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A mixed-method analysis on students' critical thinking and problem solving skill development in Malaysian public universities

S A Rodzalan¹ and M M Saat²

¹ Department of Technology Management, Universiti Tun Hussein Onn Malaysia, Parit Raja Batu Pahat, Johor, Malaysia

² Department of Accounting and Finance, Universiti Teknologi Malaysia, Skudai Johor, Malaysia

E-mail: shazaitul@uthm.edu.my

Abstract. Employers nowadays are looking for potential fresh graduates who are able to think outside the box, so that they can produce with quality works. However, they are failed to do so and this situation result in high unemployment rate among graduates, mainly in Malaysia. With this concern, this paper aims to examine students' critical thinking and problem solving skill development after undergoing an industrial training. Further investigation also examines relationship of the skill development with respect to supervisors' leadership styles. Both quantitative and qualitative methods were employed, with three hypotheses were tested. A total of 2,000 undergraduate students from six public universities in Malaysia involved in pre- and post-training surveys. In assessing students' critical thinking and problem solving skill, eleven items in Belbin inventory on Thinking role was used. Meanwhile, nine employers and twelve students were participated in the interviews and they were asked regarding their perception of industrial training in assisting the development of critical thinking and problem solving skill. Descriptive analysis (such as mean), paired samples t-test, correlation and content analysis were utilized for the data analysis. Overall, results reveal that students developed in their critical thinking and problem solving skill upon completion of the industrial training. The results also demonstrate that there is a relationship between transformational leadership style the skill development. The findings of this study provide the necessity for industrial training stakeholders to improve industrial training program, mainly by implementing appropriate leadership styles.

1. Introduction

One of challenges faced by higher learning institutions is to produce graduates who possess with both hard and soft skills (and known as generic skills), as required by employers nowadays. Specifically, the employers seek potential employees who are able to think outside the box as it provides an advantage for the organization to stay compete with others. Therefore, university graduates as one of the sources for human capital should meet with the employers' requirement. Unfortunately, most of them were still lacking to think critically in solving the problems as reported by past studies [1, 2]. An option to develop students' generic skills is through sending them to industrial training. The industrial training exposes students with real working environment, provides practical work, enhances students'



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knowledge and skills as well as serves with employment opportunities. Specifically, industrial training can be defined as students' placement in an organisation by taking part in supervised practical work in selected industries, either outside or inside the country, within a certain period of time before they are awarded certificate, diploma or degree [3].

It is undeniable that industrial training could develop students' generic skills [4], however, little research has looked into the development of specific skills such as critical thinking and problem solving skill. The limited research of this area has motivated this study to be conducted. Thus, this pre- and post-training study aims to examine the development of students' critical thinking and problem solving skill after attending the industrial training program. In addition, it also attempts to examine the relationship of this skill development with regards to the factor of supervisors' leadership styles refer to transformational, transactional and laissez-faire.

The next sub-section discusses on model of critical thinking and problem solving, and leadership model. It also includes past studies related to this skill and its relationship with the factor supervisors' leadership styles. The following section then explained methods used and continues by reporting the findings. Subsequently, it concludes with a brief discussion and outlines both practical and empirical implications.

1.1. Model of critical thinking and problem solving skill

In describing students' thinking process, this study implements model by [5] which is the main focus in learning and teaching context. The model suggests that students engaged with learning process through repetitive activities, memorizing, understanding and reflecting. All of these processes require them to think in order to achieve effective learning outcomes and thereby enhance problem solving skill. However, the order of thinking differs at each stage. For example, reflecting stage requires higher order thinking (critical thinking) as compared to repetitive or memorizing stage. There are factors which may influence students' thinking process. These factors are teacher-student relationship, collective or collaborative studying, deep approach and transformational learning. In the context of this study, lecturer plays main role in providing clear instruction and conduct interesting activities in the class. The lecturer should provide students with challenging tasks that require them to think critically, instead on focusing in rote learning [6].

Moving from repetitive activities or memorizing into understanding stage, students may influence with the second factor, which is collective or collaborative studying. By working collaboratively, students will experience the process of analyzing the problems and express their ideas to other team members [7] which later enhance their understanding of knowledge learned. At this understanding stage, students will attempt to make sense of the knowledge learned through deep approach to learn. Students who integrate with this approach have commitment to understand the knowledge, and thereby reflected in using variety of methods.

