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# Message from the Editor-in-Chief

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**January 01, 2020**
**Prof. Dr. Muzaffer ELMAS**
**Sakarya University**

 

 

 

 

 

**Table Of Contents**



 

# IMPROVING GROUP/TEAM ASSESSMENTS IN TECHNICAL EDUCATION: AN EMPIRICAL EXPERIMENT

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**ABSTRACT**
In the technical curriculum in general and in engineering curriculum in particular. most of the modules have group work for their projects/coursework. Group work plays an important role in team building, confidence and interpersonal skills and makes them fit from the industry perspective. As a teacher and assessor it becomes a challenge to assess the group work as a whole or on an individual basis as most of the time individual contribution of the student towards the project is unknown. The action research project focused on strategy and approaches to improve the group work assessment by implementing a rubric which consist of individual accountability of each student in a group work.
From the overall group work project evaluation it was seen that the action research project on the group work has helped the students to develop transferable skills, teamwork skills and social interactions as well as learning about beliefs and attitudes. Also the students agreed that their leadership skills increased which is imperative requirement of any industry. The curriculum product and process model along with constructive alignment theory has made students achieve their outcomes easily for their group work process.
**Key words:** Engineering curriculum, Group Work, Group Project Evaluation, Curriculum product and process model.

## 1. Introduction

Group work is a required skill in both learning and employ-related contexts, according to Davis (1993) research suggests that students learn best when they are enthusiastically involved in the process. Learning is always related to a curriculum and how well it is designed, reflecting on curriculum we need to keep a number of things in our minds like, social and vocational needs, skills development, relevant subject specific knowledge, and the ability to apply this knowledge in a variety of situations. **Looking into various curriculum theories the "product" and the "process" model (Sheehan, 1986)** defined more of these skills learning activities. He explored the strengths/ weakness of product & process model and recommended that although the product framework may offer added structured measurement of results, the **process framework** would offer additional opportunities for learners to identify their learning requirements with prominence on learning abilities and reflection as part of the evaluation method. *To embed the above skills within a student proper activity need to be structured throughout the learning phases*. As per the **group work research by (Helle et al, 2006) states** that there are many interferences in establishing consistency of assessments in group work, while marking a group

work for example what are the evidence or criteria the grades will be based, additional challenge is how would the involvement of each team member be weighted in the grade, do all the members get equal ranking despite the fact that students put in effort differently in their project work? Based on these challenges an action research project is undertaken for assessing group works and it would be fascinating to discover the students and educators insights for these challenges.

The **curriculum** can also be seen an insight to **constructive alignment theory** (John Biggs, 2003) in which the learning outcomes are formulated first, then the assessment development followed by teaching and learning activities, the challenging part is the way they are assessed.

## 2. Literature review

Every programme is **based on a curriculum, as per Stenhouse (1975)** "A curriculum is an attempt to communicate the essential principles and features of an educational proposal in such a form that it is open to critical scrutiny and capable of effective translation into practice". There are many aspects relative to the description which provides it noteworthy feature like concentration on essential principles, reviewing and critically scrutinizing it from time to time, basically there are many curriculum models which can be suited as per the programme.

According to **(FEU 1980, London)** there are 7 variants of curriculum models as shown in figure 1 below. Every model has an assumption. In the 1st place **deficiency model** assume that students have learning deficits which need to be checked before proceeding further. The areas can be literacy, interpersonal, or lack of recognition. In the **competency model** practical aspects are considered. **Information based model** mostly related to the acquisition of knowledge. **Socialization** is alarmed with the introduction of the learner into the societal environment. It is categorized by the growth of values & behavior, and expectations related to the necessities of the industry, vocational and society matters. The 4 models which have just been defined in a brief are all **product models**, i.e. the importance is given to the result of a learning involvement.
The other group of model is a **process model**. In this the attention is on learning gained from work knowledge and real world experiences. It consists of open-ended activities for students for learning developments. The concentration is on the significance of the learning while it is happening instead of on preset results.

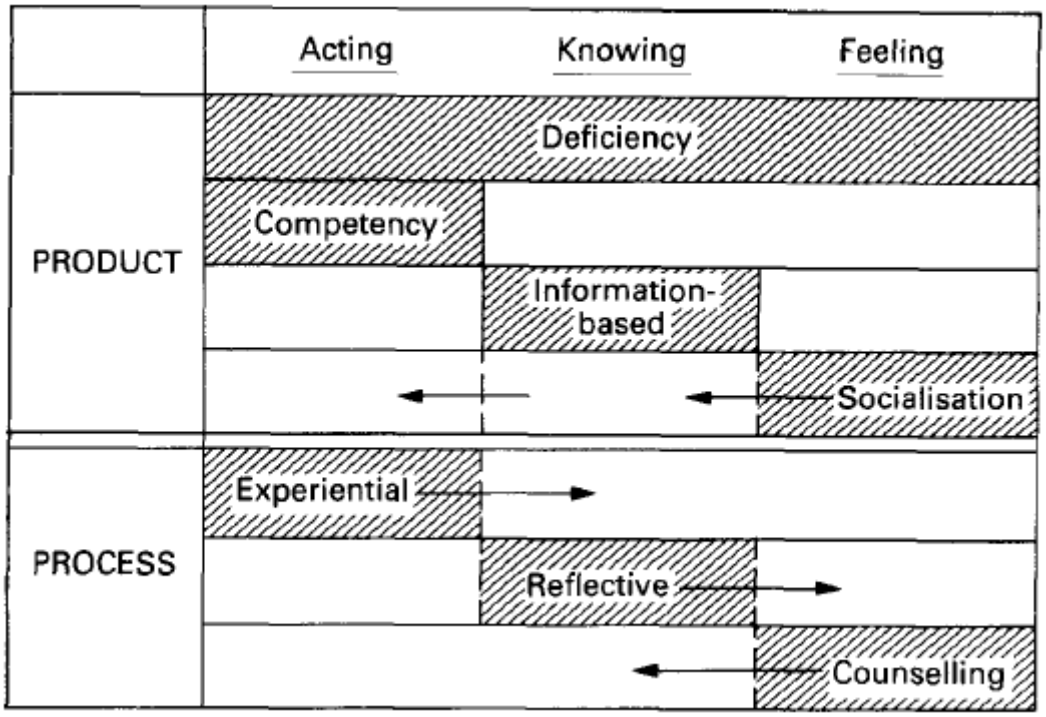



**Figure 1: Models of the curriculum**

Group projects / group-work are widely used in higher education, It is widely recognized that group-work has academic, practical and social benefits (e.g. Lee *et al*., 2015, Noonan, 2013). However there are many challenges including student perceptions of unfairness (MacFarlane, 2016; Rogers & Smith, 2014), exclusion (Noonan, 2013) and assessing (Lee *et al*., 2015). Group-work supports the development of key skills and

graduate attributes, however it is important to recognize that group-work *does not* automatically benefit students; to do this it needs to be well planned, structured and supported. This requires planning, input and support from the tutors. Evidence is clear that if group-work is to be successful, it needs to be facilitated and students need preparation and guidance (e.g. Noonan, 2013). Group-work that is not well planned and supported can impede learning, create a difficult social environment and cause students to experience stress and distress. Group-work, perhaps more than any other form of evaluation highlights the ethical issues inherent in evaluation (Noonan, 2013).

Unfortunately there is no simple formula for doing group-work well; there is no single 'best' approach to forming groups, managing the process and assessing. All approaches have advantages and disadvantages and need to be considered within the context of the programme, the stage, the nature of the assessment, student characteristics and so on.

### 2.1Group Size

Group size plays a very important part in group work. As per (Beebe & Masterson, 2003) a small group should be of 3 or more people. Group of 2 is not encouraged because there are not enough members to exchange ideas (Csernica et al., 2002). As per (Davis, 1993) a group should comprise of at least 4 to 5 members.

### 2.2 Group Selection

Group selection can be either instructor based or self-select. Self-select groups often divert toward friendship (Csernica et al., 2002) and can lead to socializing with friends rather than concentrating on their group work (Cooper, 1990). Research suggests that groups which are assigned by the tutor have a tendency to accomplish in an improved manner than self-established groups (Felder & Brent, 2001).

### 2.3Group process monitoring

According to (Davis, 1993) one method to monitor the group is to ask group device action plan. The action plan involved allocating roles and responsibilities among all the group members. Creating a consent form to help them write their goals and objectives for the group, another method is to ask them to have weekly or individuals for their works.

### 2.4 Assessing / Evaluation

Group work evaluation is not an easy task for the tutor, there should be a clear idea of how the group work is to be evaluated, the instructor need to decide what is to be evaluated, the process, product, or both. Sometime the same grade is assign to the whole group if contribution is not the same from all members which may promote unhappiness (Davis, 1993). If the entire group is graded as a total, then their presentation should add as a percentage in their final grade (Cooper 1990; Johnson & Smith 1991)

If the group process is assessed the student should be able to mention their efforts, their group member's efforts and the process as total. With respect to evaluation, it is important the students should know and understand how they will be assessed. One method is to have structured grading rubric for both the process and the product. The rubric not only lists the criteria by which the work is assessed but also the student's knowledge of the material (Finson & Ormsbee, 1998). Stevens and levi (2005) advice the use of rubrics because they convey prospects to the students and help to focus their efforts, improve student accomplishment and improve the efficiency of feedback. Additionally rubrics are useful beyond evaluation because it help students understand the assignments (Mckeown, 2011).

## 1. A Brief Review on Action research

Action research is result-oriented research i.e. group / personally owned and conducted. It is a helix cycles of research and action consisting of four major components: plan, act, observe and reflect The terms "action" and "research" highlights the important features of this method: trying the ideas in practice as a means of increasing knowledge and improving curriculum, teaching, and learning (Kemmis & McTaggart, 1988)

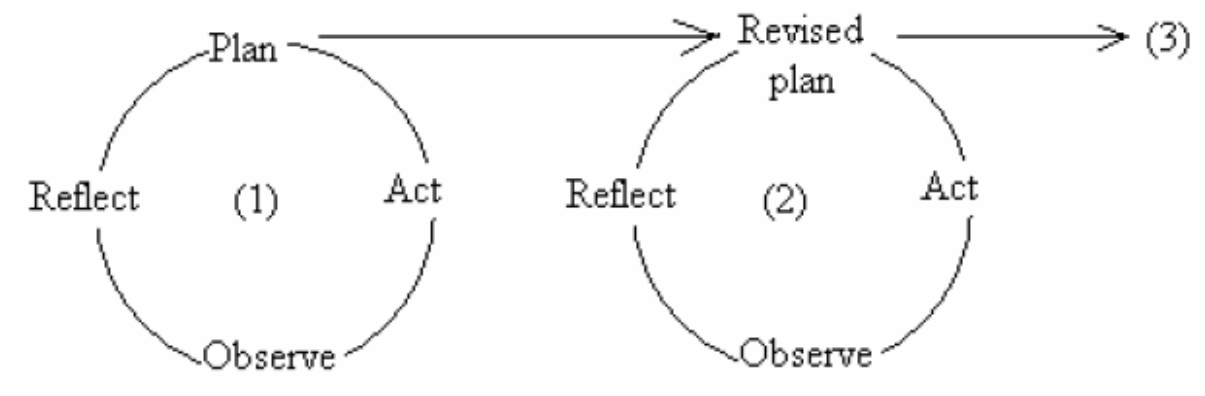



**Figure 2: Action research cycle.**

The concept of "action research" is focused not only on a learner acquisition of knowledge and understanding, but on that learner using this knowledge and understanding "wherein learners participate in studies both as subjects and objects with the explicit intention of bringing about change in the setting under study" (Raelin and Coghlan 2006, p. 671).

The purpose of this action research project will be to identify and implement a strategy or an approach to improve group work in engineering by considering the curriculum models for this approach.

## 2. Action Research Methodology on Group Work

As mentioned in the introduction, group work is a required skill in both learning and employ-related contexts, according to (Davis, 1993) research suggests that students learn best when they are enthusiastically involved in the process. As group work assessment is a difficult process and there are no proper guidelines involved for the assessment.

In past teaching, I have found that its difficult to convince students to get involved in the group work, because some students think their contribution will not be seen in the group work, marks allocation will be same as other whether you are actively involved or not, and there are free riders who take advantage of the process as a result it becomes more complex to assess group as a whole and individually.

The action research project was implemented on level 5 mechanical engineering students; module AME5005 for coursework 1with 24 students registered for the module, it has group work as summative assessment for 50% weightage of the entire module. Apparently no further guidelines is provided how the group work assessment will be done, this creates a challenge to the educators how they will frame and evaluate the group work which take care of both the group marks and their individual marks.

In this project I focus my attention how the group work experience can be improved so each student can get benefit of their contribution. Based on information obtained from above review of action research and past experience, developing a simple and practical action research plan for the project.

**Phase I. Plan**

1. Designated class activities.

- Initially the module was discussed with the help of module guide and students were communicated with the aims and objectivities of the activities.
- Initial student survey questionnaire was developed through Google forms (Appendix 13.1) to understand their response towards group work. It was found that most of the students had worked in the group for more than 3 to 4 times, so students were allowed to form their own group with their prior experiences. 4 to 5 students were only allowed to be in a group
- Simultaneously tutors experienced were also recorded via a Google form (Appendix 13.2).
- Rubric was clearly explained to the students via the information provided on the board and it was clearly communicated that the rubric was divided into 2 parts, one part takes care of group activity for 50 marks and other part takes care of preparing individual report and individual presentation
- The group activity consists of in class activities and visit to industries where live data can be collected about the product which need to be designed.

2. Implementation.

The above activities will be applied during the lectures and tutoring. Basically, the implementation will include building of a cordial and responsive learning community. During the teaching, the activities will be carefully monitored, observed and recorded. Actions will be revised and new actions will be added as the enactment progresses.

3. Evaluation and reflection

Feedbacks data will be analysed. Issues will be identified. Data will be collected to measure students' reaction to the plan based on:

- Students interactions in the lecture
- Student-Tutor interactions each week in the lecture
- Students initiating interactions each week in the lecture
- Students getting involved in group activities each week in the lecture

4. Revising the plan and repeating the plan based on the above feedbacks

**Phase II. Action**

In action phase, I started implementing class activities and strategies selected in the planning phase. I started with the design activities in the class, students started sitting in their assigned groups, in class activity and tutorials were provided, students started brainstorming each other to do the activities, students started filling their team contract in the first week and started assigning the roles and responsibilities to their team, formats provided in Appendix 13.3 & 13.4, students started maintaining their weekly logs.

In the initial weeks, students haven't got familiar well and were a bit shy, I have to help them a bit to get them involved into problem solving tasks in classroom and have to build trust of a cooperative working culture, making them understand the importance of communication within the group, sharing ideas, participating in group activities and discussions. After some weeks of teaching, the collaborative culture has been successfully developed in the class; students are much more quick to respond to class activities than they were in the beginning of the semester.

**Phase III. Evaluation and Reflection**

In this phase, the data I collected during the teaching was evaluated to improve the plan.
Group evaluation was done based on several factors like.

1) Self and peer assessment by their own group.
2) Marks obtained in individual report writing.
3) Individual Marks from the group grade.
4) Overall group work performance of all groups.
5) Overall project evaluation using mean and standard deviation.

All together 21 feedbacks were collected in the overall project evaluation using the
qualitative data analysis method. An overall project analysis was done on various factors like Development of skills, Attitudes towards group work and Attitudes towards assessment for any improvement is done with the implementation of the strategy using mean and standard deviation approach. The results were plotted in the graphs.

**Phase IV. Revise plan and repeat the cycle.**

Based on the qualitative feedbacks, some of the actions planned in the beginning of the semester have been revised, adjusted or added to improve the class activities. Specific measures are as following

- Demonstration of procedure of each task during the process of lecturing
- Discussing and summarizing at the end of lecture.
- Breaking up groups of same members and restructuring groups so responsive and slow students are better mixed up
- Encouraging more students to visit tutor for discussing about their
problems, concerns and issues in the study

## 3. Data Collection

### 3.1 Analysis of student's perception of group work from the questionnaire

Total of 23 students took group work and the questionnaire was responded by 19 students (82.60%), from the responses **73.7%** have chosen the group with the prior experience of working in the group with the members, 52.6% students have work more than 5 times in a group, 52.6% found very good working in a group, **73.3% prefer to work in group assignments,** 52.6% prefer to splitting up the work in the group. when it comes to implement strategies for encouragement of group work **73.7%** prefer having meetings, 63.2% prefer helping

each other, **52.6%** prefer sharing workloads and sharing information. When it comes to skill development in a group work, 68.4% assumes it will improve team work skills, 47.4% assumes improve communication skills. **42.1%** feel the biggest drawback of working on group assignments is to rely on others.

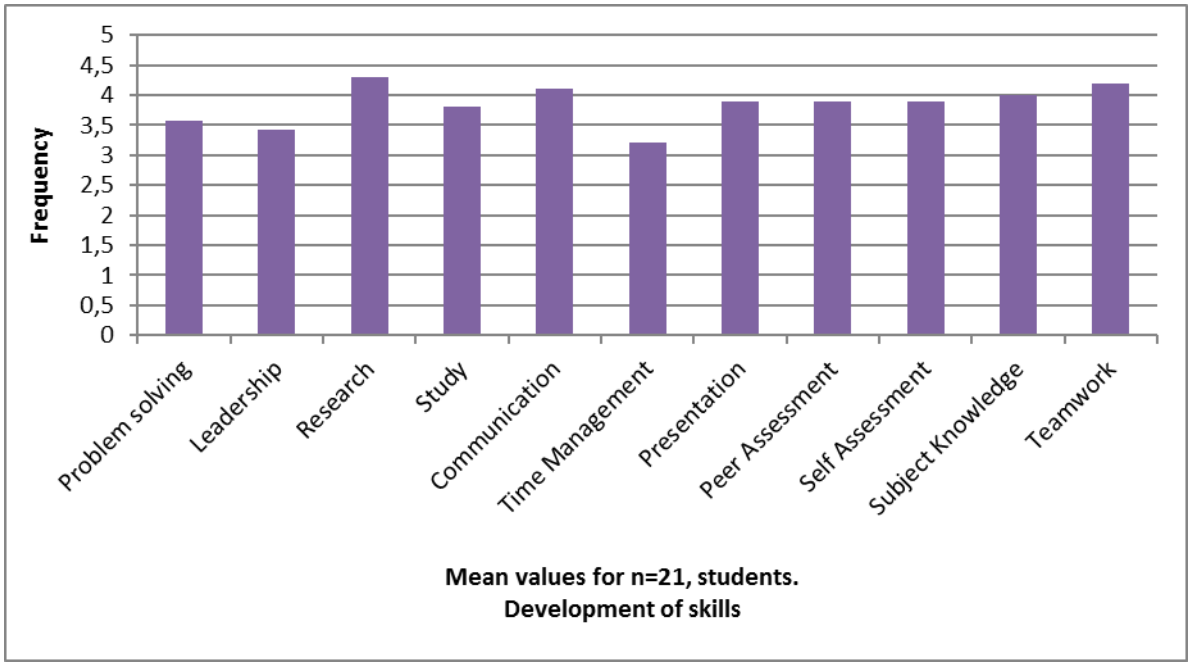
**3. 2 Analysis of instructor's perception of group work from the questionnaire**

The questionnaire was sent 10 instructors of different subject area and level which has experience in group work, out of 10 instructors 9 responded to the questionnaire, some uses group work because it is a summative assessments or it is in their curriculum, some use it as a formative assessment. Some instructors responded that group work develop confidence, communication and leadership skills. Some assess student's group work as group and individual, some via blogs and some via Q & A sessions, some via peer review of students. As per some instructors some issues student group confront are uneven participation, role clarity, individual participation and performance in group, social loafing.

**4. Analysis of group work**

**4.1 Analysis based on Skills**

At the end of the group work for about 7 weeks students were asked to fill a group work project evaluation survey , the survey was marked on a scale of 1 to 5 (1= Strongly disagree, 5= Strongly agree), out of 24 students, 21 students filled the survey.

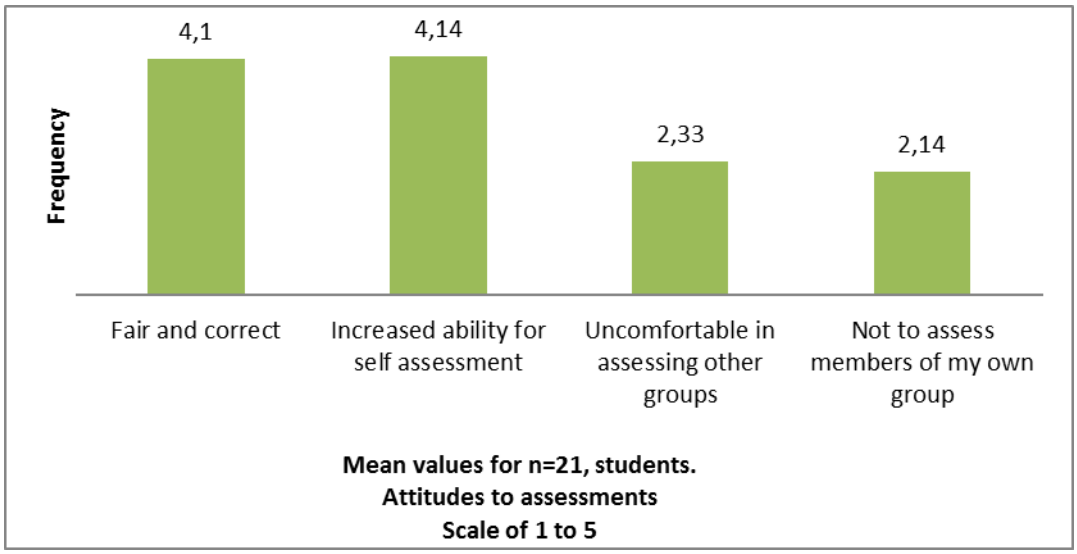



**Graph 1 Development of skills**

**Development of skills**

On a survey scale of 1 to 5 we can observe from above graph 1 that most of the skills were improved during the group work, the above graph illustrate that students research work, their communication skills, teamwork skills were improved a lot, problem solving, leadership, time management, self and peer assessment were also enhanced.

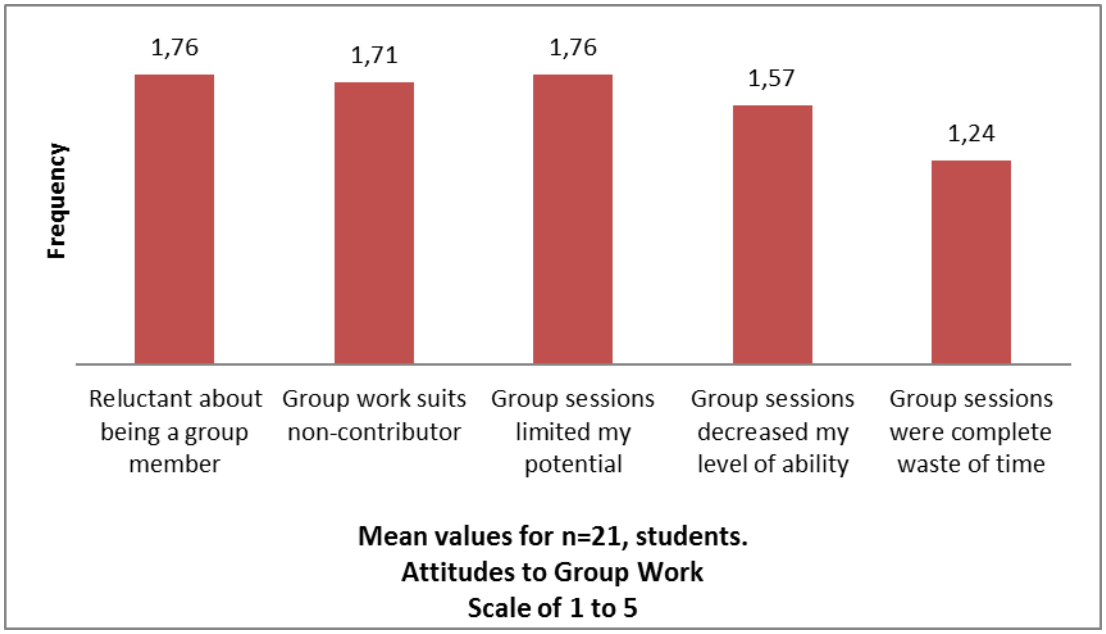
  




**Graph 2 Attitudes to Assessments**

**Attitudes to Assessments**

On a survey scale of 1 to 5 and from above graph 2 we can observe that students agree that assessments were fair and correct and increased their ability for self-assessments, some students felt uncomfortable in assessing other as well as own members of the groups. More awareness has to be developed within the students for the self and peer assessments.



