Factors Influencing the Improvement of Students' Critical Thinking and Problem-Solving Skill

An Industrial Training Intervention

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Abstract—Critical thinking and problem-solving skill is important for university students to increase their chances of securing a work placement. One way to improve this skill is believed through experiences gained from an industrial training. This study aims to investigate the impact of industrial training on the improvement of students' critical thinking and problem-solving skill. Further, it aims to explore the influence of selected factors on this skill improvement. These selected factors are demographic profiles of students, supervisors and organization, students' motivation, job scope, supervisor leadership styles and organizational culture. The study adapted Belbin Team Role Self-Perception Inventory as the research instrument of the research. A total of 1,227 students and 485 students from six public universities in Malaysia, have completed the pre survey and post survey respectively. Using paired t-test analysis, result exhibited that students' shown improvement in their critical thinking and problem solving upon completion of their industrial training. The results also exhibited that this skill improvement is best predicted when students performed independence job scope, being supervised by male supervisor and the supervisor and when the supervisors exercise transformational leadership styles. Some practical and empirical implications were drawn from the findings of this study.

Keywords—Critical thinking; problem solving, skill; industrial training; university students

1 Introduction

Critical thinking is an active process which conceptualizes, applies, analyze, synthesizes and evaluates information that is gathered from one's experience, reflection, observation or communication [1]. This process is important especially when dealing with complex and complicated problems as it requires high level of thinking [2]. As claimed by [3], critical thinking is a form of problem solving, where individual with

high-level of thinking are able to think differently, which resulted in an extraordinary outcome [4]. These extraordinary outcomes are due to metacognitive process of thinking used, which recalled and synthesized previous knowledge learned and experience acquired throughout his or her lifetime in the thinking. This process known as a reflection on past knowledge or actions [5]. In performing the reflection process, it will involve certain strategies in order to solve a problem [6]. The simplest analogy on reflection process is when a 5 years-old child is able to switch on the lamp after remembering on her mother actions. This analogy indicates that people starts to reflect back on their past actions.

Due to today's highly competitive business environment and increasing number of fresh graduates have urged employers to become very selective in the recruitment process. Those who are able to solve complex and complicated problems will have higher chances to be recruited. Unfortunately, those who cannot will remain unemployed. This situation gives a sign where university students should and must have an ability to think outside the box. Nevertheless, graduates are still very much lacking in this skill and as a result, failed to meet employers' expectations [7,8]. One of the barriers for students to improve in their thinking skills is argued due to traditional method of teaching and learning which give significant emphasize on rote learning. Using rote learning, students only remember or memorize the information instead of performing active learning [9]. Active learning is a process of learning where knowledge is acquired through questioning and make reflective actions on the information gained during the learning process [7]. Active learning helps students to have better and deeper understanding which consequently will help and improve their ability to solve complicated problems in critical way.

Critical thinking and problem-solving skills are important in enhancing graduates' employability as to assure that they are capable in coping with the advancement in work context [10]. Thus, the importance of this skill has prompted higher learning institutions to play a more significant role in producing a higher quality graduates who are better equipped, not only with the technical skills but with the soft skills required. One of the efforts taken by higher learning institutions in improving students' critical thinking and problem-solving skill is by insisting the university students to undergo industrial training. Often this effort is based on the notion that universities can and should produce holistic graduates who are ready for future employments [11]. The industrial training has been considered to provide students an opportunity to apply what they have learnt in the classroom to real workplace environment, and with the same aims to improve their critical thinking and problem-solving skill [12]. A study by Dvergsten and Haugen [13] using pre- and post-study found that experiential learning is an effective means to improve students' critical thinking skill [13]. This is supported by Smith et al. [14] whereby students are able to transfer their knowledge with the assistance of experts (in this case supervisor) during industrial training as reflection of knowledge through practical or hands on work.