As mentioned by [8], reflection process is one of essential elements in critical thinking. Reflection requires one's thought in making inferences, analogies, evaluations and explore deep understanding regarding the specific knowledge, and these relate to problem solving [9]. The outcome of reflecting process then results in the transformational learning as it influences the whole learning process. In short, transformative learning requires students to have broader view based on their past experience through critical reflection process.

1.2. Full Range Leadership Model (FRLM)

The FRLM represents three leadership styles that start with the lowest leader interaction of laissez-faire behaviour to transactional leader behaviour and reaching the highest transformational leader behaviour. These three leadership styles are represented by eight distinct factors of leadership behaviours. In particular, [10] proposed that the leader who avoids involvement in leading process is called laissez-faire leader. The laissez-faire is the most ineffective leadership style as the leader avoids taking decision, delay to deal with problems and ignore with the responsibilities and authority given

[10]. In this situation, the laissez-faire leaders can be said to have no leadership behaviour as they hands over all the work to their followers. In the context of this study, trainees who being supervised by laissez-faire supervisor will become more independent and being given freedom in accomplishing the tasks. However, lack of supervision may undermine their generic skills development as less interaction between trainee and supervisor and worse, it prevents them to explore new knowledge [11].

Secondly, the transactional leadership style is described as leaders who either actively or passively monitor the work by providing followers a contingent reward for attaining targeted goals. As developed by [10], transactional leadership style has been characterized as an exchange relationship between leader and followers. Here, "exchange" means that the followers will receive rewards (such as financial benefits and promotion) for achieving targeted goals. This type of leader is more focusing on meeting specific goals [12], without taking any consideration to change followers' personal values and commitment to work. In addition, [13] suggested that leader monitors followers' work and takes corrective action in timely manner by exhibiting management by-exception (active) behaviours. In contrast, passive leader will only intervene when the problems are occurred. Thus, in relation to this study, trainees may have low generic skills development and vice versa when they were being supervised by passive supervisor. Moreover, the exchange of contingent rewards may extrinsically motivate the trainees' commitment to work in short term.

Unlike transactional leader, transformational leaders being characterized as leaders who are respected, charismatic and able to motivate employees by inspiring them, stimulate their thinking and treat them individually. Specifically, there are four main behaviours of transformational leadership style which are idealized influence, inspirational motivation, intellectual stimulation and individualized consideration [10]. Firstly, the idealized influence is the degree where the followers view their leaders as a role model to be inspired with. The leaders who maintains with high moral standards may influence their followers to emulate them [10]. Secondly, the leaders' ability to drive commitment of their followers in attaining the goals is known as inspirational motivation behaviour. Apart from that, leaders used intellectual stimulation in order to encourage followers to think critically and solve the problems in new ways [10]. Most of the time, the leaders will provide their followers with interesting and challenging tasks and ask them to solve in their own way [14]. Thus, if supervisor assists the trainees to think critically and find other alternatives to solve the problems, it may result in improving their critical thinking and problem solving skill. Lastly, the individual consideration refers to the extent where leaders recognize followers need by treating them individually, but all are treated equitably. By having this behaviour, the leaders delegate the work to followers with the aims to provide learning opportunities and coach them if they need it. But in the scope of this study, supervisor should play a role to closely supervise and monitor trainees' work as they are newcomers to work in real workplace. Such closely supervision through regular interaction may enhance trainees commitment in their work, and thereby improve their critical thinking and problem solving skill [13].

1.3. Critical thinking and problem solving skill development

As people become adults and matured, they started to encounter with more complicated problems, especially when it comes to problems at the workplace. The notion also being supported by [15] where employees should able to think outside the box in facing those complicated problems. Thus, it is not surprisingly when educational system in worldwide concern to emphasise on students' critical thinking and problem solving skill [16]. With the concern, higher education in Malaysia has also emphasised to inculcate concept of higher-order thinking or HOT into teaching and learning process, mainly in tertiary education [17].

For that reason, a number of studies were conducted to investigate the effects of university experience (in terms of coursework, tests and assignments, classroom learning and others) regarding critical thinking and problem solving skill [18, 19]. Furthermore, there were studies that highlighted the importance of this skill, in particular to university students [21-25]. A longitudinal study by [18] indicated that students developed their critical thinking skill after undergoing learning process in the classroom. However, the study used a small number of sample size (n=34 students) which may affect

towards the validity of the study. In avoiding this issue, the present study intends to have a large number of sample sizes in order to ensure the findings are more valid and accurate. [20] found similar finding where students developed their critical thinking skill after answering high-ordered questions. In their study, they had designed three different methods with undergraduate students became the sample size of study. In contrast, a longitudinal study by [19] showed almost half of total 2,322 American College students made no significant development during first two years of college, while more than quarter of the sample size also made no significant development after an entire four year college degree.