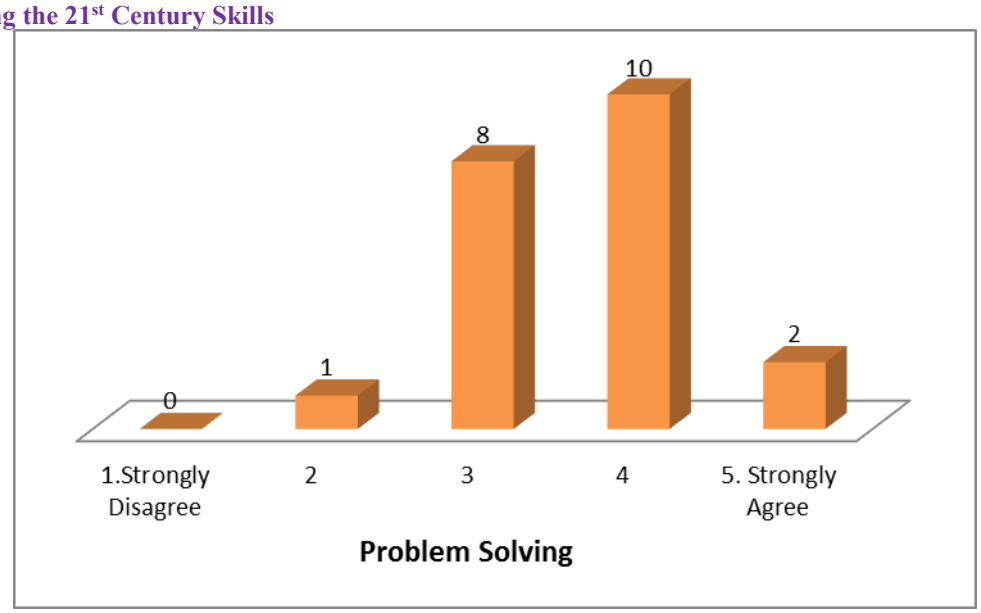

**Graph 3 Attitudes to Group Work**

**Attitudes to Group Work**

On a survey scale of 1 to 5 and from above graph 3 we can see that students did not feel reluctant being a group member, they did not feel that group work suits only for non-contributors; they did not feel that group work sessions were complete waste of time. Overall the students were very positive with the group work activities.

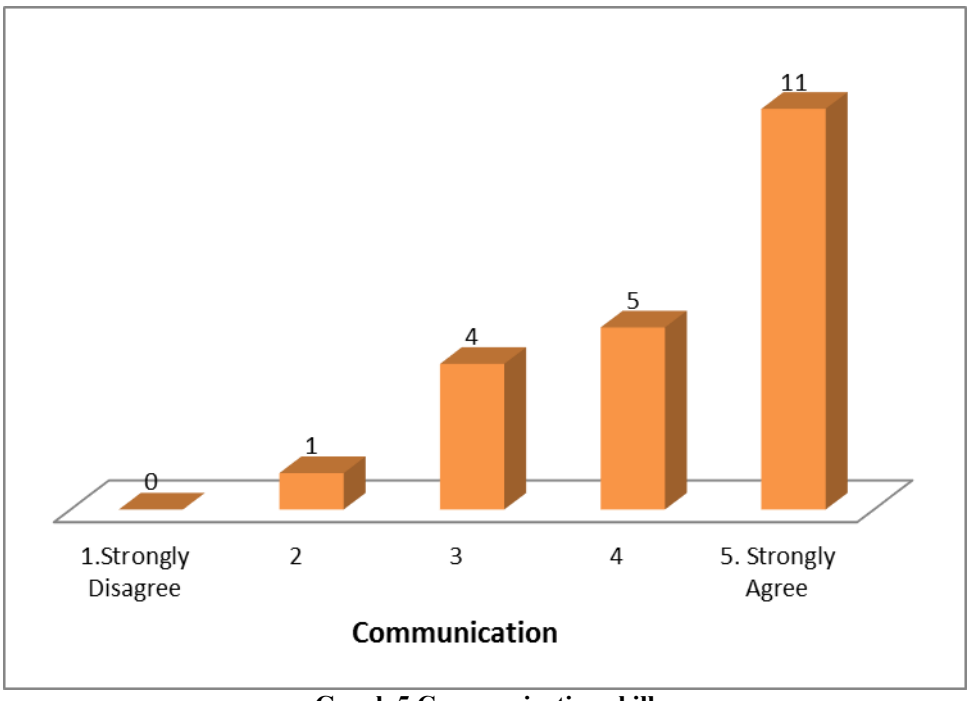
  

**Measuring the 21st Century Skills**




**Graph 4 Problem Solving**

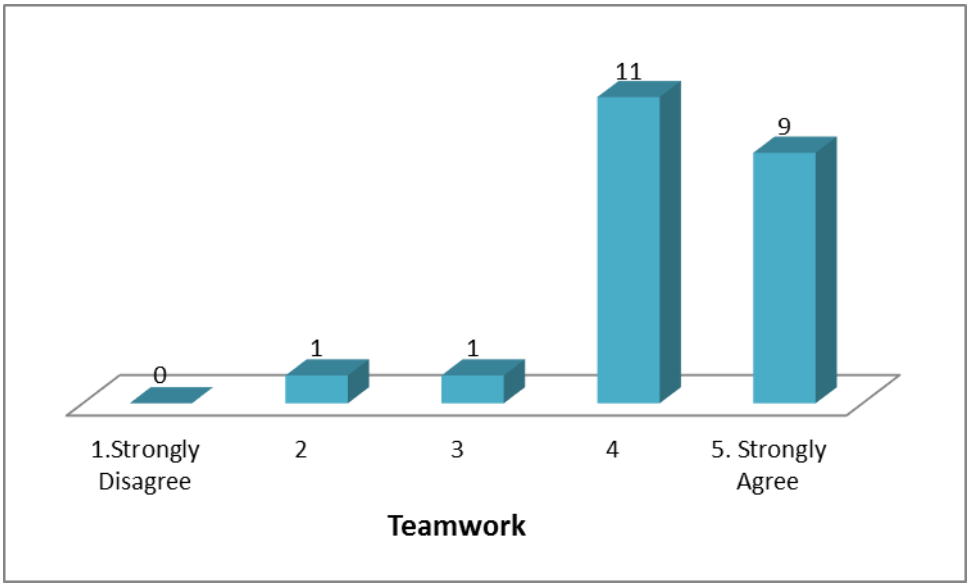
From the above graph 4 we can observe that 47.61% agree that their problem solving skills has increased considerably, 38% were in a 50-50 decision, 9.5% strongly agree that their problem solving skills in group work has increased. This shows a positive outcome on one aspect of group work workings.




**Graph 5 Communication skill**

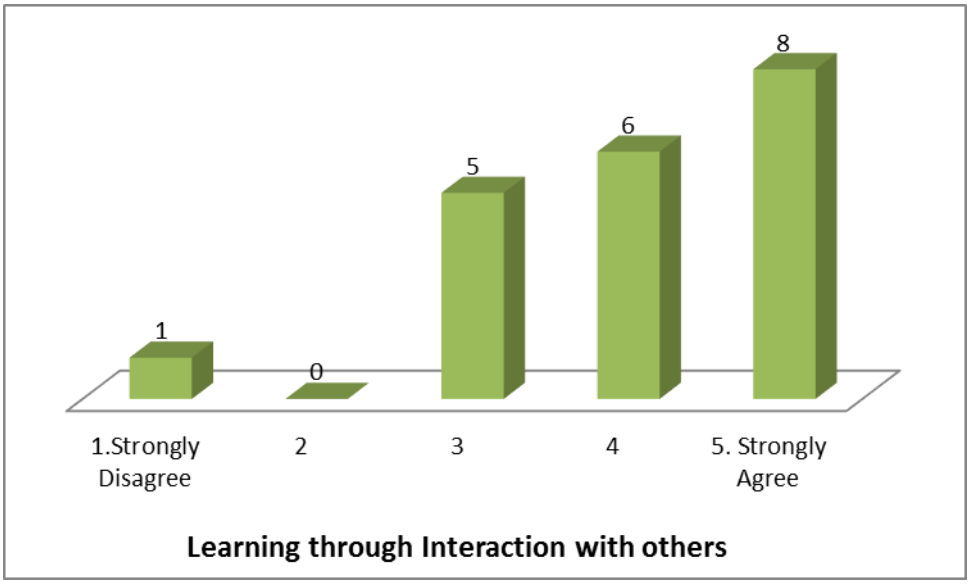
Communication plays a very important role in our day to day life as is one the important criteria of industry as a 21st century skills which employer looks at, from the above graph 5 we can observe that 52% strongly agree that their communication skills has been increased in group work, 23% agree for the improvement in the skills and 19% are in the mid decision, as a positive outcome none of the students strongly disagree about the communication skills in the group work.




**Graph 6 Teamwork Skill**

Regarding teamwork skills from the above graph 6 we can observe that 42% strongly agree, 52% agree that their teamwork skills has increased a lot working in group work which is a positive sign for the skill improvement in a student working in groups.




**Graph 7 Learning through interaction with others.**

Learning through interaction with each other will enhance learning in the group work from the above graph 7 we can observe that 38% strongly agree, 28% agree and 23% have 50-50 outcome, only 4% student strongly disagree with their skills improvement.

### 4.2 Analysis based on groups formed

For the entire class 5 groups were made, group vary in size with either 4 to 5 members. For keeping the students name as anonymous group were named as Group A, Group B till Group E, and members as 1A, 1B, 1C and so on.

Group analysis was done based on several factors like.

- Self and peer assessment by their own group.
- Marks obtained in individual report writing.
- Individual Marks from the group grade.
- Overall group work performance of all groups.

- Overall project evaluation using mean and standard deviation.

**Content validity approach was used to check the validity of the questionnaire used, internal consistency reliability approach was used to assess different test which produce similar result.**

### 4.2.1 Analysis as per Self and Peer Assessment

As per (Boud, 1990) self and peer assessment was "fundamental to all aspects of learning" and it inspires the growth of the student, who possess a good amount of individuality and who is ready to become a enduring learner, it reflects the rising need of the student and to give them an added dynamic role in handling their own learning and sufficing the requirement of industrial world for creativity, flexibility and can cope with any situation in the work place.

All the students were assessed on six parameters mention below.

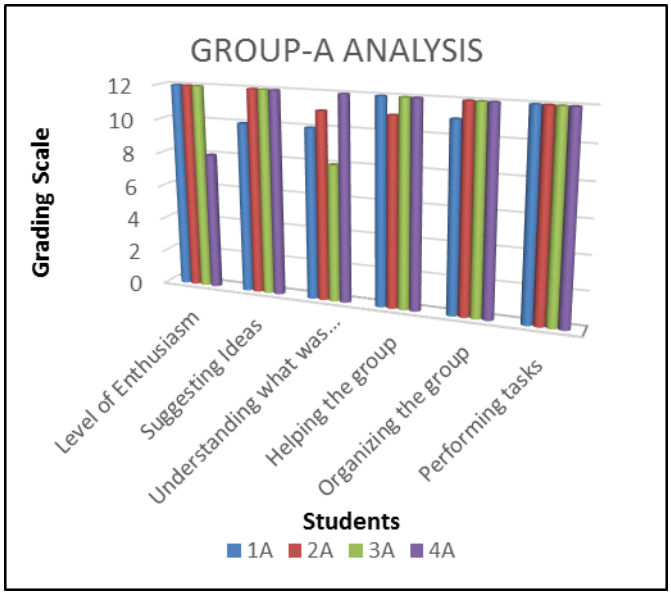
a) Level of enthusiasm / participation
b) Suggesting ideas.
c) Understanding what was required.
d) Helping the group to function well in a team.
e) Organising the group and ensuring things get done.
f) Performing tasks efficiently.

Refer to Appendix 13.6 for the self and peer assessment form

**Table 1: Group A self and peer assessment marks**

| Self and peer assessment | Group- A | | | |
|---|---|---|---|---|
| Marks Awarded to: | Student -1A | Student -2A | Student -3A | Student -4A |
| *Level of enthusiasm / participation* | 12 | 12 | 12 | 8 |
| *Suggesting ideas.* | 10 | 12 | 12 | 12 |
| *Understanding what was required.* | 10 | 11 | 8 | 12 |
| *Helping the group to function well as a team* | 12 | 11 | 12 | 12 |
| *Organizing the group and ensuring things got done* | 11 | 12 | 12 | 12 |
| *Performing tasks efficiently* | 12 | 12 | 12 | 12 |



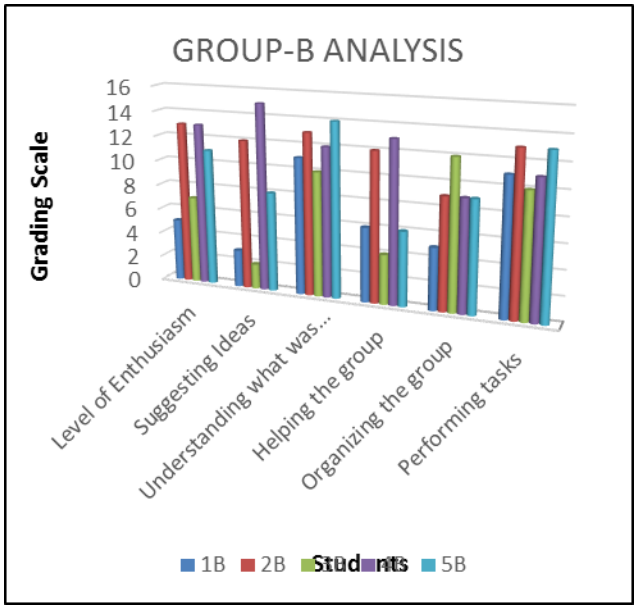

**Graph 8, Group A self and peer assessment marks**

**As we can see from the marks and the graphs all the members of the group did extremely well in participating in all areas of the group work.**

**Table 2: Group B self and peer assessment marks**

| Self and peer assessment | Group-B | | | | |
|---|---|---|---|---|---|
| Marks Awarded to: | Student-1B | Student-2B | Student-3B | Student-4B | Student-5B |
| *Level of enthusiasm / participation* | 5 | 13 | 7 | 13 | 11 |
| *Suggesting ideas.* | 3 | 12 | 2 | 15 | 8 |
| *Understanding what was required.* | 11 | 13 | 10 | 12 | 14 |
| *Helping the group to function well as a team* | 6 | 12 | 4 | 13 | 6 |
| *Organizing the group and ensuring things got done* | 5 | 9 | 12 | 9 | 9 |
| *Performing tasks efficiently* | 11 | 13 | 10 | 11 | 13 |



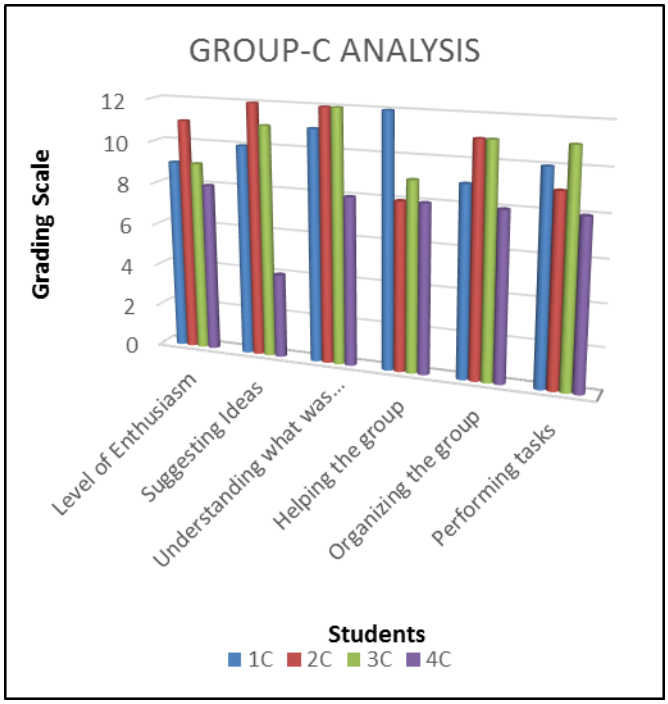

**Graph 9, Group B self and peer assessment**

**Very high variations seen in group B in all areas of work as per marks and graphs**

**Table 3: Group C self and peer assessment marks**

| Self and peer assessment | Group- C | | | |
|---|---|---|---|---|
| Marks Awarded to: | Student -1C | Student -2C | Student -3C | Student -4C |
| *Level of enthusiasm / participation* | 9 | 11 | 9 | 8 |
| *Suggesting ideas.* | 10 | 12 | 11 | 4 |
| *Understanding what was required.* | 11 | 12 | 12 | 8 |
| *Helping the group to function well as a team* | 12 | 8 | 9 | 8 |
| *Organizing the group and ensuring things got done* | 9 | 11 | 11 | 8 |
| *Performing tasks efficiently* | 10 | 9 | 11 | 9 |



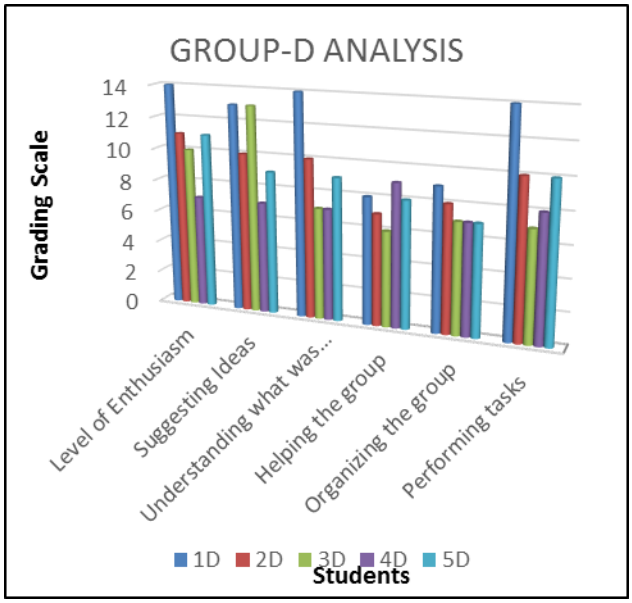

**Graph 10, Group B self and peer assessment**

**High variations seen in group C in all areas of work as per marks and graphs**

**Table 4: Group D self and peer assessment marks**

| Self and peer assessment | Group-D | | | | |
|---|---|---|---|---|---|
| Marks Awarded to: | Student-1D | Student-2D | Student-3D | Student-4D | Student-5D |
| *Level of enthusiasm / participation* | 14 | 10 | 10 | 7 | 11 |
| *Suggesting ideas.* | 13 | 10 | 13 | 7 | 9 |
| *Understanding what was required.* | 14 | 10 | 7 | 7 | 9 |
| *Helping the group to function well as a team* | 8 | 7 | 6 | 7 | 8 |
| *Organizing the group and ensuring things got done* | 9 | 8 | 7 | 7 | 7 |
| *Performing tasks efficiently* | 14 | 10 | 7 | 8 | 10 |



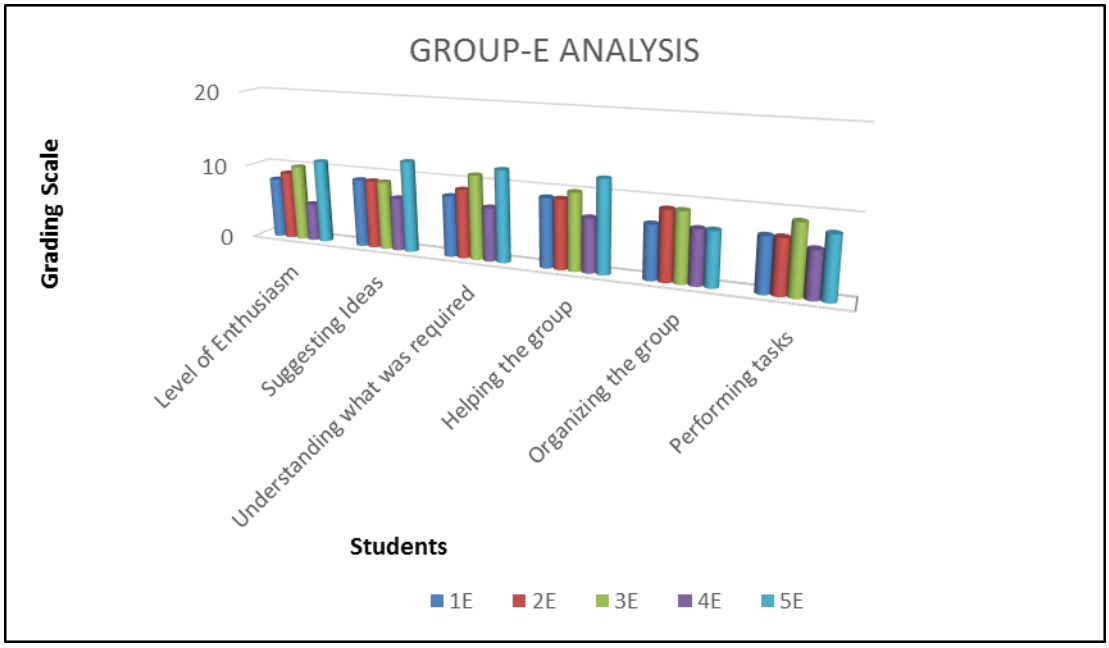

**Graph 11, Group D self and peer assessment**

**Very high variations seen in group D in all areas of work as per marks and graphs.**
**We can see that student 1D has performed well in some areas apart from others.**

**Table 5: Group E self and peer assessment marks**

| Self and peer assessment | Group-E | | | | |
|---|---|---|---|---|---|
| **Marks Awarded to:** | **Student-1E** | **Student-2E** | **Student-3E** | **Student-4E** | **Student-5E** |
| *Level of enthusiasm / participation* | 8 | 9 | 10 | 5 | 11 |
| *Suggesting ideas.* | 9 | 9 | 9 | 7 | 12 |
| *Understanding what was required.* | 8 | 9 | 11 | 7 | 12 |
| *Helping the group to function well as a team* | 9 | 9 | 10 | 7 | 12 |
| *Organizing the group and ensuring things got done* | 7 | 9 | 9 | 7 | 7 |
| *Performing tasks efficiently* | 7 | 7 | 9 | 6 | 8 |




**Graph 12, Group E self and peer assessment**

**Not much contribution was seen from all the students, students 3E and Student 5E did a consistent work in most of the areas**

## 6.2 Observations for all groups

**Table 6: Grading of all groups**

| | High | Medium | low |
|---|---|---|---|
| *Level of enthusiasm / participation* | A | E | B |
| *Suggesting ideas.* | A, C | D | B |
| *Understanding what was required.* | C | A | D |
| *Helping the group to function well as a team* | A | E | D |
| *Organizing the group and ensuring things got done* | A | C | D |
| *Performing tasks efficiently* | A | B | E |

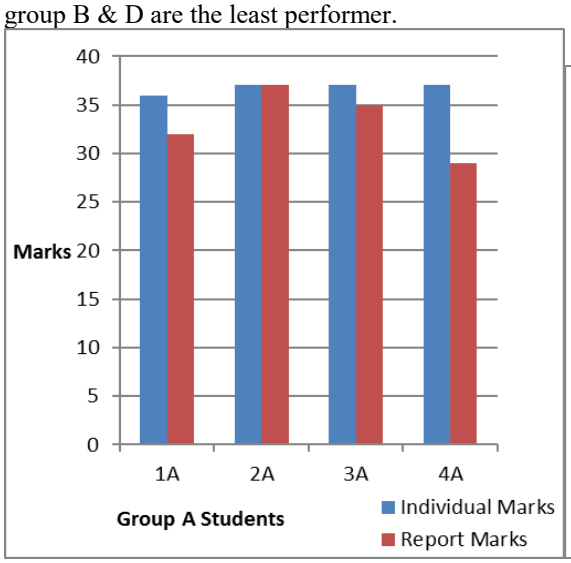
Group A- Highest performer as per self and peer assessment
Group E- Medium performer as per self and peer assessment
Group B & Group D- Lowest performer as per self and peer assessment

**NOTE:**
**Self and peer assessment was done in front of the tutor in a closed room with one student at a time as well as other student were not able to see how much their group member has contributed .**
**The format of self and peer assessment was adopted from Goldfinch (1994)**
**Refer Appendix 13.5 and 13.6 for further reference**

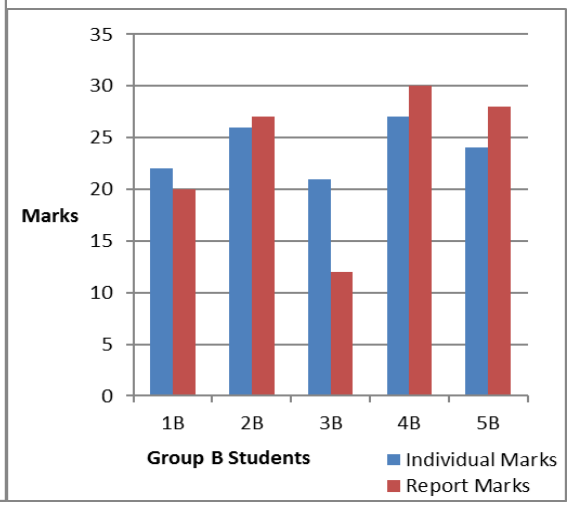
**6.4 Students group marks comparison & Overall performance of groups.**
In the below graphs we have compared the each groups report writing marks and individual marks obtained from the group grade.

