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Multidisciplinary Collaboration in Engineering Service-Learning Project

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Abstract
In recent years, industries increasingly require graduate engineers that universities produce to have the ability to function in multidisciplinary teams. This requirement is tallied with engineering professional societies. Hence, the study of multidisciplinary collaboration practices in engineering service learning project among engineering students is studied. A multidisciplinary collaborative practice referred as occasions when two or more students in the different background of engineering learn with, from and about one another to facilitate collaboration in practice to solve a problem in community service. Therefore, the engineering service project was designed, namely as Multidisciplinary Engineering Service in Community (MESIC). MESIC has highlighted the product-based with creative and innovative elements the product-based with creative and innovative elements. MESIC model is designed at the core of the previous emerging service learning model together with multidisciplinary collaboration. This study provides empirical results through pre and post survey questionnaire using one group quasi experimental approached. The data was analyzed using Rasch Measurement Model. It explored the four outcomes of multidisciplinary collaboration (value and ethics (VE); team and teamwork (TT); communication (CC); roles and responsibilities (RR)). These findings of four outcomes via survey questionnaire show a positive impact on students before and after experiencing the MESIC program. It is part of the study to enhance and improve students' outcomes in multidisciplinary team.
Keywords: Multidisciplinary Collaboration, Engineering Service, Items Construction, Engineering Education, Engineering Students

Introduction

In facing the future challenges, engineer produces need well prepared from aspects of knowledge, skills, and attitudes. ABET (2015) referred engineering competency as the ability to demonstrate the knowledge, skills, and attitudes that fix with specific tasks and the given environment. According to Tan et al., (2017), employers are more prone to choose skills that contribute to the productivity of tasks, such as communication skills and teamwork over lifelong learning, again which are more academic-driven. Industry requires graduates who are able to participate in engineering project organizations and collaborate in multidisciplinary (Chinowsky, 2011). Thus, students learning it would be an advantage with a more comprehensive outcomes in multidisciplinary approach. Moreover, ABET also stated the same outcome; an ability to function on multidisciplinary teams. Hence, multidisciplinary team is highlighted in this study. From the literatures, a lot of the active learning approaches are discussed, changed, and implemented to improve the student development in context of multidisciplinary team. Engineering service learning one of the approaches (Coyle et al., 2005). Service learning is a pedagogy that promotes educational experiences in which students participate in and reflect upon organized activities that meet identified community needs to gain further understanding of concepts being taught and a broader understanding of the overall discipline (Hatcher and Bringle 1997; Litchfield et al., 2016). Hence, the concept of service learning can be concluded as experiential learning in meaningful ways; by doing, we learned. Multidisciplinary Engineering Service in Community (MESIC) is one of the engineering service learning that technically developed to enhance multidisciplinary teams among undergraduate engineering student. MESIC has five elements. There was multidisciplinary collaboration, engineering design, student centered, community served, and partnership. Rasch (1960) defined that Rasch Model is one of the reliable and appropriate method in assessing students' ability. Masodi et al., (2010) proves that this method can classify grades into learning outcomes more accurately especially in dealing with small number of sampling units. Othman et al., (2012) stated that Rasch Measurement Model can be an effective tool in evaluating the reliability and quality of any assessment tools for courses. Rasch focuses on constructing the measurement instrument with accuracy rather than fitting the data to suit a measurement model with of errors (Masodi et al., 2010). Therefore, this study used Rasch Measurement Model to evaluate the reliability and the quality of multidisciplinary collaboration outcomes.

Methodology

Experimental quantitative study with Mechanical, Electrical, Chemical, and Civil Engineering students were conducted at the southern university in Malaysia. By using one group quasi experimental approach, quantitative analysis via survey questionnaire have been carried out, involving 20 undergraduate engineering students from four different faculties. Students were divided into 5 groups. The competencies selected focused on four outcomes of multidisciplinary collaboration ;(value and ethics (VE); team and teamwork (TT); communication (CC); roles and responsibilities (RR)) that adapted from healthcare field as in Table 1. Rasch Measurement Model using the Winstep analysis was carried out to investigate the student outcomes. For the data collection, pre and post analysis were using the same instrument.

Table 1
The multidisciplinary collaboration student outcomes adapted from healthcare field (IPEC, 2016)

Learning Outcome	Description
Value and Ethics (VE)	To work with individuals of other engineering disciplines to maintain a climate of mutual respect and shared value/ethics traits during finding local issues at community served
Roles/Responsibilities (RR)	To use knowledge of one's own role and those of other engineering disciplines to appropriately assess and address the issue/niche/solution needs of the community served
Communication (CC)	Can communicate with team members, community served, partnerships in a responsive and responsible manner that supports a team approach in delivering product to community served
Team and Teamwork (TT)	Apply relationships-building values and the principles of the team dynamic to perform effectively in multidisciplinary team and deliver product to community served

