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DISCOVERING GROUP PROJECTS TO IMPART TECHNICAL SKILLS TO UNDERGRADUARE ENGINEERING STUDENTS

Parulkumari P. BHATI[a], Jelena ZASCERINSKA[b]

[a] Nirma University, India
[b] Centre for Education and Innovation Research, Latvia

Abstract. Group projects in higher engineering education are considered as an effective method for imparting technical skills to undergraduate engineering students. The research aim is to analyse engineering students' self-evaluation of their participation in group projects during their undergraduate studies. The empirical study was carried out in January-February 2024. 211 undergraduate engineering students from India took part in the online survey questionnaire. For data analysis, the frequency and percentage of respondents' answers was investigated. The obtained findings were interpreted, and the study results were summarized. The empirical study allowed for finding out that the respondents' time management skills, team work skills, academic writing and academic presentation essential for the success of group projects' implementation need to be advanced. The conclusion is that the respondents are aware of the importance and relevance of the group projects' method for the imparting technical skills to undergraduate students. The empirical study allows for a conclusion that team work skills of engineering students have to be increased as the majority of the respondents expressed their wish to act as the group manager, and not as a group member. The implications on the organization and implementation of group projects are formulated.

Keywords: dyads, group composition, group project, technical skills, triads, digital tools in teaching essay writing, essay writing, foreign language, global context, interactive activities, mother tongue, visual aids

INTRODUCTION

Technical skills are in TOP 10 skills essential in contemporary employment. It should be noted that modern employment - being either paid employment, entrepreneurship, or to full-time self-employment (Ahrens, Zascerinska, & Markussen, 2022) - is rooted in project work (Zascerinska, Aleksejeva, Zascerinskis, Gukovica, & Aleksejeva, 2020). A project aims to contribute to the formation of a system of knowledge and skills embodied in the final intellectual product; to promote autonomy, the ability to think logically, define problems and make decisions, receive and use information, plan, develop literacy and more (Khatamova, Ismailova, & Akbarova, 2019).

Diverse technical skills in almost every field and industry, from IT and business administration to health care and education are on a high demand (Coursera staff, 2024). By technical skills, specialized knowledge and expertise required to perform specific tasks and use specific tools and programs in real-world situations are meant (Coursera staff, 2024). Technical skills can be divided into basic technical skills and more advanced technical skills (Coursera staff, 2024). Table 1 presents sub-skills belonging to basic technical skills and more advanced technical skills.

Table 1

Basic and advanced technical skills (by authors)

Type of technical skills	**Basic technical skills**	**Advanced technical skills**
Sub-skills	-cloud computing in Google Drive -navigating social media platforms	-programming languages, -technical writing, or -data analysis

Unlike workplace skills, also called soft skills, such as communication and time management, technical skills often need specific education and training to acquire (Coursera staff, 2024). For these purposes, higher education aimed at workforce preparation promotes students' enrichment of their technical skills by different methods.

Group projects in higher engineering education are considered as an effective method for imparting technical skills to undergraduate engineering students. It should be pointed that group project have a positive effect on students' soft skills, too (Zascerinska, Aleksejeva, Zascerinskis, Gukovica, & Aleksejeva, 2020). Due to the positive effect of group project in engineering students' technical and soft skills, the last few decades have seen a growing emphasis on group projects as part of engineering education programmes (Crawley, Malmqvist, Ostlund, Brodeur, Edstrom, 2014).

The aim of the present research is to analyze the organizational aspects of group projects in order to propose implications for higher education sector.

RESEARCH METHOD

The empirical study was initiated to answer the research question: How to organize group projects for the enrichment of undergraduate engineering students' technical skills?

The purpose of the empirical study was to analyze engineering students' self-evaluation of their participation in group projects during their undergraduate studies.

The empirical study refers to the exploratory type. Table 2 created on the basis of our previous work (Ahrens, Zascerinska, Bhati, Zascerinskis, & Aleksejeva, 2021; Ahrens, Foerster, Zaščerinska, & Wasser, 2020) explains the ground of the selection of the exploratory study.

Table 2

Reasons for the selection of the exploratory study

Reasons	A short explanation
Under-explored topic	-Only few works are published, -The outset of either research or study on a topic
Flexibility	Researchers are supposed to discover new meanings, elements, links, factors, etc. if compared to explanatory or descriptive studies
Non-structure	Exploratory study is not limited by a formal structure. Researchers have a freedom to build their own structure
Scope identification	Exploratory study aim to outline "the boundaries" of the analysed phenomenon.

The empirical study was carried out in January-February 2024. 211 undergraduate engineering students from India took part in the online survey questionnaire. It should be noted that the respondents could select more than one option when answering the survey questionnaire questions. Table 3 describes the engineering students' computer programmes skills.

Table 3

Respondents' computer programmes skills

Computer programmes and software skills	Number of replies
Programming languages (HTML, CSS, JavaScript, Python, etc)	185
Cloud computing	52
Front-End Development	63
Back-End Development	63
Cybersecurity	76

Table 3 shows that the majority of the respondents is skillful in programming languages.