With regards to the issue of skill deficiency, this study aims to investigate the impact of industrial training on the improvement of students' critical thinking and problem-solving skill and further to identify best predictor that contribute to this skill improvement. The predictors to be tested are student's demographic profile (gender,

ethnicity, field of study and academic performance), industry supervisor's demographic profile (gender, ethnicity, working experience and working position), organization's demographic profile (types of sectors and companies, and organizational size), student's motivation (intrinsic and extrinsic), supervisor's leadership styles (transformational, transactional and laissez-faire), job scope (independence and working with people), and lastly organizational culture (individualism versus collectivism and power distance).

2 Literature Review

Industrial training also known as an internship [15] or practicum [16]. Industrial training program is a combination between theoretical of the education and practical of world of work. This due to education is one of utmost importance for any country [17]. This program can be described as opportunities offered by organizations in terms of practical experiences [18] which graduates are willing and capable to learn as beginners on specific professions for a certain period of time [15]. Despite of giving students with practical experiences, yet the industrial training also can enhance the skills among students [18]. This has been supported by Khalid, Hamid, Sailin, Othman, Awang and Mat Nor [19] and Azmi, Kamin, Noordin and Nabil [20] who have found that the skills (technical and non-technical skills) of the graduates can be develop through industrial training program. In Malaysia, industrial training conducted is based on the following objectives and goals as outlined by Ministry of Higher Education [21]. These objectives and goals are:

1. To expose students with the real working environment
2. To expose students with the latest technology and knowledge in the market
3. To expose students with specific practice in respective fields of specialization
4. To enhance students' knowledge, skills (especially generic skills) and experiences regarding organization
5. To produce competent graduates
6. To improve employment opportunities
7. To close the links between higher education institutions (HEIs) and industries.
   Source:[21]

Usually, industrial training program can be either full time or part time based on specific period that been offered to the undergraduate students. Ahmad et al. (2018) in their study said that industrial training program is profitable for the students and university as well as industries itself [15]. In other words, it is a win-win cooperation between all stakeholders. Industrial training program can be considered as an effective way to increase the employability of the graduates itself [19].

Industrial training can be implemented in various industries. Based on research conducted by Ahmad, Mat Ali and Sulaiman [15], a number of different industrial background had participated in the study [15]. The paper revealed that students' performance in industrial training at the level of high satisfactory related to the skills. This show that industrial training is essential factor to prepare students for "work-

ready" in industries. However, the study created by Mohd Nor and Ismail [22] was aimed to investigate the effect of industrial training on academic performance of accounting undergraduate students in Malaysia [22]. The result show that a positive impact of industrial training on the academic performance of accounting students. Different from the study conducted by Azmi, Kamin, Noordin and Md. Nasir [20], that focus on engineering undergraduate students who have undertaken the industrial training program to see the competencies of the engineering graduates itself [20]. The findings of the research found that 100% students expect that while doing industrial training can exposed especially to real workplace in the industry. While the study form by Sharzadin, Utebayev, Syzdykova, Shaushekova, Kossybayeva, Mukhatayev and Kurymbayev [23], are focus on teaching industrial training in mathematics teacher education [23]. The study was made between modern teaching industrial training and the relevant experience in the 20th century. Hence, the next section will discuss on the methodology of the study.

3 Materials and Methods

A pre and post survey was conducted in order to achieve the research objectives. A total 2,000 students who about to undergo their industrial training have participated in the pre survey test. These students were among those study in six different public universities in Malaysia. After data screening, 1,227 questionnaires were left to further data analysis. Using similar respondents, the researchers have collected 485 usable questionnaires in the post survey through online medium. The questionnaire, as main research instrument for this study comprise of three sections. All demographic profiles of students, industry supervisors and organization were belonged to Section A. Meanwhile, factors of students' motivation, supervisor's leadership styles, job scope and organizational culture were outlined in Section B. Section C consists of questions related to critical thinking and problem-solving skill. This skill items were adapted from Thinking Roles of Belbin Team Role Self-Perception Inventory (BTRSPI) [24]. Motivation items were adapted from various sources (like [25,26]). Item for job scope were adapted from Hackman and Oldham [27] and Osland and Kolb [28]. A Multifactor Leadership Questionnaire (MLQ) [29] and Hofstede's cultural dimensions [30] were employed in measuring leadership styles and organizational culture respectively. In data analysis, demographic data were analyzed using descriptive analysis while paired t-test analysis was used in analyzing the improvement of critical thinking and problem-solving skill with industrial training as an intervention.

