

The Effectiveness of Higher Order Thinking Skills for Generating Idea among Technical Students

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Abstract— Higher order thinking skills (HOTS) is an imperative aspect in teaching and learning especially at higher education institutions. Students with higher order thinking skills are able to find new ways to solve their daily problems and make appropriate decisions. Hence, the purpose of this research was to evaluate the effectiveness of HOTS for generating idea among technical students. This quantitative approach research used the quasi-experimental design with one treatment groups and one control group comprising 81 students. Marzano HOTS was used for generating idea in this research. Meanwhile, individual assignment evaluation rubric was modified to assess the level of achievement on the students' assignments. The findings showed that there was significant differences between treatment group and control group on the overall individual post assignment result. There were significant differences between treatment group and control group on the five evaluation criteria of individual post assignment result. Besides that, the findings revealed that treatment group have significant differences between individual pre and post assignment on overall and five evaluation criteria result. Consequently, learning HOTS by using self-instructional manual approach for generating ideas is significantly effective.

Keywords— Generating idea, Marzano higher order thinking skills, quasi-experimental, technical students.

I. INTRODUCTION

IN this era of globalization, knowledgeable and skilled workforces are indispensable in a country's economic growth [1]-[2]. Workforce must be equipped with the skills to think like efficiency information handling, problem solving, collaboration, critical and creative thinking [3]-[4]. Reference [5] states that the ability to generate creative ideas also are the

skills required in the job market. This is because generating ideas is a crucial part in decision making and resolving a problem [6]-[8].

Nowadays, world continuous change thrives on creative individual. The important keys to success in today's intensely competitive and dynamic environment are creativity and innovation [9]. Creativity has always played a central role in generating idea. Core part of the innovation process are ideas [10]. Each innovation begins with an idea [11]. Idea is a basic element of thought which can be visual, concrete or abstract [12]. Idea also is all stages of the cycle of abstract thinking [13]. Consequently, idea defined as something such as a thought or conception that potentially or actually exists in the mind as a product of mental activity [14].

However, generating idea is a process of creating, developing and communicating ideas. Therefore, generation of ideas is categorized as a higher order thinking skills (HOTS) activities that require high level creative thinking and action [15]-[16]. Complex thinking skills such as problems solving, creating, analyzing, evaluating and others are needed to process the collected information [17]-[18] for generating an idea.

Idea generation occurs in our brain through cognitive, metacognitive, chemical and biological process [15]. HOTS is the highest level in the hierarchy of cognitive processes. HOTS enable students to overcome the challenges that too much information in this information age, but the time for processing is limited [19]. HOTS can help individuals analyze information in a systematic way to solve unique problems [20]-[22].

Additionally, HOTS challenges us to interpret, analyze and manipulate information [23]-[24]. An individual with high level thinking will be able to use the new information or prior knowledge and manipulate information to obtain a reasonable response to new situations [25]-[26]. Consequently, creative ideas can only be generated through high level thinking, instead of the low level thinking through the application of knowledge learned in daily lives.

In conclusion, mastering HOTS is important to nurture talent for inventions because HOTS can help an individual to generate and produce new ideas, hypotheses and to confirm by experiment and observation. HOTS is one of the factor to achieve success in one's inventions [27]. In other words, HOTS is needed to build the essential elements to produce an

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unique, original and useful creation.

II. PROBLEM BACKGROUND

In the 21st century, students at Institute of Higher Education (IHE) are given a variety of academic and non-academic projects that require them to solve problems creatively. University students need to generate ideas to complete their coursework either in the form of written assignments or completing a project [28]. Thus, [29] stated that generating new ideas is often emphasized as students' assignments become more complex and challenging.

Good ideas cannot be generated easily. Interesting ideas are not instant successes but need to take time to develop it. A number of obstacles in understanding and application of idea generation techniques also exist among students [30]. According to research [6], the majority of technical students regardless of gender, year of study or intake have difficulty in generating ideas when completing coursework assignments individually.

Many technical students have difficulty generating ideas whether it is to be used to produce concrete or abstract product [31]. Technical students have a high level of difficulty in producing projects (concrete idea), and a moderate level of the difficulty in completing a written assignment (abstract idea) for engineering education courses [32].

This finding is consistent with studies of [33] stating that most students are not able to think outside of the box and generate ideas intuitively and spontaneously. The factor contributing most to the difficulty in generating ideas among technical students is deadlock of ideas. Deadlock of ideas is a reflection of the weakness of a thinking skills [34].

