Journal of Engineering Science and Technology
Special Issue on PEKA 2016, November (2016) 1 - 12

THE EFFECTIVENESS OF INDUSTRIAL TRAINING FROM THE PERSPECTIVE OF STUDENTS OF THE CIVIL AND STRUCTURE ENGINEERING DEPARTMENT

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Abstract

This paper discusses the effectiveness of the industrial training from the perspective of students who have undergone 12 weeks of industrial training. A questionnaire was distributed to 47 Third Year students at the Civil and Structural Engineering Department (JKAS), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM). The sample comprise of 21 male and 26 female students. The questionnaire consists of three parameters, namely students' knowledge, skills, and attitude towards industrial training. These parameters were identified as three domains of educational activities based on Bloom's Taxanomy. Students were required to answer 23 questions to assess their perception before and after undergoing industrial training. The Likert scale used in the questionnaire comprises of a one to five level of satisfaction scale (1 = not at all satisfied to 5 = extremely satisfied).The Winstep and Microsoft Excel software was used to analyse the survey. Winstep was used to evaluate the validity and reliability of the questions, while Microsoft Excel was used to assess the effectiveness of the industrial training from students' perspective, namely whether their perception has improved, remain unchanged, or decreased. The Rasch Model analysis showed that the questionnaire is reliable and valid. Fifty percent of the students said that industrial training had increased their knowledge and skills, while 39 percent of the students admitted that their attitude remain unchanged after completing their industrial training. Findings on knowledge and experience acquired by the students during industrial training could serve as guidance when planning for a better career in the future as well as to the industrial training programme.

Keywords: Rasch model, Validity, Reliability, Industrial training, Survey.

1. Introduction

As Malaysia moves towards becoming a developed country, graduates are expected have excellent academic achievement and skills before entering into an increasing challenging real working world. In tandem with the fast-paced development that is taking place in Malaysia and industry requirement for competitive and dynamic graduates, universities and industry have been making concerted effort to train students while they are still pursuing their studies. A curriculum structure which integrates knowledge, work experience, human skill, and technical skill is needed to ensure that universities produce graduates with excellent qualification. To meet this requirement, industrial training (IT) during study period has become an important component in preparing students at the university level. Industrial training provides students with exposure to actual professional experience in the industry which they would be entering after they have completed their studies; it also provides them with the opportunity to secure a job upon graduating [1].

Industrial training is a compulsory component and is also the prerequisite set by the Board of Engineering Malaysia (BEM) through the Malaysian Engineering Accreditation (EAC) for any engineering program in Malaysia [2]. To comply with the BEM requirement in producing competent and quality graduates, the curriculum structure at the Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM) makes it compulsory for third year students who have completed at least six semesters of engineering studies to undergo Industrial Training (IT). FKAB students from the Civil and Structure Engineering (JKAS), Electrical and Electronic Engineering (JKEES), Chemical and Process Engineering (JKKP), and Mechanical and Material Engineering (JKMB) Departments would have to undergo IT, either in the public or private sector, for 12 weeks in their third year of study.

Although the importance of IT is undeniable, Zaidi [3] and Wilton [4] stated that IT provides the opportunity for students to practice everything they have learned in class and helps to inculcate generic skills; it also help to catapult graduates to a good start at the beginning of their career. Therefore the effectiveness of IT from students' perspective has to be examined. In this study, students' views and perception prior to and after undergoing IT will be evaluated. The assessment was done through a questionnaire distributed to students when they return for the final year of their studies. The questionnaire assesses students' level of knowledge, skills, and attitude based on their exposure to IT. There are a total of 47 third year students in the Civil and Structural Engineering Department for the 2014/15 session. A minimum of 42 sample size is required based on the number of population [5]. The sampling structure used in this study is the random sampling method. The Rasch Model analysis will be used to evaluate the validity and reliability of the data, and the basic statistical analysis will be used to assess students' perception before and after IT.