4 Results

In total, only 1,227 out of 2,000 students have completed the pre survey. Since most of the students did not returned back to their respective universities after the completion of industrial training, the researchers only managed to gather 485 usable questionnaires in the post survey. As expected, female respondents dominate the sam-

ple as compared to male respondents in both phases. Both phases also exhibited that high number of Malay respondents and then followed with Chinese respondents. With respect to field of study, it exhibits that majority of the respondents are Engineering students, followed by Science and Social Science students.

In supervisors' demographic profile, the number of male and female supervisors in industry who supervised the students was quite the same which is one to one ratio. Similar to students' demographic, majority of the supervisors are Malay, followed by Chinese, Indian and others ethnicity. Almost half of the supervisors are those who in middle management position and slightly in the same percentage was lower management position. Only 12.4% supervisors hold position as top management. The greater number of supervisors who are being assigned to supervise the students are those who have work more than 9 years.

Regarding the organizational demographic profile, most of the respondents got their placement in private sectors, as compared to public sector. More than half of them also performed their industrial training at national companies. With respect to organizational size, majority of the respondents undergone their industrial training in small organization where number of employees are less than 50. There are 30.7% respondents attended industrial training in large organization (consist of 151 employees and above), while the remaining in medium organization size. Table 1 represents results of selected factors that might influence students' critical thinking and problem-solving skill improvement. Two constructs of intrinsic and extrinsic motivation were used in measuring students' motivation.

Table 1 shows that students are highly agreed with both factors that motivate them to work during industrial training. The frequency of job scope was classified into four categories refer to never (1 – 1.75), seldom (1.76 – 2.5), sometimes (2.51 – 3.25) and always (3.26 – 4.0). Result in Table 1 exhibits both types of job scopes are within sometimes category, but most of the respondents stated that they performed independence job as compared to working with other people. The level of leadership however was categorized into high score (9 – 12), moderate score (5 – 8) and low score (0 – 4). Surprisingly, the respondents claimed that most of the supervisor exhibited laissez-faire leadership style and followed by transactional leadership style. Transformational leadership fall into moderate level with the score range of 7.70. Organizational culture is measured using a seven point of scale ranging from 'Strongly disagree' (1) to 'Strongly agree' (7). It appears that both organizational culture constructs fall into high level of agreement.

Table 1. Responses on selected factors

Selected Factors	Mean/Score Range*	SD
Intrinsic motivation	5.52	1.23
Extrinsic motivation	5.50	1.31
Independence job	3.19	0.76
Working with people job	2.86	0.87
Transformational leadership	7.70*	1.60
Transactional leadership	8.38*	1.93
Laissez-Faire leadership	8.61*	1.87
Individualism versus collectivism	5.27	1.20
Power distance	5.33	1.21

Table 2. Paired sample t-test of critical thinking and problem solving skill improvement