Based on research [35], a total of 375 technical students responded that none of the technical students perceived their thinking skills' levels to be high. Only four Marzano HOTS, namely comparing, inductive reasoning, deductive reasoning and investigation are rated at the moderate level. On contrary, nine Marzano HOTS are rated as low.

Students who are weak in HOTS cannot complete the tasks based on cognitive and metacognitive effectively [36]. Implications, academic performance will be affected. The need to generate multiple ideas has become a necessity for every student in order to complete their course assignments. Consequently, overcoming the difficulty in generating ideas is crucial.

As a solution, students need to learn HOTS to address the difficulty in generating ideas [37]. This is because HOTS is a metacognitive process that teaches how to use a method of observing and learning process information in idea generation.

We hypothesized that using HOTS can address the difficulty in generating ideas effectively. It may lead to the problem in completing students' course assignments. Consequently, to test this hypothesis, the following research objectives were arisen. The specific objectives of this study are to identify:

- i. The difference in overall mean scores of individual post assignment between treatment group and control group.

- ii. The difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group.
- iii. The difference in overall mean scores between pre and post individual assignment for treatment group and control group.
- iv. The difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group.

III. RESEARCH METHODOLOGY

The effectiveness of using HOTS in generating ideas was identified based on the quasi-experimental design. Quasi-experimental design is one of suitable research design which is particularly suitable for evaluating the effectiveness of a treatment on thinking skills [38]-[39]. Marzano HOTS was used for generating idea in this research through self-instructional manual. This quasi-experimental design consists of one control group and one treatment group (Table 1). Both groups were given pre and post individual assignment. The present study is commonly referred to as a quasi-experimental study, a design that could also be called a hybrid form between an observational study and an intervention. The total study extended over a period of 10 weeks. After the pre individual assignment (O_1), treatment group started the treatment by using the Marzano HOTS self-instructional manual (X_T), whilst the control group without any treatment but remain by using ordinary learning module (X_C). After the treatment, both group were given post individual assignment (O_2). Both pre and post individual assignments were marked by their lecturer based on individual assignment evaluation rubric.

Table I Pre and post individual assignment

| Treatment Group | O_1 | X_T | O_2 |
|-----------------|-------|-------|-------|
| Control Group | O_1 | X_C | O_2 |

A. Population and Sample

Population is a group of people who have similar characteristics. Population should be identified appropriately based on the research to be conducted [40]. In this study, the target population was the year 1, 2, 3 and 4 technical students in Bachelor of Civil Engineering, Electrical and Electronic Engineering and Mechanical Engineering.

A total of 81 technical students who were taking the subject *Creativity and Innovation* (CNI) were involved with the quasi-experimental design on assessing the effectiveness of Marzano HOTS in assignment achievement. These 81 technical students are second year students from Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia. There were 41 students for treatment group and 40 students for control group.

The sampling procedure used for this research was cluster random sampling. This is because this sampling procedure allows the selection of respondents were able to donate a lot of relevant information in depth [41] to the research. The

Levene's test ($> .05$) showed that at the pre intervention period, both groups of student were homogeneous.

B. Research Instrument

Two set of individual assignments and individual assignment evaluation rubric have been used as research instrument. Both sets of individual assignments consisting of pre and post individual assignments have the same topic that is generating ideas for new solutions based on the given terms.

Individual assignment evaluation rubric is used to evaluate pre and post individual assignments. The mean scores of individual assignments among respondents can be identified. The evaluation of individual assignments include five main criteria, namely Idea, Design, Functions, Material and Dimensions. Each criterion is equipped with a rubric level from level 1 to level 5 which shows the achievement of idea generation.

Verification of content and design of individual assignments and individual assignment evaluation rubric have been done by the eight experts which consists of design of research instrument, thinking skills, technical and language. Prior to the actual research, a pilot test was conducted to determine the reliability of the instrument and to achieve the desired objective of this study. The internal-consistency reliability value for two set of individual assignments is .81 and .83 respectively.

For individual assignment evaluation rubric, the reliability between raters (Inter-Rater) was obtained by using Cohen's Kappa test which involving two assessors. Cohen's Kappa for reliability score between the two raters for this evaluation rubric is $\kappa = .758$. This means that all research are suitable and reliable for obtaining stable scores.