2. Assessment Method

The questionnaire contains 23 questions, which are divided into three main parameters which measure knowledge, skill, and attitude. These three parameters were choose based on three domains of learning which is known as cognitive for knowledge, affective for attitude and psychomotor for skill given by Bloom [6]. Furthermore these parameters need to be measured and implemented through Outcome Based Education (OBE) as required by the Malaysian Engineering Accreditation (EAC) [2]. The first parameter, knowledge, contains seven questions (item) which measure students' level of knowledge. This parameter was developed based on the learning outcome of the industrial training course which is a basic course in the faculty. The second parameter, skill, contains seven questions (item) and assesses students' perception regarding oral and written communication skills, leadership, the use of equipment or software, and management. The final parameter, attitude, contains nine questions (item) and assesses student's attitude such as dignity, traits, etc. Table 1 lists the parameters measured in the questionnaire.

Table 1. Parameters and items measured.

Parameter		Items
Knowledge (K)	K1	Subject knowledge
	K2	Ability to apply knowledge
	K3	Ability to acquire new knowledge
	K4	Recognize the need for lifelong learning
	K5	Ability to study and analyze technical problem
	K6	Recognize the role of engineers in society
	K7	Recognize the role of engineers in sustainable development
Skill (S)	S1	Oral presentation skill
	S2	Written communication
	S3	Skill to use modern engineering or IT tools
	S4	Skill to manage engineering project or arts
	S5	Ability to listen and respond
	S6	Ability to make decision
	S7	Leadership
Attitude (A)	A1	Good self esteem
	A2	Self confidence
	A3	Good self-management
	A4	Good time management
	A5	Curiosity
	A6	Ability to work independently
	A7	Ability to adapt to working environment
	A8	Teamwork
	A9	Ability to work under pressure

All questions must be answered based on 5 point Likert scale, from 1 (not at all satisfied) to 5 (extremely satisfied). Students' perception will be evaluated based on the frequency scale chosen by each student before and after undergoing industrial training. The increase, decrease or no change scale, prior to and after undergoing industrial training will be recorded and presented in percentage form, plotted and tabulated at the end of this study.

In addition to evaluating students' perception through the questionnaire, this paper will also determine the validity and reliability of the questionnaire through the Rasch measurement model using the Winstep software. This model will also measure data reliability and validity in addition to evaluating the reliability the Cronbach Alpha (α). Data reliability could be revised through the reliability index and the separation of the items and the respondents. This will be discussed later in the paper when discussing the result of this survey. The evaluation of data reliability will be done through the fit statistics and rating scale measurement. For the fit of statistics measurement, three main criteria were reviewed, namely PtMC, MNSQ, and z-std.

PtMC is the correlation coefficient of the point of measurement. Correlation coefficient, r, is just as important as any other statistical values. An r value (absolute value) less than 0.35 is generally regarded as representing a low or weak correlation. A value between 0.36 and 0.67 indicates moderate correlation, and a value between 0.68 to 1.0 indicates a strong or high correlation. An r value equal to or more than 0.90 means a very high correlation [7].

The second characteristic in item fit is the mean squared or MNSQ. MNSQ refers to the fit statistics which indicate data accuracy or fit with the model. MNSQ is the fit statistics that meet the pattern of responses on the items and the respondents (students) targeted. An MNSQ value of 0.5 and lower indicates that the measurement is not very effective, 0.5 to 1.5 indicate sufficient degree of effectiveness, 1.5 to 2.0 indicates of lack efficiency for the development of measurement, and a value more than 2.0 indicates weakness in the measurement system [8].

The final characteristic in the item fit is the z-std which is also known as the t-test. It highlights data improbability, namely if the data really fit the model. This value will give an indication of how the patterns of response meet normal expectation. A value less than -2 indicates that data that are too easy to expect, 1.99 to 1.99 means that data can be well-expected, and a value between 2.0 and 2.9 indicates that the data is unexpected, and the value 3 and above indicates unexpected data. The characteristics of item fit explained could also be used to identify respondents who were careless when answering the questionnaire. This is to increase the quality of the research data analysis in order to ensure a more precise analysis [9].

The data validity measurement through the determination of the rating scale is a unique function in the Rasch measurement model which does not exist in classic statistics. It is able to determine the use of the best scale that should be utilized in a research instrument. Scale calibration is an important element in data reliability and validity. Data validity will determine whether or not the data collected is valid for further analysis and processing. Non-calibrated instrument will cause the data to be invalid and, subsequently, the analysis will not be accurate. However, the Winstep software is not a suitable tool for the analysis of the final result of this survey, namely to compare the response to the before and after IT questionnaire. Finally the researchers will analyse the result using Microsoft Excel to get the different before and after IT.

