Classroom design attributes: An investigation of staffs' and students' preferences

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ABSTRACT – This exploratory research utilizes interviews and online survey collected from staffs and students and examines on how lecturers and students perceive effective classroom design attributes at the University of Nottingham Malaysia Campus. The studies were carried out among students and staffs from all the faculties namely Engineering, Science, Arts and Social Science. The findings demonstrate how several classroom design attributes relate naturalness, individualization and simulation to students' learning experience. In addition, this research highlights the importance of conducting assessment on classroom redesign initiatives to justify and improve classroom spaces conducive to future generation of students.

1. INTRODUCTION

The design, facilities and conditions inside a classroom play significant role in ensuring both lecturers and students experience the best teaching and learning environment, respectively [1]. Literature studies have indicated several design attributes that affect these aspects namely naturalness, individualization and stimulation as described in Table 1 [2].

Table 1 Classroom design attributes.

Design principles	Attributes
Naturalness	Light, sound, temperature, air quality
Individualization	Choice, flexibility, connection
Stimulation	Complexity, colour, texture

Barret et al. [2] investigated the above attributes for primary school students (UK). Current investigation was conducted to collect information among undergraduate students and lecturers at the University of Nottingham Malaysia Campus to determine the key attributes affecting undergraduate classroom design.

2. METHODOLOGY

The studies were carried out at the University of Nottingham Malaysia Campus involving students and lecturers from the Faculty of Engineering, Science and Art and Social Science. It consisted of two parts namely a survey interview to identify the key attributes and an online survey. In Part 1, the interview consisted of 20 students and 11 lecturers (voluntary participants) from various academic backgrounds such as Science, Engineering and Arts & Social Science. During interview, the interviewees were asked about their opinions/comments on their teaching/learning experience in classroom, possible improvement, special requirement in classroom and concept of an ideal classroom etc. All interviews were transcribed and coded using NViVo software (ver. 10 released 2012, QSR International).

In Part 2, an online survey was created based on the feedbacks from part 1. Several key design attributes were identified, and an online survey form was created using Qualtrics software (Qualtrics Int., USA). A total of 374 students participated in the online survey. The survey consisted of 50 questions where the participant needs to rate based on categories such as 'Strongly Disagree', 'Somewhat Disagree', 'Neither agree nor disagree', 'Somewhat Agree' and 'Strongly Agree'.

3. RESULTS AND DISCUSSION

Analyses of interviewees' answers in Part 1 confirmed the design attributes as proposed by Barrett et al. [2]. Outcomes from the survey show the following design parameters frequently raised from the interviewees such as (i) Quality and user-friendliness of equipment, (ii) Flexibility of furniture, classroom layout and equipment, (iii) Level of naturalness of the learning environment and (iv) Classroom decoration, especially in terms of walls colours.

However, among the three design principles, individualisation and naturalness seemed to be more important than stimulation as described by both lecturers and students. For example, although wall's colour was mentioned several times during interview, but it was not emphasized as an important attribute. Lecturers preferred plain, light, bright and white colours with minimal décor while students preferred more colourful walls and do not need to be white colour all the times. These very different preferences (lecturers vs students) could be due to generational gap as the current generation of students are more exposed to technology

and requires more stimulating environment [3,4].

Based on the above findings, an online survey questionnaire was developed, and 374 students responded. Key findings are as summarized in Table 2 for questions with more than 80% rating.

Table 2 Key findings from online survey.

Question	Agreed & strongly agreed
a) Blinds and/ or curtains should be present, of good quality, in good condition and easily accessible, so that the natural lighting level can be controlled manually.	91%
b) There would be a good sound isolation system, so that noise from the corridors and the outdoor areas would be eliminated.	94%
c) The shape/size of the classroom is such that I can hear the lecturer clearly wherever I am seated.	94%
d) The air conditioning should not be centralized; students and lecturers can decide the ideal temperature is in each lecture.	83%
e) Classroom should be adapted to various learning activities.	84%
f) Classroom should have ergonomic and comfortable furniture.	87%
g) The facilities available in the classroom should be well maintained.	95%
h) The desks/chairs should be comfortable, ergonomic and suitable for both left- and right-hand users.	89%
i) There should be more sockets or ports for electrical device/ laptop.	81%

Based on the above findings, it can be seen that students demanded several attributes such as follows:
   a) Access to natural lighting/air conditioning which is controllable.
   b) Good soundproof system.
   c) Good classroom layout that enable students to hear/see clearly during lecture.
   d) Flexible classroom equipped with ergonomic/comfortable furniture.
   e) Well maintained facilities.
   f) Classroom equipped with more sockets/ports for electrical devices.

4. CONCLUSION

The studies clearly indicate the needs to improve and take into consideration of key classroom design attributes in future. This is to fulfil the needs of both lecturers and students and also to improve the teaching and learning experience.

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Enhancing classroom engagement through web-based interactive tools

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ABSTRACT – Technology has seen a recent widespread integration into teaching environments in view of generation Z of students whom has grown up with technology all around them. The study was carried out by conducting online surveys among students from foundation in engineering and undergraduate from Department of Chemical and Environmental Engineering. It examined how students perceive the effectiveness of Web-Based Interactive Tools (WIT) at the University of Nottingham Malaysia (UNM). Key findings demonstrated that the WIT tools were helpful in retaining student interests and encouraged engagement in learning. In addition, this research highlighted the importance of using WIT tools to foster students' engagement and enriched the quality of student learning in the classroom.

1. INTRODUCTION

Under the University of Nottingham's Global Strategy 2020, with mission to provide high quality education to students, UNM needs to consolidate and strengthen the teaching quality in order to address the changing expectations from students. It is time to change the ways of teaching to align to the values and learning styles of these new learners, especially Generation Z, which grown up with ubiquitous access to information technology and internet. Generally, the prevalent weakness of typical teaching style at UNM is the overwhelm emphasis on lectures where there is a paucity of two-way interaction between learners and teachers. Laurillard [1] considers the learning process as a kind of conversation and asserts that this process 'must be constituted as a dialogue between teacher and student (or student and student) and operating at the level of description of actions in the world' (see Figure 1). In alignment with the concept proposed by Laurillard, the web-based interactive tool could address the above weak point in a generic way that principally can help in every subject.

Personal response system that was offered by web-based interactive tools could allow students in a class to contribute an anonymous response to the questions queried by the lecturer, providing immediate feedback on the aggregated class responses via Open Ended Questions or Multiple-Choice Questions (MCQ), all of which increase interactivity in lectures for all audience sizes, can use this in any way expressible.