C. Data Analysis

Each assignment allocated 15 marks. The weightage of mean scores for five evaluation criteria are different (Table II). The mean scores of individual assignments were analyzed using SPSS software. Statistical analysis was done via an "intention to treat" comparison of post intervention scores and comparison of the change in scores from pre- to post intervention.

Table II Weightage of mean scores for five evaluation criteria

| Evaluation Criteria | Weightage of Mean Scores |
|---------------------|--------------------------|
| Idea | 4.00 |
| Design | 3.00 |
| Functions | 3.00 |
| Material | 3.00 |
| Dimensions | 2.00 |

The statistics selected for data analysis was based on the research questions as illustrated in Table III. Inferential test analysis is used to answer all the research questions. The findings are presented in the table format with calculation of

mean score.

Table III Summary of research questions and statistical techniques used in the study

| No | Research Questions (RQ) | Statistical Techniques |
|-----|--|------------------------|
| RQ1 | Is there any significant difference in overall mean scores of individual post assignment between treatment group and control group? | ANCOVA |
| RQ2 | Is there any significant difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group? | MANCOVA |
| RQ3 | Is there any significant difference in overall mean scores between pre and post individual assignment for treatment group and control group? | MANOVA |
| RQ5 | Is there any significant difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group? | MANOVA |

IV. RESULTS AND DISCUSSION

Inferential statistics were used as analytical tools. Parametric statistical techniques were used with the inferential statistics.

A. The Difference in Overall Mean Scores of Individual Post Assignment between Treatment Group and Control Group

Result of ANCOVA analysis test in Table IV shows that there was significant difference in overall mean scores of individual post assignment between treatment group and control group. Results of this analysis confirm that the treatment has a positive impact on student achievement in ideas generation after controlling control variables gender, academic achievement, socio economic status (SES), learning styles and mean scores of pre individual assignment.

HOTS is an indispensable component for generating ideas [42](Othman & Rahman, 2011). Idea generation is HOTS activity that requires creative thinking and action on higher level [16]. HOTS has an ability that is essential in the process of idea generation. For example, students with HOTS are able to combine elements together to form an interlinked or serve as a reorganization or elements to a new idea, pattern or structure [43] (Anderson & Krathwohl, 2001).

Table IV Difference in overall mean scores of individual post assignment between treatment group and control group

| Group | N | Mean Scores | SD | p |
|-----------|----|-------------|------|------|
| Treatment | 41 | 10.01 | 2.20 | *.00 |
| Control | 40 | 6.03 | 2.00 | |

*Difference is significant at the .05 level.

B. The Difference in Mean Scores of Five Evaluation Criteria of Post Individual Assignment between Treatment Group and Control Group

Result of MANCOVA analysis test in Table V indicates that there was significant difference in mean scores of five evaluation criteria between treatment group and control group.

This is because HOTS is the highest level in the hierarchy of process thinking [44] (Bloom et al., 1956), which emphasized metacognitive to teach students how to receive and process information and experience [23]-[24] (Mohamed, 2006; Ea et al., 2005) to generate ideas.

HOTS allow students to think better [45] (Othman et al., 2010) and know how to use a variety of techniques or strategies to obtain relevant results through information and details of sources used [43] (Anderson & Krathwohl, 2001), exploring new opportunities, generate new ideas [46] (Milvain, 2008) and thus improve academic achievement [47]-[48], [23] (Tee, 2013; Subramaniam, 2009; Mohamed, 2006). Consequently, treatment group students are capable of generating an idea that encompasses all five criteria ideation in detail

Table V Difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group

| Criteria | Group | Mean Scores | SD | <i>p</i> |
|-----------|-----------|-------------|------|----------|
| Idea | Treatment | 2.62 | 0.82 | * .00 |
| | Control | 1.46 | 0.68 | |
| Design | Treatment | 2.21 | 0.65 | * .00 |
| | Control | 1.34 | 0.62 | |
| Function | Treatment | 2.17 | 0.73 | * .00 |
| | Control | 1.22 | 0.57 | |
| Material | Treatment | 1.80 | 0.57 | * .00 |
| | Control | 1.28 | 0.53 | |
| Dimension | Treatment | 1.22 | 0.54 | * .00 |
| | Control | 0.74 | 0.61 | |

*Difference is significant at the .05 level.

