

Table 5: Summary of Participants' challenges toward collaborative learning

Themes	Sub-themes	Sample Codes
Creates group conflict	learners are not in the same phase	*Someone may try to take over the jump team members at a different speed* (P2) *Your partner is not doing good work or is unwilling to commit to the project which can cause a serious problem* (P17) *Some classmates do stuff last minute and can be hard to work with as a team*(P27) *Sometimes one person could get away with learning easily* (P31)
	delegation of work	*Sometimes the work is not evenly distributed, and I often feel that I have to lead and organize the group and conduct a larger percentage of work than my peers* (P25) *Others do minimal effort* (P28) *Collaborative learning cannot guarantee that every student has the same enthusiasm* (P34)
	setting of common time among group members	*Organize suitable times with classmates to meet and collaborate* (P14)
Hinders learning process	unclear instructions from tutors	*Collaborative learning without proper guidance will hinder the learning process, especially on materials that are new for students since students do not have a proper understanding of the subject yet* (P6)
	time constraints	*Not enough time to complete the activity* (P30)
	language barrier	*Trying to understand other students due to language barriers* (P24)

Lessens objectivity in the assessment of students' learning		*There are times when students who have not taken part in the group work completely benefitted from the work* (P20)

Relationship of participants' age to their attitudes and challenges in collaborative learning

It can be noted in Table 6 that age has a significant positive correlation with the participants' agreement with challenges in collaborative learning. This suggests that as the participants get older, their level of agreement on the items on challenges also increases. Contrary to previous studies which established that aging does not impede academic achievement (e.g., Imlach et al., 2017), the current result offers a different perspective on how age can be related to the academic challenges students may encounter.

Table 6: Relationship of participants' age to their attitudes and challenges in collaborative learning

		Attitude	Challenges	Age
Attitude	Pearson's r	—		
	p-value	—		
Challenges	Pearson's r	0.256	—	
	p-value	0.131	—	
Age	Pearson's r	0.14	0.347*	—
	p-value	0.416	0.038	—

Note. * p < .05, ** p < .01, *** p < .001

Differences in participants' attitudes and challenges in collaborative learning when grouped based on socio-demographic profile

To establish if there is a significant difference in the participants' attitudes and challenges in collaborative learning when they are grouped based on their socio-demographic profile, One-Way ANOVA (Welch's Test) was done. Results show that of all the socio-demographic profiles (i.e., age gender, civil status, degree program), only the degree program in which the participants were enrolled is related to their levels of agreement on the challenges. Participants from the Graduate Diploma in Engineering Technology (Mechanical) gave significantly higher challenges rating compared to participants from Graduate Diploma in Engineering Technology (Civil). This implies that participants who specialized in mechanical engineering encounter more and a higher level of challenges than participants who specialized in civil engineering. It could be attributed to the fact that the mechanical engineering program involves the applications of complicated mathematical calculations and the synergy of concepts such as mechanics, electricity, machinery, thermodynamics, kinematics, and structural analysis among others.

Table 7: Difference in participants' attitudes and challenges to collaborative learning based on the degree program

	Program	N	Mean	SD	SE
Attitude	Bachelor of Engineering Technology (Civil)	13	3.24	0.4781	0.1326
	Bachelor of Engineering Technology (Mechanical)	16	3.14	0.3683	0.0921
	Graduate Diploma in Engineering Technology (Civil)	5	3.00	0.5598	0.2503
	Graduate Diploma in Engineering Technology (Mechanical)	2	3.03	0.0471	0.0333

	Bachelor of Engineering Technology (Civil)	13	2.71ab	0.6532	0.1812
Challenges	Bachelor of Engineering Technology (Mechanical)	16	2.65ab	0.2425	0.0606
	Graduate Diploma in Engineering Technology (Civil)	5	2.04b	0.1900	0.0850
	Graduate Diploma in Engineering Technology (Mechanical)	2	2.92a	0.1179	0.0833

Conclusion

The findings reveal that there is an overwhelming acceptance of collaborative learning among engineering students, particularly in the New Zealand tertiary education context. It also proves that the previous challenges, which are rooted in group conflict brought by irresponsibility within groups, on collaborative learning documented by previous scholars still exist nowadays. Others consider that the strategy hinders the learning process and lessens objectivity in the assessment of students' learning. This underscores the demand among engineering educators to be prepared for an array of challenges when implementing collaborative learning activities. In terms of learners' demographics, only age and degree programs have established a relationship with participants' challenges in collaborative learning.

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