In relation to the importance of critical thinking and problem solving skill, [21] studied on the importance of critical thinking skill according to the disciplines. In their findings, engineering discipline was still vague with the concept of critical thinking skill as compared to humanities discipline. A study in Ghana found that both employers and graduates agreed with the importance of critical thinking skill for accounting education [23]. This study used survey method of 46 employers and 164 accounting students. There are studies which also investigated on critical thinking and problem solving skill development within the context of industrial training. Industrial training is a platform where students are able to transfer their knowledge to contexts beyond education, which involve practical tasks that require some reflection on knowledge learned in university, add up with assistance from the experts [26]. Such opportunities permit students to improve knowledge, skills and attitude as an early preparation into the future career. In assessing the development of critical thinking and problem solving skill towards working experience, [32] conducted interviews with 12 students who had completed their training. Based on the interview sessions, students were able to experience how to solve problems effectively.

Other past study showed the occurrence of reflection process throughout work-based experienced (WBE) module acquired by students [26]. Thus, it aligns with the critical thinking model which also stressed out the reflection process where students are able to think critically, and look the problem in various perspectives [5]. As they are able to think critically, it may motivate them to work harder and simultaneously increase their job satisfaction. In contradict with the encouraging result of both skill, [25] found that graduates were still shortage with problem solving skill although it is important. This perception was based on the interview sessions with 30 employers. Furthermore, a cross sectional study on 118 students also produced with negative results, where students were unable to think critically and solve problems during industrial training [4].

1.4. Relationship between supervisors' leadership styles and critical thinking and problem solving skill

With regards to supervisors' leadership styles, a number of past studies did confirm that a leader with transformational leadership was able to enhance follower's thinking skill [13, 21, 27, 28]. It is closely linked to one of the factors in transformational leadership, which is intellectual stimulation [10]. Such leader always encourages and helps followers to view problems in other perspectives by stimulating them to be innovative and creative in solving the problems [27, 28]. On the other hand, transactional and laissez-faire leadership styles seem to have no influence on students' critical thinking and problem solving skill. This is due to the transactional leader only intervenes when needed and provide rewards when the followers attaining goals, while the laissez-faire leader gives total freedom to the followers to complete the tasks given [10].

2. Research method

A pre- and post-training survey (before and after industrial training) was conducted to examine the development of students' critical thinking and problem solving skill. Based on the population of undergraduate students from Malaysian public universities, students from three fields of study (social science, science and engineering) were selected as the sample size. A total of 2,000 questionnaires were distributed in the pre-training survey, but only 1,227 questionnaires were completed and usable for data analysis. The researcher has self-administered the pre-training survey during industrial

training briefing sessions. For the post-training survey, a total of 485 students completed the similar questionnaire through online medium. In addition to the pre- and post-training survey, the researcher also conducted interview sessions with nine employers and twelve students (similar students who have participated in the survey).

Both pre- and post-training survey comprises of eleven items related to critical thinking and problem solving skill. Meanwhile, nineteen items of supervisors' leadership styles are also included in the post-training survey. In measuring the development of critical thinking and problem solving skill, students had to rate their acceptance based on seven point scale ranging from "strongly disagree" (1) to "strongly agree" (7). Students were asked to rate the items of supervisors' leadership styles based on five point Likert scale; Not at all' (0); 'Once in a while' (1), 'Sometimes' (2), 'Fairly often' (3) and 'Frequently' (4). All items used in obtaining the development of critical thinking and problem solving skill data were adapted from Thinking roles of Belbin Team Role Self-Perception Inventory (BTRSPI) [29]. In regards to supervisors' leadership styles, a Multifactor Leadership Questionnaire (MLQ) by [30] was employed. They categorized nineteen items according to three leadership styles refer to transformational, transactional and laissez-faire. With respect to interview sessions, the employers and students were asked regarding their perception on the effectiveness of industrial training in developing critical thinking and problem solving skill. The data from interview sessions provide support for the quantitative findings.