Literatures [2-6] reported the pedagogical benefits of using web-based interactive tools (WIT) in classroom, such as:

(a) It encourages collaborative learning, which allow students to share information easily and provide opportunity to partake in lesson
(b) It makes responses/feedbacks anonymous and this encourages more participations from students
(c) It helps to address a variety of learning styles among students where the learning process fits individual requirements
(d) It helps knowledge retention instead of just listening to lectures in conventional classroom
(e) The tools are user friendly. All they (students) need is a device that can be connected to the internet (e.g. smartphone/tablet).
(f) It makes learning process fun and enjoyable. It can boost engagement and motivation in the classroom.
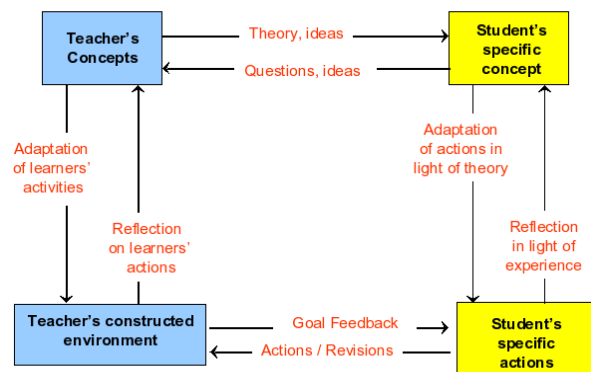

Figure 1 The Laurillard's conversational model [1].

Therefore, seeing the benefits of WIT, the present study aimed to assess the effectiveness of various WIT in enhancing student engagement in class. The main objectives are as follow:

(a) To explore and assess the features and reliability of selected WIT.
(b) To evaluate and analyse the student engagement activities when using WIT in class.
(c) To compare and measure the effectiveness of WIT versus conventional teaching.

2. METHODOLOGY

The studies were carried out at the University of Nottingham Malaysia involving students from Foundation in Engineering and undergraduate from Department of Chemical and Environmental Engineering. Three types of WIT, namely Padlet, Kahoot

and Socrative, were explored and evaluated using an online survey. These tools are easy to access and can be downloaded free of charge from the internet. Features of these tools could range from canvas (where users can write their opinions/answers anonymously), clicker (provides instant feedback from students), quizzes/survey and flowchart/diagram/graph. These interactive tools were applied in selected teaching modules from the foundation/undergraduate studies as well as intermediate and advanced level according to Bloom's taxanomy. Observations will be made in class to measure the response of students qualitatively, when these tools are used in the classroom. Students were also invited to fill up survey questionnaires at the end of class to obtain students' feedbacks on the use of WIT versus conventional classroom teaching. The online survey, consisting of 11 questions, was designed using Likert type questions using scale from 1 (strongly disagree) to 5 (strongly agree), and was created using Qualtrics software (Qualtrics Int., USA). Statistical analyses will be carried out using SPSS software upon data collection. Cronbach's alpha test was performed to check the reliability of survey questions, with an alpha value of > 0.70 signifying a good reliability in the results.

3. RESULTS AND DISCUSSION

A total of 396 students have participated in this survey. From the total study population, 44% of respondents were from Foundation in Engineering and 56% from Department of Chemical and Environmental Engineering students. The breakdown of the students were shown in Figure 2.
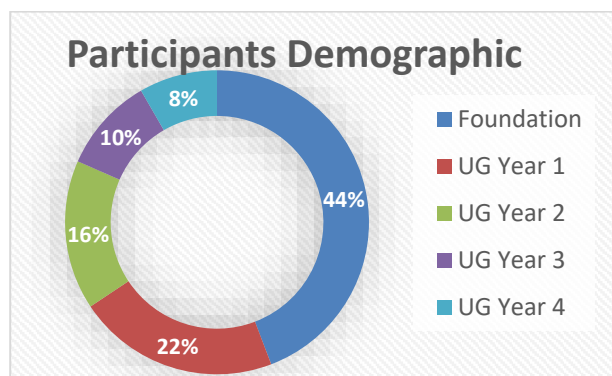

Figure 2 Participants Demographic, where UG: Undergraduate.

Key findings from the survey are summarized in Table 1.

The points below showed some additional feedback obtained from the students regarding the use of WIT (comments are posted as received).

(a) Padlet is a great way to communicate with the lecturer during class time without having to interrupt his/her teaching flow as they can check padlet when they are ready to address the questions or comments. The fact that it is anonymous as well encourages more people to use it and not be shy. I hope more classes incorporate this sort of communication tool.

(b) This WIT should be used in all module, to have more interaction with student, create a lively

class & make students more enthusiast be present

(c) It's fun and a really interactive way of learning as well as being innovative.

(d) I think WIT made the learning process more fun and it made my understanding of the subject better. It engaged me to do better every time so i would study the content after class so i could get a better score every time.

(e) WIT is really an interactive tool and i feel that lectures are made fun through WIT as everyone can actively engage in the learning process. Personally I feel that Kahoot is a really nice tool and it has seen that a lot of lecturers start to appreciate WIT.

Table 1 Key findings from online survey.

Questions	(% Agree & strongly agree)
1. I think the WIT tool is easy to use.	84.1
2. I could focus in every item/question in the WIT activities.	68.7
3. WIT has made the lecture/class more fun and engaging.	85.1
4. WIT has motivated me to learn in the classroom.	64.5
5. WIT has made me keen to participate more in the classroom.	76.8
6. WIT activities has improved my understanding in the covered topic.	65.8
7. WIT activities has enhanced my thinking and problem solving skills.	63.5
8. WIT activities has encouraged me to continue study even after the lecture class.	50.9
9. I think I will attend the class more often if WIT activities is implemented in this course.	61.9
10. I think the lecturer has conveyed his/her enthusiasm for the course through the WIT activities.	79.9
11. I wish these WIT activities are used in other courses as well.	74.4

Additionally, the usage of WIT was mentioned in a Learning Community Forum (LCF) of the Department of Chemical and Environmental Engineering in October 2018, with comment stated: *"Wall for offline communication (padlet.com) is very useful for students not comfortable with speaking aloud; students suggest implementing a similar concept in other lectures to increase interactivity and student engagement."* Based on the findings above, results showed that:

(a) > 70% students agreed WIT help them in

classroom response system (Q1, Q3, Q5, Q10, Q11).

(b) 50% - 70 % students agreed WIT bring a lot of interaction to the classroom (Q2, Q4, Q6, Q7, Q8, Q9).

The collated results had also showed a good reliability, with a Cronbach alpha value of 0.919 among the questions. Majority of students enjoyed the competitive/interactive nature of the WIT and comment that it helps them retain knowledge and actively engage in learning. Classroom should be a fun place and lecture should be engaging.

4. CONCLUSION

This work concludes that WIT tools helped to engage students and improve students learning experience at UNM. With the implementation of WIT, we could provide a more conducive learning environment for students. Students will be more proactive and engaged with the lecturers in their learning. This will ensure their knowledge retention in a more effective way and could improve the students' academic performance significantly.

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MyMUET – An interactive crowdsourced Malaysia University English Test online learning application

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Keywords: MUET; crowdsource; education

ABSTRACT - This paper presents MyMUET, a proposed interactive Online Learning for MUET Examination with crowdsourcing assessment. The design of MyMUET was the result of data collection from ninety one participants and a subject matter expert, an English lecturer. The advantages of MyMUET includes crowdsourced peer-to-peer assessment which are found to be highly correlated with instructor assessment and demonstrate strong inter-rater reliability.