Items	Critical thinking and problem solving	Mean		Mean differ-ence	SD	t	Sig.
		Pre	*Post*				
1	In seeking satisfaction through my work, I tend to have a creative approach to solve problem solving.	5.25	5.38	0.13	1.17	2.437	.015*
2	In carrying out my day-to-day work, I tend to see pattern in solving problems where others would see items as unconnected.	5.11	5.26	0.15	1.27	2.618	.009**
3	When suddenly asked to consider a new project, I am able to take an independent and innovative look at most situation.	5.07	5.14	0.07	1.27	1.148	.252
4	I can see how ideas and techniques can be used in perceiving new relationships.	5.18	5.22	0.05	1.25	.800	.424
5	I analyse other people's ideas objectively, by evaluating both advantages and disadvantages.	5.36	5.36	0.00	1.24	.000	1.000
6	In seeking satisfaction through my work, I like to make critical discrimination between alter-natives.	5.05	5.17	0.12	1.37	1.883	.060
7	When trying to solve a complex problem, I like to weigh up and evaluate a range of sug-gestions thoroughly before choosing.	5.33	5.35	0.02	1.26	.325	.745
8	In carrying out my day-to-day work, I can usually find the argument to deny unsound proposition (ie. propositions that contain of invalid facts).	4.87	5.03	0.17	1.35	2.722	.007**
9	If I am suddenly given a difficult task with limited time and unfamiliar people, my feel-ings seldom interfere with my judgment.	4.77	4.93	0.16	1.51	2.323	.021*
10	When suddenly asked to consider a new project, I approach the problem in a carefully analytical way.	5.13	5.25	0.12	1.25	2.141	.033*
11	I take considerable amount of time to make judgement but most often, the judgement made is accurate.	5.06	5.16	0.10	1.22	1.814	.070
	Overall critical thinking and problem-solving skill	5.11	5.21	0.10	.087	2.482	.0138

**Significant at the 0.01 level (2-tailed); *Significant at the 0.05 level (2-tailed)

In measuring critical thinking and problem-solving skill improvement, the researchers had calculated mean difference (mean post-training minus mean pre-training). The mean is calculated from all eleven items for both phases of data collection. The positive mean difference indicates the improvement of this skill. Results in Table 2 shows that there is a significant improvement in critical thinking and problem-solving skill with a positive mean difference of 0.10. The results indicated that industrial training has proven as one of platform to enhance their skill. Meanwhile, results also exhibited that students have highly significant improvement ($p<0.01$) in two items. Specifically, they tend to connect information in solving the problems (Item 2) and they can identify and argue when invalid information arises (Item 8). In addition, the students also were reported to improve significantly in three items; as they can think critically to solve problem (Item 1), they can control their emotion when deal with unfamiliar people and in time constraint (Item 9) and they will analytically think if get new task (Item 10).

Table 3. Regression model (students' critical thinking and problem-solving skill)

Model	R	R2	Adjusted R2	Std. Error of the estimate
1	0.367a	0.135	0.123	0.61184
2	0.399b	0.159	0.151	0.60500
3	0.412c	0.170	0.177	0.60105

a. Job scope (independence); b. Job scope (independence), Supervisors' leadership style (transformational); c. Job scope (independence), Supervisors' leadership style (transformational), Supervisors' gender (male)

In determining the influence of selected factors on students' critical thinking and problem-solving skill improvement, a multiple regression analysis with stepwise method was employed. This study has recoded the categorical data for all demographic profiles into dichotomous variable or known as dummy variable. It is need to recode the data since multiple regressions only analyses variables with continuous data. Table 3 shows that the correlation between dependent variable (critical thinking and problem-solving skill) and a combination of three predictor variables (Independence job scope, transformational leadership and male supervisors) is 0.41. The relationship between these four predictor variables and dependent variable is significant as F $(4,458) = 23.820$ at $p<0.01$. The adjusted R-squared value from model summary is 0.177 which means 17.7% of variation in students' critical thinking and problem-solving skill is accounted by variation in the three organizational factors namely, job scope (Independence) and supervisors' leadership style (transformational) and supervisors' demographic (male supervisor). This variation is acceptable in Social Science research as asserted by Gaur and Gaur [31]. The regression coefficients (B) showed in Table 4 revealed positive and direct relationship with critical thinking and problem-solving skill. An increase by one unit in self and independence job scope, results to increase 0.199 units and similar to transformational leadership style. Besides, students who were supervised by male supervisor have higher (0.160) improvement in their critical thinking and problem-solving skill than those who were supervised by female supervisor.