In analyzing the data, paired samples t-test was used to measure critical thinking and problem solving skill development. Besides, correlation analysis was conducted in identifying the relationship between the skill development and supervisors' leadership styles. Meanwhile, content analysis was used in analyzing the qualitative data.

3. Findings

The following analysis was to report students' demographic profile, related to gender, age, races and academic discipline. A total of 2,000 students from six public universities in Malaysia answered the pre-training questionnaire with 1,227 usable questionnaires in this pre-training. However, the number of respondents in the post-training decreased approximately 40% from the pre-training. In pre- and post-training, female respondents constitute more than half of the sample compared to males. This is consistent with statistics provided by the Ministry of Higher Education Malaysia (Statistics of Malaysian Higher Education, 2009). The proportion of ethnicity in pre- and post-training was almost similar, as Malay respondents dominate the sample followed by Chinese respondent and the remaining were Indians and other races. The distribution of respondents in regards to field of study appears that the ratio is almost the same for pre- and post-training. Briefly, the majority of respondents were engineering students, the next largest consists of science student, followed by social science students.

With regards to demographic profile of employers who have being interviewed, there are three males (SS1, SS2, E1; SS: *Social Science*, E: *Engineering*) and six females (SS3, S1, S2, S3, E2, E3; S: *Science*) employers were participated in semi structured interviews. Out of nine interviewees, there are four employers with experienced of eight to twelve years in supervising the trainees, while the rest are six years and below. Meanwhile, there are five males (SS4, S3, E1, E2, E5) and seven females (SS1, SS2, SS3, S1, S2, E3, E4) students were participated in the semi structured interviews. Out of four social science students, two of them were assigned in accounting department (SS1, SS2), while the other two in audit and finance (SS3) and human resource department (SS4). Meanwhile, there are two science students who undergone their industrial training under research and development department (S2, S3), but only one Science student has been placed in administrative department (S1). On the other hand, there are three out of five engineering students were assigned in project site (E2, E3, E4) while the other two engineering students were placed in consultation (E1) and testing and inspection department (E5).

3.1. Critical thinking and problem solving skill development

Paired samples t-test results show that students who undertook industrial training have developed in

critical thinking and problem solving skill in all eleven items (positive mean difference). Students developed significantly ($p < 0.05$) in three items related to have creative approach to solve problem (1), feelings seldom interfere with judgement if given to work with limited time and unfamiliar people (9) and approach the problem in analytical way (10), while the other two items; able to see pattern in solving problems where others would see items as unconnected (2) and able to deny propositions that contain of invalid facts (8) were reported to have highly significant development ($p < 0.01$).

Using the paired samples t-test, it is found that students have developed significantly in critical thinking and problem solving skill after finishing their industrial training. This can be seen from the mean score of pre-training is lower than mean score in post-training (5.11 to 5.21).

3.2. *Relationship between supervisors' leadership styles and critical thinking and problem solving skill development*

This section highlights that there is a positive relationship between transformational leadership style and critical thinking and problem solving skill ($r = 0.244$, $p < 0.05$). However, correlation analysis for *Transactional* and *Laissez-faire* show different results as it appears that there is no relationship occurs between these two leadership styles and critical thinking and problem solving skill. This suggests that as supervisors implement more with this leadership style, the more students will develop in critical thinking and problem solving skill. The findings indicate that the development of students' critical thinking and problem solving skill is only associated with transformational leadership styles, but not with the other two leadership styles.

3.3. *Employers' perception on critical thinking and problem solving skill development*

A number of employers raised an issue of students' attitude related to their thinking and problem solving skill. For instance, SS2 reiterated '... most of the trainees always follow the guideline given to them without having any initiatives to solve the problems'. In other words, students are unable or most probably avoid thinking critically as they have being given a certain way or guideline on how to do and solve the problem by their supervisor. In fact, SS2 also asserted that 'trainees are less independent and very most situation they need close supervision, and I observed only few of them are able to solve on their own'.

Out of nine employers, only E1 highlighted that trainees were unable to develop critical thinking and problem solving skill due to lack of creative approach and unable to link theory into practice. This is evident based on his observation, '... usually, I notice they (trainees) prefer to solve the tasks in simple ways, whereas there are many ways to solve it'. Again, he suggested that the lecturers most probably should adopt learning process which is more fun and attractive, despite focusing on the traditional method of rote learning. Based on these observations, it is evident that students' attitude in relying on the guideline and less independent may undermine their development in critical thinking and problem solving skill.