3. Result and Discussion

Forty seven Third Year students from JKAS were involved in this study, namely 21 male and 26 female students. Data reliability and validity analysis based on the Winstep analysis must be performed to ensure that the study result is of high quality before discussing the findings regarding students' perception. Table 2 shows the result of the reliability index revision for this survey. The Rasch Model column in the table shows an acceptable value in the Rasch Model analysis, while the next two columns present the findings before and after the students underwent IT. The Cronbach alpha reliability value for both analyses show that the value is within a good range [10]. In addition to measuring the Cronbach alpha reliability value, the Rasch Model also measure the reliability index and respondent segregation (students) and the items in the questionnaire. Table 2 shows that the value for student reliability index and items exceed the value required by the Rasch Model. This shows that the data obtained by this study is reliable.

Table 2. Reliability and validity index.

	Rasch Model	Before IT	After IT
Cronbach alpha	>.60	.95	.97
Respondent reliability	>.81	.94	.90
Item reliability	>.81	.90	.83
Respondent separation	>2.00	4.01	3.01
Item separation	>2.00	2.94	2.24

Data validity analysis was done using the point measure correlation and calibration structure. Table 3 shows point measure correlation for the validity of the items. In order for an item to be invalid, several criteria must be fulfilled, namely the items must lie within the following scales: PtMea Corr $0.32 < x < 0.8$, MNSQ outfit $0.5 < y < 1$, and ZSTD outfit $-2 < z < 2$. If an item's values for all three criteria fell outside the range, the item has to be revised. Table 3 shows that the MNSQ and ZSTD outfits values for items K1, K6 and K7 prior to undergoing IT (the circled item) lie outside the range. However, these items do not require revision since only two of the three criteria lie outside the range.

Most of the MNSQ outfit data in Table 3 fall between 0.5 and 1.5, which indicate a sufficient degree of effectiveness of the measurement. Therefore the data accuracy fits the model. Most of the z-std data fall between -2 and 2, which indicate that the data is what should be expected. Finally, the PtMea Corr, r, shows that correlation for almost all items after IT is higher than that before IT. Based on the r value for knowledge parameter, the data shows almost all items of knowledge is increased except for K6 which shows that students are not aware of their role and their contribution as an engineer in society during IT. As for the skill parameter, the higher values of r for each item show that IT can improve their skills as expected. Meanwhile for the attitude parameter, most of the r value is however slightly decreased but the value still indicates strong or high correlation which falls between 0.68 to 1.0.

Table 3. Item validity: Point measure correlation.

	Before IT			After IT		
	MNSQ outfit	ZSTD outfit	PtMea Corr	MNSQ outfit	ZSTD outfit	PtMea Corr
K1	1.63	2.40	0.56	0.95	-0.10	0.77
K2	0.73	-1.30	0.74	0.75	-0.80	0.81
K3	1.06	0.30	0.63	0.96	0.10	0.73
K4	1.28	1.30	0.54	0.97	0.20	0.65
K5	0.97	0.00	0.70	0.79	-0.80	0.82
K6	1.51	2.20	0.67	0.95	0.10	0.65
K7	1.82	3.20	0.57	0.68	-0.30	0.68
S1	0.86	-0.60	0.76	0.98	0.00	0.84
S2	1.02	0.20	0.68	1.36	1.20	0.76
S3	1.21	1.00	0.68	1.19	0.80	0.72
S4	0.71	-1.40	0.81	0.71	-1.30	0.84
S5	0.76	-1.20	0.75	0.60	-1.20	0.81
S6	0.88	-0.50	0.69	0.91	-0.20	0.75
S7	1.04	0.70	0.71	1.15	0.70	0.77
A1	0.70	-1.30	0.76	0.40	-1.20	0.77
A2	0.72	-1.50	0.74	0.68	-0.60	0.70
A3	0.68	-1.60	0.75	0.84	-0.20	0.70
A4	0.76	-1.20	0.76	1.13	0.50	0.70
A5	0.98	0.00	0.63	1.74	1.50	0.60
A6	1.02	0.20	0.73	1.08	0.30	0.73
A7	0.78	-1.60	0.68	0.97	0.10	0.67
A8	0.77	-1.10	0.72	1.17	0.50	0.66
A9	0.86	-0.60	0.67	0.57	-1.40	0.81