Table 4. Multiple regressions analysis (stepwise) for predicting students' critical thinking and problem-solving skill

Model	B	t	Sig
Constant	0.977	3.775	.000**
Job scope (independence)	0.199	2.828	.005**
Supervisors' gender (male)	0.160	1.997	.046*
Supervisors' leadership style (transformational)	0.044	2.056	.040*

** Significant at the 0.01 level (2-tailed); * Significant at the 0.05 level (2-tailed).

Based on the multiple regression analysis result, the following equation was formulated to predict the improvement of critical thinking and problem-solving skill, result from industrial training intervention.

$$Y = 0.977 + 0.199X1 + 0.160X2 + 0.044X3 \tag{1}$$

where,
Y = Critical thinking and problem-solving skill
X1 = Job scope (independence)
X2 = Supervisors' gender (reference_male)
X3 = Supervisors' leadership style (transformational)

5 Discussion

Both objectives of this study had been achieved. Firstly, it aims to investigate students' critical thinking and problem-solving skill improvement based on industrial training intervention. Findings indicate that in overall, students have benefited from undergoing industrial training as they are able to solve problem critically. This is consistent with a study by Dvergsten and Haugen [13], where experiential learning, including industrial training requires students to make reflection on knowledge they have learnt at the university and then translate it into hands on work during the training period. This can be supported when students are able to solve problems when others unable to solve it and able to make justification of unsound proposition. Interestingly, they able to cope with their emotions when required to work with unfamiliar people and in time constraints, which in line with the employer's observation from a study by Sulaiman and Sapuan [32]. This situation can be a good sign for future employers in recruiting future employees who have high resistance in facing with any challenges [33]. In the same boat, learning process is more meaningful if students are able to use their cognitive skill in order to solve the complex problems [34]. In fact, constructivism learning theory stated that learning by doing can enhance students' cognitive skill or in this study refer to critical thinking.

Secondly, this study focuses to explore the influence of selected factors on critical thinking and problem-solving skill improvement. Results of multiple regressions analysis revealed that this skill improvement are best predicted if students performed job independently. This finding also might be closely related to an individual's internal motivation as it found to affect his or her tendency to think critically [35]. In other

words, students choose to think critically when they have high interest and independence on tasks given. This is also consistent with argument made by Esterle and Clurman [36], where the encouragement of critical thinking includes one's 'feeling', which associated with willingness and interest of specific tasks. Further, the improvement of critical thinking and problem-solving skill is best predicted if students being supervised by male and transformational supervisor. In terms of gender, past studies found mixed results; man performed better in critical thinking and problem solving [37,38,39,40] female performed better in critical thinking [41] and there is no difference between genders in respect to their critical thinking abilities [42,43]. It is undeniable that transformational leadership can stimulate followers' critical thinking skill as numerous studies have proven this claim [41,44,45]. Such leaders will stimulate followers though and cognitive thinking through different perspectives in solving problems. Consequently, the followers will able to think innovatively and critically since they gained support and encouragement from their leader.

The outcomes of this study have lent credence to the scope of knowledge in critical thinking and problem-solving skill. It also contributes to all stakeholders that affected to industrial training. The stakeholders should fully utilize the industrial training programme as it proven to improve students' critical thinking and problem-solving skill. Students can benefit from industrial training in translating theory into practical through reflective and active learning. Besides, higher learning institutions can benefit from the training is assisting the institutions to produce holistic graduates. Host organization, meanwhile can benefit by knowing latest knowledge from the students. Since the industrial training importance to the stakeholders, thus it is recommended that students should properly consider right industrial training placement. Higher learning institutions and organization should find ways to improve the effectiveness of industrial training programme. For example, to consider given appropriate job scope and supervisor in organization should implement transformational leadership style.

6 Acknowledgement

7 References

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