Table 2
Items for multidisciplinary collaboration outcomes in MESIC

No.	Item
A1	I am competent in my engineering discipline
A2	I am able to work independently
A3	I acknowledge the academic discipline of other engineering discipline
A4	I am clarified with of my engineering discipline for its learning direction
A5	I am able to contribute to the society utilizing my engineering discipline
A6	My course is better than other engineering discipline
A7	Other parties believe that my discipline is superior than other engineering discipline
B1	Individual in my area able to work independently without diversity
B2	My course will dominantly contribute to any multidisciplinary projects
B3	Involvement of other engineering discipline in a specific work will induce difficulties due to different approach
C1	I am comfortable working with other engineering students
C2	I am always delighted to share my course's materials and information with others.
C3	I am convinced that diversity of engineering discipline will develop better result
D1	My course's knowledge and skills are more valuable than other engineering discipline
D2	I am able to identify the students' strength and weaknesses in different engineering background
D3	It is necessary to seek advices from other fields to make progresses in any projects or work
E1	Working in diverse team will increase the team's capability
E2	The outcome of students in a diverse team is more effective

E3	The involvement of engineering students from different discipline will enhance the capability to solve complex problems
E4	I am able to communicate well with students from other engineering discipline
E5	I respect different ideas and views from students in different discipline even though it is not theoretically accurate
F1	I do not need other students from different discipline in order to understand different discipline as I can find the information regarding it independently
F2	Learning the basic of other engineering discipline is unnecessary and irrelevant.
F3	Solution can only be made effectively with the same discipline of students in a team.
F4	I am proud with the engineering discipline I have enrolled.
F5	Engineering is a field which require collaboration of multiple discipline.

These items in questionnaire is coded as number 1 for pre and number 2 for post. The items are adapted from Interprofessional Educational Collaborative (IPEC) in healthcare field.

Results and Findings

The data collected indicates the positive results of multidisciplinary learning outcomes. All the students reported they had increased their learning of multidisciplinary collaboration outcomes after attended MESIC. An overall explanation on how well the questionnaire were constructed and whether student's outcome levels exist or otherwise, can be read from the summary statistics as depicted in Table 3. The first statistic refer as separation, which is the index of spread of item positions. If the index reads 2.0 or below, the item may not have sufficient breadth in position, which will further cause item redundancy. If that happened, we may wish to reconsider the rating scale that has been applied in this study. The item separation is 4.9, an even broader continuum than a person. This separation index translates to about four levels of item difficulties (strongly agree; disagree; agree; strongly agree). Next, with the reliability index of person valued at 0.96 with Cronbach's alpha 0.85, it indicates that the items are in line with consistently reproducing a participant's score. In parallel to this, the item reliability of 0.96 indicates that a similar item hierarchy along the variable is highly reproducible in a similar sample from the population. This means good reliability at which items measuring students' learning abilities.

Table 3
Summary statistic for item

SUMMARY OF 52 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	57.9	20.0	.00	.42	.98	-.1	.98	.0
S.D.	14.1	.0	2.21	.06	.30	1.0	.31	1.0
MAX.	78.0	20.0	3.69	.67	1.78	2.3	1.78	2.3
MIN.	33.0	20.0	-3.91	.36	.46	-2.1	.47	-2.1

```
 REAL RMSE    .44 TRUE SD    2.16  SEPARATION  4.90  ITEM   RELIABILITY  .96
MODEL RMSE    .42 TRUE SD    2.17  SEPARATION  5.13  ITEM   RELIABILITY  .96
 S.E. OF ITEM MEAN = .31
```

UMEAN=.0000 USCALE=1.0000
ITEM RAW SCORE-TO-MEASURE CORRELATION = -1.00
1040 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 1640.67 with 966 d.f. p=.0000

For item distribution map is depicted in Table 4. From the analysis, the outcome of communication (CC) shows the higher reflect between students, followed by team and teamwork (TT), roles and responsibilities (RR), and values and ethics (VE). Item measures gave the indication on the level of difficulty the students encountered in values and ethics.

Table 4 Person Item Distribution Map

```
 PERSON - MAP - ITEM
     <more>|<rare>
 4         +
           |  A6B   B3B   F1B   F2    F2B
 3         +  B1B   F1
           |  A7B   B1    B3    D1    D1B   D2    F3    F3B
 2        +S  A7
           |  A6    B2    B2B
 1         +
           |
 0      XX T+M A1   A2
       XXX S|  A2B   A4    A5    E4    F4
-1   XXXXX M+  A1B   C1    C2    D2B   E2    E5    F4B   F5
    XXXXXX  |  A3    A4B   C3    D3    E3
-2    XXXX S+S A5B   E1    E2B   E3B   E5B
           T|  C2B   D3B   E1B   E4B
-3          +  C1B   C3B   F5B
            |
-4          +  A3B
     <less>|<frequ>
```

Conclusion

As a conclusion, this study reveals engineering service learning (MESIC) highlights a positive impact to multidisciplinary team outcomes. The purpose of this study was to investigate the extent of undergraduates' practicing multidisciplinary collaboration in engineering service learning project MESIC is achieved. Other than that, this study also reveals that Rash Measurement Model also can be used in engineering education research by enhancing multidisciplinary collaboration in engineering service learning. For future research, more elements of MESIC such as engineering design, partnership, student centered and community served can be evaluated and analysis.

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