1. INTRODUCTION

Recent technologies in education support the use of crowdsourcing for the purpose of creating education contents, provide practical experience for learners, exchanging complementary knowledge and provide evaluation for learner [1]. Crowdsourcing for education is defined as a type of online activity in which an educator, or an educational organization proposes to a group of individuals via a flexible open call to directly help learning or teaching [2]. Actors involved in crowdsourcing includes both human and non-human actors and may be divided into four roles: organizers, learners, contributors, and information technology platforms [3]. This paper shall propose a design of crowdsourcing tutor assessment for MUET to enable flexible participation for educators in the learners education

MUET Malaysia is an English proficiency test administered by the Malaysian Examination Council (MEC). It is also known as the Malaysian University English Test, it is usually taken by students who aim to further their degree studies in Malaysian public universities [4]. The main purpose of E-MUET mobile application is to provide an effective online learning and practice for the students that takes MUET examination [5]. Examination due to insufficient practices and exposure to MyMUET will provide practices for all the four main modules which are reading, writing, speaking and listening.

2. METHODOLOGY

A survey was conducted to ninety one participants who have experience sitting for the MUET exam. The sampling method used was convenience sampling. A MUET subject matter, a UTeM English lecturer was also involved to provide opinion on the current and proposed model or solution for an E-MUET application. Other information that was elicited from the data collection was

(a) What is the process flow or current framework of the current manual system?
(b) What are the limitations and technical constraints of the current manual system or process?
(c) What are the major problems encountered that require the proposed system to solve?

The data obtained from the study was used to design MyMUET, a crowdsourced tutor assessment application.

3. RESULTS

A significant number of 90% of students who participated had achieved a band of 3 and above in MUET examination, implying a good command of English in the participants as most university require a band of 2 or 3 and above.

Speaking module has been rated as the toughest examination for the participants. A total of 55.6% or 50 out of 91 students believed that the in-class training provided for MUET is not sufficient to provide practices to score for MUET examination. This is quite alarming as it is a very significant figure.

The current system or framework of registering and sitting for MUET examination is shown in Figure 1. The students are required to attend several coaching classes in their institution before sitting for the exam. The coaching provided by their respective institutions however is deemed not sufficient by the respondents. There is also no approach for those who want to register themselves as tutors to participate in the interaction because the lecturers have been selected by the university and the places are limited. Students also require to sit in groups for their speaking lesson to have more practise according to the MUET format. This is may be time consuming and may only allow practise to take place when there are accessibility to a group of students. Individual speaking practices are not available, decreasing opportunities of self-improvements in the speaking section.
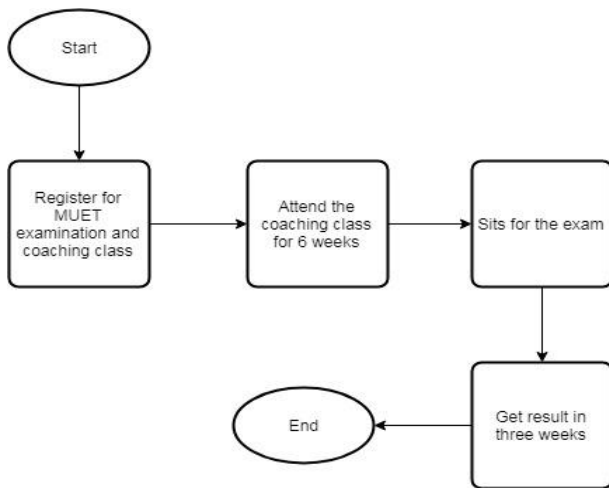
Figure 1 Flowchart of current system.

An overwhelming 76.7% of students also responded that they prefer a combination of classroom and online learning. An astounding figure of 91% of students also supported the idea of using a mobile application. A feature to include feedback for tutor service also was positively received by 88% of participants.

4. PROPOSED SOLUTION

The proposed MyMUET solution process flow is found in Figure 2. Reading is one of the sections that will tested for the students during examination. A student needs to answer the multiple-choice questions by reading a paragraph given. In the reading module, students will be given practices for their verbs, nouns, vocabulary and grammar. Multiple choice of questions will be given, and it may improve the reading skills of the students. Second section is listening, students need to listen to the audio being played in the examination hall and answer the questions. Meanwhile, listening module in E-MUET application will provide the audio and together with the questions for the students to practice themselves.
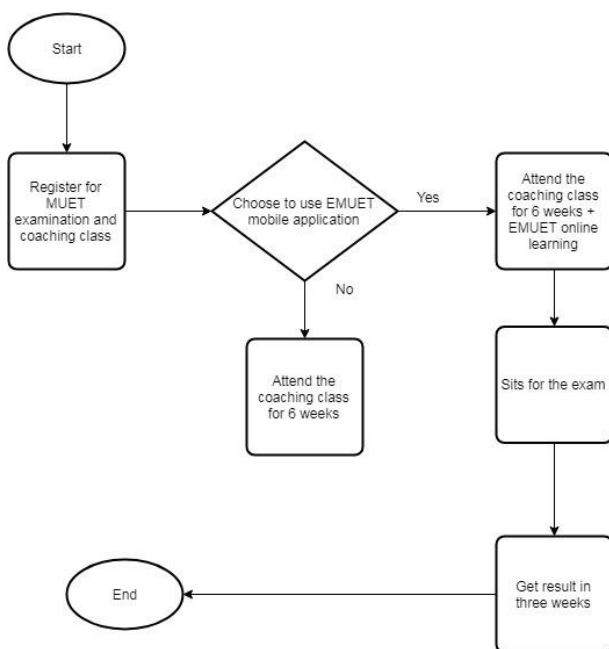

Figure 2 Proposed MyMUET.

The third section is the writing section. The students may submit their writing answer in the application. The final module is speaking. There will be a group of four students who will need to participate according to the given topic for them. Students may improve their speaking skills through this E-MUET mobile application. In E-MUET mobile application, each student may choose their own tutor. The tutor would be providing their feedback for the writing and speaking.

5. CONCLUSION

Challenges still exist to elevate the application of crowdsourcing in education. Invalid, inaccurate, or biased contribution is to be concerned [1,6]. Quality control methods for crowdsourcing in education is significant and need further research [5].

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The suitability of the case teaching method and problem-solving strategies to improve problem solving skills of undergraduate: A literature review on mechanical engineering

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ABSTRACT – Distributed force in mechanical engineering's unit can be package in case studies, then students make models of mechanics and mathematical equations. However, students find it difficult to identify a problem to solve it. Problem solving skills is need by an engineer. In this paper the method of improvement is introduced The ability to solve problems through a combination of The Case Teaching Method and problem solving strategies are made to be more effective in increasing them.

1. INTRODUCTION

Mechanical engineering is the application of the principles and problem-solving techniques of engineering from design to manufacturing to the marketplace for any object. This course is conducive to students' capacity of mechanics analysis required by upper-division courses and engineering practice activities [1]. Mechanics can be defined as that science which describes and predicts the conditions of rest or motion of bodies under the action of forces. It is divided into three parts: mechanics of *rigid bodies,* mechanics of *deformable bodies,* and mechanics of *fluids* [2]. Mathematical and physics-related concepts are extensively covered in the learning process which requires students to have strong abstract thinking and reasoning ability. Equations in physics are only consequences of statement simplification from a process that happens in nature. This kind of presentation causes the loss of some vital concepts in physics that are supposed to invite students to think more deeply [3]. Mechanical engineers need to take active and leading roles in solving these challenges associated with the transformation to a sustainable society. Stakeholders and students are expecting engineering programs to prepare the students for the challenges described above and the education must continuously be developed to meet these needs, see, eg. [4,5].