Table 4 reflects the engineering students' digital skills.

Table 4

Respondents' digital skills

Digital skills	Number of replies
User Experience (UX)	132
Wireframing	30
Responsive Design	74
Branding	68
Visual Design (Color Theory, Typography, etc.)	92

Table 4 highlights that the majority of the respondents has developed their skills in user experience.

Table 5 emphasizes the engineering students' copyright skills.

Table 5

Respondents' copyright skills

Copyright skills	Number of replies
Search Engine Optimization	123
Content Creation	121
Landing Page Copy	38
Headline Writing	70
Topical and Keyword Research	71

Table 5 highlights that the majority of the respondents is able to use search engine optimization and content creation skills.

Table 6 presents the engineering students' software skills.

Table 6

Respondents' software skills

Copyright skills	Number of replies
Adobe Software (Photoshop, InDesign, Illustrator, etc.)	109
Microsoft Office (Word, Excel, Powerpoint, etc.)	160
Point of Sale Systems (Harbortouch, Clover, etc.)	19
QuickBooks or Other Accounting Software	27
CAD or Other Engineering Programs	111

Table 6 illustrates that the respondents' majority is keen to use Microsoft Office (Word, Excel, Powerpoint), CAD or other engineering programs, and Adobe Software (Photoshop, InDesign, Illustrator, etc).

The survey questionnaire results demonstrate that the respondents obtain advanced technical skills.

For data analysis, the frequency of respondents' answers was investigated. The obtained findings were interpreted, and the study results were summarized.

STUDY RESULTS

Each of survey questionnaire questions was based on the 10-point scale. 1 point meant the lowest value, and 10 points – the highest value.

Table 7 gives an overview of the engineering students' answers in regards to their willingness to work in a group project.

Table 7

Respondents' willingness to work in a group project

Points of the 10 point scale	Number of replies	Percentage
1	5	2.4%
2	8	3.8%
3	13	6.2%
4	26	12.3%
5	28	13.3%
6	8	3.8%
7	19	9.0%
8	33	15.6%
9	18	8.5%
10	53	25.1%
Total	211	100%

Table 7 reveals that the majority of the respondents have a high interest in working in a group project.

Table 8 gives an overview of the engineering students' answers in regards to their willingness to work in a group project.

Table 8

Respondents' answers about their role in a group project

Role	Number of replies	Percentage
Group leader	65	30.8%
Group manager	63	29.9%
Group member	83	39.3%
Total	211	100%

Table 8 points out that the majority of the respondents prefers to be a group member in a group project.

Table 9 reveals that the engineering students' answers in regards to the means of group project.

Table 9

Respondents' answers about the means of group project

Role	Number of replies	Percentage
Face-to-face	100	47.2%
Hybrid	92	43.3%
Online	18	18.5%
Total	211	100%

Table 9 discloses that the majority of the respondents prefers face-to-face or hybrid work in a group project.

Table 10 emphasizes the engineering students' time management skills in accordance to their answer to the survey questionnaire.

Table 10

Respondents' answers about their time management skills

Role	Number of replies	Percentage
1	6	2.8%
2	5	2.4%
3	5	2.4%
4	7	3.3%
5	26	12.3%
6	14	6.6%
7	40	18.9%
8	52	24.7%
9	31	14.7%
10	25	11.9%
Total	211	100%

Table 10 allows finding that the majority of the respondents developed good time management skills.

Table 11 emphasizes the engineering students' team work skills in accordance to their answer to the survey questionnaire.

Table 11

Respondents' answers about their team work skills

Role	Number of replies	Percentage
1	5	2.0%
2	13	6.0%
3	7	3.0%
4	2	0.9%
5	17	8.0%
6	7	3.0%
7	24	11.0%
8	55	26.1%
9	50	23.0%
10	37	17.0%
Total	211	100%

Table 11 reveals that the majority of the respondents developed good time management skills.

Table 12 emphasizes the engineering students' self-evaluation of writing skills in accordance to their answer to the survey questionnaire.

Table 12

Respondents' answers about their writing skills

Role	Number of replies	Percentage
1	5	2.4%
2	5	2.4%
3	5	2.4%
4	7	3.3%
5	17	8.0%
6	22	10.4%
7	49	23.3%
8	43	20.3%
9	35	16.6%
10	23	10.9%
Total	211	100%

Table 12 reveals that the majority of the respondents leverage good writing skills.

Table 13 emphasizes the engineering students' presentation skills in accordance to their answer to the survey questionnaire.

Table 13

Respondents' answers about their presentation skills

Role	Number of replies	Percentage
1	5	2.4%
2	8	3.7%
3	8	3.7%
4	12	5.7%
5	18	8.6%
6	26	12.4%
7	38	18.0%
8	38	18.0%
9	33	15.6%
10	25	11.9%
Total	211	100%

Table 13 reveals that the majority of the respondents developed good presentation skills.

