Journal of Engineering Education Transformations ,
Volume 34 , No. 3, January 2021, ISSN 2349-2473, eISSN 2394-1707

Effectiveness of Collaborative Learning Among Gen Z Engineering Students

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Abstract: Collaborative learning helps to get the most out of students' academic as well as intellectual capabilities by engaging a team of students in self-regulated learning activities under the supervision of course coordinators. At the swipe of a screen, Generation Z (Gen Z) hasthe solutions to every problem. The need to promote interactive and productive learning and to cater to the needs of current Generation Z (Gen Z) engineering students, collaborative learning is considered to be one of the most profound approaches which can be incorporated in the teaching and learning process on the campuses. The aim of this research is an attempt to understand the engineering students' insights towards collaborative learning and its effectiveness. The study population of this action research is the second-year electronics and communication engineering students (N=60; males=33; females=27) on a core course at St Joseph Engineering College, Mangaluru, Karnataka, India. They were selected on the basis of their performance in the previous test. The collaborative activity was conducted in two phases. Six Thinking Hats activity was adopted for collaborative learning activity. A detailed research design with a structured questionnaire has been used to measure the effectiveness of the activity. Collaborative learning is found to be an effective method in enhancing learning among Gen Z engineering students, with a positive correlationbetween collaborative learning and student performance and the assessment parameters of the presentation indicate that the students participated actively.

Keywords: Collaborative learning, Group presentation, Generation Z, Student engagement, Student understanding.

1. Introduction and Literature Review

Technology is life and breath forGen Z engineering students and they live amid information and entertainment. Unlike traditional learners, Gen Z engages with information to tackle challenges and come up with their solutions. Collaboration learning is one of the effective teaching learning tools. When we analyse the Engineering education, it demands lot discussions, demonstrations, presentations, brainstorming and participative sessions. Collaborative teaching tool is more comprehensive and best suited to meet these requirements compare to other tools. More over engineering is more of team work where collaboration is inevitable and collaborative learning tool prepares them for their work place conditions as well. As we look into the literature there are considerable work have been

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reported on the research work, taking collaborative learning as a tools on students of different walks of life except engineering. The effectiveness of collaborative learning for engineering education is yet to be explored substantially with ample of data. In the present work we are analysing the effectiveness of collaborative learning with robust data from engineering education field. The present research work focused on studying the outcome of collaborative learning on the learning values of engineering students' and their experiences towards the collaborative learning activities in their classroom. The activities were carried out during the classroom sessions of Power Electronics and Instrumentation which is a core course undertaken by the second year (third semester) B.E. Electronics and Communication Engineering students (Under Graduates) in St. Joseph Engineering College, Vamanjoor, Mangaluru, Karnataka.

Different allies are categorized based on the birth year due to different set of historical events and associated phenomena that creates a discrete gap among the generations (Parry & Urwin, 2011). Following the Veterans, Baby boomers and Generation X, the fourth generation, which was acknowledged as Generation Y received vast attention from the researchers in the last decade. Born between 1982 and 2000, the Gen Y was also known as the Millennial. Their unique and distinct individualities were widely studied and debated in education and industries all over the world (Desai &Lele, 2017).

The rising generation which is identified as the Generation Z (Gen Z) has replaced the Gen Y and entered into their twenties. Gen Z was born between the mid-1990s to early 2010s (Cameron &Pagnattaro, 2017; Rothman, 2014; William, 2015). For Generation Z, technology is whole and soul and they are strangled between information and entertainment. They have solutions for every problem under the sky at their fingertips just by a click. They engage with information, not just absorbing it, to tackle challenges ahead technologies that support independence and flexibility. Collaborative learning encourages them to use the technologies and to come up with their solutions. Their world is always active with spending much of the time doing productive and creative activities and continuous interactions. They are uncomfortable adapting to the traditional learning methods, instead, they enjoy visual communications and participating in collaborative sessions, thereby harnessing technologies that help them make their mark. This generation is the actual global generation and they cannot imagine a life without the internet and smart phones (Andrea, Gabriella & Timea, 2016).