Case studies have been found to increase students' critical thinking and problem-solving skills, higher-order thinking skills, conceptual change, and their motivation to learn. Despite the popularity of the case study approach within engineering, the empirical research on the effectiveness of case studies is limited and the research that does exist has primarily focused on student perceptions of their learning rather than actual learning outcomes. The case study approach was rated higher than the traditional lecture approach. Students reported that case studies were better at helping them to improve their communication skills, ability to think critically, and apply the concepts and skills learned in the course [6].

Solving problems effectively requires students to identify, define and solve problems using logic, as well as lateral and creative thinking. In the process, students arrive at a deep understanding of the topic area and construct new knowledge an understanding on which they are able to make decisions [7]. Students need to be able to transfer the ability to solve problems in one context into new and different contexts and situations. Certain aspects of problem solving are transferable, even if the particular problem to be solved is discipline- or context-specific.

2. METHODOLOGY

The research method used in this study is a qualitative method. We completed this study in two parts.Part 1 involved a literature search and structured summary. Part 2 consisted of synthesizing the results of the literature review and developing recommendations by an expert panel about teaching practice-based learning and improvement for effective learning in mechanical enginering course.

3. RESULTS AND DISCUSSION

This paper examined about distributed force and centroid used the case teaching method and problem-solving strategies. We have assumed so far that the attraction exerted by the earth on rigid body could be represented by a single force. This force, called the force of gravity or the weight of the body, was to be applied at the center of gravity of the body. Actually, the earth exerts a force on each of the particles forming the body. The action of the earth on a rigid body should thus be represented by a large number of small forces distributed over the entire body.

Problem solving is a literative, or cyclical process. The various steps in the process outlined below need to be carry out and revisited from time to time. Figure 1 shows the combination of the case teaching method and problem-solving strategies.
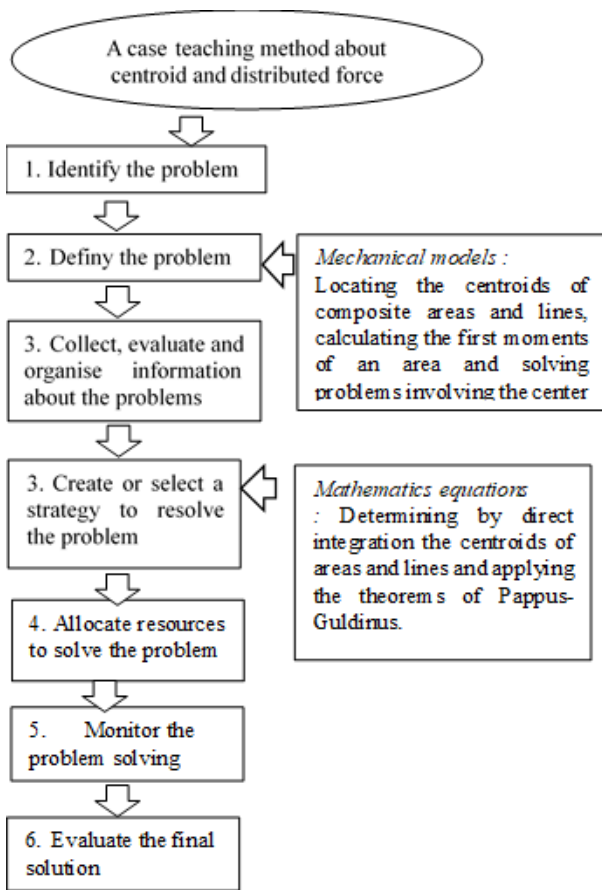
Figure 1 Case teaching method and problem-solving strategies.

4. CONCLUSIONS

The main question raised in this article concerned the suitability of the Case Teaching Method and problem-solving strategies as an overall strategy for engineering education.

We conclude from the literature review and the practical examples that Case Teaching Method and problem-solving strategies can be successfully applied in engineering programs. Problem solving skills reasons to use Case Teaching Method and problem-solving strategies are equally important in engineering. The accent, however, will be more on application and integration of knowledge than on acquisition. In engineering some topics are characterised by a hierarchic knowledge structure and complex problem solving.

These topics cannot be approached without risk in Case Teaching Method and problem-solving strategies setting. Therefore, separate direct instruction and supervised practice are needed: direct instruction of outlines, demonstration of expert problem solving, teacher-guided discussions, problem solving tutorials with specially structured group work.

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The impact of EQ, SQ and IQ towards AQ using path analysis and Rasch logit for modelling purpose among mechanical engineering students

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Keywords: Emotional Quotient; Spiritual Quotient; Adversity Quotient; Path analysis; Rasch logit; mechanical

ABSTRACT – This paper investigated the impact of EQ, SQ and IQ towards AQ among Mechanical Engineering students for modelling purpose using path analysis and Rasch logit. The quantitative approach with survey design involved 383 students using proportionate stratified multistage cluster sampling. The path analysis and multiple regressions revealed 29.2 percent's of AQ may explained by the predictors. The EQ (β = .337, p<.001) was the highest significant impact, followed by SQ (β = .301, p<.001) and IQ (β = -.02, p>.05). The final predictive model was AQ = .893 + .288*EQ + .285*SQ - .011*IQ with good model fitness.

1. INTRODUCTION

Most students are struggle for many pressures from various aspects such as inner and external factors of adversities. Adversity is a difficult situation or event that brings challenges in the lives of people [1]. For technical students, they need to prepare themselves to be a part of Fourth Industrial Revolution (4IR). Oosthuizen [2] stated that ten types of intelligence framework (Fourth Industrial Revolution Intelligence Framework). In Malaysia, we are relying on three dominant types of intelligences such as EQ, SQ and IQ based on National Education Philosophy (NEP) for student self-development. To strengthen this framework of NEP, we see that Adversity Quotient (AQ) was needed as a factor to help students to cope with a variety of challenges of future life, thus actively take up possible challenges in the future [3]. Stoltz [4] defined AQ as the ability of someone to withstand the difficulties and to overcome it. Furthermore, continuous demands of the mechanical industry were encouraged to investigate the impact of Emotional Quotient (EQ), Spiritual Quotient (SQ), and Intellectual Quotient (IQ), towards AQ and how to evaluate purposed models by examining the relationships between all variables.

2. METHODOLOGY

The research approach was a fully quantitative with survey research design. The variables involved exogenous (EQ, SQ, and IQ) and endogenous (AQ). The AQ generated based on four constructs of CORE model from IKBAR instrument [5]. EQ was measured by USMEQ-i with seven constructs of (i) emotional control; (ii) emotional maturity; (iii) emotional conscientiousness; (iv) emotional awareness; (v) emotional commitment; (vi) emotional fortitude and (ix) emotional expression [6], SQ was measured by Integrated Spiritual Intelligence Scale (ISIS) with five constructs of (i) consciousness; (ii) grace; (iii) meaning;

(iv) transcendence and (v) truth [7], and the IQ was measured by Ravens Advanced Progressive Matrices (RAPM) which just contained general intelligence [8]. All the instruments have been tested their validity and reliability aspects. The study involved 383 respondents of Mechanical Engineering students using clustered multistage stratified proportional sampling in five polytechnics according to zone (West, North, East, South, and Borneo).