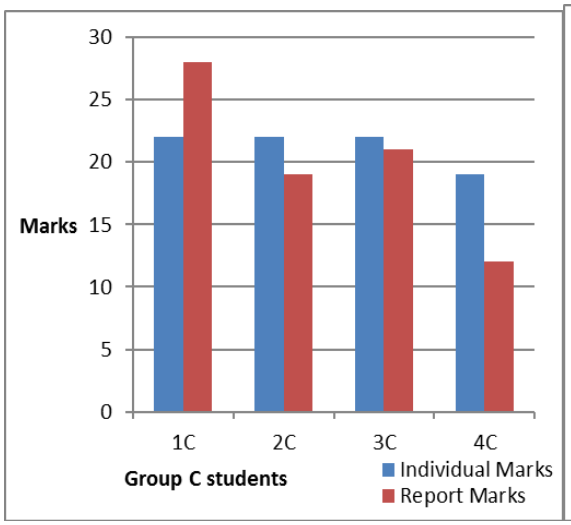
From the below graphs we can see that group A has done excellent work in gaining individual marks as well as in report, group E has also shown good performance in both works, group C are the average performer and group B & D are the least performer.



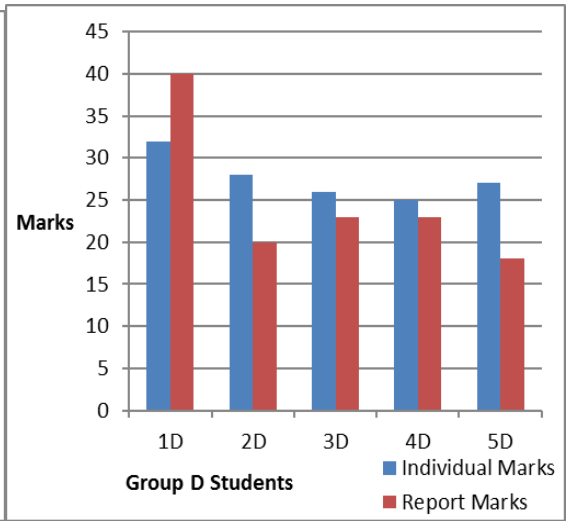

**Graph 13: Group A marks**



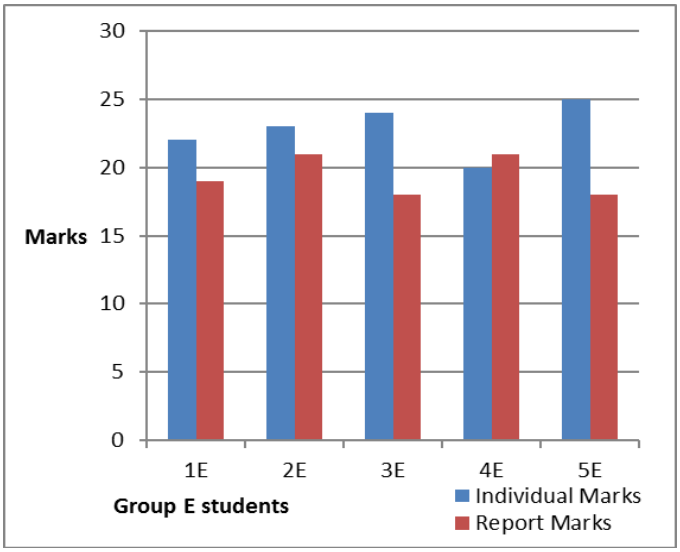

**Graph 14: Group B marks**




**Graph 15: Group C marks**

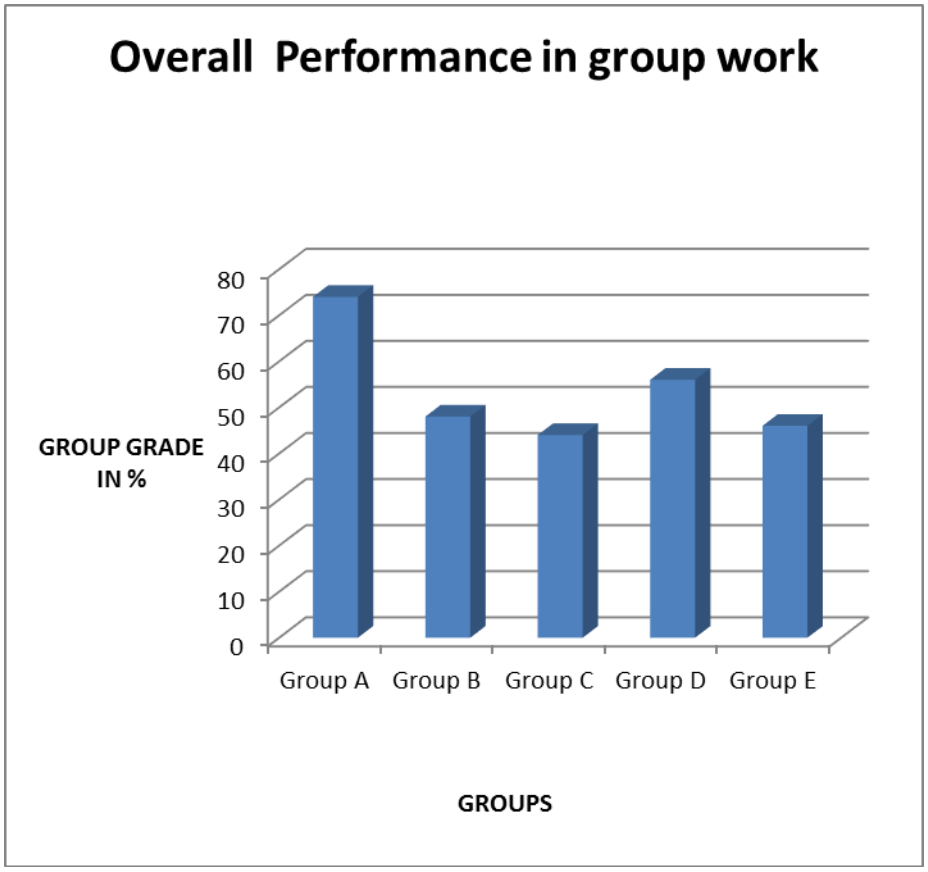



**Graph 16: Group D marks**




**Graph 17: Group E marks**




**Graph 18: Overall group performance**

In the overall performance graph, group A leads, following with group D, then group B & E showing equal performance with the least performance shown by group C

**Note:**
**Refer Appendix 13.8 for overall group performance marks in detail.**

## 7 Overall Project Evaluation

For evaluating the success of the project, the students n=21 completed a detail questionnaire as shown in the Table 1 below from total 23 students.
The questionnaire was built on three areas i.e.

a) Development of skills
b) Attitudes towards group work
c) Attitudes towards assessment

For analysis purpose mean and standard deviation were calculated from all the 21 students' response.
The **mean** is the **average** of all the numbers, here n=21.
The **standard deviation** is a measure how spreads out numbers are across the mean.

**Note:**
**All students' responses are scanned and attach in extra documents in the Moodle as a form of evidence**.

**Table 7: Group Work Project Evaluation questionnaire results, (n=21)**

| | Mean Rating | Standard Deviation |
|---|---|---|
| ***Developments of skills.*** (1= Strongly disagree, 5=Strongly agree ) | | |
| How do you feel the exercise has improve the following skills: | | |
| Problem solving | 3.5 | 0.74 |
| Leadership. | 3.4 | 0.92 |
| Research | 4.3 | 0.79 |
| Study | 3.8 | 0.98 |
| communication | 4.1 | 1.06 |
| Time management | 3.2 | 1.04 |
| Presentation | 3.9 | 1.02 |
| Peer assessment | 3.9 | 0.66 |
| Self-assessment | 3.9 | 0.92 |
| Subject knowledge | 4.0 | 0.65 |
| Teamwork | 4.1 | 0.79 |
| ***Attitudes to Group work*** (1= Strongly disagree, 5=Strongly agree ) | | |
| It was easy to work collaborate in the group | 3.4 | 1.59 |
| I learned more through interaction with others | 3.6 | 1.07 |
| The group work sessions: | | |
| (a) Were enjoyable | 3.7 | 0.86 |
| (b) Helped me to learn | 3.9 | 0.95 |
| (c) Enhanced my motivation/interest levels | 3.9 | 0.92 |
| (d) Help me integrate more with other students | 4.1 | 0.95 |
| I feel reluctant about being a group member | 1.7 | 1.01 |
| I feel that group work only suits the non-contributor | 1.7 | 1.24 |
| The group sessions: | | |
| (a) Limited my potential | 1.7 | 1.01 |
| (b) Decreased my level of ability | 1.5 | 0.84 |
| (c) Were a complete waste of time | 1.2 | 0.52 |
| ***Attitudes to assessments*** (1= Strongly disagree, 5=Strongly agree ) | | |
| I felt the peer assessment was fair and correct | 4.1 | 0.81 |
| Group session increased my ability to assess myself And peers in a more analytical way | 4.1 | 0.70 |
| I felt uncomfortable about assessing other groups | 2.3 | 1.08 |
| I would prefer not to assess members of my own group | 2.1 | 1.03 |

**Adopted from: Paul Humphreys, Victor Lo, Felix Chan, Glynn Duggan (2001), Developing transferable group work skills for engineering students, International journal of engineering education, Vol 17, No 1, pp. 59-66**

**a) Development of Skills**

In terms of **development of skills,** the marks are ranging from **3.9 (peer assessment)** to ***(teamwork-4.1)*** with score averaging from 3.8 over the 11 categories specified in the development of skills category, a score greater than 3.0 can be seen as positive response to the skill development, the mean values rating suggest that the process adopted to develop transferrable personal skills to have been successful.

**b) Attitudes towards group work**

In terms of **Attitudes towards group work,** a favorable reaction was attained for easy to collaborate in a group (3.43) and they learned more through interaction with others (3.62), it helped them to learn (3.9). The response also indicate the students were content in being a part of a group (1.7) and they do not feel that group work suits only non-contributor (1.7), the students feel that group sessions benefited and not a waste of time (1.2).

**c) Attitudes towards assessment**

***Attitudes towards assessment*** indicate that students felt that peer assessment was fair and correct (4.1), however with respect to applying peer evaluation they were indifferent to evaluating other groups (2.3) and to being evaluated by fellow students of their own group (2.1).

The overall standard deviation seen is very close to the mean in most of the cases.

From the above statistics we can say the process adopted for the group work was a success

## 8 Summary of the findings

As per the analysis done for all the group we have seen that all students participated in group work and found it very interesting, as per the findings seen in the table 7 for overall project evaluation we have seen that the students agree that their development skills has been increased because of group work, they were able to interact to each other and share their ideas in the group. Students had already worked in a group work but they found the current rubric very interesting because they were able to show their individual work through individual presentation, taking team roles for their work and participating in meetings for which students created a Padlet as evidence to upload their work.

Group A can be seen doing well in all the areas with all members actively participating in all the tasks followed by group D, Group A marks were extremely good and have shown proper response throughout the group work. Group D was the lowest performer in all the areas as we see the students were not able to keep a track of their work with poor meetings and unable to share their ideas properly within the group.

Some students feel reluctant to assess other groups as well their group members. With the help of mean and standard deviation values we can see that the standard deviation values are very near to the mean which indicates that the process adopted for the group work was a success.

## 9. Recommendations

Based on the data analysis and keeping in mind the limitations of this research project presented above, the following recommendations can be made.

**Group formation**— Current students had preferred forming their own groups based on friendship. However, working in the same group may not be very effective because of postponement of work. There are numerous methods in which groups can be assembled and several norms that can be used to form groups and assess your students' proficiency. One way is to create Tutor formed groups where in each group there will be a combination of students to include intelligent students with weak ones.

**Record Group meeting** — Many groups had not met frequently to discuss agenda and progress which then led to delay in tasks and incoordination. It is very difficult for students to organize their schedules.

Students need to know the importance of regular meetings with an agenda. Substantial extent of tasks can be completed in short durations, only if the group is familiar with what task is scheduled next. Hence groups should maintain a record of their meetings. The record should include the members present, date and time of meeting, discussion topic, outcome, and any problems faced, proposed solutions and when to meet next.

**Interim reports and group progress feedback**- It was observed that some groups were reluctant to discuss their group work progress on a regular basis. This affected the quality of work presented directly at the final stage.

Formative assessment marks can be included in the rubric for Interim Report submissions so that it will compel groups to meet the Tutor for group progress feedback and improve the quality of their work.

**Team-building exercises to build cohesive groups**— In the action research project no team building exercises were conducted. So it is recommended that activities like group discussion or debate, referring of books on Teamwork to students by Tutor should be conducted.

**Importance of Self and peer assessment**

Some students were reluctant to perform Self and Peer assessment. The students need to be enlightened about these areas since that would help them realize what they can learn from others and what they are themselves good at.

## 10. Conclusions

From the overall group work project evaluation we have seen that the action research project on the group work has overall helped the students to develop transferable skills, teamwork skills and social interactions as well as learning about beliefs and attitudes. Also we can see that the students agree that their leadership skills has been increased which is the requirement of any industry, the curriculum product and process model along with constructive alignment has seen students achieving the outcomes very easy for their group work process.

As a tutor implementing a group work with the product and process method made me learn how student understand working in a group, how the development of rubric plays a very important role in group work and how important is for a student to achieve his own grade when working in a group, also I have seen that students are more reluctant to do self and peer assessment for themselves and for their group members as well as other groups, for the future works self and peer assessment awareness needs to be increased and should be adopted in all the works.to increase the comfort in evaluation.

## 11. Further Study

From the current findings of the action research project and recommendations further study can be done in the following areas.

1) Various ways of Group formation methodology needs to be explored. Example tutor recommended groups.
2) Techniques and tools to perform Self and peer assessment can be probed.
3) Different Team-building exercises can further be investigated to build cohesive groups.
4) (Goldfinch,1994) method of transforming group grade to individual grade by integrating a weighted grade allocated by the tutor can be explored.
5) Making more improvement in the rubrics so that student has more accountability of their work in groups.
6) SWOT analysis can be implemented in the group work at various intervals to understand the progress.

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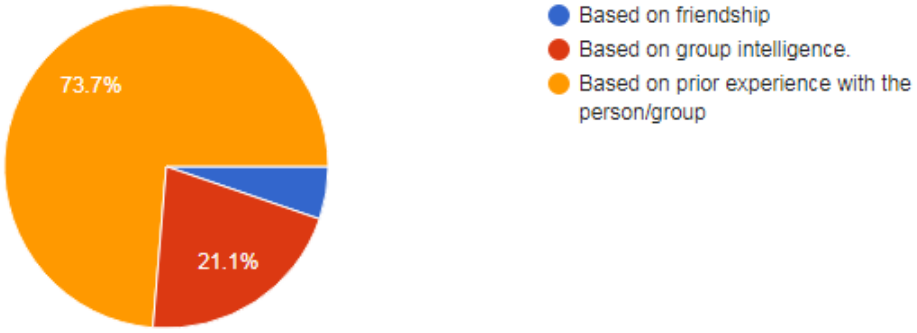
## 12. APPENDIX

### 13.1 Initial Student Survey Questionnaire for Group Work

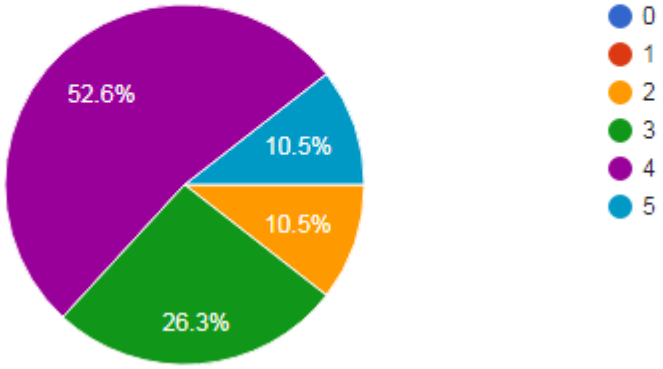
1) How do you choose group.

19 responses

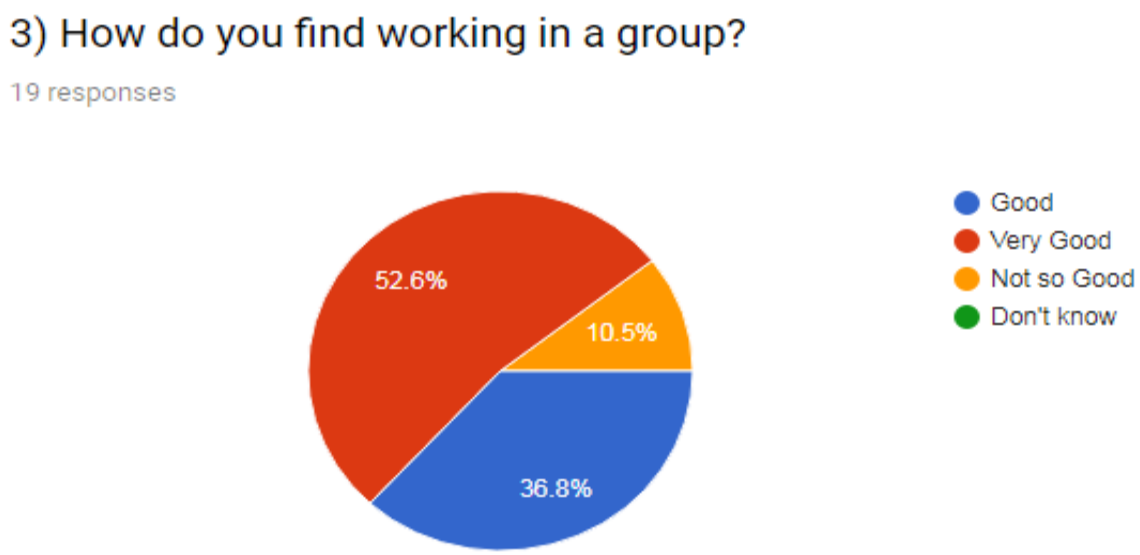


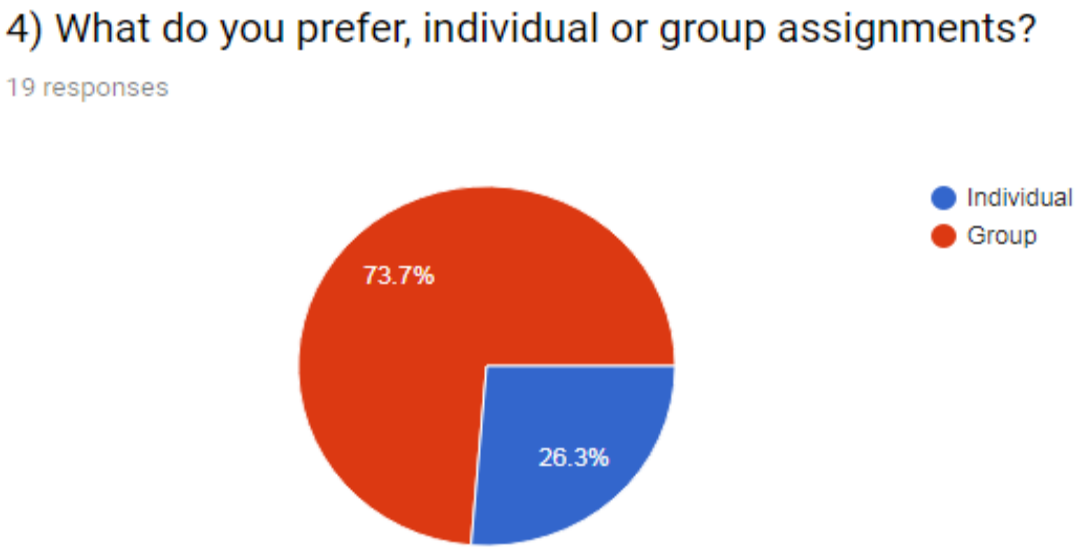

2) Have you work in the group projects before. How many times?