On the other hand, four employers mentioned that they felt trainees had developed their critical thinking and problem solving skill throughout the industrial training period. These employers reported that this development resulted as they were able to reflect theory into practical work, and were able to understand tasks given. Employer, E2 said: 'When I ask them how to solve the problem, they are able to solve it in their own ways...I am very satisfied'. However, SS3 employer argued that this development may take time. She further explained that in the beginning, the trainees faced difficulties to understand the relationship between practical and theoretical aspect, but they were able to overcome this situation as they observed what have being done by their supervisor.

3.4. *Students' perception on critical thinking and problem solving skill development*

Out of twelve trainees, nine of them agreed that they have development in their critical thinking and problem solving skill. For example, SS2 asserted that, 'Once I enter this company, I realised that I need to think outside the box because most of the work is complicated. In fact, the guideline given also just tells you the basic solution'. She added that, it requires her to think creatively in solving the

problems. Moreover, S2 reiterated that: ‘...I must find other alternatives when inspecting the quality of the equipment ...’. By having similar opinion, E1 shared his experienced:

‘During industrial training, I learn how to speak with others, but most importantly, I noticed that I am able to become a good problem solver. For example, there is a case where I need to handle the process of filing. Worse, they handled me the failed project. So, I need to start from the scratch, which requires me to think critically. At first, it quite difficult, but I still managed to solve it. The best thing, my supervisor was impressed with my ideas.’

On the other hand, there are three trainees (SS3, E3 and E4) claimed that they have less development in critical thinking and problem solving skill. This is evidenced based on claimed made by SS3, ‘... I just follow the guideline, no need to think other method in solving the problem’. However, she realised that job rotation during six months of industrial training allow her to think critically. As she mentioned, ‘In accounting department, I just follow the guideline in order to ensure the account is OK, but when transferred to taxation department, I need to think critically. It was two different things to do’.

All the trainees agreed that the supervisor’s approach in stimulating their thinking also one of the factors that lead to develop the skill in solving problem critically. SS4 stressed out that, ‘Even though my supervisor provides the trainees with close supervision, yet, she did not allow you to have similar solution as others. We need to find other approach in solving the problems.’ He also highlighted that his supervisor only provide some hint to solve the problems. In other words, SS4’s supervisor intends to stimulate the trainees’ thinking, by teaching them not to rely only to one solution. Other than that, SS2 emphasised that passion and interest while working is also important factors to develop skill in solving problem critically. She said, ‘My work is quite challenging and require a lot of critical thinking. Because I love my work, I managed to handle it.’

4. Discussion and recommendations

This study aims to examine the development of students’ critical thinking and problem solving skill after undergoing industrial training. The industrial training appears to be an imperative method in developing students’ critical thinking and problem solving skill. Result of paired samples t-test shows that there is an increment of overall mean score in the post-training. This supports result from a pre-and post-training study by [31], where he found that students’ perceived development in their critical thinking and problem solving skill. In similar vein, data from qualitative finding based on stakeholders (employers and students) perceptions also support the quantitative findings, where students were able to think critically in solving the problem. Nevertheless, employers stressed out the issue of students’ attitude who avoid thinking critically.

When examining the results of the eleven critical thinking and problem solving skill items, students highly agreed that they evaluated both advantages and disadvantages of other people’s ideas in solving the problems. Most probably, they have being taught to evaluate pro and cons before making decision in solving the problem. They also have a creative approach and innovative look in solving problem. Furthermore, they agreed that they were able to make accurate judgement if they were allocated with sufficient time. This agreement supports the observation made by the employers and consistent with a study by [4]. Besides, students perceived that they were able to work under pressure and unfamiliar people which give good impression to future employers as they were able to cope with real life situations [32]. The results from this study seem to support the model by [5] where students required to understand and reflect what they have learned in classroom as these processes lead to higher order thinking in solving the problems.

Correlation analysis showed that there is a relationship between transformational leadership and critical thinking and problem solving skill. However, the other two leadership styles (transactional and laissez-faire) show no relationship with this skill development. This expected finding might be related the factor of intellectual stimulation of transformational leadership where supervisors stimulate their students to be innovative and creative by looking old situations in new perspectives [13]. On top of that, intellectual stimulation, as part of transformational leadership is identified to help fosters

subordinates' motivation through engagement of inner interest and psychological needs [33]. As a result, the students will apply skills that they acquired from supervisors and thus show development upon completion of their industrial training.

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