C. The Difference in Overall Mean Scores between Pre and Post Individual Assignment for Treatment Group and Control Group

Result of MANOVA analysis test in Table VI tabulates that there was significant difference in overall mean scores between pre and post individual assignment for treatment group. Whilst, there was no significant difference in overall mean scores between pre and post individual assignment for control group.

This shows that the treatment group using Marzano HOTS self-instructional manual has succeeded in increasing the mean scores of 24.3 percent from the 15 marks. On the other hand, there is increasing very low mean scores between pre and post individual assignments for control group, so there is virtually no increase. The findings of this study have shown that if a longer duration of treatment used in this study be able to get higher achievement in generating idea.

This is in line with the opinion of [49] and [38] Masek & Yamin (2012) and Behar-Orenstein & Niu (2011) who asserts that a longer treatment period will result in a higher significant increase on achievement of idea generation. Thus, learning and practice HOTS in a long period can improve student achievement in generating idea more effectively [50] (Miri, David & Uri, 2007).

Table VI Difference in overall mean scores between pre and post individual assignment for treatment group and control group

| Group | N | Pre | | Post | | <i>p</i> |
|-----------|----|-------------|------|-------------|------|----------|
| | | Mean Scores | SD | Mean Scores | SD | |
| Treatment | 41 | 6.46 | 1.96 | 10.10 | 2.16 | * .00 |
| Control | 40 | 5.85 | 1.60 | 6.03 | 2.00 | .66 |

*Difference is significant at the .05 level.

D. The Difference in Mean Scores of Five Evaluation Criteria between Pre and Post Individual Assignment for Treatment Group and Control Group

Result of MANOVA analysis test in Table VII shows that there was significant difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group. Whilst, there was no significant difference in mean scores of five evaluation criteria between pre and post individual assignment for control group.

For treatment group, mean scores increased the most between pre and post individual assignments are ideas and design criteria. This was followed by the criterion function, dimensions and materials. This is because Marzano HOTS provide some stimulus questions that are used to help students think diverge. There are eight types of Marzano HOTS. Each type of Marzano HOTS has its own graphic management and evaluation form.

So, with stimulus questions, more information can be collected and analyzed in the graphic management. Each step of the HOTS process will be done by the student when all the part of graphic management were completed with the information obtained. With these information, then the process of idea generation can be carried out smoothly and effectively.

Table VII Difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group

| Criteria | Group | Pre | | Post | | <i>p</i> |
|-----------|-----------|-------------|------|-------------|------|----------|
| | | Mean Scores | SD | Mean Scores | SD | |
| Idea | Treatment | 1.44 | 0.63 | 2.66 | 0.82 | * .00 |
| | Control | 1.44 | 0.63 | 1.50 | 0.66 | .70 |
| Design | Treatment | 1.19 | 0.52 | 2.24 | 0.64 | * .00 |
| | Control | 1.19 | 0.52 | 1.34 | 0.62 | .24 |
| Function | Treatment | 1.41 | 0.60 | 2.19 | 0.73 | * .00 |
| | Control | 1.13 | 0.45 | 1.22 | 0.57 | .44 |
| Material | Treatment | 1.53 | 0.41 | 1.8 | 0.58 | * .00 |
| | Control | 1.32 | 0.58 | 1.28 | 0.53 | .74 |
| Dimension | Treatment | 0.89 | 0.48 | 1.23 | 0.54 | * .00 |
| | Control | 0.74 | 0.52 | 0.78 | 0.59 | .73 |

*Difference is significant at the .05 level.

V. CONCLUSION AND RECOMMENDATIONS

This study indicated that the HOTS has a positive impact on student achievement either overall or five evaluation criteria in ideas generation after controlling control variables gender, academic achievement, SES, learning styles and mean scores of pre individual assignment. The research findings support the teaching and learning of HOTS that will enable students to be aware of their own thinking skills and using it while generating idea. Through this awareness, students can improve their performance on those tasks. Models, strategies, techniques, and activities are model lesson plans showing how thinking skills could be taught together with subject matter using the integrated approach have been implemented in the school system [25]. Nevertheless, a self-instructional manual can be an alternative approach because it can cater to the more extendable individual differences of learner's abilities, interest and degrees of application. Consequently, students should be assisted to acquire HOTS; either through the conventional teaching and learning environment or a self-instructional, individualized manual for generating idea.