Gen Z has a very short span of attention and cannot focus or analyse complex information for an extended period. Their brains are bound to complex networks and visual images since childhood. They get easily bored and quickly jump to another area of interest (Rothman, 2014; Shatto & Erwin, 2016). From the positive perception, they are the "highly evolved eight-second filters", who can swiftly sort through and weighs an enormous volume of info (Cameron & Pagnattaro, 2017). They read critically, write persuasively, work collaboratively, think creatively, solve complex problems, manage information, use digital technology and practice communication tools. The exceptionally short focus or concentration span of Gen Z encounters incredible challenges while implementing traditional teaching-learning methods.

Yee & Yoon (2018) and Seemiller & Grace (2017) pointed out the satisfactory acceptance of collaborative learning approaches by Gen-Z students. They pointed out that even though Gen Z desires independent learning, they prefer working in a team as well. The thought was substantiated by proof that Gen Z likes collaboration and prefers interaction (Thacker, 2016; Desai & Lele, 2017). Conversely, there are also controversial findings that claim that Gen Z is the digital inherent who prefers social media over direct communication (Rothman, 2016) and lack interpersonal skills, which affects social behaviour (Turner, 2015).Keser&Ozdamli (2012) investigated and put forward various trends in collaborative learning for the 21st century Gen Z learners.

A. Role of Collaborative Learning

Collaborative learning was identified as the trend in the 21st century for Gen Z learners (Laal, Laal & Kermanshahi, 2012). It is a learning style that encourages the participation of a team of learners to think and work together on issues of critical concerns to yield a productive solution (Laal & Laal, 2012; Laal & Ghodsi, 2012). Learners are required to work in teams that are wisely designed to endorse positive interdependence, appropriate use of collaborative skills, group processing, and individual accountability. While working as a team, the learners plan and manage, collect and correlate, discuss and interpret, analyse and apply, present and create (Zambrano, Kirschner, Sweller& Kirschner, 2019).

Besides sharing ideas and resources, they plan cooperatively which builds an effective cooperative learning experience for the learners (Manathunga& Leo, 2015; Zakaria, Solfitri, Daud&Abidin, 2013). Ajaja & Eravwoke (2010) noted that most of our attitudes and values are formed by sharing our knowledge and thoughts with that of others who have acquired it in different ways which in turn shapes our perceptions. Collaborative learning enhances motivation and participation among students in the classroom atmosphere (Hernandez, 2012; Scager, Boonstra, Peeters, Vulperhorst & Wiegant, 2016). This was supported by Desai & Lele (2017) and Le, Janssen & Wubbels (2016) who said that learners enjoy learning and helped them to build a positive attitude towards learning.

Various learning styles are incorporated since its inception which includes Student-Team-Achievement-Divisions, Teams-Games-Tournament, Think-Pair-Share, Teams-Assisted-Individualization, Jigsaw, Group Investigation (Bell, Urhahne, Schanze & Ploetzner, 2010). Magnisalis, Demetriadis, and Karakostas (2011) in their contributions stated various classification schemes of adaptive and intelligent systems for collaborative learning and its impacts on student learning. They further suggested that the team of heterogeneous learners can result in more productive and positive learning outcomes.

B. Impact of Collaborative Learning:

Collaborative learning has positive impacts on Gen Z in improving the attention span, the involvement of learners and reducing the drop-outs than in traditional classroom methodology (Chandra, 2015; Baker, 2015; Rocca, Margottini& Capobianco, 2014). Fu, 2013 stated that though a small number of learners exhibited indifference to this learning style, they were willing to think over problems independently and finish the given tasks on their own. He highlighted the importance of flexibility to incorporate different individual learning styles.

Davidson & Major (2014) and Sulaiman & Shahrill (2015) concluded that collaborative learning is a powerful mechanism in supporting Gen Z students to perform academically well. It develops intellectual and social skills to prepare them for living and working in the rapidly changing environment of the 21st century.