19 responses



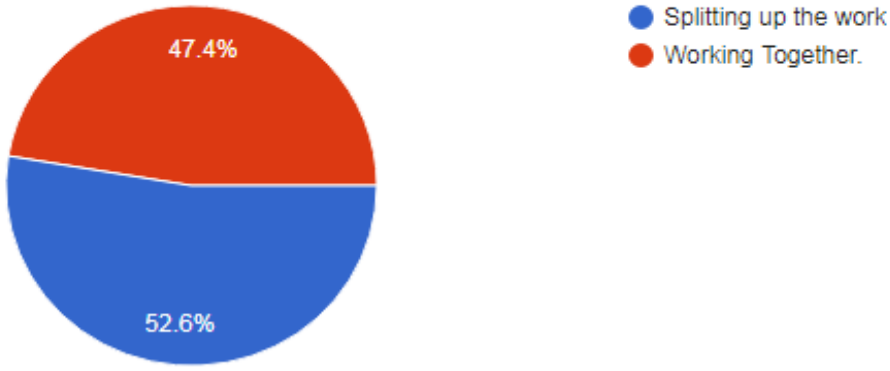


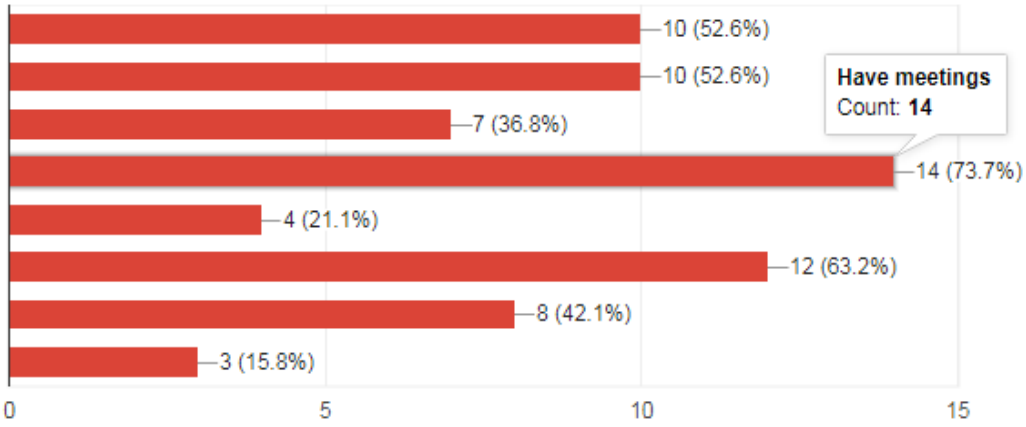
5) Which do you prefer when working on a group assignment?

19 responses




6) Which strategies will you use to encourage fair contribution from all members to a group assignment?

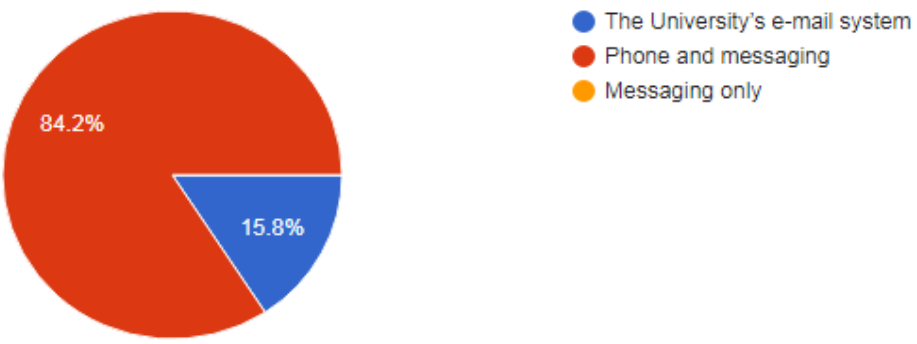
19 responses



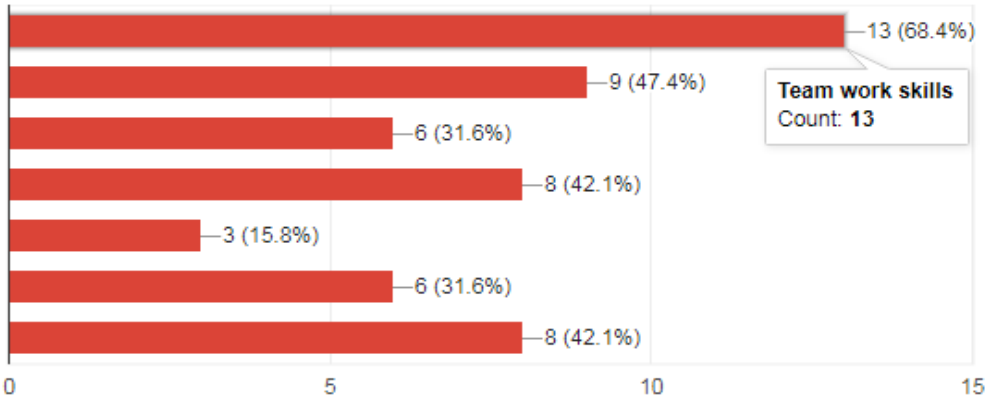
7) Which communication tools will you use for group communication if you are not physically together?

19 responses




8) What skills do you feel you can develop when you work on a group assignment?

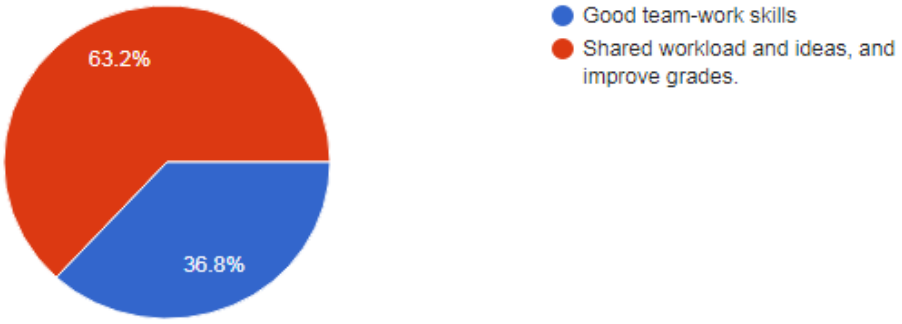
19 responses



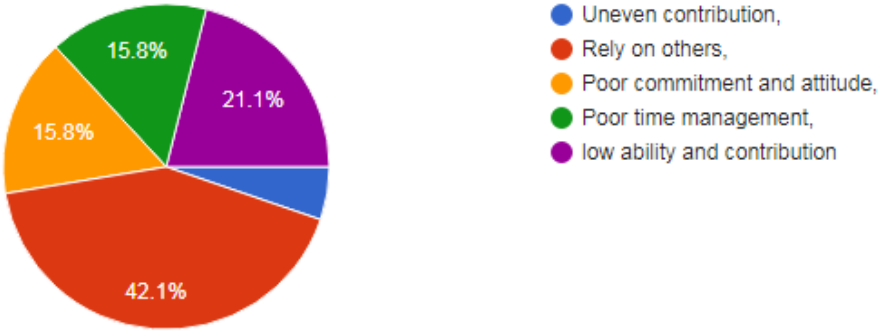
9) What do you feel is the biggest benefit of working on group assignments?

19 responses




10) What do you feel is the biggest drawback of working on group assignments?

19 responses



### 13.2 Questionnaires for Teachers/Tutors about their experience of Group Work

1. Which student groups do you work with (i.e. subject area and level)?

8 responses

| |
|---|
| Accounting |
| Level 4 & 5 Higher education |
| Mechanical Engineering - HEL4 |
| Engineering Level 4 & 5 |
| HE4,HE5,HE6 |
| both |
| Subject area |
| Level 5 -Software Based System Analysis and Design |

2. Why do you use group work with your students?

8 responses

| |
|---|
| Innovations |
| a. requirement of the module assessment.<br>b. in skill-based curriculum team work is essential. So students are exposed to group work |
| Formative assessments |
| It is required in their curriculum |
| YES |
| group evaluation |
| As part of summative assessment |
| To encourage building up of ideas and the importance of team skills |

## 3. What do your students gain from working in groups?

8 responses

| |
|---|
| Develop Teamwork skills |
| a. learning from each other in accomplishing a particular task<br>b. learn how to work in groups |
| Collaborative ideas, summarize/revise topics learnt, discuss/share information etc.. |
| team work |
| CONFIDENCE,TEAM PLAY,LEADERSHIP SKILLS,COMMUNICATION SKILLS |
| group based learning |
| Working in cohesion, sharing knowledge, team work |
| 1)They learn to support the ones who are weak, 2)they learn to respect others opinions and 3)understand how to come to a common solution despite of starting with different opinions.4) Collaborative thinking[ One starts an idea, other builds around it] |

## 4. What are the main group exercises and activities which you give students to perform?

8 responses

| |
|---|
| Report preparation |
| a. presentation<br>b. team-based projects and tasks |
| group discussion and presentation to the whole of the class |
| group projects |
| HANDOUT FOR EXERCISES IN CLASS,PROJECTS |
| project preparation, project presentation |
| case study discussions |
| Problem Analysis and Propose Solution. |

5. What are the most useful group-work resources (e.g. books, websites etc.) which you use as a lecturer?

8 responses

| |
|---|
| Books, journals, websites |
| Belbin's team theory and assessment |
| journals, newspaper clippings, website resources |
| projects |
| WEBSITE |
| multiple |
| Books and websites |
| Books |

6. What are the most useful group-work resources which you recommend to students?

8 responses

| |
|---|
| Books and journals |
| Belbin's team theory and assessment |
| websites |
| blog |
| WEBSITE |
| online |
| Books and websites |
| Books |

## 7. How do you assess student groups and their work?

8 responses

| |
|---|
| Group and individual |
| Group output and individual participation |
| visual assessment on their participation, oral questionnaire etc.. |
| blog and viva |
| YES |
| based on specific criteria |
| Individual contribution and Q&A sessions |
| The work is split in two Categories:Individual and Group work. In Group work, I check who brings forth which points/ideas. |

## 8. What are the main issues which your student groups confront?

8 responses

| |
|---|
| Taking decisions |
| individual participation and performance within the group |
| uneven participation. |
| passive learners |
| FREE RIDERS IN A GROUP,MOTIVATION FOR SELF DIRECTED STUDY |
| role clarity |
| Social loafing and avoiding responsibilities |
| Some team members do not participate as much as others do. |

## 9. What feedback have you received from students concerning their group work?

8 responses

| |
|---|
| Happy than individual work |
| Some do not like group work |
| same, complaints on uneven participation |
| some are inactive in the group |
| MORE ACTIVE IN A GROUP RATHER DOING ALONE |
| moderately ok |
| Lack of synergy, goal congruence, lack of participation |
| That some do not perform the given activity (sometimes activity dependency is present) which delays the entire assignment. |

## 10. How do you prepare your students to undertake group work? What theories and concepts are they taught and what resources do they need?

8 responses

| |
|---|
| Theories of group behaviour |
| Familiarize them with group work concepts and application |
| usually they would be briefed about the general topic, they would be asked to research online for various sources, check if they are on right track, put specific questions to be discussed and later ask students to present before the class. |
| clear assignment tasks are given for group work |
| PLANNING,TIME MANAGEMENT |
| class lectures and preparatory sessions |
| Have yet to use or test theories. Specific guidelines and marking criterias are shared |
| They are advised to conduct meetings and record minutes of meeting. This helps to understand who are present and what work is achieved by whom by that time.<br>A Timeline Chart/ Gantt Chart also is helpful in this case. |

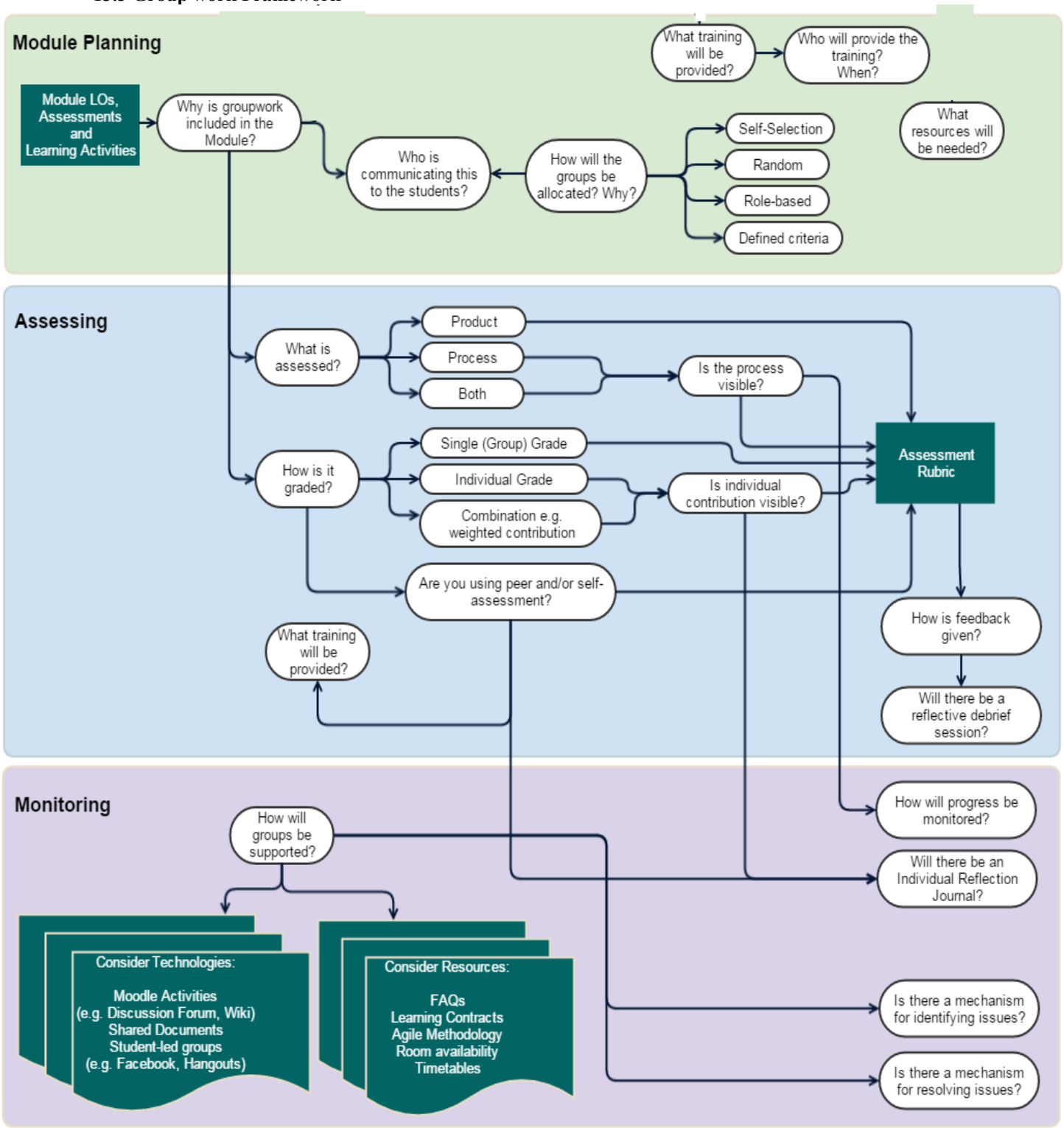
## 11. What research would you like to see concerning student groups?

8 responses

| |
|---|
| Promotes students learning |
| how to assess accurately group work |
| to encourage even participation |
| how to bring passive learners to active in group |
| HOW TO ASSESS INDIVIDUAL CONTRIBUTION OF A GROUP WORK EFFECTIVELY |
| individual contribution and individual learning from group work |
| Use of academic sources |
| I would like to undergo more training in assessing Group Work as to how to motivate each student to put in his best efforts.<br>The 5 and 6 question has brought forth a very insightful point. I would like to pursue these more to train students regarding Group related rules, ethics and guidelines. |

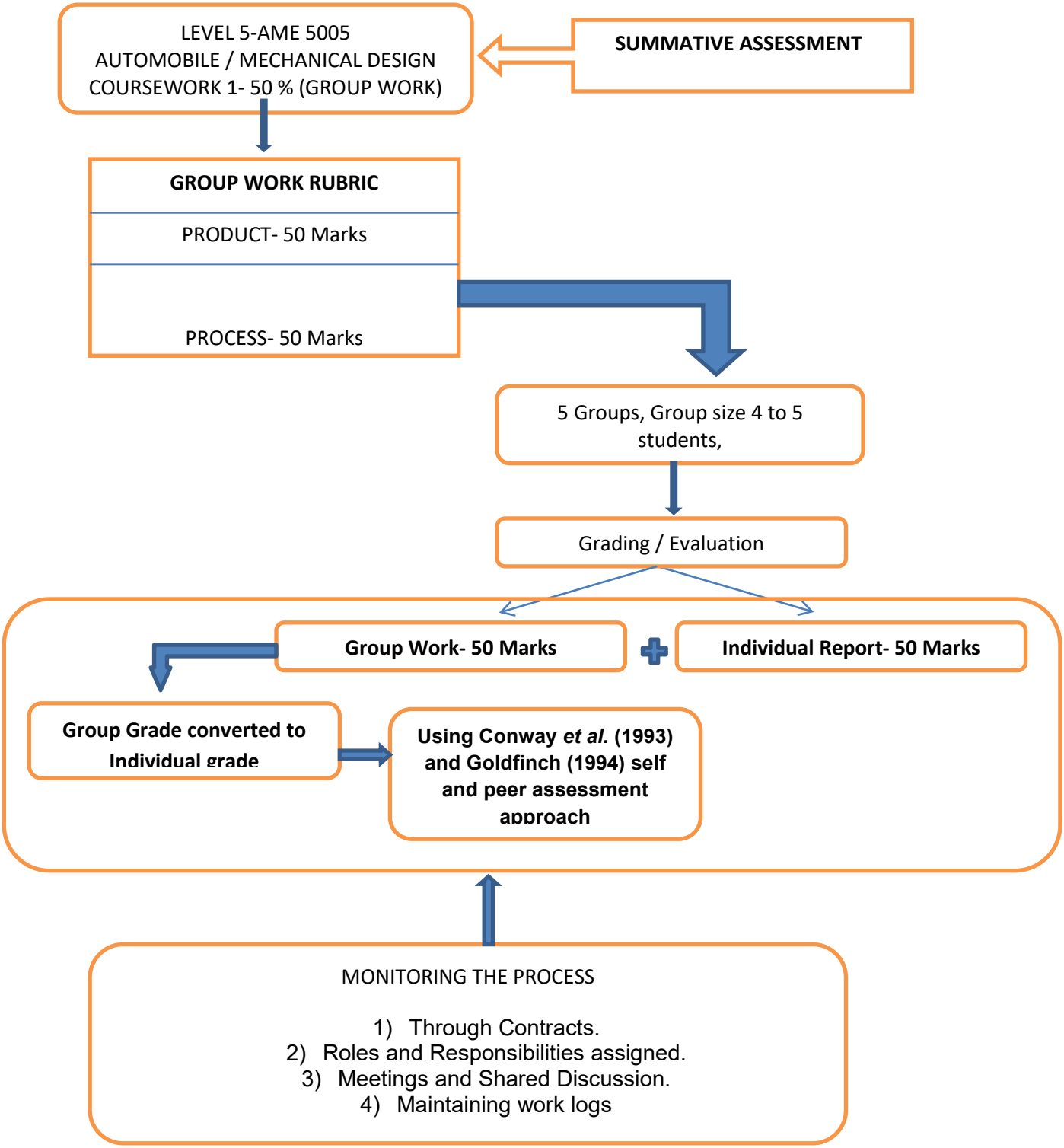
  

**13.3 Group work Framework**



**13.4 Methodology flowchart for group work assessment.**



### 13.5 RUBRIC PLANNING

**13.5.1 Development of New Rubric for Group Work**

| No. | Criteria | Marks |
|---|---|---|
| I | **Individual Assessment** | 50 |
| 1 | Individual log sheet of meeting with tutor. | 5 |
| 2 | Individual report | |
| | • Introduction to the design assignment | 5 |
| | • Creation of PDS (Product Design Specification) | 5 |
| | • Calculations | 10 |
| | • Solid work part model | 5 |
| | • Solid work assembly | 5 |
| | • 2D drawings with Bill of materials. | 5 |
| 3 | Presentation<br>The presentation should reflect your individual contribution towards the project. | 10 |
| | | |
| II | **Team Assessment** | 50 |
| 1 | Allocation of work with consent. | 5 |
| 2 | Issues Identified about the system | 10 |
| 3 | Market research. | 10 |
| 4 | Proposed system design (at least 3 design) | 5 |
| 5 | Proposed material selections for the system design. | 10 |
| 6 | Minutes of meetings held by the group (Project log using Padlet) | 10 |
| | | |
| | **Total** | 100 |

**13.5.2 Old Rubric of group work for the same class for different module**

| MARKING SCHEME & WEIGHTAGE OF ASSESSMENT | | |
|---|---|---|
| **1. Group Presentation** | **50%** | |
| **2. Individual Report** | **40%** | |
| **Report will be marked out of 100marks** | | **Marks** |
| General presentation of report | | 10 |
| Design | | 30 |
| Manufacturing | | 20 |
| Testing | | 15 |
| General discussion and conclusions | | 15% |
| Overall clarity and lucidity of Report | | 10% |
| **3. Blog** | | **10%** |

**13.6 Team Contract**

Team Name: _____

Date: _____

| GOALS: What are our team goals for this project?<br>What do we want to accomplish? What skills do we want to develop or refine? |
|---|
| |
| EXPECTATIONS: What do we expect of one another in regard to attendance at meetings, participation, frequency of communication, the quality of work, etc.? |
| |
| POLICIES & PROCEDURES: What rules can we agree on to help us meet our goals and expectations? |
| |
| CONSEQUENCES: How will we address non-performance in regard to these goals, expectations, policies and procedures? |
| |

We share these goals and expectations, and agree to these policies, procedures, and consequences.

_____

Team member name

_____

Team member name

_____

Team member name

_____

Team member name

_____

Team member name

**13.7 Possible Roles on Teams**

Student teams often function most effectively when members have designated roles. These can be instructor-determined or established by the groups themselves, e.g., by giving teams a list such as the one below and asking them to decide on and delegate appropriate roles within their group.

The roles you – or your students – assign will depend on the goals of the assignment, the size of the team, etc. They can be fixed or rotating. Here are some possible group roles, but the list is not exhaustive. Think creatively and come up with your own!

| | |
|---|---|
| Facilitator: | Moderates team discussion, keeps the group on task, and distributes work. |
| Recorder: | Takes notes summarizing team discussions and decisions, and keeps all necessary records. |
| Reporter | Serves as group spokesperson to the class or instructor, summarizing the group's activities and/or conclusions. |
| Timekeeper | Keeps the group aware of time constraints and deadlines and makes sure meetings start on time. |
| Devil's Advocate | Raises counter-arguments and (constructive) objections, introduces alternative explanations and solutions. |
| Harmonizer | Strives to create a harmonious and positive team atmosphere and reach consensus (while allowing a full expression of ideas.) |
| Prioritizer | Makes sure group focuses on most important issues and does not get caught up in details. |
| Explorer | Seeks to uncover new potential in situations and people (fellow team members but also clients) and explore new areas of inquiry. |

| | |
|---|---|
| Innovator | Encourages imagination and contributes new and alternative perspectives and ideas. |
| Checker | Checks to make sure all group members understand the concepts and the group's conclusions. |
| Runner | Gets needed materials and is the liaison between groups and between their group and the instructor. |
| Wildcard | Assumes the role of any missing member and fills in wherever needed. |

13.8 **Method of Deriving Individual Marks from a Group Grade**

## Appendix 1. Details of Method 1—Conway *et al.* (1993) and Goldfinch (1994)

The method is based around the allocation of a group mark by the tutor to the work produced by the group and manipulation of this group mark to derive a mark for the individuals within the group. The formula adopted is as follows:

Equation 1: Individual student's mark = PA factor × Group mark

where PA stands for peer assessment.