The second validity analysis conducted is the calibration structure analysis. It was done to test the suitability of the existing current scale. The number of scale must be corrected if the current scale fell within an invalid range. Figure 1 shows the rating scale calibration structure before and after IT. There are two scale determination methods, the calibration structure determination and the category probability curve graph assessment. Calculation of the calibration structure value (category measure) should be between 1.40 and 5.00 (1.40 < S< 5.00), which is the difference of value between the Likert (category label). The second method requires an assessment of the graph shown in the figure. Any scale overshadowed by other scales must be removed from the study. Figures 1(a) and (b) show the perception analysis before and after IT respectively. The calculation of the calibration structure was done and no scale was found to be outside the range. This was validated through the assessment of the graph shown in the figure, which shows that no scale is overshadowed or overlapped by other scales. The data analysis after IT shows that students only chose scales 3, 4 or 5 to rate the perceptions listed in the questionnaire. This shows that there is an improvement in their perception after undergoing IT. The majority of students chose 4 or 5 to indicate improved perception. Therefore, scales 1 and 2 should not be removed as the level of increase has to be measured before and after IT. All in all, the validity and reliability of the questionnaire data are at a good level. No removal or revisions need to be done to this questionnaire.

The following discussion on the effectiveness of IT from students' perception is based on the result of the survey. The 23 questions in the survey were divided into three parameters: knowledge, skill, and attitude. Table 4 shows students' perception of the knowledge parameter. Seven items were listed in this parameter. The majority of the students agreed that IT has increased their knowledge in the field that they worked in (K1), their ability to apply their knowledge (K2), their ability to study and analyse technical issues (K5), and their awareness regarding the role of engineers in the society (K6) and sustainable development (K7). For item K4, awareness of the need for continuous learning, an equal percentage of students, namely 46.8 percent, stated that their perception has increased or has not changed. However, almost 50 percent of the students stated that their ability to learn (K3) remains same during industrial training and slightly more than 10% stated that their ability to acquire new knowledge decreased. This could be due to the students being placed in an area that is not compatible with their field of study or due to obstacles faced by the students or the company.

The findings on students' perception regarding skill parameter in IT are shown in Table 5. The majority of the students stated that they have achieved more than 50 percent improvement in oral presentation (S1), written communication (S2), using modern engineering equipment or software (S3), managing engineering projects (S4), making decision (S6), and individual leadership (S7) skills. However, 57 percent of the students stated that their ability to listen and respond (S5) remains unchanged and only 40 percent believe that that have improved in this skill. It is possible that most of the students find that their exposure to IT did not improve their skills in the aspect due to the lack of knowledge or due to the obstacles or technical issues they faced at work.

Table 6 presents the findings on the attitude parameter. More than half of the students stated that their confidence (A1) improved after they underwent IT. However, the majority of the students stated that there was no change in eight items, including self-dignity (A1), good self-management (A3), good time management (A4), curiosity (A5), ability to work independently (A6), ability to adapt to work environment (A7), ability to work in groups (A8), and ability to overcome work-related stress (A9). The results for this parameter show that students feel that the 12-week industrial training that they underwent did not have an impact on their attitude although the experience did help them to improve their confidence.

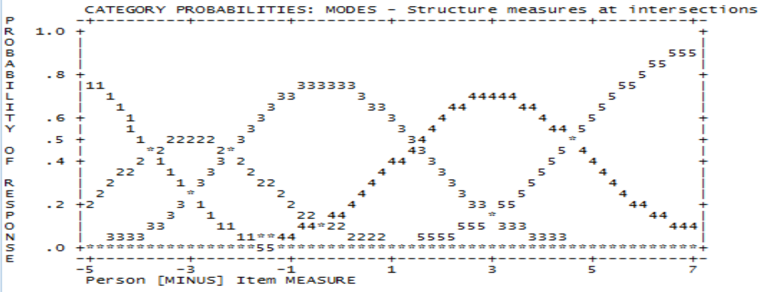
SUMMARY OF CATEGORY STRUCTURE. Model="R"

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	STRUCTURE CALIBRATN	CATEGORY MEASURE	
1	1	3	0	-1.26	-1.79	1.23	1.31	NONE	(-4.99)	1
2	2	33	3	-.78	-.81	1.06	1.03	-3.75	-3.02	2
3	3	318	30	.91	.90	1.03	1.03	-2.26	-.38	3
4	4	492	47	2.81	2.85	.99	.95	1.45	3.01	4
5	5	212	20	4.62	4.56	.94	.94	4.57	(5.70)	5

OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.