While much research has been conducted on CL, very few studies have explored the effect of CL on student engagement and compare its effectiveness with other models. Gokhale (2000) has discussed the CL and its positive outcomes. She emphasized that the CL not only leads to a clear understanding of the concepts but also opens up new domains of learning such as critical thinking, evaluation, etc. Reyes & Techounikine (2006) advocate the impotence of structural awareness support in collaborative learning. They discuss the matter of group structure which is required to promote collaborative interactions. The tools presented in their paper focus on the notion of enhancing coherence in threaded conversation systems. Lucila, Guimaraes & GiseleBruegger (2006) explain the multi-facets of a collaborative education model that involves the students in reflection, participation, and construction of their knowledge. The authors present the model of VLE (Virtual Learning Environment) and its take away. Baker's (2015) description is centred on the cognitive-linguistic process of collaboration of problem solutions and their conceptual underpinnings. Laisema & Wannapiroon (2014) introduced the design of a model for creative problem solving and collaborative learning. They showed that the CL technique increases knowledge and skills in information and communication technology. Martins (2007) introduces a tool based on progressive assessment and student learning style.

Laakso, Myller&Korhomen (2010) studied the effects of interaction in CL using the technique of Video Analysis of Algorithm Visualization.They showed that higher engagement among the students enhances learning in CL activity. They found that the amount of discussion among the students and different engagement levels among the students has a positive impact on the outcome of collaborative activity. They also observed that students do more discussions about the topic in a CL environment compare to normal classrooms. They concluded that engagement goes hand in hand with collaboration so that the engagement taxonomy level has an influence over the CLprocess as well as the learning outcomes. Bouta&Retalis (2013) studied the engagement of primary school children in the CL mathematics class. They showed that the flow of activities conducted in the CL-class has a positive effect on enhancing students' behavioural, affective and cognitive engagement in the CL process. These activities seem to motivate the students to engage in the learning

process in various forms. Hang, Meng, Pablos& Sun (2017) showed that student engagement in CL using the IT environment and studied the relation between student learning and student engagement. They proposed a model of CL based on different types of motivations of students. They showed that mutual trust, social influence, and reward valence have a positive influence on teamwork engagement and positive effects on personal success. The purpose of our research is to find the relation between collaborative learning and student achievement particularly among the engineering students.

The research question we ask is "How is the student achievement and CL related among the second-year students of ECE?". To answer this question, we analysed the data from the student's achievement score of those students who participated in the collaborative activity.

C. Hypothesis

The hypothesis is that "There is a significant relationship between CL and student achievement of the second-year students of ECE".The research question which has been asked is "What is the relationship between CL and the student achievement in the second-year students of ECE?"

2. Method

The experimental design consisted of the assessment of the observable behaviours of the student's engagement during the Collaborative Activity and their performance in the assessment test conducted after the activity. The activity conducted was Group Presentation.

As a part of the evaluation process of the effectiveness of collaborative learning and the achievement of expected learning outcomes, the students were divided into two sets and the activities were carried out over a series of topics for various modules of the course. Considering the unique and distinct characteristics of Gen Z engineering students and the various collaborative learning styles, the research was conducted to assess the design of collaborative learning activities, the effectiveness of learning style incorporated, the involvement of the learner in the activities and comparison between traditional methods and collaborative learning. A well-structured questionnaire was prepared for conducting the research.

A. Participants

B.E. in Electronics and Communication Engineering has a course, Power Electronics and Instrumentation that combines the academic and instrumentation skills to carve out a career in the field of measurements, electronics with a comprehensive understanding of complex processes. Electronics and Instrumentation Engineers have to carry out a variety of tasks such as data acquisition, conducting research, installing, developing, testing, maintaining and designing various instruments used in the industry. Automation and computer-aided techniques help engineers to formulate ways to control these systems in the industry.

For admission to B.E. in Electronics and Communication Engineering branch, the candidate is needed to have passed the higher secondary school certificate (10+2) examination with Mathematics and Physics as mandatory subjects with Chemistry as another technical subject. The minimum percentage required is 50% aggregate in the 3 major subjects; however, it could be higher for some universities. For admissions to IITs, it is mandatory to qualify in the Joint Entrance Examinations (JEE). English is also one of the compulsory subjects in the qualifying examination for some universities apart from college-level criteria.