The PA factor is further derived as follows:

Equation 2: PA factor = w% + (100% − w%) × PA score

w% is the percentage of an individual's mark which is taken directly from the group mark. Hence, if w% was 50%, the group mark would count for 50% of each student's assessment regardless of their contribution to the group. So, if a group received a group grade of 60%, every group member would be given 30% as of right, the remainder of their mark reflecting their contribution to the work. This latter contribution is obtained from the PA score.

The PA score is obtained by asking the students to assess each others' contributions on a peer assessment form. Each individual's scores are then added up to give an Individual PA total. This is then divided by the Average PA Total for the group to give the individual's PA score.

$$\textit{Equation 3: PA Score} = \frac{\textit{Individual PA Total}}{\textit{Average PA Total}}$$

The PA score reflects the individual's effort in comparison with the other members of the group.

Conway *et al.* (1993) applied this method but used a value of 0% for w% in Equation 2. This means that a student's grade is made up *entirely* of a modification to the group grade to reflect their individual contribution. This modifies Equation 1 as follows:

Equation 4: Individual student's mark = PA Score × Group mark

**13.9 Goldfinch (1994) self and peer assessment form example**

**Group members:**

**Grading Criteria:**

*0: Not Contributed;*

*1: Satisfactory Contributed;*

*2: Medium Contribution:*

*3: Full Contribution;*

| **Marks Awarded to:** | | | | | |
|---|---|---|---|---|---|
| **Marks Awarded by:** | | | | | |
| *Level of enthusiasm / participation* | | | | | |
| *Suggesting ideas.* | | | | | |
| *Understanding what was required.* | | | | | |
| *Helping the group to function well as a team* | | | | | |
| *Organizing the group and ensuring things got done* | | | | | |
| *Performing tasks efficiently* | | | | | |
| **Totals** | | | | | |

*-Adapted from Conway et al. (1993) and Goldfinch (1994)*

;

**13.10 Overall group performance marks**

| Group | Student | Group Grade in % | Individual Marks from Group Grade | Individual Report writing marks |
|---|---|---|---|---|
| A | 1A | 74 % | 36 | 32 |
| | 2A | | 37 | 37 |
| | 3A | | 37 | 35 |
| | 4A | | 37 | 31 |
| B | 1B | 48% | 22 | 18 |
| | 2B | | 26 | 27 |
| | 3B | | 21 | 12 |
| | 4B | | 27 | 30 |
| | 5B | | 24 | 28 |
| C | 1C | 44% | 22 | 28 |
| | 2C | | 22 | 19 |
| | 3C | | 22 | 21 |
| | 4C | | 19 | 12 |
| D | 1D | 56% | 32 | 40 |
| | 2D | | 28 | 20 |
| | 3D | | 26 | 22 |
| | 4D | | 25 | 23 |
| | 5D | | 27 | 18 |
| E | 1E | 46% | 22 | 18 |
| | 2E | | 23 | 21 |
| | 3E | | 24 | 16 |
| | 4E | | 20 | 19 |
| | 5E | | 25 | 18 |

# INVESTIGATION OF COMMUNICATION SKILLS OF GIFTED STUDENTS IN TERMS OF VARIOUS VARIABLES

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**ABSTRACT**
The aim of this study is to examine the communication skills of gifted students in terms of various variables in order to form a program model to support their interpersonal communication skills. After determining the interpersonal communication skills of the students in Science and Art Center (BİLSEM), it is aimed to improve the communication skills of these gifted students by applying programs that support the communication skills. The quantitative part of the study was applied to a total of 338 gifted students aged between 13 and 18 years through a scale adaptation to determine communication skills. The 23-item 6-dimensional model was found to be consistent in confirmatory factor analysis. As a result of the study, the scale was found to be reliable and valid. According to the findings, a significant difference was found in communication skills of gifted students according to gender and school type. There was no significant difference according to grade level.
**Keywords:** gifted student, scale, communication skills

## Introduction

Gifted students, who experience communication deficiencies and problems, prefer to use three ways in the context of unacceptable environments. The first is that they isolate themselves from the environment. When they are perceived as unwarranted by others, they prefer to display extreme behaviors as the second way and in the third they try to show the same behaviors as their peers. This leads to the lack of potential for them (Clark, 1997). Although the communication skills of gifted individuals are generally high, they may have communication problems due to reasons such as avoiding mistakes, high self-confidence, self-centeredness, seeing oneself different and superior, not being understood by their peers. Because of their advanced mental development, they tend to communicate with individuals who are older than them in general (MEB, 2017).

Gifted individuals in adolescence prefer to stay away from their peers (Buescher, 1985). It is suggested that such problems in peer relations stem from the lack of social skills (Kennedy, 1988). They prefer not to stay away from their normal peers but also from each other during adolescence (Silverman, 1988).

In a study, a number of disorders affecting interpersonal communication were identified due to attention deficit based on hyperactivity, developing opposing attitudes and behavioral problems (Webb, 2000). When such problems are not taken under control, failure may occur and children may have more severe consequences regarding the sensitivity caused by the special ability and inconsistencies are observed between the age of intelligence and chronological age of these children (Silverman, 1993). Gifted children do not have the same development as their peers and also have problems communicatively because their emotional and social developments are different (Coleman & Cross, 1998).

It has been understood that as the age of the students receiving special education grows, their communication problems increase along with their adolescent development. When the literature is examined and the researches

  

are taken into consideration, the problem of this research is related to the determination of the level of interpersonal communication skills among the gifted students in terms of various variables.

The aim of this study is to examine the communication skills of gifted students in terms of various variables by adapting the Communication Scale developed in 2002 by Susan Barkman and Krisanna Machtmes into Turkish.

**Findings**

*Study Group*

The adaptation of the scale was performed on 338 gifted students aged between 13 and 18 years. Within the scope of the research, 161 (47.6%) of the sample were female and 177 (52.4%) were male. The students in the sample; 163 (48.2%) of them were in private schools; 175 (51.8%) were in public schools. 294 people were at the level of 7-9 (87%); 44 people are in the class level of 10-12 (13%).

*Communication Scale*

The Communication Scale (Barkman & Macthmes, 2002), which consists of 23 items and 6 sub-dimensions, is graded over a 5-point likert. The sub-dimensions of the scale were:

- Awareness of one's own styles of communication
- Understanding and valuing different styles of communication
- Practicing empathy
- Adjusting one's own styles of communication to match others' styles. (Communicative adaptability)
- Communication of essential information
- Interaction management

The scale consists of 23 items and the score values vary between 23 and 115. The higher the scores are, the higher the communication skills are determined. When the literature on communication skills was examined, it was found that reliability coefficients were acceptable in the researches using the communication scale and that it was seen as the most appropriate measurement tool according to the age level to measure the communication skills of young people (Duerden et al., 2010). Validity varies according to the degree to which the scale wants to measure. In the original scale, it was found that the internal consistency of both factors was high. As a result of the study applied to 338 gifted students, the reliability of the communication scale was found to be .90.

**Translation of Communication Scale into Turkish**

During the adaptation phase, Krisanna Machtmes was contacted in digital form. Necessary permits have been obtained for adapting the communication scale to measure the communication skills of gifted students between the ages of 13-18 in Turkish. The original language of the scale was translated into Turkish by independent translators so that it can be used in the participants whose native language is Turkish. Four different translations were applied by the translators. They work as two experts in the field of special education in the Science and Art Center and two teaching staff in the Communication Sciences.

In the next stage, the Turkish version of the scale was translated into English by five English teachers. The items of the scale were compared by translating from Turkish to English and from English to Turkish. In the next stage, the scale was piloted to 102 gifted students studying at Science and Art Center in order to test the comprehensibility of the items. The questions were reorganized in a comprehensible way when the students could not understand. In the last stage, the reliability and validity study of the scale was made.

*Item Analysis and Reliability*

As a result of the analysis conducted to determine item discrimination, the corrected correlation coefficients were found to vary between .37 and .60. Table 1 shows the result of the analysis.

**Table 1.** Correlation Scores of Communication Scale Items

| Number | *rjx* | Number | *rjx* | Number | *rjx* |
|---|---|---|---|---|---|
| 1 | .49 | 9 | .40 | 17 | .53 |
| 2 | .52 | 10 | .49 | 18 | .53 |
| 3 | .58 | 11 | .51 | 19 | .37 |
| 4 | .54 | 12 | .60 | 20 | .50 |
| 5 | .59 | 13 | .58 | 21 | .53 |
| 6 | .60 | 14 | .59 | 22 | .45 |
| 7 | .42 | 15 | .54 | 23 | .54 |
| 8 | .44 | 16 | .41 | | |

  

Cronbach's (α) coefficient for the whole scale was found to be .90.

**Table 2.** Scale Statistics

| Mean | Variance | Std. Deviation | N of Items |
|---|---|---|---|
| 90,2071 | 199,993 | 14,14187 | 23 |

According to Table 2, the mean communication scale of 23 items was .90, variance was .199 and standard deviation was .14.

**Table 3.** T test for gender

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 95% Confidence Interval of the Difference | |
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Equal variances assumed | ,722 | ,396 | 2,260 | 336 | ,024 | 3,45931 | 1,53086 | ,44803 | 6,47059 |
| Equal variances not assumed | | | 2,268 | 335,851 | ,024 | 3,45931 | 1,52550 | ,45856 | 6,46006 |

Since α value (α: 0,024 <α: 0,05) calculated according to Table 3 is less than 0.05, there is a significant difference in the communication skills of gifted students according to gender.

**Table 4.** Communication skills for gender

| | gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| | female | 161 | 92,0186 | 13,50392 | 1,06426 |
| | male | 177 | 88,5593 | 14,54062 | 1,09294 |

Table 4 shows that communication skills of female students are higher than male students.

**Table 5.** T test for grade level

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 95% Confidence Interval of the Difference | |
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Equal variances assumed | 1,269 | ,261 | ,950 | 336 | ,343 | 2,17161 | 2,28627 | -2,32560 | 6,66883 |
| Equal variances not assumed | | | ,944 | 56,422 | ,349 | 2,17161 | 2,29973 | -2,43454 | 6,77776 |

  

As the α value calculated according to Table 5 (α: 0.34> α: 0.05) is higher than 0.05, there is no significant difference in communication skills according to grade level of gifted students.

**Table 6.** T test for school type

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 95% Confidence Interval of the Difference | |
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Equal variances assumed | ,429 | ,513 | -2,535 | 336 | ,012 | -3,87183 | 1,52715 | -6,87582 | -,86784 |
| Equal variances not assumed | | | -2,524 | 323,591 | ,012 | -3,87183 | 1,53398 | -6,88966 | -,85400 |

Since α value (α: 0,012 <α: 0,05) calculated according to Table 6 is less than 0.05, there is a significant difference in the communication skills of gifted students according to the type of school.

**Table 7.** Communication skills for type of school

| | school | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| | private | 163 | 88,2025 | 14,91505 | 1,16824 |
| | public | 175 | 92,0743 | 13,15121 | ,99414 |

When Table 7 is examined, it is seen that the communication skills of gifted students at public school are more than the gifted students at private school.

**Conclusion and Discussion**

The aim of this study was to adapt the Communication Scale developed in 2002 to Turkish and to get the opinions of gifted students to express their communication skills within the scope of quantitative questions prepared on the basis of scale items.

When the literature is examined, it is understood that gifted students would enter into a more successful education process by going into a continuous research and overcoming communication-based problems during their education process (Lang, et al., 1999). Gifted students experience an ongoing inquiry process. An inquisitive approach reflects the spirit of inquiry and inquiry of accepted truths in education (Eskicumalı, 2001).

According to a research, it has been found that there is a relationship between the scores of lifelong learning tendencies of the gifted students and the problem solving styles scale. Accordingly, it is thought that the fact that they receive more education about lifelong learning tendencies may contribute to problem solving styles in general (Dervişoğulları, 2019). Therefore, communication based trainings are one of them. It is obvious that these students can be successful in their professional lives in the future with the right education.

It has been stated that gifted students can be successful in their chosen professional fields with the right guidance (Kara, 2019). When the researches are examined, it is stated that the success of these students in different fields can be realized by gaining the right communication skills. Thanks to their communication skills, they exchange information, make friends, receive emotional support and get to know each other better. However, with the increasing dependence on mobile phones, traditional face-to-face communication has become quite difficult and bizarre for new generation students (Liu, 2019: 28).

It is easier for gifted students to overcome this situation. In fact, these students can use the new media efficiently in line with their needs (İşman & Kara, 2017). However, the effects of the learning environment and teacher roles on the learning process cannot be denied (Çelik, 2017). Therefore, it is considered necessary to prepare a supportive training program for the communication skills of gifted students.

  

In this study, communication scale adaptation developed by Barkman and Machtmes (2002) was applied to gifted students. Barkman and Machtmes tried to measure the communication skills of adolescents between the ages of 12-18. Reliability coefficient was found as .8. However, the standards range from .5 to .9 depending on the intended use and content for the scale. The internal consistency number was .79. As a result of the adaptation of the communication scale in our study, the reliability coefficient was found to be .90, which indicates that the measurement tool is suitable for measuring the communication skills of gifted students.

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**Communication Scale**

| | |
|---|---|
| 1. | Herhangi bir kişi ile konuşurken göz teması kurmaya çalışırım. |
| 2. | Söylemeye çalıştığım şeyi beden dilim ile ifade ederim. |
| 3. | Söylemek istediğim şeyi pekiştirmek için beden dilimi kullanırım. |
| 4. | Söylemeye çalıştıkları şeyi pekiştirmek için insanların ellerini kullandıklarını fark ederim. |
| 5. | Ne söylemeye çalıştığımı göstermek için ellerimi kullanırım. |
| 6. | Ne söylemeye çalıştıklarını anlamama yardımcı olması için insanların vücut dilini izlemeye çalışırım. |
| 7. | Kendi söyleyeceğimi düşünmeye başlamadan önce karşımdakinin sözünü bitirmesini beklerim. |
| 8. | Diğer insanların sözlerini kesmeden onları dinlerim. |
| 9. | Bir insanın beni sadece dinlediği fakat söylediklerimi anlamak için kulak vermediği zamanı bilirim. |
| 10. | Cevap vermeden önce kişinin ne söylediğini anladığımdan emin olurum. |
| 11. | Başkalarının ne söylediğini anladığımdan emin olmak için onların söylediklerini yeniden ifade ederim. |
| 12. | Arkadaşlarımın neler yaşadıklarını anladığımı bilmeleri için kendi tecrübelerimi kullanırım. |
| 13. | Birini dinlerken ne hissettiğini anlamaya çalışırım. |
| 14. | Başkalarının bakış açısını anlamaya çalışırım. |
| 15. | İki kişi aynı şeyi farklı şekillerde söylemeye çalıştıkları zaman bunu fark ederim. |
| 16. | Konuşma tarzımı iletişim kurduğum kişiye göre ayarlarım (arkadaş, ebeveyn, öğretmen vb.) |

| | |
|---|---|
| 17. | Beni anlamasına yardımcı olmak için karşımdakinin benimle nasıl konuştuğuna bağlı olarak konuşma biçimimi değiştiririm. |
| 18. | Söylemeye çalıştığım şeyi pekiştirmek için ses tonumu kullanırım. |
| 19. | Derdimi anlatmak benim için kolaydır. |
| 20. | İnsanlar hiç durmadan konuştuklarında sohbeti yeniden yönlendirmenin yollarını bulurum. |
| 21. | Sadece ses tonuna tepki vermek yerine karşımdakinin söylediklerine cevap vermeye çalışırım. |
| 22. | Konuşmadan önce kafamda birtakım düşünceler kurarım. |
| 23. | Birisi sinirlendiğinde sakinleşmesine yardımcı olmak için ses tonumu değiştiririm. |

  

# NON-PARAMETRIC VALUE-ADDED OF TVET HIGHER EDUCATION INSTITUTIONS IN CHILE

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**ABSTRACT**
DEA (data envelopment analysis) was used to explore the efficiency of IP and CFT institutions that provide technical and vocational training in Chile. Several inputs and outputs were included: years of accreditation (quality certification), total assets of the IP/CFT, total student enrollment, percentage of former high school students coming from public schools, charter schools, and private schools, teachers´ years of education, total number of teachers, and the infrastructure in squared meters ($m^2$). Results indicate that 15 out of 27 CFT institutions (55%) and 12 out of 31 IP institutions (38,7%) are efficient. On the other hand, 12 CFT institutions out of 27 (45%) and 19 out of 31 IP are inefficient (61,3%). There is no correlation between the accreditation awarded by the CNA (National Accreditation Commission) and the efficiency measures obtained with DEA Analysis suggesting the need to establish a measurement of quality for TVET (technical and vocational) institutions in Chile.
**Keywords:** Technical education, Higher education, Educational Efficiency.

## Introduction

Organizational effectiveness measures are common in the assessment of the impact of educational institutions around the world (Szuwarski, 2019). Such approach generally includes multiple factors or inputs and then assigns them different weights depending on their importance for organizational effectiveness (Charnes, Cooper & Rhodes, 1978). As an example, a study measured 6 conditions of productive change within schools: the institutions with a higher impact were those with vision, higher standards, focus on assessments, accountability, cooperative culture and collaboration (Gemberling, Smith, & Villani, 2000).

The core of value-added measures is getting to know the relative change in student´s skills depending on certain inputs such as teacher's contributions to individual student standardized scores (Douglas, 2011). Production functions such as the Cobb-Douglas parametric function is used to establish the added value of higher-education institutions (Dawson & Lingard, 1982). The latter relates a group of inputs with a series of outputs. The function calculates the returns to scale, which is the amount of output that will be obtained when a certain amount of inputs is used whenever inputs change proportionally (Ospina, 2017). This can represent the efficiency that institutions have regarding student learning and progress. The Cobb-Douglas function is defined by:

$$Q(L,K) = AL^{\beta}K^{\alpha} \quad \textit{Equation 1}$$

Equation 1 above indicates that a product (Q) is a function of a constant (A), an amount of labor (L) plus an amount of capital (K). Labor and Capital are raised to the power of the constant beta ($\beta$) and alfa ($\alpha$), which range between 0 and 1. They represent elasticity per each of the variables (the percentage change in the outcome variable whenever Labor or Capital change) (Maddala & Miller, 1991). In educational research, "L" and "K", would be replaced by a set of institutional variables or inputs (number of teachers, infrastructure, total enrollment, etc.).

DEA (Data Envelopment Analysis) is a technique used to establish the non-parametric added value by institutions such as schools and universities. It differs from parametric techniques because it compares an institution to their peers and it does not use a fixed benchmark and neither includes measurement error because all error in DEA is considered just inefficiency (Worthington, 2001). The term envelopment stems from the fact that the production frontier envelops a set of observations (Alfonso & Santos, 2008). DEA can be described as follows:

Decision Making Units –the target of evaluation under DEA techniques – by performing the same type of functions and having identical goals and objectives, can be understood as, for instance, firms, government bodies, non-profit institutions or even countries. When a DMU attains the optimal level of output with a given amount of inputs, taking technology as a given, we say that this DMU is technically efficient, that is, it is operating at the production possibility frontier. In opposition, when it produces less than the output that could

  

be attained with the current bundle of inputs, the DMU is said to be inefficient (Cunha & Rocha, 2012, p.8).

Education may not be fully modeled as a production function because many environmental and contextual variables have an impact in the process of teaching and learning of children and youth. For example, Astin (1991) proposes an Input-Environment-Output model in which outputs (such as degrees awarded, number of graduates, etc.) depend on inputs (for example, student ability, teaching quality, etc.) considering contexts (peers, faculty, programs). However, in the present study non-parametric added value of Technical and Vocational Education and Training institutions (TVET) is used. The aim is to account for gains in the number of graduates and retention within the first year of TVET education (outputs) by taking advantage of DEA analysis, a non-parametric value added technique. DEA has the capacity to capture the efficiency of these institutions and also serves the purpose to develop a ranking based on the efficiency index (Mizala, Romaguera, & Farren , 2002).

The goal of this paper is to provide an initial approach to the efficiency of TVET institutions in Chile. Chile is a Latin American country that has overcome economic and developmental challenges and now is part of the OECD countries (OECD, 2017). In few years, Chile has increased access to tertiary education, mainly due to TVET education (an equivalent to the American community college institutions) which reaches 44% of total enrollment in higher education (Arroyo & Pacheco, 2018). The TVET system is composed of IP (professional technical institutions) and CFT (Center for technical training/ community colleges) which completed a total enrollment of 503.772 students in 2018 (CNED, 2019). The IP awards a professional title after 4 years of technical training, while CFT award a diploma after 2,5 years. Universities can also award technical diplomas, but IP and CFT cannot provide the equivalent to a University diploma. Universities in Chile reached a total enrollment of 673.143 students in 2019.

As private education providers are increasing their offer to Chilean students, quality concerns in TVET education are raised. 70% of CFT institutions and 60% IP institutions are not quality accredited yet (see Arroyo y Pacheco, 2018). Measurements such as non-parametric value-added can help decision makers and governmental agencies to improve education for children and youth. In this article, a measure of effectiveness is presented by using non-parametric value added in TVET education. The analysis focuses on IP and CFT institutions with complete data for the 2017 academic year.

**Literature review**

Alabdulmenem (2017) studied 25 public universities and their value added to outcomes such as number of new entrants, number of enrollees, and number of graduates to these public institutions. Input variables included number of faculty and administrators. Only 15 institutions were operating with perfect efficiency. The most inefficient universities had suboptimal and less productive inputs. The first one had 1000 more administrators than the number that would make it perfectly efficient (2003 against 1907 administrators), the second institution had a perfectly efficient number of faculty and administrators (inputs) but produced less new associates enrollees. The study concludes that universities in an economic affluent country such as Arab Emirates may be sub-optimally efficient with the proper amount of inputs. Finally, the study underscores two properties of DEA, it compares equivalent DMUs (units such as universities or schools) relative to one another, and their comparison may involve several inputs and outputs, which makes non parametric measures proper to capture the efficiency of higher education institutions.

A similar study of efficiency, in Portugal, by Alfonso & Santos (2008) used DEA analysis in order to estimate a frontier to separate universities that might qualify as “performing well” from inefficient ones depending on educational spending. Inputs included the “University spending” and “number of teachers”. Outputs included “undergraduate success rate” and “number of doctoral dissertations”. The analysis concludes that in the 52 universities studied the average overall efficiency scores ranged from 0. 77 to 0.83. This means that performance was between 23 and 17 percent less efficient than it should be if it were located on the production possibility frontier.

In a study regarding school efficiency, Al-Enezi, Burney, Johnes & Al-Musallam (2010) evaluated the value added of public schools in Kuwait with DEA analysis. In this study, the output variables were the “number of students” and the “number of graduates”. Inputs included the number of teachers, administrative staff and number of classrooms. The results indicate that efficiency could be improved if inputs decreased by improving managerial practices. In addition, returns to

scale for all schools are generally increasing, suggesting that schools could be more efficient by expanding their size. The average efficiency in Kuwait in a scale 0 (inefficient) to 1(efficient), is 0.621 for kindergarten, 0.801 for primary, 0,590 for middle school and 0,718 for high school.

  

Szuwarzynski (2019) assessed the performance of 37 public Australian universities based on data from year 2015. The study includes inputs such as the "number of publications and citations", "number of completed doctoral degrees", "amount of research grants", and "percentage of science graduates·. The results provide a ranking in which the public universities score 0.50 to 1.80 in the efficiency index.