CATEGORY LABEL	STRUCTURE MEASURE	S.E.	SCORE-TO-MEASURE AT CAT.	----ZONE----		50% CUM. PROBABLTY	COHERENCE M->C	C->M	ESTIM DISCR	
1	NONE		(-4.99)	-INF	-4.14		0%	0%		1
2	-3.75	.60	-3.02	-4.14	-1.96	-3.93	46%	21%	.89	2
3	-2.26	.19	-.38	-1.96	1.41	-2.11	67%	62%	.98	3
4	1.45	.09	3.01	1.41	4.68	1.43	62%	77%	.97	4
5	4.57	.10	(5.70)	4.68	+INF	4.61	72%	48%	1.07	5

M->C = Does Measure imply Category?
C->M = Does Category imply Measure?



(a) Before IT

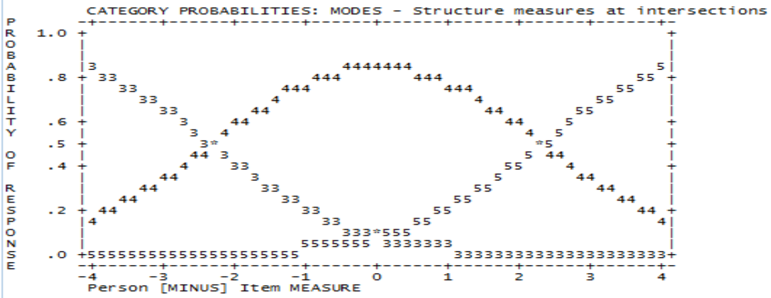
SUMMARY OF CATEGORY STRUCTURE. Model="R"

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	STRUCTURE CALIBRATN	CATEGORY MEASURE	
3	3	80	9	-1.62	-1.49	.92	.91	NONE	(-3.44)	3
4	4	493	54	.58	.54	.98	.87	-2.34	.00	4
5	5	347	38	3.61	3.63	1.05	1.04	2.34	(3.44)	5

OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.

CATEGORY LABEL	STRUCTURE MEASURE	S.E.	SCORE-TO-MEASURE AT CAT.	----ZONE----		50% CUM. PROBABLTY	COHERENCE M->C	C->M	ESTIM DISCR	
3	NONE		(-3.44)	-INF	-2.36		69%	28%		3
4	-2.34	.14	.00	-2.36	2.36	-2.35	74%	86%	1.06	4
5	2.34	.10	(3.44)	2.36	+INF	2.34	81%	74%	.96	5

M->C = Does Measure imply Category?
C->M = Does Category imply Measure?



(b) After IT

Fig. 1. Rating scale category structure.

Table 4. Students' perceptions of knowledge parameter.

		Increase	No change	Decrease
K1	Subject knowledge	61.7	34.0	4.3
K2	Ability to apply knowledge	68.1	29.8	2.1
K3	Ability to acquire new knowledge	40.4	48.9	10.6
K4	Recognize the need for lifelong learning	46.8	46.8	6.4
K5	Ability to study and analyze technical problem	68.1	29.8	2.1
K6	Recognize the role of engineers in society	59.6	38.3	2.1
K7	Recognize the role of engineers in sustainable development	61.7	38.3	0.0

Table 5. Students' perceptions of skill parameter.

		Increase	No change	Decrease
S1	Oral presentation skill	57.4	36.2	6.4
S2	Written communication	53.2	46.8	0.0
S3	Skill to use modern engineering or IT tools	61.7	34.0	4.3
S4	Skill to manage engineering project or arts	59.6	38.3	2.1
S5	Ability to listen and respond	40.4	57.4	2.1
S6	Ability to make decision	59.6	34.0	6.4
S7	Leadership	53.2	40.4	6.4

Table 6. Students' perceptions of attitude parameter.