The course, Power Electronics and Instrumentation, mainly includes the combination of electronics sensing parts with instrumentation engineering. The course helps to create, construct and maintain measuring and control devices. The topics in this course include:

- Need for power conversion
- Power electronic converters
- classifications and scope of Power semiconductor switches
- diodes, SCR, GTO and transistors (BJT, MOSFET and IGBT)
- Static and dynamic characteristics
- DC to DC conversion: Buck, Boost and Buck-Boost converters, circuit configuration and analysis with different kinds of loads

- Choppers: single quadrant and two-quadrant operation with DC motor load and steady-state analysis
- Rectifiers: single-phase operation, power factor, harmonics, and effect of various loads
- Dual converters; Four quadrant drive and load characteristics
- Inverters: single-phase and three-phase bridge
- Switched Mode Power Supplies: Isolated Flyback Converter, Isolated Forward Converter.
- Instrumentation- Electronic indicating, display, recording and measuring instruments, signal generators, frequency generator, Principles of measurement, Bridges, Transducers
- Electrical Transducer, Resistive Transducer, Resistive position Transducer, Resistance Wire Strain Gauges, Resistance Thermometer, Thermistor, LVDT
- Instrumentation Amplifier using Transducer Bridge, Temperature indicators using Thermometer, Analog Weight Scale and Programmable Logic Controller.

B. Materials

The quantitative analysis was performed on the students' scores of student engagement and student understanding in the Group oral presentation. The groups were formed based on the marks scored (out of 50) in their first internal assessment which was part of the curriculum in the university B.E. program. The average of the six subjects was considered to categorize students into five categories. The details are shown in Table 1.

Table 1: Student Categories

Theaveragerange of marks	*Category*
0-20	1
21-35	2
36-40	3
41-45	4
46-50	5

12 groups were formed with 5 students from each category, conducted in two phases (6 groups in each phase). Six Thinking Hats activity was adopted to facilitate the activity. Each student was assigned a colour code. Each member according to their colour code was instructed to prepare for the Group oral presentation on the topics assigned. The subject topics assigned were from module 5 of the syllabus that included Transducers-types of transducers and Programmable Logic Controllers. The announcement, group's details, instructions, guidelines of the activity and the rubrics for the assessment were posted on Google classroom; a learning management system used to communicate with the students online 15 days before the day of conduction of the activity. This gave enough time for the students to prepare. 15 minutes were allotted for each group for the presentation, 3minutes per student to present on the topic, identifying them with the colourcode. The Blue Hat role was played by the facilitator i.e. the faculty. The description is illustrated in Table 2.

Table 2: Colour Code Description

Time allotted	*Description of the student- colour code*
3 minutes	White Hat-Facts and Information on the topic
3 minutes	Red Hat-Feelings/emotions towards the topic
3 minutes	Black Hat- Negative aspects of the topic
3 minutes	Yellow Hat- Benefits/positive aspects of the topic
3 minutes	Green Hat-Alternatives of the topic

C. Procedure

The main objective of the assessment of student engagement during collaborative activity was the assessment of observable behaviours. Refer to the Appendix for the rubrics used to assess Group oral presentation and student's behaviour for the CL.

Each student was administered individually. Three faculty members from other departments who are part of the research team assisted in the assessment

process. At the end of the collaborative activity, a quiz was administered on the topics assigned for the activity to measure the student's achievement. 15 minutes was allotted to answer the quiz questions. The whole activity took 1 hour 45 minutes to complete. The scores obtained were tabulated and analysed.

3. Results

The research was conducted at St Joseph Engineering College at Mangalore in the Karnataka state of India. The course was part of the B.E. degree program in Electronics and Communication Engineering branch. The participants were 2nd-year 3rd semester ECE Students. The mixture of girls and boy students were part of the research work. 60 students participated in the activity. Out of 60 students, 33 were boys and 27 girls. Written Consent was collected from the students and the participation was solely voluntary. Students were given full freedom of option to decide whether to be part of the study or not. The final consented 43 students were part of the research work.

The descriptive statistics in Table 3 show the mean scale score for group presentation. The internal consistency of the scale expressed through reliability coefficients (α=0.881) is strong.

Table3:Reliability Statistics of group presentation

Cronbach's Alpha	*Mean*	*Std. deviation*	*skewness*	*Kurtosis*
0.881	27.6512	7.92189	-1.063	2.207

Frequency analysis illustrated in Table 4 shows that the performance of students in the presentation was good. Their engagement in learning the course was excellent.