In Europe, Agasisti & Haelermans (2016) compared the efficiency of public universities finding that different incentives (funding based on outcomes or basal funding) may cause variations in performance. Output variables included: "total graduates" and "research grants". The analysis included 71 universities from the Netherlands and Italy. Results show that the cost for performance (average percent efficiency) calculated in a trans-log production function is slightly higher for Netherlands (Mean= 0,555, SD =0.08) compared to Italy (Mean= 0,534, SD =0.10). The results confirm that Dutch universities spend less money than their counterparts in transforming a student into a graduate.

Finally, in Chile, Mizala, Romaguera, & Farren (2002) estimated the parametric value added of schools in a sample of 2000 schools using data of SIMCE tests of 4$^{th}$ grade students. Several inputs were included: i) student's characteristics: including socioeconomic level, vulnerability index, ii) School characteristics: including the type of school, school size, pupil-teacher ratio, whether pre-k is provided, gender, iii) Teacher characteristics: average teacher experience. Average efficiency for these schools is 0.953, which is higher than schools in developed countries which generally exceeds 0.70. However, the authors estimated that 708 schools had below average achievement (low scores in standardized tests) and below average efficiency (calculated with DEA).

From the previous review of literature, it can be concluded that DEA analysis is generally used to account for efficiency in Universities and analysis are performed in one country at a time (except the cross country study of Agasisti & Haelermans, 2016). Analysis are also focused on institutions instead of curricular programs and TVET (technical and vocational) education has not been addressed by using efficiency analysis with DEA. The present study contributes to literature by providing an analysis of TVET institutions and their value added in the context of Chile.

## Method

### Participants

Chile has a total of 42 IP (professional) institutions and 49 CFT (Community colleges) registered. From these institutions, a sample of 27 IP and 31 CFT with complete information in all variables was used for the DEA analysis.

The sample necessary for DEA is expressed as three times the number of inputs times the number of outputs. The sample used in this study exceeds the desirable size to have enough discriminatory power (Spaho, 2015).

### Data

Data was obtained from public records from the Ministry of Education of Chile. Data regarding input variables include the following:

*Institutions with Autonomy*: IP and CFT that have completed a license process that formally enable them to provide and open new undergraduate technical programs. The Ministry of Education grants the license.

*Institutions Under Supervision*: IP and CFT which were not granted full autonomy and cannot apply for accreditation (verification of quality of programs and institutions)

*Institutions Under Licensing:* New or recent IP and CFT which are open and allowed to offer approved programs of undergraduate training.

*Years Accredited*: Years of accreditation. The process of accreditation is voluntary and it is headed by the CNA (Commission of National Accreditation) after IP and CFT undergo a process of self-assessment and external assessment of quality. The more years of accreditation granted mean that IP and CFT are better qualified to train technical and vocational students.

*Total Assets:* Total resources invested by the IP or CFT institution.

*Total Enrollment*: Total number of students enrolled in an IP or CFT institution.

  

*% of Public Schools student´s enrollment*: Percentage of students enrolled in higher technical and vocational education who were former high school students in public schools.

*% Private school student´s enrollment:* Percentage of students who were former high school students in private schools.

*Avg. Number of teachers with Bachelor degree:* Average number of instructors with a Bachelor Degree at IP and CFT institutions.

*Avg. Number of teachers with Masters*: Average number of instructors with master´s degrees at IP and CFT institutions.

*Infrastructure ($m^2$):* squared meters built in infrastructure serving IP and CFT students.

*Retention rate (first year):* percentage of students who are retained after the first year of higher education studies.

*Total Graduated students per cohort*: Number of graduated students from IP and CFT per cohort (2017).

**Procedure**

DEA analysis (Data envelopment analysis), is a non-parametric linear programing method, that uses various inputs and outputs to account for production (outputs) (Emrouznejad & DeWitte, 2010). Linear programming refers to the use of different equations and inequations, as well as restrictions that help define an optimization problem (i.e., minimize cost to improve production) and provides an efficiency scores for each institution (DMU or Unit) represented in this study by the IP and CFT institutions. Main characteristics of DEA are that it is not dependent on a functional form (i.e., linear function), it helps to compare institutions to their peers (instead of a comparison to an ideal unit), and the researcher is able to assign different weights to different productive factors (inputs).

DEA calculates efficiency as defined in equation 1, where *u* and *v* represent the weights of the outputs and inputs:

$$efficiency = \frac{u1 * (output1) + u2 * (output2)}{v1 * (input\ 1) + v2 * (input\ 2)} \quad equation\ 2$$

In order to define the weights for inputs and outputs a linear programming problem is solved per each unit or DMU (Sarmha, 2018).

$$Maximize\ for\ DMU = \frac{u1 * (output1) + u2 * (output2)}{v1 * (input\ 1) + v2 * (input\ 2)}, with\ the\ following\ constraints:$$

$$\frac{u1 * (output1) + u2 * (output2)}{v1 * (input\ 1) + v2 * (input\ 2)} \leq 1\ for\ the\ DMU1$$

$$\frac{u1 * (output1) + u2 * (output2)}{v1 * (input\ 1) + v2 * (input\ 2)} \leq 1\ for\ the\ DMU2$$

$$\frac{u1 * (output1) + u2 * (output2)}{v1 * (input\ 1) + v2 * (input\ 2)} \leq 1\ for\ the\ DMU3$$

$$u1, u2, v1, v2 \geq 0$$

In the present study DEA analysis is used to evaluate the comparative effectiveness of higher education TVET (technical and vocational training and education) institutions with their peer institutions. The analysis will inform if the use of resources (the number of students, the academic staff, the financial resources of the institutions, etc.) is according to the output produced by institutions (ranking of quality /accreditation, rate of employment, number of alumni per cohort). The analysis is based in a frontier of best practices of institutions against which the use of resources and outputs by other institutions are compared (Worthington, 2001). The method has been widely used in educational research due to its characteristics:

  

Part of the usefulness of DEA relies on the fact that, besides producing a ranking of sampled educational institutions based on efficiency measured by a technical efficiency score, it also identifies the over-use of specific resources that cause any given institution to fall where it does in the analysis, providing as well a custom list of peers for any given institution. These peer institutions are the ones to whom an administrator should look when trying to determine to what extent operational procedures might be copied – or at least learned from – in order to address the over-use of resources (Cunha & Rocha, 2012, p.3)

Another benefit of DEA is that it provides a single index number indicating the proportional reduction of inputs (or augmentation of outputs) necessary (or desirable) for an institution to reach the efficient frontier (Worthington, 2001, p. 251). However, "DEA can tell us how well we are doing compared to our peers but not compared to a "theoretical maximum" (Cunha & Rocha, 2012, p. 9) due to its non-parametric nature. In this context, CRS or "constant returns to scale" mean that DMU´s (IP and CFT institutions in the present study) are able to linearly scale the inputs and outputs without increasing or decreasing efficiency (Alfonso and Santos, 2008). Thus no matter the magnitude of the DMU (institution), it can transform their inputs to outputs (i.e., big as well as small institutions can do it).

The only downsize reported in the literature is that in DEA there are no parameter estimates for the function and hence no significance test is presented for the parameters calculated (Al-Enezi, Burney, Johnes & Al-Musallam, 2010). However, efficiency estimates in DEA can be correlated to other measurements of efficiency to test for validity (e.g., correlation between efficiency and quality accreditation as presented in this study). Also, it is important to consider the importance of inputs in relation to outputs to implement a reliable analysis (Emrouznejad & DeWitte, 2010)

**Results**

The analysis of non-parametric value added with DEA analysis encompasses a measure of efficiency of the institutions that does not depend on any functional form (e.g., linear function). The present analysis includes an initial approach to the non-parametric value added of IP and CFT institutions in Chile. Technical and Vocational Education has gained importance in Chile, a country in which higher education is available for free for low income students (up to the sixth level of income).

In the present study the first analysis encompasses a correlation of the variables included for the case of IP and CFT institutions. The second analysis, presented in Tables 2 and 3 introduces the DEA (Data envelopment analysis) or non-parametric value added for the technical and vocational institutions that currently enroll students in Chile. Table 2 includes the effectiveness of CFT institutions and Table 3 for IP institutions.

The approach is a naïve value added measure in which the effectiveness of institutions to achieve student´s on-time graduation and retention is tested. Variables include: years of quality accreditation, total assets of the IP/CFT, total student´s enrollment, percentage of former high school students coming from public schools, charter schools, and private schools, teachers´ education (percentage of teachers with a Master´s, University or Technical degree), total number of teachers, and the infrastructure in squared meters ($m^2$)

*Descriptive analysis*

Table 1, includes the descriptive statistics of the sample of CFT and IP institutions grouped by total enrollment. The first and second panel in table 1 represents the varying size of IP and CFT institutions. They include IP institutions with total enrollment under and above 3191 students (the median number of students for the full sample). The second panel includes two groups of CFT institutions with total enrollment under and above 861 students.

The smaller IP and CFT institutions are autonomous and they are accredited (recognized as quality institutions) for an average of years ranging from 0.15 to 1.5 years (maximum accreditation is 7 years). They vary in total assets, being the CFT not as economically affluent as the IP institutions. Total enrollment is also higher in small IP institutions but CFT are accepting more public high school graduates (44%) compared to IP (31%). Also, CFT institutions have less teachers with Bachelor (5.3 teachers in average) and Master`s degrees (0.8 teachers in average). The retention rate is above 50% for IP and CFT, but the graduation is low compared to total enrollment in both small IP and CFT institutions.

  

**Table. 1**
*Groups of Chilean TVET institutions and total enrollment.*

| Inputs/Outputs | Small IP (Professional Institutions) Total Enrollment under 3191 students | Small CFT (Community Colleges) Total Enrollment under 861 students |
|---|---|---|
| Institutions with Autonomy | 22 IP | 12 CFT |
| Institutions Under Supervision | 1 IP | 3 CFT |
| Institutions Under Licensing | 2 IP | 4 CFT |
| Years Accredited | 1.52 years | 0.15 years |
| Total Assets | $3.171.878 | $96.535 |
| Total Enrollment | 2840 students | 277.8 students |
| % of Public Schools student | 31% | 44% |
| % Private school students | 13% | 8% |
| Avg. Number of teachers Bachelor | 46.78 | 5.3 |
| Avg. Number of teachers Masters | 12.52 | 0.85 |
| Infrastructure ($m^2$ built) | 5277 $m^2$ | 2454 $m^2$ |
| Retention rate (first year) | 64% | 58% |
| Total Graduated students per cohort | 920 | 77 |
| Inputs/Outputs | Larger IP (Professional Institutions) Total Enrollment above 3191 students | Larger CFT (Community Colleges) Total Enrollment above 861 students |
| Institutions with Autonomy | 6 IP | 19 |
| Institutions Under Supervision | 0 IP | 0 |
| Institutions Under Licensing | 0 IP | 0 |
| Years Accredited | 4.1 years | 2.68 years |
| Total Assets | $57.775.302 | $9.180.567 |
| Total Enrollment | 49478 | 6861 |
| % of Public Schools student´s enrollment | 40% | 45% |
| % Private school student´s enrollment | 2,9% | 2% |
| Avg. Number of teachers with Bachelor | 473 | 110.65 |
| Avg. Number of teachers with Masters | 101.94 | 24.4 |
| Infrastructure ($m^2$ built) | 161.329 $m^2$ | 8214 $m^2$ |
| Retention rate (first year) | 69% | 64% |
| Total Graduated students per cohort | 8960 | 1509.4 |

Larger IP and CFT have full autonomy granted by the Ministry of Education to provide undergraduate technical programs and they have an average of 2 to 4 years of quality accreditation. Total assets are higher for IP institutions compared to CFT. As in the small size group of institutions, IP are larger in total enrollment but CFT accept more public high school students. Also, IP have more resources (infrastructure, teachers with bachelor and master´s degrees) compared to CFT´s. The retention rate is around 60% and the total graduate students per cohort are 8960 in IP and 1509 in CFT which is a low rate compared to total enrollment.

*Graphical Representation of outcomes*
Figures 1 and 2 represent the relation between inputs and outputs used in the data envelopment analysis performed. A few IP institutions show higher total assets and higher graduation rates compared to CFT institutions which score lower in graduation rates but have a higher percentage of public school students (figure 1).

Figure 2 displays the retention of first year students in both IP and CFT institutions. A few IP institutions have more assets compared to the CFT institutions. CFT with larger assets also have more impact on the graduation rate of students. CFTs tend to have more students who come from public high schools. In summary, CFT show higher retention in the first year compared to IP, but IP tend to have more graduates and this can be related to institutional characteristics such as less enrollment of public highs school students and higher assets.

  

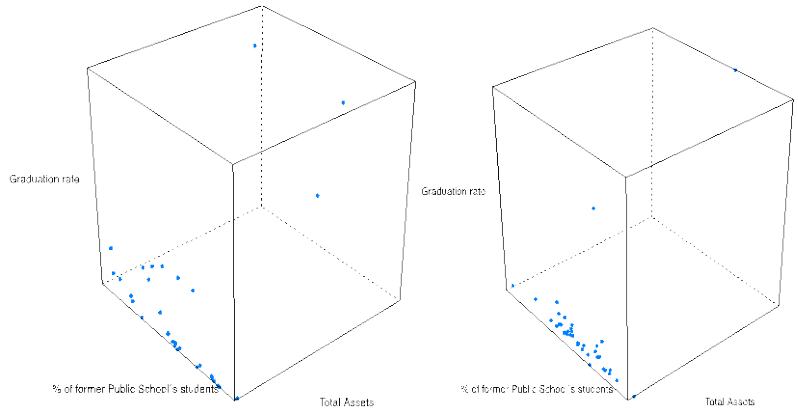


*Figure 1.* Graduation rate as an outcome of total assets and % of former Public school students enrolled. IP is represented on the left and CFT institution on the right cube.

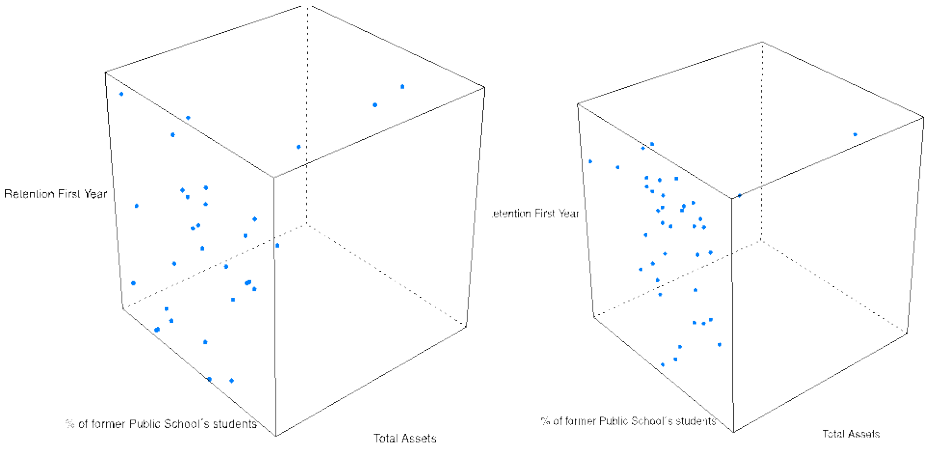


*Figure 2.* Retention per year as an outcome of total assets and % of former Public school students enrolled. IP is represented on the left and CFT institution on the right cube.

*DEA Analysis.*

The software R and the package "DEA" were used to calculate the efficiency of each IP and CFT institutions. The efficiency is presented in table 2 (for CFT institutions) and 3 (for IP institutions). Each institution was identified with a unique "ID " number and the efficiency value (theta) is displayed in a scale from 0 (inefficient) to 1 (efficient).

The DEA (Data Envelopment Analysis) includes the units for which data was complete in the databases open to the public by the Ministry of Education. The first analysis shown in table 2, indicates that 15 out of 27 CFT institutions (55%) are efficient reaching a coefficient of 1. On the other hand, 12 institutions out of 27 could improve their efficiency (45%). Regarding IP, 12 out of 31 institutions are efficient (38,7%) and 19 out of 31 institutions are inefficient (61,3%). It is important to notice that the present study has used only two outcome variables that may not fully tap onto the definition of "quality". However, it is a first approach to implement the non-parametric value- added measurement in TVET institutions in Chile.

The efficient CFTs in table 2 (panel 1) differ in the number of years accredited as high quality institutions (ranging from 0 to 7 years), they also vary in size (total enrollment of students ranging from 38 to 50423 students) and infrastructure (from 200 $m^2$ to more than 10.000 $m^2$) and they tend to have a higher proportion of public education enrollees (reaching up to 60% of students) and a short proportion of students coming from private high schools (up to 9%). For efficient CFT the average retention rate is 65% and the average graduation rate is 1695 students per cohort (with a range between 12 and 12000 students)

  

The efficient IP`s in table 3 (see panel 1) include institutions that vary in size (total enrollment varies from 88 students to 100.200 students). These institutions vary in the proportion of public high school students (from 4% to 57%) and they are staffed with more educated teachers compared to effective CFTs (where the number of master´s degree teachers range from 1 to 540). For effective IP, retention reaches in average 68% and graduation is around 3808 students (with a range between 12 and 22696 students).

Further steps in DEA analysis are finding out the excesses or the lack of resources that make an institution inefficient (panel 2 in tables 2 and 3). In order to estimate the causes of inefficiency the multipliers were calculated. They are the outcome of multiplying the lambda values (obtained per institution in the DEA analysis) times the value of each input. The lambdas are the values of input variables that restrict the constraints limiting the efficiency of each unit to be no greater than 1. When the multipliers are calculated for all IP and CFT, all outcomes are 0. This means that is not excess or lack of resources that impact efficiency, but efficiency could be increased with the current resources in IP and CFT institutions.

  

**Table 2.**
Efficiency in CFT Institutions (Efficient CFT displayed in panel 1, Inefficient CFT in panel 2) (n= 27 CFT)

| *ID* | 534 | 241 | 782 | 285 | 236 | 312 | 701 | 390 | 374 | 280 | 498 | 536 | 367 | 260 | 430 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Efficiency*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** | ***1*** |
| ***Autonomy*** | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| ***Accredited*** | N | N | N | N | N | N | Y | N | N | N | Y | Y | Y | Y | Y |
| ***Years Accredited*** | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 3 | 5 | 3 | 7 |
| ***Enrollment*** | 38 | 39 | 50 | 52 | 60 | 844 | 879 | 903 | 1399 | 2951 | 2994 | 3088 | 5461 | 37972 | 50423 |
| ***%Public*** | 0,261 | 0,061 | 0,313 | 0,640 | 0,370 | 0,573 | 0,221 | 0,345 | 0,326 | 0,494 | 0,500 | 0,564 | 0,642 | 0,443 | 0,396 |
| ***%Charter*** | 0,739 | 0,091 | 0,479 | 0,360 | 0,556 | 0,374 | 0,622 | 0,558 | 0,586 | 0,481 | 0,404 | 0,428 | 0,341 | 0,498 | 0,495 |
| ***%Private*** | 0,000 | 0,848 | 0,000 | 0,000 | 0,037 | 0,004 | 0,097 | 0,028 | 0,023 | 0,004 | 0,013 | 0,006 | 0,002 | 0,017 | 0,034 |
| ***Retention*** | 0,480 | 0,813 | 0,735 | 0,496 | 0,704 | 0,725 | 0,651 | 0,525 | 0,459 | 0,678 | 0,569 | 0,796 | 0,766 | 0,680 | 0,702 |
| ***Graduation*** | 12 | 12 | 49 | 94 | 9 | 355 | 253 | 558 | 533 | 482 | 779 | 721 | 1016 | 7853 | 12624 |
| ***Magister*** | 0,545 | 0,000 | 0,727 | 0,000 | 0,000 | 9,527 | 0,568 | 1,659 | 0,455 | 12,500 | 10,114 | 4,409 | 0,523 | 80,446 | 322,481 |
| ***Professional*** | 0,932 | 1,818 | 2,182 | 0,477 | 0,545 | 25,94 | 12,864 | 23,318 | 10,639 | 66,023 | 51,795 | 20,705 | 66,22 | 658,255 | 843,351 |
| ***Technical*** | 0,523 | 0,000 | 0,545 | 0,386 | 0,818 | 0,143 | 2,114 | 3,523 | 1,241 | 0,364 | 7,591 | 0,659 | 1,545 | 75,714 | 135,794 |
| ***total teachers*** | 2,341 | 1,818 | 3,455 | 0,864 | 2,636 | 40,62 | 15,614 | 28,591 | 12,580 | 79,614 | 71,000 | 26,068 | 70,13 | 826,382 | 1379,100 |
| ***$m^2$*** | 220 | 1500 | 7765 | 1923 | 200 | 763,6 | 2511,6 | 8214 | 14616,56 | 16474 | 5689,8 | 14224 | 1735 | 204480 | 345966 |

| *ID* | 427 | 492 | 273 | 591 | 691 | 305 | 319 | 229 | 398 | 382 | 261 | 307 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Inefficiency*** | ***0.27*** | ***0.33*** | ***0.44*** | ***0.52*** | ***0.53*** | ***0.57*** | ***0.58*** | ***0.61*** | ***0.65*** | ***0.81*** | ***0.84*** | ***0.93*** |
| ***Autonomy*** | Y | Y | N | Y | Y | Y | Y | N | N | Y | Y | N |
| ***Accredited*** | N | N | N | N | N | N | N | N | N | N | N | N |
| ***Years Accredited*** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Enrollment*** | 600 | 223 | 451 | 73 | 169 | 77 | 333 | 74 | 554 | 157 | 533 | 130 |
| ***%Public*** | 0,598 | 0,442 | 0,537 | 0,250 | 0,543 | 0,529 | 0,944 | 0,411 | 0,527 | 0,223 | 0,572 | 0,174 |
| ***%Charter*** | 0,335 | 0,558 | 0,454 | 0,327 | 0,449 | 0,221 | 0,049 | 0,375 | 0,438 | 0,568 | 0,401 | 0,678 |
| ***%Private*** | 0,002 | 0,000 | 0,000 | 0,000 | 0,000 | 0,250 | 0,007 | 0,161 | 0,019 | 0,151 | 0,005 | 0,074 |
| ***Retention*** | 0,589 | 0,333 | 0,500 | 0,699 | 0,703 | 0,466 | 0,676 | 0,375 | 0,660 | 0,500 | 0,528 | 0,458 |
| ***Graduation*** | 28,000 | 44,000 | 84,000 | 9,000 | 17,000 | 35,000 | 80,000 | 5,000 | 158,000 | 19,000 | 279,000 | 9,000 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Master`s*** | 0,000 | 0,000 | 0,182 | 0,000 | 0,250 | 0,000 | 0,000 | 0,000 | 1,500 | 0,886 | 0,500 | 0,341 |
| ***Professional*** | 8,091 | 2,045 | 7,795 | 4,750 | 3,614 | 2,636 | 3,273 | 1,040 | 6,909 | 4,227 | 11,000 | 1,864 |
| ***Technical*** | 2,909 | 1,841 | 0,841 | 1,341 | 0,000 | 0,773 | 0,000 | 0,443 | 0,136 | 2,182 | 1,545 | 3,659 |
| ***Total teachers*** | 12,023 | 3,886 | 8,818 | 6,091 | 3,864 | 3,409 | 3,273 | 1,483 | 8,682 | 7,295 | 13,205 | 5,864 |
| ***$m^2$*** | 3424 | 5892 | 2120,59 | 5637 | 960 | 1825 | 877 | 454 | 1518 | 959 | 4438,88 | 913,58 |