2.1 Rasch Measurement Model

Rasch model will transform the ordinal data into interval data through the logits to be applied for regression and path analysis. Rasch Model combines the algorithm that specifies the expected probability of an item as i and individual capacity as n in the mathematical form equations. The mathematical formula for the Rasch model is as followed by Bond & Fox [9]. The rating-scale model is an extension of the dichotomous model which items have more than two response categories (e.g., Likert-type scales). In this research, each item has four response choices (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree) it is modelled as having three thresholds. The model is represented in the Equation (1).

$$P_i = \frac{\exp[\beta_n - (\delta_i + \tau_k)]}{1 - \exp[\beta_n - (\delta_i + \tau_k)]} \tag{1}$$

Where,
Pi = probability of getting a correct answer for item i
βn = ability parameter for respondent n
δi = difficulty parameter of an item i
τk = kth threshold

2.2 Regression and Path Analysis

Multiple regressions are useful to see the impact based on Beta (**β**) coefficients or beta weights that is able to estimates the results that have been standardized so that the variances are one. The extension of the path analysis is multiple regressions. Model from the correlation matrix, two or more casual models are compared. Path analysis is useful to evaluate causal models by examining the relationships between a dependent variable and two or more independent variables. Regression weight is predicated by the model. Then the goodness of fit statistic is calculated in order to see the model fitness through three categories such as absolute fit (Chisq, RMSEA, GFI), incremental fit (AGFI, CFI, TLI, NFI) and parsimonious fit (Chisq/df).

3. RESULTS

Multiple regression analysis revealed 29.2 percent's of AQ variance may explained by the predictors. The EQ (β = .337, p<.001) was the highest impact, followed by SQ (β = .301, p<.001) and IQ (β = -.02, p>.05). The final predictive model was AQ = .893 + .288*EQ + .285*SQ - .011*IQ. It can be used to predict AQ among respondents. The data also relatively normal based on Durbin Watson test (1.802) within the range of 1.5 to 2.5 [10]. However, Hair [11] stated that at least three fit indexes by including at least one index from each category of model fit mentioned in Table 1.

Table 1 The summary of model fitness.

| Name of index	Indices value	Comments for level of acceptance
Root Mean Square Error Approximation (RMSEA)	.097	RMSEA with 0.05 to 0.10 Acceptable
Goodness of Fit Index (GFI)	.994	GFI > 0.9 Acceptable
Adjusted Goodness of Fit Index (AGFI)	.941	AGFI > 0.9 Acceptable
Tucker Lewis Index (TLI)	.899	TLI > 0.9 Acceptable
Normed Fit Index (NFI)	.979	NFI > 0.9 Acceptable
Comparative Fit Index (CFI)	.983	CFI > 0.9 Acceptable
Chi-square/ degree of freedom (χ^2/df)	4.582	χ^2/df $\leq$ 5.0 is acceptable
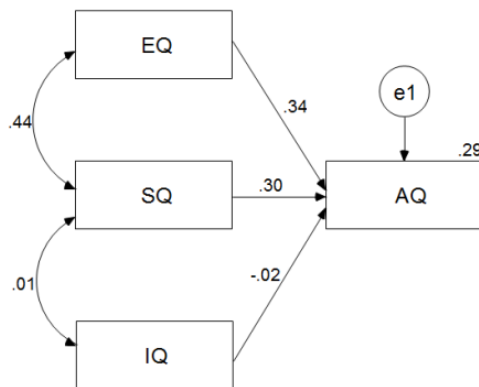
Figure 1 The path analysis.

Figure 1 through the estimates of standardized regression weights shows the moderate and significant impact of EQ and SQ towards AQ. In the other side, the impact of IQ towards AQ is very small and non-significant results. The moderate correlation between EQ and SQ shows the mixture of emotional and spiritual elements are beneficial to AQ compared to IQ.

4. SUMMARY

In conclusion, the moderate impact of the EQ and SQ towards AQ statistically shows the potential of these intelligences to be applied in self-resilience programme development for mechanical students. It proved statistically the relationships between the variables. The newly found results would encourage further studies on exploring new types of intelligences as tested variables.

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Line balancing of two-sided assembly cell in lean manufacturing

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ABSTRACT – The concept of line balancing is an important part in lean manufacturing. It ensures that effective work will keep improving productivity. In this study, the load balancing down the two-sided assembly work cell of glove making facility have been enhanced by stopper jigs installation and repositioning of operators. Result of the value stream levelling (mura) maximized operation capacity, avoided bottleneck, and achieved new output at maintainable fixed costs. The findings are evidence that this technique is useful in reducing operational wastes (muda). Hence, lean practices successfully enable flexible cells production to be carried out at a constant and predictable rate.

1. INTRODUCTION

One of the most important process in gloves making facility is cuffing. Cuff is a part of glove encircling the wrist. It is essential to determine effective cycle time or the repeated gloves entries by practical integration such as u-shaped lines, parallel stations or processing alternatives [1-4]. In defining the underlying concept, an assembly line here involved similar work done manually at individual workstations in the work cells. The cuffed gloves are streamed down from one operator (cuffer) to another until they reach the end of the cell line and pack into boxes. Lean manufacturing can enhance manufacturing capacity by controlling relevant work levelling and waste [4-6]. Thus, the purpose of this research is to investigate efficiency of operators and improve the cuffing speed.

2. METHODOLOGY

The objective of this study is to achieve 27 pieces/minute target for each operator (cuffer) and load balancing of higher than 68 packs/min between both sides of workstations at a consistent glove cuffing length of about 210mm (Figure 1). Baseline data for current position cuffing speed is average at 23 pieces/minute per operator (cuffer). So, two solutions were proposed which are by adding-on stopper jig and position rotation (and repositioning) of the cuffers.

2.1 Stopper Jigs Installation

Stopper jig (Figure 2) is a component that will help the cuffing process to standardize the length of gloves. Modification of the two-sided assembly line is done by adding stopper jigs at each workstation on the left (L) and right (R) sides that carry similar cuffing process.
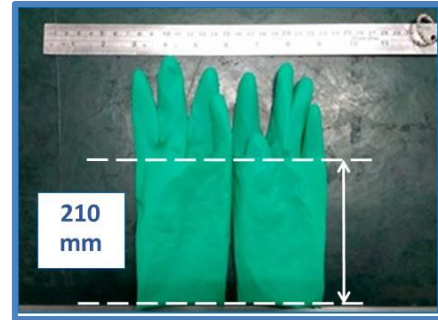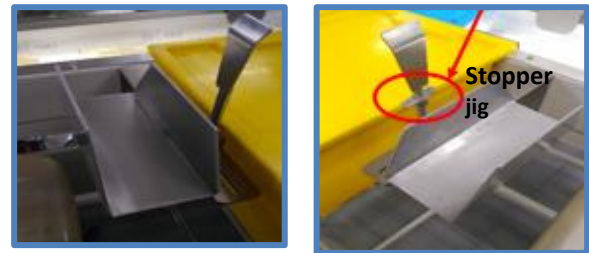

Figure 1 Cuff length of gloves.