Table 4: Content Delivery by the Presenter

Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
1	2.3	2.3	2.3
5	11.6	11.6	14.0
15	34.9	34.9	48.8
22	51.2	51.2	100.0
43	100.0	100.0	

We asked the students to answer 10 questions to assess their learning. These questions were on the topics which they learnt through CL. Table 5 shows the mean scale score for student's achievements. The internal consistency of the scale expressed through reliability coefficients (=α0.668), moderately strong.

Table 5: Reliability Statistics for the student's achievements

Cronbach's Alpha	*Mean*	*Std. deviation*	*skewness*	*Kurtosis*
0.668	5.7674	2.33847	-0.057	-1.145

Pearson's correlation between the variables was administered to the data set to check the relation between the variables. From Table 6, it can be concluded that the student who delivered the presentation effectively in CL understood the concept well and scored high in assessment (Pearson Coefficient= 0.3).

Table 6: Correlations

		Students achievement	Group Presentation
Students achievements	Pearson Correlation	1	0.294
	Sig. (2-tailed)		0.056
	N	43	43
Group Presentation	Pearson Correlation	0.294	1
	Sig. (2-tailed)	0.056	
	N	43	43

4. Discussion

The main purpose of the study was to examine the effectiveness of CL in the performance and achievement of Gen Z engineering students. It was hypothesized that there is a significant relationship between CL and the student's achievement of the Gen Z learners in the second year of Electronics & Communication Engineering who actively engaged in the collaborative activity.

The results suggest that there is a significant positive relation between CL and students' achievements. The assessment parameters of the presentation also indicate that the students participated actively. Our results coincide with the findings of Keser&Ozdamli (2012) which highlights the constructive impact of CL upon Gen Z learners. Through peer support and thought processes acquired during interaction with one another, students taught using CL scored top grades than those taught using traditional methods. Our observations agree with Ajaja&Eravwoke (2010).They found that CL is an effective way of teaching compared with normal chalk and talk method. They observed that students using CL scored higher marks compared with the traditional methods of teaching. This achieved due to the high level of student participation in learning activities. Each student in the group is given a particular role in the activity and they performed it correctly which helped other students to understand the topic. When students face problems they are forced to think critically which increased their critical thinking abilities. CL is a useful tool to develop problem solving, reasoning and critical thinking skills. Students in CL classroom exhibit better attitude towards learning than traditional teaching environment. CL also increases student interaction and group building abilities which is useful for them in their future professional life in the industry.

It is believed that when students are challenged with tasks that they must solve, they are enforced to reason and think critically to crack the given problems. Highly inspired teams were found successful in terms of preparation, sharing responsibilityand executing the task while few students implemented the task by dividing up the workload among themselves (Hernandez, 2012).

The findings clearly emphasize the fact that faculty members need to adopt CL in their classrooms to engage all categories of Gen Z learners for better learning. Students will be more attentive; interactive and enjoying their classroom sessions. The faculty members can also deliver the contents efficiently within the stipulated period. This will also reduce the absenteeism of the learners, eventually resulting in scoring good grades for the university examinations, as it was observed that during the day of the collaborative activity attendance was 100%.Gen Z learners have limited attention span and they cannot be expected to focus on continuous traditional lectures nor dutifully on complicated assignments. Instead, they prefer interactions, participative and visuallyappealing learning methods likeCL with captivating pictures and videos (Yee & Yoon, 2018).Our findings provide strong proof that CLencouraged Gen Z learnersto learn engineering subjects very effectively. The findings of this research could be generalized to learners of any branch/year of engineering, irrespective of location and gender. The observed achievements of the students can be attributed to the improved engagement of the students and their motivation as a result of collaborative learning. For future work, the impact of collaborative learning on other parameters like motivation and student behaviour for hands on sessions or laboratory work can be studied.

Acknowledgement

We express our sincere appreciation to all the students who participated in the study and many thanks to our IUCEE Engineering Education Research (EER) Mentors for their valuable feedback, time and guidance. The authors acknowledge the St. Joseph Engineering College, Vamanjoor, Mangaluru and Saintgits College of Engineering, Kottayam, Kerala, India for the support and encouragement.

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