**Table .3**
Efficiency in IP Institutions (Efficient IP displayed in panel 1, Inefficient IP in panel 2) (n=31 IP)

| **ID** | **714** | **767** | **99** | **676** | **126** | **176** | **139** | **155** | **152** | **117** | **143** | **111** | **137** | **101** | **108** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Efficiency*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***1.0*** | ***0.90*** | ***0.88*** | ***0.81*** |
| ***Autonomy*** | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| ***Accredited*** | N | N | Y | Y | Y | N | Y | N | Y | N | Y | Y | N | N | N |
| ***Years Accredited*** | 0 | 0 | 5 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 5 | 7 | 0 | 0 | 0 |
| ***Enrollment*** | 88 | 152 | 586 | 764 | 3292 | 4809 | 8571 | 9568 | 11462 | 13105 | 95914 | 100219 | 676 | 371 | 324 |
| ***%Public*** | 0,108 | 0,104 | 0,333 | 0,044 | 0,446 | 0,612 | 0,505 | 0,332 | 0,576 | 0,526 | 0,439 | 0,275 | 0,138 | 0,428 | 0,191 |
| ***%Charter*** | 0,205 | 0,385 | 0,548 | 0,313 | 0,500 | 0,338 | 0,371 | 0,569 | 0,370 | 0,402 | 0,478 | 0,610 | 0,654 | 0,407 | 0,631 |
| ***%Private*** | 0,675 | 0,481 | 0,013 | 0,642 | 0,009 | 0,006 | 0,019 | 0,021 | 0,011 | 0,029 | 0,024 | 0,054 | 0,158 | 0,010 | 0,134 |
| ***Retention*** | 0,673 | 0,792 | 0,876 | 0,768 | 0,470 | 0,476 | 0,777 | 0,596 | 0,845 | 0,529 | 0,697 | 0,815 | 0,671 | 0,510 | 0,473 |
| ***Graduation*** | 12 | 14 | 58 | 128 | 4843 | 3517 | 2628 | 3452 | 1739 | 667 | 22696 | 17377 | 121 | 102 | 37 |
| ***Master`s*** | 3,273 | 1,500 | 2,386 | 8,159 | 13,614 | 8,795 | 91,295 | 27,106 | 14,932 | 126,477 | 70,250 | 540,864 | 7,477 | 0,614 | 4,409 |
| ***Professional*** | 10,864 | 4,705 | 11,500 | 21,068 | 62,295 | 110,628 | 108,614 | 132,084 | 149,614 | 221,250 | 1626,932 | 1410,477 | 14,955 | 5,636 | 5,614 |
| ***Technical*** | 1,227 | 0,000 | 0,795 | 14,023 | 2,750 | 2,434 | 9,523 | 4,505 | 21,795 | 4,318 | 226,318 | 181,455 | 0,682 | 0,455 | 0,000 |
| ***teachers*** | 18,864 | 6,409 | 15,159 | 44,568 | 78,841 | 122,648 | 213,182 | 163,696 | 200,568 | 356,364 | 1925,318 | 2165,636 | 23,795 | 6,705 | 10,023 |
| ***$m^2$*** | 945 | 845 | 4858,52 | 3725 | 46663 | 9491 | 27157,1 | 34744,59 | 8906 | 2182 | 146411 | 228227 | 1226 | 1201,850 | 1110 |

| ***ID*** | **171** | **144** | **129** | **193** | **120** | **116** | **183** | **123** | **162** | **132** | **103** | **106** | **100** | **165** | **104** | **693** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Inefficiency*** | ***0.30*** | ***0.35*** | ***0.41*** | ***0.42*** | ***0.42*** | ***0.44*** | ***0.44*** | ***0.49*** | ***0.49*** | ***0.50*** | ***0.56*** | ***0.57*** | ***0.60*** | ***0.63*** | ***0.68*** | **0.77** |
| ***Autonomy*** | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| ***Accredited*** | N | Y | Y | Y | N | Y | N | Y | Y | Y | Y | N | Y | N | Y | N |
| ***Years*** | 0 | 4 | 4 | 3 | 0 | 3 | 0 | 4 | 3 | 3 | 5 | 0 | 6 | 0 | 3 | 0 |
| ***Enrollment*** | 1182 | 3198 | 987 | 1022 | 2671 | 24132 | 1181 | 26134 | 1088 | 3191 | 4291 | 4532 | 37361 | 4799 | 1813 | 383 |
| ***%Public*** | 0,274 | 0,267 | 0,191 | 0,300 | 0,478 | 0,456 | 0,290 | 0,389 | 0,286 | 0,321 | 0,383 | 0,493 | 0,371 | 0,544 | 0,139 | 0,127 |
| ***%Charter*** | 0,583 | 0,593 | 0,516 | 0,562 | 0,436 | 0,480 | 0,585 | 0,539 | 0,607 | 0,566 | 0,531 | 0,445 | 0,514 | 0,402 | 0,720 | 0,479 |
| ***%Private*** | 0,027 | 0,099 | 0,283 | 0,106 | 0,018 | 0,021 | 0,079 | 0,009 | 0,017 | 0,018 | 0,014 | 0,020 | 0,042 | 0,007 | 0,026 | 0,380 |
| ***Retention*** | 0,437 | 0,758 | 0,619 | 0,710 | 0,445 | 0,681 | 0,673 | 0,720 | 0,504 | 0,696 | 0,736 | 0,435 | 0,753 | 0,657 | 0,751 | 0,678 |
| ***Graduation*** | 32 | 282 | 50 | 177 | 744 | 3659 | 260 | 3736 | 161 | 588 | 1159 | 911 | 5624 | 169 | 262 | 42,000 |
| ***Master´s*** | 7,082 | 7,659 | 2,778 | 2,886 | 3,500 | 77,411 | 1,364 | 20,881 | 2,352 | 17,273 | 17,341 | 15,932 | 205,825 | 34,341 | 14,727 | 2,409 |
| ***Professional*** | 42,468 | 51,818 | 48,733 | 13,318 | 52,818 | 423,610 | 11,114 | 254,267 | 13,318 | 62,614 | 62,750 | 29,795 | 523,619 | 114,477 | 20,773 | 8,091 |
| ***Technical*** | 4,339 | 5,409 | 3,261 | 2,818 | 6,682 | 21,834 | 2,477 | 43,295 | 3,466 | 0,114 | 5,136 | 0,114 | 76,437 | 1,682 | 0,000 | 0,068 |
| ***Teachers*** | 55,355 | 75,227 | 60,392 | 19,091 | 63,000 | 531,052 | 15,227 | 321,205 | 20,000 | 80,091 | 85,909 | 46,000 | 857,911 | 153,568 | 38,295 | 15,386 |
| ***m²*** | 6017,61 | 8832,00 | 6118,0 | 3015,00 | 12553,4 | 189116 | 4623 | 64373 | 2420 | 5872 | 14519 | 5277 | 337666 | 16474 | 4188 | 1590 |

*Correlation analysis.*
The correlation between the effectiveness obtained with DEA analysis and the years of accreditation (a proxy variable of institutional quality) was $r$ =-0.123 for IP institutions and $r$ =0.0729 in the analysis for CFT institutions. This indicates that the accreditation of quality may not be a precise measure of the efficiency of institutions. In the case of IP institutions, the relationship is negative and small in magnitude. On the other hand, the relation is positive but close to 0 in the case of CFT institutions, meaning no strong relationship between the measurements exists.

**Discussion**
It is important to notice that the efficiency measure obtained in the present study relates to two outcomes (retention and graduation), excluding all others such as employability, satisfaction of students, relationship with other institutions or applied research. Other outcomes may provide a bigger picture of the quality of IP and CFT institutions.

DEA analysis has the advantage that efficiency is calculated regarding other institutions that are similar in inputs to obtain certain outcomes. Thus the non-parametric approach allows a more precise estimation of the value-added by an institution.

In the present study we did not have access to outcomes such as student grades or any other measure of achievement. However, the analysis was carried with retention of first year students and the graduation rate as outcomes. Although these measures may not be sufficient to account for the quality of institutions, they are a first approach to measure quality in the context of Chilean TVET institutions.

One of the shortcomings of the present study is the difficulty to provide a finer analysis including TVET curricular programs instead of institutions. However, the approach used enabled us to compare institutions with varying characteristics and the data on inputs and outputs is reliable and rich (it was obtained from the Ministry of Education in Chile).

The findings of the present study indicate that IP and CFT institutions have a retention rate above 50%, but the graduation is low compared to total enrollment in both small and large IP and CFT institutions. Also, CFT show higher retention in the first year compared to IP, but IP tend to have more graduates than CFT. Although there is varying composition in the student body and institutional resources, IP tend to be more affluent and enroll more students while CFT tend to have less resources and a larger share of public school students. This finding is interesting because despite public funding for higher education is now devoted to low income students (in the form of full scholarships) resources in TVET do not match those for Chilean CRUCH Universities (a selective group or “ivy league” universities) which are 6 times higher according to Arroyo & Pacheco (2018).

DEA analysis indicates that 15 out of 27 CFT institutions (or 55%), and 12 out of 31 IP institutions (or 38,7%) are efficient, whereas 12 CFT institutions out of 27 (45%) and 19 out of 31 IP are inefficient (61,3%). This is a large proportion of inefficient institutions. It is striking that the DEA analysis indicates that there is not a lack or excess of resources in inefficient institutions but a need to improve outcomes (graduation and retention) with the current inputs. The analysis shows that the number of graduated students does not match the total enrollment and retention in TVET institutions (slightly above 50%). The analysis also reveals that efficient CFT have an average retention rate of 65% and the average graduation rate is 1695 students per cohort. For efficient IPs, retention reaches in average 68% and student graduation is equal to 3808 students.

Finally, the correlation between the years of accreditation and the efficiency (theta) calculated in the present study (DEA Analysis) means no strong relationship between the measurements. This may mean that quality can be defined in different ways, however, non-parametric analysis such as DEA may help understand the inefficiencies in context. This because IP and CFT are compared to each other instead of being compared to a standard based on mean values or ideal values. Also, DEA permits to include several input variables to account for the efficiency of IP and CFT institutions.

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**Syntax**

```
# DEA
library(readr)
DAE_IP <- read_csv("~/Desktop/DAE IP.txt")
View(DAE_IP)

library(rDEA)
IP<-1:31
Y<-DAE.IP[IP,c("TituladosPregrado2017", "Retencionprimerano")]
X<-DAE.IP[IP,c("matriculatotal", "anosacredita", "Municipal","mconstruidos")]

di_naive = dea(XREF=X, YREF=Y, X=X[IP,], Y=Y[IP,], model="input", RTS="variable")
write_csv(di_naive, file = "deaIP")
```

  

```
CFT<-1:38
X<-DAE.CFT[CFT,c("matriculatotal", "anosacredita", "Municipal","mconstruidos")]
Y<-DAE.CFT[CFT,c("TituladosPregrado2017", "Retencionprimerano")]

di_naive1 = dea(XREF=X, YREF=Y, X=X[CFT,], Y=Y[CFT,], model="input", RTS="variable")

write.csv(di_naive1, file = "deaCFT")

#Generate new database with Multipliers (lambda values * variable values for inefficient IP/CFT)

CFTmultipliers<-merge(DAE.CFT,CFTconstant) ## Merges original database “DAE.CFT” with the output of “dea” analysis which we renamed as “CFT constant” to produce a dataframe in which lambda (multipliers) and theta opt (inefficiency) values are included

CFTmultipliers1<-as.data.frame(CFTmultipliers)
view(CFTmultipliers1)

CFTmultipliers1$M1<-CFTmultipliers1$lambda.1*CFTmultipliers1[,1]

View(CFTmultipliers1$M1)


#Graphics

## 3d plots of variables (x,y,z)

install.packages(car)
install.packages("car")
install.packages("lattice")
install.packages("scatterplot3d")
install.packages("rgl")
Library(lattice)

cloud(DAE.CFT$TituladosPregrado2017~ DAE.CFT$Patrimonio.total+ DAE.CFT$Municipal, xlab = "Total Assets", ylab = "% of former Public School´s students", zlab= "Graduation rate", main= "Non-parametric Added Value Chilean Colleges 2018", pch= 16,par.settings= par.set,Groups= DAE.CFT$ID,plot=TRUE, aspect= c(1,1),panel.aspect= 1)

 cloud(DAE.IP$Retencionprimerano~ DAE.IP$Patrimonio.total+ DAE.IP$Municipal, xlab = "Total Assets", ylab = "% of former Public School´s students", zlab= "Retention First Year", main= "Non-parametric Added Value Chilean Professional Institutes 2018", pch= 16,par.settings= par.set,Groups= DAE.IP$ID,plot=TRUE, aspect= c(1,1),panel.aspect= 1)
```

  

# TEAM FORMATION AND GROUPING PROBLEM FOR GRADUATION PROJECTS

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**ABSTRACT**
The aim of this study is to develop an assignment system for Graduation Project Group Formation (GPGF). In the Faculty of Engineering, Cyprus International University (CIU), students from different departments are forming interdisciplinary project groups depending on the requirements of the proposed project. Current assignment method is causing problems like students can be assigned to project where their knowledge on specific courses required by that project is very limited or the ones that they don't want to study. These two reasons can decrease the quality of the project. Another problem is the group setup, where the attitude of the students and their personal characteristics affects the performance of the team. In this study, an assignment methodology is being designed, which considers students characteristics (behavior) and academic performance to achieve team harmony and improve quality of the graduation projects. An assignment algorithm is formulated for assigning students to the graduation projects.
**Keywords:** Personal Behavior, Team formation, Assignment algorithms

## 1. INTRODUCTION

This paper pertaining assignment problem within the education domain. Assignment problem arises in diverse situations, where problem involves the allocation of resources or people to enable jobs or tasks to be performed satisfactorily. In this study, information of students and project requirements are recorded in a database. It can be accessed via a website. Students are asked to fill a questionnaire that determines their personal characteristics. Instructors and the project coordinators will use the website for project description and requirements entry.

Designed assignment algorithm assigns students according to their personal characteristics and their academic performances. Groups should have students with openness, conscientiousness, emotional stability, agreeableness and extraversion characteristics to achieve a balance for heightened performance of the group. At the same time, group member's knowledge on project topic should be above acceptable level. In this paper, assignment algorithms, collected personal characteristics, project requirements and future work have been discussed.

### 1. 1 Assignment Problem

According to Andrew J. W. (2007), this type of problem involves the allocation of resources or people to enable jobs or tasks to be performed satisfactorily. In our study, problem is classified as a problem where each student will be assigned (become a group member) to one single Graduation Project.

### 1.2 Group Allocation Problem

Group allocation problem is categorized into three sub problems by Andrew J. W. (2007).

**The New Student Allocation Problem (NSAP):** The new student allocation problem (NSAP) is a clustering problem in allocating new students to their corresponding class with minimum intelligence gap by sorting method.

**Student Project Allocation Problem (SPAP):** This is related to assigning a person to a particular project or cases based on performance and preference or interest of student and lecturer.

  

**Space Allocation Problem (SAP):** This refers to a problem to allocate resources to space areas, for example, allocating rooms and at the same time satisfying several requirements and constraints.

### 1.3 Solution Techniques

In addition to algorithm for finding feasible and optimal assignments to groups, in literature Mathematical modeling and Metaheuristics algorithms are also been used.

Mathematical Modeling is translating of problems from an application area into tractable mathematical formulations whose theoretical and numerical analysis provides insight, answers, and guidance useful for the originating application.

Metaheuristic is a higher-level procedure or heuristic designed to find, generate, or select a heuristic (partial search_algorithm) that may provide a sufficiently good solution to an optimization problem, especially with incomplete or imperfect information or limited computation capacity. (Kallrarth, 2014).

## 2. METHODOLOGY

In this research designed methodology could be summarized in 3 steps.

1. Project descriptions obtained from instructors
2. Attributes of students will be collected
   - Academic Attribute: grades of students will be obtained from Registrar
   - Behavioral Attribute: students were asked to fill a questioner
3. Assignment algorithm will be run to assign students to projects

### 2.1 Project Description

Project Supervisors are asked to fill the Project Description Form on the web site, as seen in figures 1, which contains:

- Project description: fully describe the objective and requirements of the project.
- Number of students and departments
- Requirements courses for the project for every student (discipline related departmental courses).

| **Project Title** | **The Team Formation Problem for Graduation Project Selection** |
|---|---|
| **Project Summary:** | |
| **Project Requirements:**<br>**It is vital that instrumentation, experimental equipment, computer software etc, be functional at the start of the project. Please indicate your requirements as follows:-** | |
| i) Equipment service/repair calibration etc. | ---------- |
| ii) Technician effort prior to project | ---------- |
| iii) Technician effort during the project | ---------- |
| iv) Visits for data collection off-campus | ---------- |
| v) Materials & other consumables | ---------- |

Student Requirements

| Program | Course 1 | Course 2 | Course 3 |
|---|---|---|---|
| INDE | | | |
| INDE | | | |
| CMPE/ISE/MIS | | | |

Figure 1: Project Description Form

### 2.2 Attributes Classification and Questionnaire

There are two major attribute classifications for each student, the Academic attribute and Behavioral attribute. The Grade attribute places students in categories base on their performances and departmental courses they have taken while the behavioral attribute deals with the physical and emotional behavioral state of students.

  

Emotional state of humans mostly determines their actions in certain activities. For example, if a certain student has issues of 'quick to anger', other students will have issues working in groups with them. The best way to handle people like this is to pair them with students who can tolerate such behavior and do not have similar emotions, which is students that are not easily provoked or those who are slow to anger. The behavioral attribute can further be broken down into five sub-categories.

**2.2.1 Academic Attribute**

Performance of the student in their departmental courses is defined as Academic attribute. In CIU Engineering Faculty, there are ten departments and for each department ten departmental courses have been selected which are used by students in their graduation projects. For determining Academic attribute, letter grade of students have been entered for courses they passed. Following table contains list of those departments and selected departmental courses.

Table 1: Departmental Course List

| DEPT. | Course 1 | Course 2 | Course 3 | Course 4 | Course 5 | Course 6 | Course 7 | Course 8 | Course 9 | Course 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Civil Eng.** | CVLE 262 | CVLE 222 | CVLE 212 | CVLE 351 | CVLE 331 | CVLE 332 | CVLE 381 | CVLE 361 | CVLE 372 | CVLE 341 |
| **Industrial Eng.** | INDE204 | INDE212 | INDE232 | INDE372 | INDE441 | INDE221 | INDE321 | INDE341 | INDE352 | INDE433 |
| **Electrical Eng.** | EELE362 | EELE324 | EELE321 | EELE342 | EELE234 | EELE212 | EELE202` | EELE262 | EELE221 | EELE212 |
| **Petrol, Oil and Gas Eng.** | MCLE 270 | ENRE 404 | ENVE 202 | EELE342 | MCLE 476 | ENRE 405 | ENRE 402 | EELE234 | MCLE 371 | INDE352 |
| **Computer Eng.** | CMPE 214 | CMPE 226 | CMPE 213 | CMPE 242 | CMPE 313 | CMPE 314 | CMPE 381 | CMPE 361 | CMPE 372 | CMPE 331 |
| **Bioengineering** | BIOE213 | BIOE401 | BIOE112 | BIOE308 | BIOE252 | BIOE252 | BIOE305 | BIOE101 | BIOE361 | BIOE302 |
| **Environmental Eng.** | ENVE 343 | ENVE 104 | ENVE 201 | ENVE 202 | ENVE 206 | ENVE 305 | ENVE 301 | ENVE 402 | ENVE 411 | ENVE 431 |
| **Energy Systems Eng.** | ENRE 315 | ENRE 404 | ENRE 308 | ENRE 403 | ENRE 306 | ENRE 403 | ENRE 402 | ENRE 405 | ENRE 302 | ENRE 303 |
| **MIS** | MIS479 | IT102 | ITEC101 | WP101 | ISE100 | ISE464 | MIS479 | MIS402 | WP102 | ISE400 |
| **Mechanical Eng.** | MCLE 222 | MCLE 270 | MCLE 475 | MCLE 212 | MCLE 372 | MCLE 445 | MCLE 476 | MCLE 303 | MCLE 312 | MCLE 371 |

As defined in the Project Description Form, students who took required course for a project will become a candidate for that project. One among those candidate students will be assigned to that projects by the Assignment Algorithm.

**2.2.2 Behavioral Attribute**

The Big Five personality traits are Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. These five factors are assumed to represent the basic structure behind all personality traits (John M. & Grohol P. 2019).

1. **Openness**: students in this category are open to others, they share ideas and are always open to new experiences, which will guarantee that they will agree to work with other people's ideas and methods. Two or more can be placed in the same group.
2. **Conscientiousness:** conscientious people tend to be efficient and organized. They are mostly dependable. They are people who will not want to participate much in a group work, as they will always want to work singly. Though they might be hardworking, they cannot be put as group leaders. Maximum of two in a group.
3. **Extraversion**: Extraversion people enjoy being around people more than being alone. They get their energy from being around others, so they tend to be more sociable. People in this category will be good leaders if appointed, as they will always try to bring the group together. Two or more can be placed in a group.
4. **Agreeableness**: High scorers for this trait are often trusting, helpful and compassionate. This checks if an individual will relate easily with other group members, especially strangers. Two or more can be placed in the same group.

  

**5. Emotional stability**: People with high scores for this trait are usually confident and do not tend to worry often, they can be appointed as group leaders because they are mostly focused. Though focused, they will always want to be in charge of every group activity. Not more than one in a group.

Table 2: Behavioral Attribute Questionnaire

| No | QUESTION | EXPLANATION |
|---|---|---|
| 1 | Will you love to work on topics from other departments? | The answer to this question will help narrow down topic selection to the topic the student is interested in, which will increase the student's participation in the group work. (**TOPIC PREFERENCE**) ***Agreeableness.*** |
| 2 | Do you prefer working in a large or small group of people? (from 1 for very small to 10 for very large) | This question will help in placing students in topics with large or small group of participants. **(GROUP NUMBER PREFERENCE)** ***Conscientiousness.*** |
| 3 | Do you prefer telling people what to do or prefer being told what to do? (from 1 for being told what to do to 10 telling people what to do) | This will help pick out those who want to be leaders and want to control their groups so they can be distributed evenly to get all group works done. **(GROUP LEADER PREFERENCE)** ***Emotional stability.*** |
| 4 | How deep do you like group work? | This will give idea on how members love group work. **(LOVE FOR GROUP WORK)** ***Openness.*** |
| 5 | How deep do you participate in a group works? | This will give full idea and help categorize students on level of group work participation. **(MEMBERS PARTICIPATION)** ***Extraversion*** |
| 6 | At what level (1 – 10) will you like to help other group members do their own part of work? | This will how members who can help other group members to make sure the group work is completed. **(DEDICATION TO COMPLETION)** ***Emotional stability.*** |
| 7 | In estimation, how many group works have you participated in? (from 1 to 10 or more) | This will give the level of experience individuals have in a group work **(GROUP WORK EXPERIENCE)** ***Extraversion.*** |
| 8 | How much time can you dedicate to your group work? (from 1 to 10 or more) | This will point out those who will put full effort in achieving the goal of the group work. **(GROUP WORK DEDICATION)** ***Emotional stability.*** |
| 9 | Do you know how to lead people in a group work? (from 1 for no experience to 10 for very experienced in leader people) | This question will help point out those who can and will want to control a group work **(GROUP LEADER SELECTION)** ***Emotional stability.*** |
| 10 | Do you love to meet new people? (from 1 for don't like meeting new people to 10 for love meeting new people) | This will show students who won't mind working with anyone, not necessarily friends **(FAMILIARIZATION/MEMBERS ACCEPTANCE)** ***Openness.*** |
| 11 | Among this three, which will you classify as your attitude towards others. Polite(P), Neutral(N), Rude(R) | This will tell the way of approach of group members towards each other. |

Measuring scale used in the questioner is from 1 to 10, 1 being very poor and 10 being very good.