Figure 2 Stopper jig installation on cuffing tool.

2.2 Operator's Position Rotation and Repositioning

Figure 3 shows the three cuffers (P) arrangement on left (L) side and right (R) side, who shall each rotate position at P1L, P2L, P3L, P1R, P2R, and P3R. P1 needs to work faster than the other two. While P2 has to cuff the gloves to back up P1, P3 must perform cuffing even faster to back up P1 and P2. The purpose of position rotation is to verify that they are able to produce the best output given different situations. Next, the cuffers repositioning is implemented in which changes only affected the left side, in particular P1L and P2L positions. As operators are right-handed, the change helps P1L and P2L to work comfortably. This is exhibited by Figure 4. The original and new cuff outputs for both sides are recorded. Data collection were carried out for two weeks.
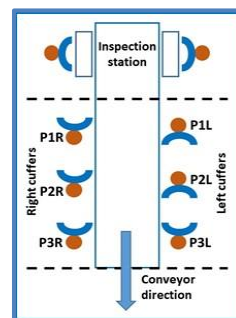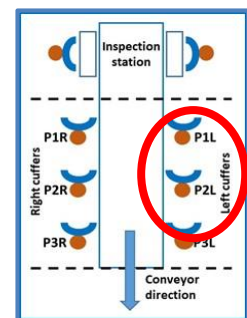

Figure 3 Position rotation.   Figure 4 repositioning.

3. RESULTS AND DISCUSSION

After two weeks of monitoring, comparison between before and after stopper jigs installation was analysed. Results in Figure 5 clearly demonstrated that the stopper jigs have improved the cuffing speed. The left side cuffers were able to cuff more gloves than the right side. Productivity exceeded the expected target by 30 pieces/min for the left workstations. Stopper jigs have successfully facilitated standardization of the glove's length in the process. The load balancing was improved from 68 packs/minutes to 72 packs/minutes with six cuffers. However, load balancing remains the same for left and right sides of P3 workstations, while P1 and P2 could achieve 70 and 72 packs/minutes respectively. Although the target was positive, cuffers P3 must maintain its critical role to built-up buffers for P1 and P2 because the needs for gloves checking and screening. The cuffers repositioning as in Figure 4 complimented the stopper jigs installation and helped to off-set the cuffing process setback due to rejection and quality issues [7].
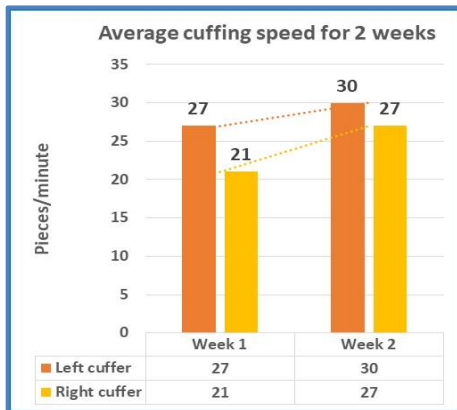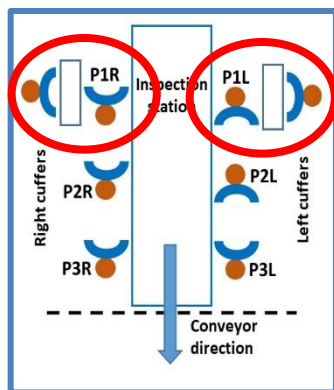

Figure 5 Improved output with stopper jigs.

Figure 6 Attachment of P1 with inspection station.

Further analysis as in Figure 6 has indicated another possible solution played by P1L and P1R cuffers. For this case, position 1 attached to the respective inspection stations could save time when loading gloves. The output of position 1 was also improvised on both sides of the workstations. Therefore, it should help position 2 to increase buffers for downstream packing process. The load balancing between all left and right sides workstations was indeed equally effective.

4. CONCLUSION

The study presented an effective model to improve two-sided assembly line balancing. In this sense, it was essential to introduce two add-ons modification in the forms of stopper jigs and positions rotation (and reposition) as alternative solutions in lean manufacturing [8]. Left sides workstations showed dominant results compared to the right-hand sides. At no additional cost, the lean value stream or mura as a process-based practice enable production to eliminate muda factors mainly transportation, inventory, motion and waiting wastes that are bottleneck to gloves cuffing process [4,9]. These are achieved by the increase in cuff speed of 27 pieces/min and 72 packs/min. Hence, it is possible to adopt and maintain flexibility of cells production using two-sided assembly line with right methodology [10]. While this model can be useful for other cell workstations of such nature, various products samples and operators' profiles (and numbers) can be considered for better understanding in the future research of two-sided assembly line.

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Structural Equation Model (SEM) in assimilating EQ, SQ and AQ for mechanical students' context

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ABSTRACT –This paper investigated the fitness of a measurement model of intelligences for mechanical students using Structural Equation Modelling (SEM). The research was performed on 383 mechanical engineering students chosen randomly in polytechnic. The results using AMOS 21 software from SEM indicated that the measurement model of intelligences with $\chi2=198.928$, $p<0.05$, $\chi2/df =1.970$, GFI=0.941, AGFI=0.920, RMR=0.01, CFI=0.977, RMSEA=0.05, provided a better model fit. All factor loadings are ranging from 0.73 to 0.87, with standardized coefficient, β ranging from 0.54 to 0.76. In conclusion, the model proposed represents an adequate description of EQ, SQ and AQ for mechanical students.

1. INTRODUCTION

Fourth Industrial Revolution (4IR) Intelligence Framework suggested by Oosthuizen [1] concentrating on ten types of intelligences. In Malaysia, we are count on three dominant types of intelligences such as EQ, SQ and IQ based on National Education Philosophy (NEP) for student self-development. This research will be testing new measurement model provided for technical students especially for mechanical students with the added value of AQ to the framework. The basic idea is to see how well the combinations of existing intelligences such as IQ and SQ can be strengthen with the third element of intelligence i.e AQ. The combination of EQ, SQ and AQ is important because previous research by Effendi [2] proved empirically that EQ and SQ had a moderate correlation with AQ among polytechnic students. However, IQ shown very weak correlation with AQ and this study clearly boost a motivation on how the EQ and SQ has a potential to be assimilated with AQ from technical student context worldwide. Technical field are closely related to the 4IR in terms of the intelligences need to be acquired by the students. The framework is not emphasized directly to AQ even though this factor is vital to face the challenges. Stoltz [3] defined AQ as the ability of someone to withstand the difficulties and to overcome it. This paper will be investigating the measurement model fitness of intelligences for mechanical students using Structural Equation Modelling (SEM).