Our finding is that the respondents evaluate their advance technical skills positively and express their willingness to work in group projects.

DISCUSSION

The search for scientific literature on group project shows that this topic is under-explored. Only few publications were found via google search. The focus of these three publications was put on

- A structured approach to group project work (Powell, Hicks, Green, Truscott, van Silfhout, & Canavan, 2005),
- Group formation and learning for project-oriented student work (Cronholm & Melin, 2006), and
- Challenges and learning experiences in undergraduate group projects (Isaac &Tormey, 2015).

The other publications found via google search refer to project method, project work, group work, and similar. Publications with the key words - that did not contain "group project" - were excluded from further analysis.

Another finding is that the significance of group project in engineering education is growing. However, the topic of group project in scientific literature is not widely discussed. Our search revealed that the latest work on the topic of group project was published in 2015 by Isaac &Tormey.

In our study, the majority of the respondents evaluated their time management skills as good. However, meeting the timeframe when implementing group project remains an issue for students as studied by Isaac &Tormey (2015).

Formation of groups is another problem in group projects as a way of forming groups affects students' learning (Cronholm & Melin, 2006) in the group project. Forming project groups should be based on a reflected choice and the categories (Cronholm & Melin, 2006) of

- Perspectives and dynamic,
- Motivation,
- Pedagogy,
- Social relations,
- Heterogeneity and
- Coordination.

The researchers acknowledge that every group project is context-dependent (Cronholm & Melin, 2006). Therefore, some of the above presented categories can be more relevant than others in different contexts (Cronholm & Melin, 2006).

Two methods of group formation are identified in scientific literature:

- By student themselves (Cronholm & Melin, 2006), and
- By the instructor (Feichtner & Davis, 1984).

Formation of groups by students themselves is often based on friendship (Cronholm & Melin, 2006). However, this approach of group formation based on students' choice is difficult and unlikely to be effective (Cronholm & Melin, 2006).

Interestingly, students report more positive group experiences when the instructor forms the groups (Feichtner & Davis, 1984; Surikova, 2007).

In regard to a number group project members, the researchers Cronholm & Melin (2006) formed groups of six members. Opposite the proposed group structure of six members, the formation of a microgroup composed of two (so called dyads) - three (so called triads) members was found effective (Surikova, 2007). This finding on a group composed of three members is also supported by our study. The respondents of our study were offered to select a role of the three choices they would play in group projects:

- Group leader,
- Group manager, and
- Group member.

The majority of the respondents in our study preferred to be a group member in a group project. Along with this, there is nearly an equal choice of the respondents who would be a group leader or group manager.

The means of group project also plays an important role for reaching the project objectives. It was found by Isaac &Tormey (2015) that most students reported tensions within their group during their online work. This finding is also supported by the results of our study that discloses that the majority of the respondents prefers face-to-face or hybrid work in a group project.

Conventionally, a project aims at knowledge development (Khatamova, Ismailova, & Akbarova, 2019). Knowledge enrichment along with the project implementation proceed from existing knowledge through knowledge variety to new knowledge (Zaščerinska, 2011).

CONCLUSIONS

The implemented theoretical analysis helps establish the links between the development of students' technical skills and group project: group project intends to be effective for the enhancement of students' technical skills. Group project is also found useful for the enhancement of students' soft skills.

The results of the empirical study reveal that undergraduate engineering students are highly interested in the development of their technical skills. The most important technical skills for undergraduate engineering students are programming languages skills, user experience skills, social media marketing skills, consumer analytics skills, search engine optimization and content creation skills, and, finally, Microsoft Office skills. The respondents expressed their positive attitude to their participation in group projects for the enrichment of their technical skills. The majority of the engineering students are keen to be project group manager. The students prefer face-to-face format for the implementation of group projects. The empirical study allowed for finding out that the respondents' time management skills, team work skills, academic writing and academic presentation essential for the success of group projects' implementation need to be advanced.

Based on the study results as well as the analysis of other researchers' works, the implications for organisation and implementation of a successful group project propose that

- A group for the successful implementation of a project should be formed by an instructor.

- Each group of students should be a micro-group composed of three-five members.
- Each group member is assigned a role of either group leader, or group manager, or group member.
- Each group member during a group project changes his/her role, e.g. from group leader, to group manager and, later, to group member.
- Group member role allows monitoring the progress in the process of the group project implementation.
- Group project has to be organised face-to-face or at least in a hybrid manner.
- Group project evaluation is product oriented.
- Group project proceeds in three key phases, namely from existing knowledge through knowledge variety to new knowledge.
- Group project evaluation should also include student self-evaluation.

The empirical study has a limitation: the study was carried out only in one country, namely India. Literature analysis was limited by the scientific publications available via google search. If other scientific works on the topic of group project had been available, other research results would have been reached.

Future research intends to include more respondents from different educational areas as well as educational institutions, and countries. Further work could be devoted to the analysis of knowledge development within a group project.

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