- Questions 4 and 10 are used to check students Openness → Score must be > 7 to be qualified in this group.
- Questions 1 and 6 are used to check students Agreeableness → Score must be > 6 to be qualified in this group.
- Questions 2, 5 and 7 are used to check students Extraversion Score must be > 7 to be qualified in this group.
- Questions 3 and 11 are used to check students Conscientiousness. Score must be > 8 to be qualified in this group.
- Questions 8 and 9 are used to check students Neuroticism. Score must be > 6 to be qualified in this group.

## 3. ASSIGNMENT ALGORITHM

### 3.1 Assignment Algorithm

The grouping of students and assignment of projects depend on the characteristics of that project such as course requirements and the constraints that must be followed.

  

In the case here, students are to be assigned into group's base on their characteristics, which was obtained using a questionnaire and then assigning project topics to those groups. To achieve successful placements, we tried to ***maximize the benefits*** of each student and followed some constrains which gave us the possibility of grouping and placement.

**3.2 Algorithm Steps**

1. Project topics from different departments are been saved in the system with their departmental and course requirements.
2. The system will pick a non-assigned topic from list of topics.
3. Then pick students from table of required department that have not yet been assigned topics.
4. Then the system will check the sum of their scores on the required courses for that project topic.
5. The student with the highest sum will be selected and assigned to that project topic.
6. The whole process will repeat itself until number of students required for that topic is reached.
7. The loop continues until all students and topics have been assigned.

**3.3 Database Requirements and Constraints**

- A list of students is saved in database according to their departments and their departmental course grades.
- Each department has its identification number. E.g. computer engineering is department number '5'.
- All project topics are saved using their numbers in the database e.g. project 1 = 1, project 2 = 2 … project 20 = 20.
- A sample of a saved project topic with its complete requirement will look like this: 3((5,1,5), (2,2,6), (2,2,6), (10,3,7)), topic number 3 requires courses '1' and '5' from department number 5, courses '2' and '6' from department number 2, courses '2' and '6' from department number 2 and course '3' and '7' from department number 10.
- Grades are out of 4 depending on the letter grades, which are from (A (4) to D (1))

Table 3: letter Grade to Point Table

| NO | LETTERS | POINTS |
|---|---|---|
| **1** | **A** | **4** |
| **2** | **A-** | **3.7** |
| **3** | **B+** | **3.3** |
| **4** | **B** | **3** |
| **5** | **B-** | **2.7** |
| **6** | **C+** | **2.3** |
| **7** | **C** | **2** |
| **8** | **C-** | **1.7** |
| **9** | **D+** | **1.3** |
| **10** | **D** | **1** |
| **11** | **D-** | **0.7** |
| **12** | **F** | **0** |

- Score for empty course is zero (0). (Courses that student have not taken yet) for students who failed a course or might have been delayed for some reason.

**Students List Tables (table i)**

**P.NO. = Project Number GIVEN**
**C1 = Course 1**
**S.NO = Student Number**

Table 4: table showing how unselected students will appear

| CMPE(5) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.NO** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** | **P.NO.** |
| 1234 | 1 | 2.3 | 1 | 3.7 | 4 | 2 | 1.7 | 2 | 1.3 | 2 | 0 |
| 2345 | 3.7 | 2 | 1 | 2 | 4 | 3 | 1 | 3.7 | 1 | 2 | 0 |
| 3456 | 1.7 | 2 | 1.7 | 4 | 2 | 2.7 | 1 | 2 | 2.7 | 3.3 | 0 |
| 4567 | 2.7 | 2 | 1 | .3 | 4 | 2 | 3.7 | 3 | 1 | 2 | 0 |

**3.4 Selection Method**

"Select project topic to be given to students"
Project '3' selected which has the following requirements
3(, (5,1,5), (2,2,6), (2,2,6), (10,3,7)).

  

**3.4.1 Requirement Explanation**

- One student from CMPE (5) department who is good in 'database' (1) and 'visual programming' (5).
- Two students from IENG (2) department who are good in 'modelling and optimization' (2) and 'operations research' (6).
- One student from MIS (10) department who is good in 'web development' (3) and 'web design' (7).

**3.5 Pseudo code**

Default point score before selection of project topic is '0'
Default Course max = 0
y = (y1, y2, y3, … yn) "number of students"
k = (k1, k2, k3, …, k10) "for 10 departmental courses"
x = "department"
j = "students in group"
i = groups = (i1, i2, i3, …, i20)
z = "project assigned"
For Project (i, j, k)
Group = i1(j1, j2, j3, j4)
Find =j1(x, y1, z12)
If j1(x, y1, z12) ≠ 0
Skip y1.
Else If j1(x,y1,z12) = 0
Sum Course points = y1(k1 + k2)
If (k1 +k2 = course max)
Δ course max = course score y1
Else If (k1 + k2 > course max)
Δ course max = course score y1
Else If (k1 + k2 < course max)
Course max = course max
End
End when yn = y15
Assign project 'i1' to yn (course max)
End when "j" = 4
**End when "i" = 20.**

  

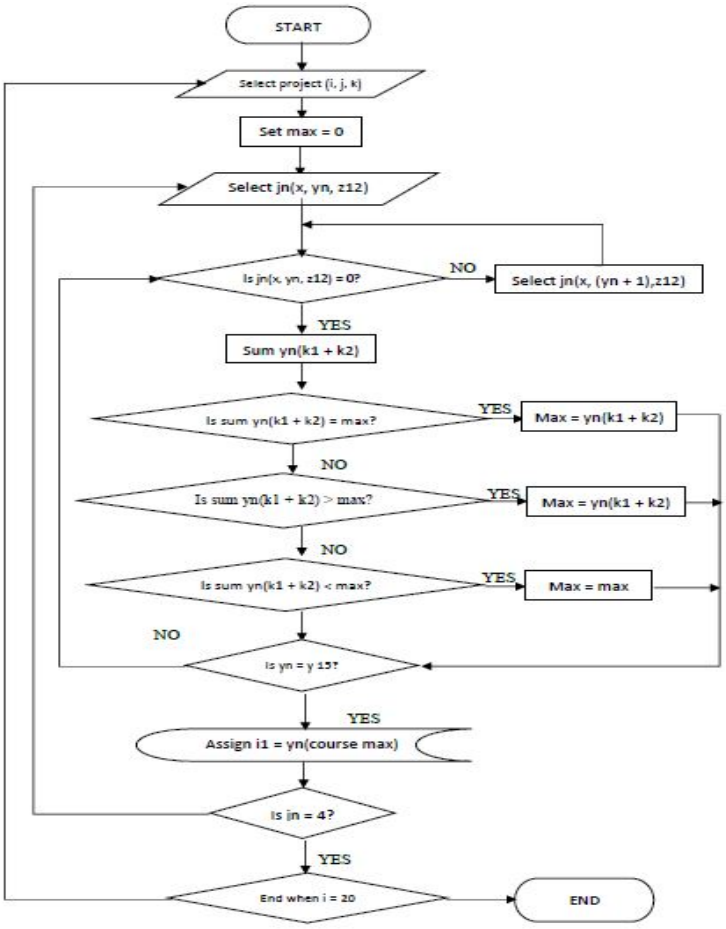


Figure 2: Algorithm Flow Chart

"Table below will show how selected students will appear in their departmental table after selection."

**P.NO. = Project Number**
**C1 = Course 1**
**S.NO = Student Number**

Table 5: How a Selected Student will appear

| CMPE(5) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.NO** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** | **P.NO.** |
| 1234 | 1 | 2.3 | 1 | 3.7 | 4 | 2 | 1.7 | 2 | 1.3 | 2 | 0 |
| **2345** | **3.7** | **2** | **1** | **2** | **4** | **3** | **1** | **3.7** | **1** | **2** | **3** |
| 3456 | 1.7 | 2 | 1.7 | 4 | 2 | 2.7 | 1 | 2 | 2.7 | 3.3 | 0 |
| 4567 | 2.7 | 2 | 1 | .3 | 4 | 2 | 3.7 | 3 | 1 | 2 | 0 |

## 4. WEBPAGE INTERFACE

The programming tools used in creating the webpage are CSS3, Java Script, PHP, my SQL and HTML 5, though PHP being the core programming language used. Below are some of the properties in which we brought into consideration during our webpage development.

- User Friendly
- Clarity
- Responsive
- Efficiency
- Consistency

The system is developed as a webpage to increase ease of access and reachability to all parties (students and lecturers).

### 4.1 Welcome Page

This page is the welcome page in which a user will see when he or she enters the webpage link. The welcome page contains information about the webpage, the student login and the lecturer login.

  

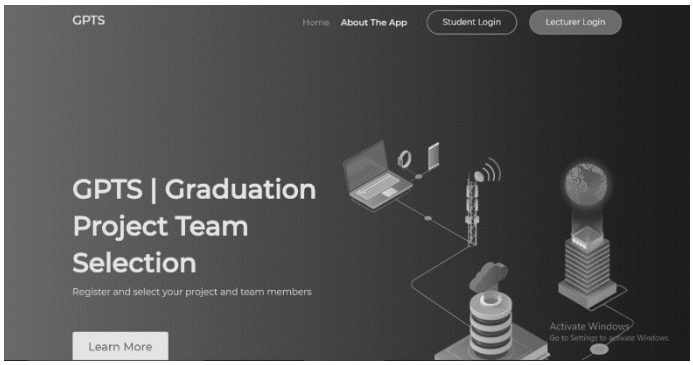

Figure 3: Welcome/Home Page

**4.2 Login Page**

The student login page is where the students go to login to the webpage. The username and password of all students is the same with the one of their school portal. Which means there is no need to create a username or password and the same implies to lecturer login.

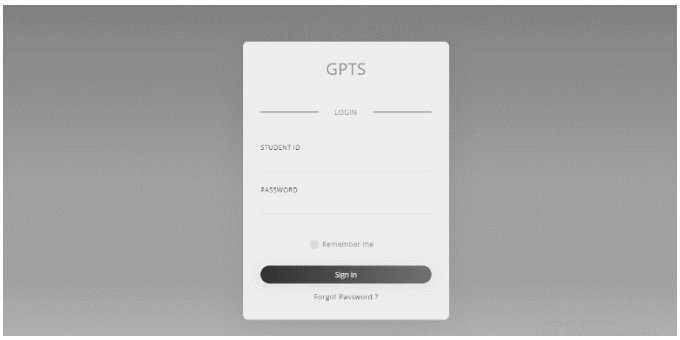

Figure 4: Login Page

**4.3 User profile**

This page is the display of all the information of the user such as name, email address, home address etc. the user profile is also taped from students/lecturers school profile, therefore having the exact information as the individual's school profile.

Figure 5: User Profile

**4.4 Topic proposal**

This page is where students go to propose or suggest a topic. This page is a suggestion page for the students. They can suggest or propose topics they feel are important and also should be included in the list of project topics. The student suggesting the topic will write the name of his or her topic and also provide the topic description and requirements.

  

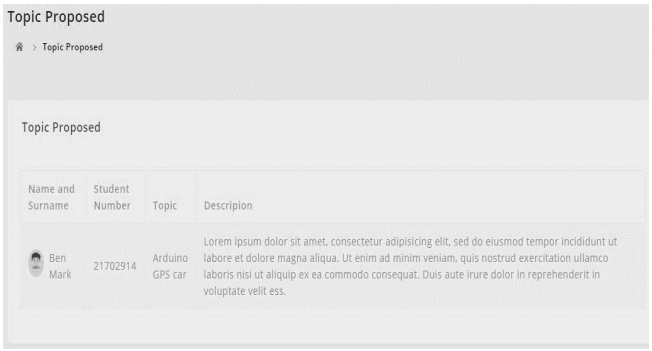


Figure 6: Topic Proposed by Student

**4.5 Lecturer page**

Lecture login page contains the same information as the student login page. A student cannot login on the lecturer's login page and vice versa. The lecture profile contains the following pages:

**4.6 List of students**

This page displays the list of students with their grades from departmental courses only. Since the matchmaker makes use of only their departmental courses, the profile will hold only their departmental courses, in which the grades will be scanned and used during matchmaking.

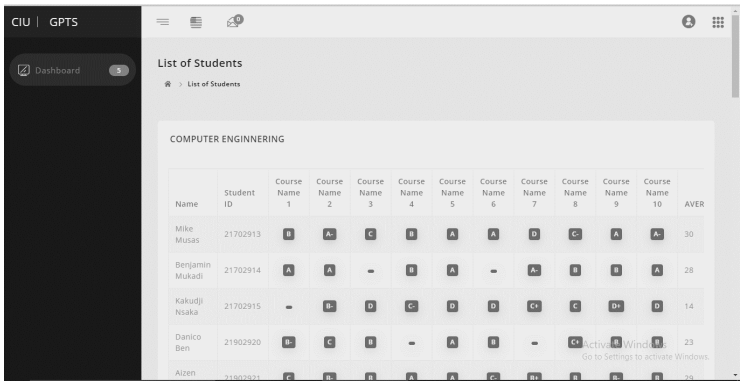


Figure 7: List of Students with Grades

**4.7 Matching Page**

This generates and creates groups for all the students in the system. The Matching page is the most important page in the system as it holds the major responsibility of the system, which is generating and pairing of students into groups. First, student's information and grades of their departmental courses are stored in the system. When the generate button is clicked, the system runs the algorithm shown in chapter three and then automatically pairs students according to their requirements. After generating the groups, it displays all students in their groups, tagging them to their proposed topics. The matching page is easy to operate, as it requires just a click of a button to generate the groups.

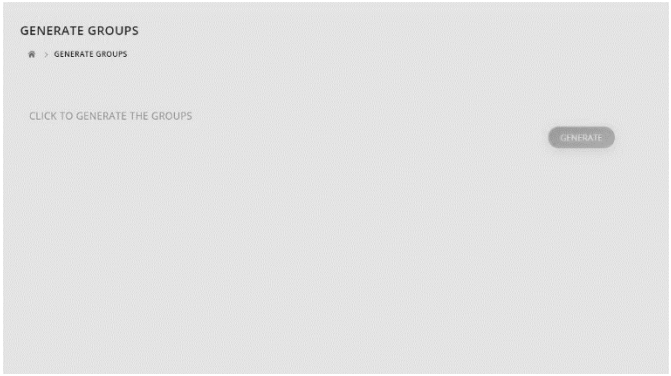


Figure 8: Matchmaker before Matching

  

## CONCLUSION

Although the solution to group placement was not an optimal one, but a feasible and usable solution to project grouping problem was developed. In this study only academic performance of students had been used for group assignment which will ease the allocation of project topics to students and team member's selection. A general methodology is been designed on how the Graduation Project Group assignments can be done in the CIU Faculty of Engineering. Personal characteristics which are defined as Behavioral attribute needs further study because of the validity check. After that, Behavioral attributes will be added to the developed assignment algorithm and achieve a balance in team member's ability, and maximize the effort or every group member.

As a future work inclusion of Behavioral attributes will need better algorithmic method, which may require use of Multi-objective optimization techniques and Metaheuristics for finding optimal group assignments.

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# THE IMPORTANCE OF RISK MAPPING IN OPEN AND DISTANCE LEARNING: A CONTEPTUAL FRAMEWORK FOR MEGA UNIVERSITIES

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**ABSTRACT**
Open and Distance Learning (ODL) is the learning environment for digital natives who were born and grew up in digital landscape. As ODL is dependent on technology, it can't be deprived of the risks that lightning fast developing new technologies pose. Every new technology comes along with new risks that have to be managed within the scope of ODL environment. Risk mapping is a risk analysis tool that visualize the risks that can be found out during initial planning phase of risk management process. It is usually presented with a two-dimensional matrix that helps defining the risks. This study aim to show usefulness of risk mapping for ODL institutions, especially in mega universities.
**Keywords:** Open and Distance Learning, Risk Mapping,

## INTRODUCTION

Open and Distance Learning (ODL) is quickly turning into an acknowledged and key piece of the standard of educational frameworks in both developed and developing countries. Especially in developing countries, this growth trend was triggered by web-based technologies. And ODL provides numerous opportunities for developing countries to reach their educational objectives (Unesco: 2002). Open and Distance Learning (ODL) is the learning environment for digital natives who were born and grew up in digital landscape.

As ODL is dependent on technology, it can't be deprived of the risks that lightning fast developing new technologies pose. Every new technology comes along with new risks that have to be managed within the scope of ODL environment.

### Risk mapping

Risk mapping is a risk analysis tool that visualizes the risks that can be found out during initial planning phase of risk management process. It is usually presented with a two-dimensional matrix that helps defining the risks. It is simply a list that includes all risk related to each other. It helps you to identify the risks in terms of probability and level of effect.

  

| Probability | Threats<br>Risk Score = Probability x Impact | | | | | Opportunities<br>High (RED) / Med (YEL) / Low (GRN) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.90<br>Very Likely | 0.05 | 0.09 | 0.18 | 0.38 | 0.72 | High | High | High | Med | Low |
| 0.70<br>Likely | 0.04 | 0.07 | 0.14 | 0.28 | 0.56 | High | High | Med | Med | Low |
| 0.50<br>Possible | 0.03 | 0.05 | 0.10 | 0.12 | 0.40 | High | High | Med | Low | Low |
| 0.30<br>Unlikely | 0.02 | 0.03 | 0.06 | 0.12 | 0.24 | High | Med | Med | Low | Low |
| 0.10<br>Very Unlikely | 0.01 | 0.01 | 0.02 | 0.04 | 0.08 | Med | Low | Low | Low | Low |
| | 0.05 | 0.10 | 0.20 | 0.40 | 0.80 | Very High | High | Med. | Low | Very Low |
| | Example Impact Definitions – May Be Tailored to Each Project Objective<br>Impact on an Objective (e.g. Cost, Schedule, Scope, Quality) | | | | | | | | | |

Figure 1: Sample Risk Mapping Graph

**METHOD**

An inductive methodology was adopted, comprising two discrete elements: documentary and conceptual analysis. According to Thomas (2006), the purposes for utilizing an inductive methodology are to consolidate information into a short outline design; build up clear connections between research objectives and findings. Furnet (2004) discusses that Conceptual analysis is a technique that treats ideas as classes of objects, events, properties, or relationships. The method includes absolutely characterizing the importance of a given idea by distinguishing and determining the conditions under which any element is grouped under the idea being referred to.

**Importance of visualization**

In today's global economy and society, if anyone is asked about present situation or future related issues regarding companies, countries and societies, you will be told that there is disturbance, uncertainty (Haksöz, 2016). That is why, overseeing and communicating risks has turned into a skill which is urgent for economy and society. When the cognitive and communicative nature of human beings is considered, Visualization has the absolute advantage in assessing and understanding the risks. Maybe, that explains why many forms of diagrams and mapping methods are in use of daily business life (Eppler & Aeschimann, 2009). As Hahn et al (2007) discusses that In their study, they have found the proof that when the risks are visualized, it is usually better at showing risks than simple text explanations. Accordingly, Rahl (2003) points out the need for risk reports that are simple and understandable. He thinks that these kind of reports can maximize value for beneficiary.

The primary advantage of visualization of risk is clarity (Eppler & Aeschimann, 2009). When it is "clear and simple", it can be fully understood by stake holders that share the risks (Cutter, 2008). During risk management process, risk visualization plays an important role not only for risk managers but also other stakeholders (Eppler & Aeschimann, 2009). Horwitz (2004 ) thinks that risk visualization can be "a key competent" for understanding the risks.

**Importance of risk mapping at mega universities**

A new type of university that is called mega university appeared 30 years ago. There are 57 mega universities in 25 countries (Berberoğlu & Berberoğlu, 2015) and the number seems likely to increase along with the demand in ODL environments. Mega universities are higher education institutions most of which are open universities that has more than 100,000 students (Rogers, 2009). Definition of mega university holds three criteria: Distance Learning, Higher Education and size (Daniel, 1996). Because of its size, it holds enormous educational, economic and logistical difficulties while serving a very large number of students (Latchem et. al, 2006). With its massive and complex structure, mega universities can be assumed as they are open to risks more than conventional higher educational institutions since they are dependent on technology that is developing with overwhelming speed. That speeds also change and shape the society along with educational trends. That is why, mega universities should take on the risk to survive in the age of uncertainty. In terms of sustainability and manageability, it is usually the best to manage risks in a simple way. From that point of view, risk mapping may be assumed as a convenient risk management tool for mega universities.

  

## FINDINGS

When *Google Books NGram Viewer* is used to show the trend for the key words "risk mapping" and "mega universities" in the corpus books in English during 1960–2008, you get the Figure 2.

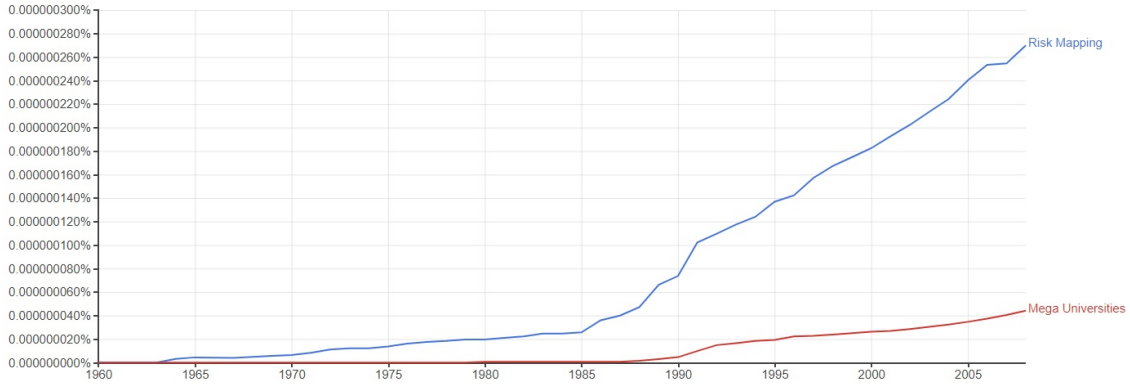


**Figure 2 Google NGram Viewer results for "risk-complexity-uncertainty" in the *Corpus of English Books* (1960–2008).**

It clearly shows that although the use of "Risk Mapping" and "Mega Universities" is increasing, the occurrence of "risk mapping" is increasing much faster, especially after the 1990s. Moreover, to our knowledge, there are no scientific studies to date that examine the visualization of risks at mega universities. These findings shows that there is not enough empirical data for risk management at mega universities

### Quality assurance and risk management

Although quality assurance and risk management might seem like different study topics, they are highly interrelated because in an enterprise, how can we implement quality assurance procedures without considering proper risk management process? In a risk aware institution or enterprise, quality assurance is made sure by assessing probable risks while using proper tools that are usable by everyone. Hence, it can be said that risk mapping tool made available to be used by every department at a mega university is an asset in terms of quality assurance procedure and risk management process.

## CONCLUSIONS

This study adopts an inductive approach to develop a framework summarizing perceptions of what constitutes 'successful' integration of risk mapping tool at mega universities. It tries to explain why visualization of risks is important at mega universities by using risk mapping assessment tool. After reviewing literature and framing a concept; it concludes that for sustainability and quality assurance issues, it might be crucial to take advantages of risk visualization.

As Daniel (1996) emphasizes the mega-universities are an important resource for the future so it is vital to strengthen them. After the revolution these institutes created within the scope of higher education, it is very important that mega universities sustain their presence in ODL environments. If they can't manage the risk in a simple way, it will be nonsense to talk about educational equity.

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