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REFERENCES

- [1] T. H. Davenport, *Thinking for A Living: How to Get Better Performance and Results From Knowledge Workers*. Boston: Harvard Business School, 2005.
- [2] R. D. Strom, and P. S. Storm, "Changing the rules: education for creative thinking," *Journal of Creative Behavior*, vol. 36, no. 3, pp. 183-199, 2002.
- [3] W. Reinhardt, B. Schmidt, P. Sloep, and H. Drachler, "Knowledge worker roles and actions – results of two empirical studies," *Knowledge and Process Management*, vol. 18, no. 3, pp. 150-174, 2011.
- [4] G. Bassham, W. Irwin, H. Nardone, and J. M. Wallace, *Critical Thinking. A Student's Introduction*. 2nd ed. Boston: McGraw Hill, 2005.
- [5] L. Redmond, *Communication: Theories and Application*. USA: Houghton Mifflin, 2000.
- [6] M. H. Yee, M. Y. Jailani, T. K. Tee, O. Widad, M. Mimi Mohaffyza and H. Razali, "Contributing factors towards difficulty in generating idea among technical students," *Journal of Technical Education and Training (JTET)*, vol. 5, no. 1, pp. 14-27, June 2013.
- [7] A. Sharp. (2013, Mar 25). *Teaching fluency in gifted classrooms: generating ideas is an important part of creative problem solving*. [Online]. Available: http://gifted-classes-materials-lessons.suite101.com/article.cfm/teaching_fluency_in_gifted_classrooms#ixzz0pFkVb76K.
- [8] J. Hoseinifar, M. M. Siedkalan, S. R. Zirak, M. Nowrozi, A. Shaker, E. Meamar, and E. Ghaderi, "An investigation of the relation between creativity and five factors of personality in students," *Procedia – Social and Behavioral Sciences*, vol. 30, pp. 2037-2041, 2011.
- [9] K. J. Wheelihan. (2011). *Creativity for success*. [Online]. Available: <http://EzineArticles.com/>
- [10] B. S. Glassman, "Improving idea generation and idea management in order to better manage the fuzzy front end of innovation," Ph.D. dissertation, Purdue University, West Lafayette Indiana, 2009.
- [11] B. Vandenbosch, A. Saatcioglu, and S. Fay, "Idea management: a systemic view," *Journal of Management Studies*, vol. 43, no. 2, pp. 259-288, 2006.
- [12] B. Jonson, "Design ideation: the conceptual sketch in the digital age," *Design Studies*, vol. 26, no. 6, pp. 613-624, 2005.
- [13] D. Graham, and T. Bachmann, *Ideation: The Birth and Death of Ideas*. New York: John Wiley and Sons Inc, 2004, pp. 4.
- [14] American Heritage Dictionary, *The American Heritage Dictionary of the English Language*, 5th Ed. USA: Houghton Mifflin Harcourt, 2011.
- [15] M. A. Abd Hamid, *Pengalangan Pemikiran Kritis & Kreatif*, 1st Ed. Skudai, Johor: Universiti Teknologi Malaysia, 2001.
- [16] B. K. Beyer, *Practical Strategies for the Teaching of Thinking*, London: Allyn and Bacon, Inc, 1992.
- [17] A. R. Abd. Rashid, *Falsafah Budaya dalam Pendidikan*. Kuala Lumpur: Penerbit Universiti Malaya, 2003.
- [18] R. E. Meyer, "Rotes versus meaningful learning," *Theory into Practice*, vol. 41, no. 4, pp. 226-232, 2002.
- [19] J. A. Phillips, "Keberkesanan pengajaran kemahiran berfikir: perubahan kepada sistem persekolahan," presented at the Seminar Kebangsaan Pengajaran Kemahiran Berfikir: Tinjauan Kejayaan Satu Dekad, 2004.
- [20] H. Astleitner, "Teaching critical thinking online," *Journal of Instructional Psychology*, vol. 29, no. 2, pp. 53-76, 2002.
- [21] J. McKendree, C. Small, and K. Stenning, "The role of representation in teaching and learning critical thinking," *Educational Review*, vol. 54, no. 1, pp. 57-57, 2002.
- [22] C. B. MacKnight, "Teaching critical thinking through online discussions," *Educause Quarterly*, vol. 23, no. 4, pp. 39-41, 2000.