2. METHODOLOGY

The research approach was a fully quantitative with survey research design. The variables involved exogenous (EQ, SQ, and IQ) and endogenous (AQ). The AQ generated based on four constructs of CORE model from IKBAR instrument [4]. EQ was measured by USMEQ-i with seven constructs of (i) emotional control; (ii) emotional maturity; (iii) emotional conscientiousness; (iv) emotional awareness; (v) emotional commitment; (vi) emotional fortitude and (ix) emotional expression [5], SQ was measured by Integrated Spiritual Intelligence Scale (ISIS) with five constructs of (i) consciousness; (ii) grace; (iii) meaning; (iv) transcendence and (v) truth [6]. The suitability of the instruments have been tested from Effendi [2] for their validity and reliability. However, the previous research was not providing evidence on factor loading for each item. This research will fill the gaps by investigate the quality by interlinking the items in one model for the application for local context. The study involved 383 Mechanical Engineering students using clustered multistage stratified proportional sampling in five polytechnics according to zone (West, North, East, South, and Borneo). The results analysed using AMOS 21 software and useful in Structural Equation Modelling, path analysis, and confirmatory factor analysis. SEM can be defined as CFA and multiple regressions because SEM is more of a confirmatory technique, but it also can be used for exploratory purposes. SEM, in comparison with CFA, extends the possibility of relationships among the latent variables and encompasses two components: (a) a measurement model (essentially the CFA) and (b) a structural model.

3. RESULTS

Figure 1 shows both the standardized beta estimate of intelligences are moderate (β =.31 and .34) with measure correlation of EQ and SQ is .40. The value of R2 indicated EQ and SQ contributed 29% in estimating AQ. The 71% may affected by other factors that can be investigate such as another types of intelligences or any other internal or external factors. Durbin Watson test (1.802) also revealed that the data relatively normal and within the range of 1.5 to 2.5 [7]. In Structural Equation Modelling, there is a series of goodness of fit statistic in order to see the model fitness through three main categories such as Absolute Fit (Chisq, RMSEA, and GFI), Incremental Fit (AGFI, CFI, TLI, NFI) and Parsimonious Fit (Chisq/df) [8]. Md Fauzi Ahmad [9] stated that the general model of goodness of fit is assessed using six criteria such as Chi-square/ degree of freedom ($\chi2/df$), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Tucker Lewis Index (TLI) and Root Mean Square Error Approximation (RMSEA). However, Hair [10]

stated that at least three fit indexes by including at least one index from each category of model fit mentioned in Table 1. The researcher could choose at least one fitness index from which category to report in depending on literature is being referred.
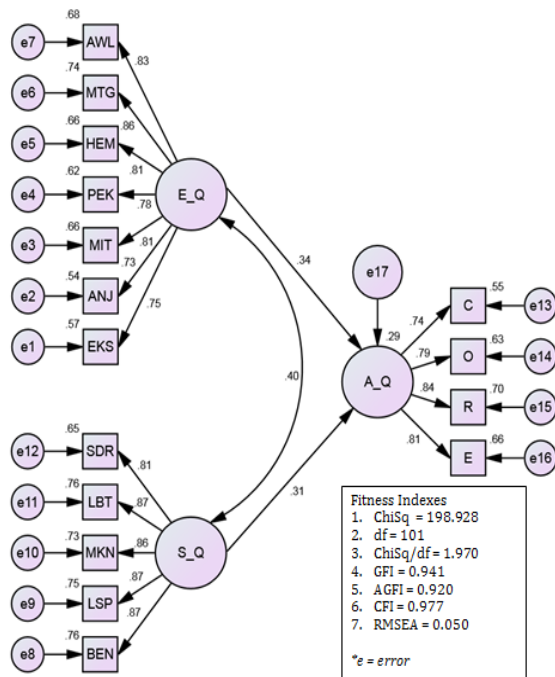

Figure 1 The measurement model.

Table 1 show the validity of the construct is defined as how well the proposed model is compared to the observed data. Initially, the measurement model provided a good fit. The χ2/df was 1.97 (χ2=198.928, p<0.05, df =101). Furthermore, the GFI was 0.941, AGFI=0.920, RMR=0.01, CFI=0.977, RMSEA=0.05 (see Table 1). All factor loadings are ranging from 0.73 to 0.87, with standardized coefficient, β ranging from 0.54 to 0.76. All fitness indexes are accepted.

Table 1 The summary of fitness index.

Name of index	Indices value	Level of acceptance
χ^2/df	1.970	$1.0 \leq \chi^2/df \leq 3.0$
RMSEA	.050	RMSEA ≤ 0.08
GFI	.941	GFI ≥ 0.9
AGFI	.920	AGFI ≥ 0.9
TLI	.973	TLI ≥ 0.9
NFI	.954	NFI ≥ 0.9
CFI	.977	CFI ≥ 0.9

Modification indices (MI) shows only one pair (e7 <--> e12; 15.112) is considered high and deemed to be redundant which is above 15 as stated by Zainuddin [11]. No modification needed because the items are not in the same construct. In the other side, this measurement model with combination of three intelligences is fit with the mechanical students. This result will open more discussions on how we can strengthen the resilience element using EQ and SQ.

4. SUMMARY

The suggested model proven statistically that other intelligence purely had high potential to be applied for technical students in facing the 4IR adversities. The research impact is to open the door on how to improve the NEP that only emphasized on EQ and SQ from original framework. The newly found results would encourage further studies on exploring new types of testing for item development and assessing the fitness for new items created.

ACKNOWLEDGEMENT

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Variability in the group's academic background is weakly associated to the outcome of a Problem-Based Learning project attainment for engineering undergraduates

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ABSTRACT – In the Problem-based learning curriculum, problem drives learning. Studies have shown that the successful learning process in the PBL assignment may rely on group composition. Thus, this study focuses on one of the group's attributes: the member's prior academic achievement variability. A Spearman rank-order correlation analysis was performed to determine the association between dispersion of individual Cumulative Grade Point Average (CGPA) from the Mean Group CGPA and the final marks of the Problem-Based Learning project. A significant but weak correlation was found. Thus, it can be concluded that prior academic achievement is weakly associated with the outcome of PBL project.

1. INTRODUCTION

Problem-based learning is pedagogical methodology by which learning is initiated by a posed problem. Problem-based learning course is introduced to engineering undergraduates to stimulate a process of determining engineering solution, which is by nature, is their calling when they are in the job market.

Students are typically placed in a group and assume roles that needed them to reconvene to integrate the information, generate and evaluate possible solutions, make needed decisions and communicate results as appropriate for the problem resolutions [1].

With various roles and responsibilities, it is indeed a challenge for every group to harness the members' strengths and downplay their weaknesses to emerge successfully as a team. Hence this study is conducted to find the relationship between the individual dispersion from the group's average CGPA with the outcome of the Problem-Based Learning project through the final project marks.

2. PREVIOUS WORK

In a study focusing on the ingredients contributing to a successful problem-based learning, Schmidt et al. concluded that the extent of learning in PBL results from neither group collaboration only nor individual knowledge acquisition only; both activities contribute equally to learning in PBL [2]. This finding shows that the basis of group formation is important to ensure that outcomes of problem-based learning can be maximized. Yeo in his studies involving human dynamics in PBL assignments [3], had pointed out that it is essential that students' learning ability and social adaptability be carefully considered in any PBL group formation. Hence, this study is directed towards highlighting one of the bases of the group formation: the prior academic performance of the group.