		Increase	No change	Decrease
A1	Good self esteem	29.8	70.2	0.0
A2	Self confidence	53.2	44.7	2.1
A3	Good self-management	38.3	61.7	0.0
A4	Good time management	42.6	53.2	4.3
A5	Curiosity	29.8	59.6	10.6
A6	Ability to work independently	31.9	66.0	2.1
A7	Ability to adapt to working environment	38.3	61.7	0.0
A8	Teamwork	42.6	55.3	2.1
A9	Ability to work under pressure	42.6	53.2	4.3

The average change in students' perception of the parameters after undergoing industrial training is as shown in Fig. 2. For the knowledge parameter, 58 percent of the students stated that their perception has improved, 38 percent stated that their perceptions remain unchanged, and the perception of four percent of the students decreased. Most of the students felt that they have better knowledge after undergoing IT. Only a small number of students felt that they are less knowledgeable and this is probably due to their inability to learn on their own during their IT compared to their ability to learn in a formal classroom setting at university. For the skill parameter, 55 percent of the students showed improved perception, 41 percent stated that their perceptions remain unchanged, and the perception of four percent of the students decreased. This shows that the majority of the students believed that their skill has improved after IT. However almost half of the students felt that IT did not help them to improve their skills and this could be due to several factors. The student might have being placed on site without having sufficient exposure to modern tools/software, or they might have only been given the task of communicating and delegating tasks to labourers. Some of the students might lack the confidence to voice out their opinion or make decisions when working with senior colleagues, and this prevents them from acquiring new knowledge. For the attitude parameter, 39 percent of the students stated improved perception, 58 percent stated that their perceptions remain unchanged, and the perception of three percent of the students decreased. This shows that, based on students' perception, industrial training is an effective way of improving students' knowledge and skills, but it did not contribute much in improving their attitude. The attitude of the majority of the students remain unchanged due to a relatively short period of IT which do not give them sufficient time to adapt the working environment, develop self-confidence, and learn the art of self-management. Furthermore some of the students have been placed in different department/section for 2-3 weeks to ensure that they gain exposure to several different fields.

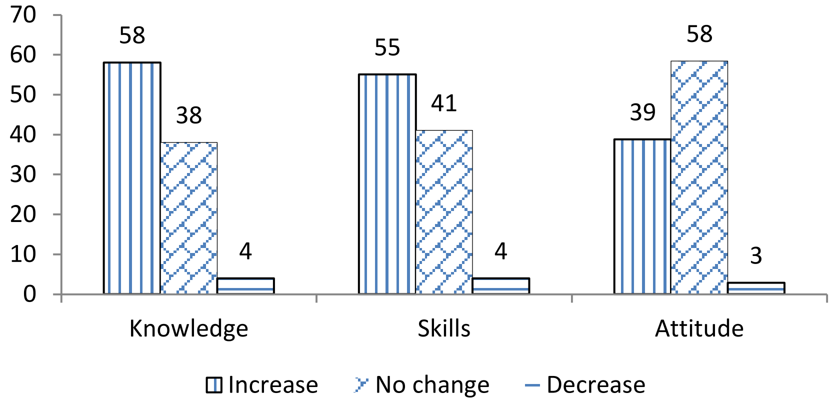


Fig. 2. Average change based on the measured parameters.

4. Conclusion

All in all, the industrial training program is clearly effective and beneficial to students as it provides professional skills not taught at the university. The knowledge and experience acquired by the students during industrial training could serve as guidance when planning for a better career in the future [11]. Based on the questionnaire administered on students before and after the industrial training program, several conclusions can be made:

- More than 50 percent of the students stated that they were able to improve their knowledge and skill parameters through the industrial training program. The remaining students are of the opinion that industrial training does not have any impact on their knowledge and skills; in fact some students feel that the training has an adverse impact on their knowledge and skills.
- Only 39 percent of the students agreed and believed that their attitude parameter improved when they undergo industrial training. More than half of the students stated that they did not experience any improvement in their attitude when their industrial training ended. Therefore, a more detailed questionnaire should be administered to identify the attitude parameter that need to be improved in future implementation.
- The analysis from the Rasch Measurement Model shows that the data obtained from this survey is valid and reliable in that the data have fufilled the matching statistics assessment and the rating scale determination.
- The measured percentage for each parameter can be determined and identified, simulataneously can be used and reported as required in OBE program.

Acknowledgment

Authors wish to express their appreciation to the Engineering Education Research Center, Universiti Kebangsaan Malaysia for the research grant PTS-2014-031 and TKK5 Co-Faculty Fund in the effort to increase the teaching and learning quality in engineering education.

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