3. METHODOLOGY

A sample of 81 students (22 females) enrolled to BEKM 4753: Programmable Logic Controller (PLC) and Automation subject was used for this study. All students were in their third year of Bachelor of Mechatronics Engineering program. Their Cumulative Grade Point Average (CGPA) in the prior semester is used obtain the Mean Group CGPA and subsequently the dispersion of individual from their group's mean. The total marks of PBL is 20% which consist of 4% from Technical Report, 4% from Oral presentation, 6% from Prototype Quality, 4% from Project Progress and 2% from Peer Assessment. The total marks of the Problem-Based Learning project and the dispersion of the individual from their group's mean CGPA are used as the dependent and independent variable respectively.

The mean group's CGPA is calculated by taking the average of all the group member's prior semester's CGPA. Then the dispersion of each individual is calculated by computing sample's standard deviation of each individual CGPA to his respective mean group's CGPA. Table 1 explains the demographic of the data which also includes the mean and standard deviation of each variable.

Table 1 The demographic of the samples.

Demographic	Data
Student's Mean CGPA	3.07 ± 0.5
Mean Group's CGPA	3.07 ± 0.25
Mean PBL marks	16.55 ± 1.18

The title of the PBL project is 'The design, development and control of a miniature chocolate wrapping work cell'. Students were divided into a 4 to 5-members per group. Students were informed of the title and project members as early as Week 3 in the semester and the presentation is at Week 13. A total of 6 weeks of brainstorming was set for the group to discuss ideas and proposed a solution. Then, students were allowed to work in the PLC lab for 4 weeks prior to the presentation week to come out with a prototype of the solution. Students were assessed in terms of the quality of the prototype, design progress and report writing. A total of 20 marks is the maximum possible marks to attain.

A Spearman's rank-order correlation analysis [4] was performed in SPSS (SPSS Inc.) to this sample to determine whether the outcome of the Problem Based Learning project can be explained by the student's CGPA dispersion from the average group's CGPA. The hypothesis of this research is that the outcome of the PBL project has a strong relationship to the variability of the prior academic performance in the group.

4. RESULTS

Figure 1 summarizes the attainment for the PBL project. The maximum marks that they can attain is 20. The mean is at 16.55 which is at the highest quarter of the maximum marks attainable. It is evident in Figure 2 that the data was not normally distributed, thus a Spearman's rank-order correlation analysis is performed to evaluate the results.

The Spearman rank-order correlation calculates a coefficient, r_s or ρ which is a measure of the strength and direction of the association. The coefficient, r_s or ρ is obtained from the following equation.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

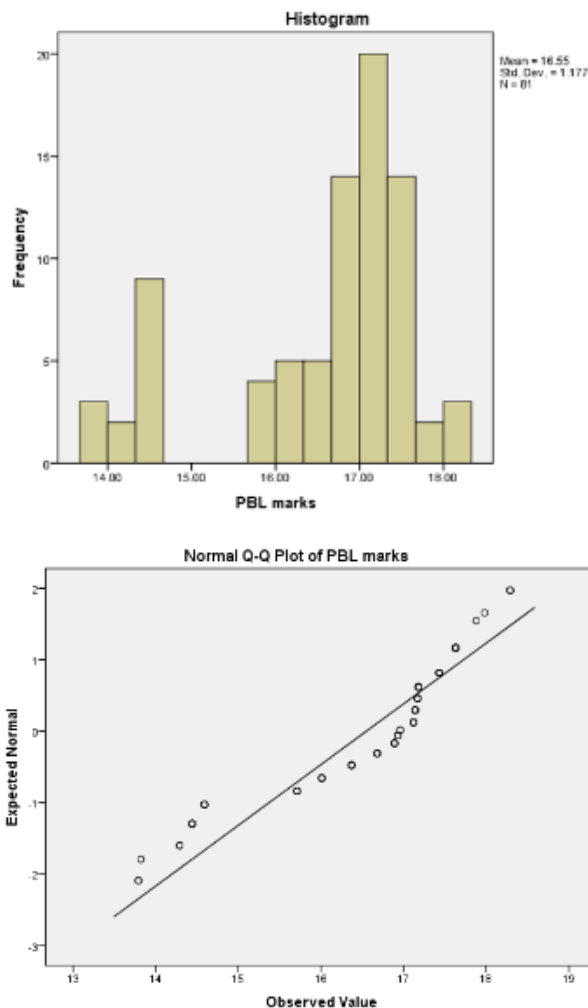Where n is the number of samples and d is the difference between ranks.

Figure 1 Distribution of the PBL project marks.

4.1 Analyzing Monotonic Relationship

A pre-requisite to run a Spearman's rank coefficient analysis is the evidence of monotonic relationship. Figure 2 shows a scatterplot between the two variables in the study.
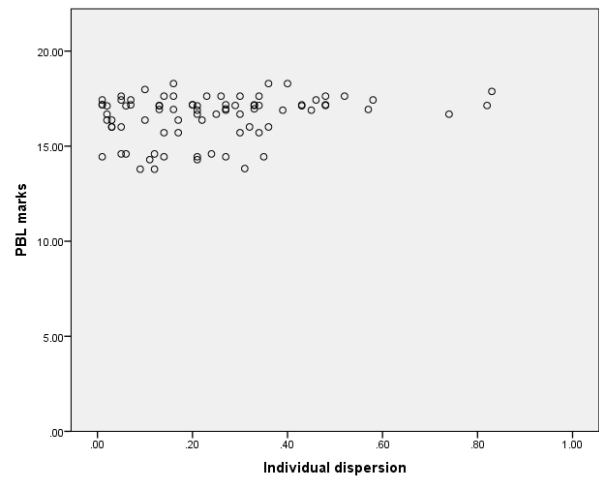

Figure 2 Plot of PBL marks attained against the individual dispersion from the group's mean CGPA.

It can be concluded from the visual inspection that there is a monotonic relationship between the individual dispersion of CGPA from their group's mean CGPA and the PBL marks, thus the Spearman's rank coefficient analysis is a viable option to investigate the relationship.

4.2 Spearman's Rank-Order Correlation

There was a statistically significant, weak positive correlation between the individual dispersion of CGPA from their group's mean CGPA and the PBL marks in BEKM 4753: PLC and Automation course, $r_s(81) = .222$, $p < .046$. Therefore, it can be concluded that based on the result obtained from this course, the previous academic scores are weakly associated with the attainment of the PBL marks. It is also supported from the data plotted in Figure 2. Even an individual dispersion from group's CGPA is up to 0.8, the PBL mark is similar to the one's that had a CGPA at the group average.

5. SUMMARY

Problem-based learning is crafted to mirror real-world demands. Previous research claimed that the learning process is contributed equally from individuals and group ideas. This study attempted to support the idea by looking at one of the aspects of PBL group's attributes: academic variation. It can be seen from the results of this course that prior academic achievements are weakly correlated with the attainment of the PBL project marks.

This result may induce two contrasting perspectives. The weaker students may either receive over-performed assessment marks because their respective group members are able to downplay their weaknesses, or the assessments were unable to capture the variability of the group's performance and roles at the individual level. These perspectives warrant a further study on the achievement at subject level to investigate whether the learning process in PBL project translates to

the individual attainment.

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