- [23] S. Z. Mohamed, "Kesan pendekatan penyebatan kemahiran berfikir kreatif dalam pengajaran karangan deskriptif dan karangan imajinatif dalam kalangan pelajar tingkatan IV," Ph.D. dissertation, Universiti Sains Malaysia, Penang, Malaysia, 2006.
- [24] J. Ea, A. Chang, and O. S. Tan, *Thinking about Thinking: What Educators Need to Know*. Singapore: National Institute of Education, Nanyang Technological University, McGraw Hill Education, 2005, pp. 72.
- [25] N. S. Rajendran, *Teaching and Acquiring Higher-Order Thinking Skills Theory & Practice*. Tanjung Malim Perak: Penerbit Universiti Pendidikan Sultan Idris, 2008.
- [26] A. Lewis, and D. Smith, "Defining higher order thinking," *Theory Into Practice*, vol. 32, pp. 131-137, 1993.
- [27] R. Sulaiman, M. Aziz, and S. S. Mok, *Kemahiran Berfikir*. Selangor: Penerbitan Multimedia, 2011.
- [28] M. Y. Jailani, M. H. Yee, A. Arihasnida., O. Widad, H. Razali, and T. K. Tee, "Penjanaan idea berdasarkan kemahiran berfikir aras tinggi bagi mata pelajaran pendidikan kejuruteraan," in *Proc. Persidangan Kebangsaan Pendidikan Kejuruteraan dan Keusahawanan 2010 (NCEE 2010)*, Kota Bahru, Kelantan, 2010, pp. 80-89.
- [29] G. D. Kuh, "Assessing what really matters to student learning: inside the national survey of student engagement," *The Magazine of Higher Learning*, vol. 33, no. 3, pp. 131-137, 2001.
- [30] V. E. Ross, "A model of inventive ideation," *Thinking Skills and Creativity*, vol. 1, no. 2, pp. 120-129, November 2006.
- [31] M. H. Yee, T. K. Tee, J. Md Yunos, N. Osman., and S. Ibrahim @ Sulong, "The perception of student on mastering the level of higher order thinking skills in technical education subjects," in *Proc. 3rd regional Conference On Engineering Education and research In Higher Education (RCEERHED 2010a)*, Kuching, Sarawak, Jun 2010, pp. 30-35.
- [32] M. H. Yee, J. Md Yunos, W. Othman, R. Hassan, and T. K. Tee, "Persepsi tahap kesukaran penjanaan idea bagi subjek pendidikan kejuruteraan," in *Proc. International Conference on Education 2010 (ICE 2010)*, Brunei Darussalam, 2010, pp. 24-27.
- [33] M. Shuib, "Developing undergraduates' thinking skills," in *Proc. Persidangan Pengajaran dan Pembelajaran di Peringkat Institusi Pengajian Tinggi (CTLHE07)*, Selangor, Malaysia, 2007, pp. 89-98.
- [34] A. R. Abd. Rashid, *Kemahiran Berfikir Merentasi Kurikulum*. Shah Alam: Penerbit Fajar Bakti Sdn. Bhd, 1999.
- [35] M. H. Yee, Md Yunos, J., Othman, W., Hassan, R., Tee, T. K. & M. M. Mohamad, "Disparity of learning styles and higher order thinking skills among technical students," in *Proc. of the 4rd World Congress on Technical Vocational Education and Training (WoCTVET 2014)*, Batu Pahat, Malaysia, November 2014, pp. 5-6.

- [36] J. A. Phillips, *Pengajaran Kemahiran Berfikir: Toeri dan Amalan*. Kuala Lumpur: Utusan Publications & Distributors Sdn. Bhd, 1997.
- [37] M. H. Yee, Md Yunos, J., Othman, W., Hassan, R., Tee, T. K. & M. M. Mohamad, "The needs analysis of learning higher order thinking skills for generating ideas," *Procedia - Social and Behavioral Sciences*, vol. 59, pp. 197-203, October 2012.
- [38] L. S. Behar-Horenstein, and L. Niu, "Teaching critical thinking skills in higher education: a review of the literature," *Journal of College Teaching & Learning*, vol. 8, no. 2, pp. 25-42, 2011.
- [39] J. H. McMillan, *Educational Research: Fundamental for The Consumer*. 6th ed. US: Addison Wesley, 2011.
- [40] D. Ary, L. C. Jacobs, and A. Razaviech, *Introduction to Research in Education*, 6th Ed. Belmont, CA: Wadsworth, 2002.
- [41] W. Wiersma, *Research Methods In Education: An Introduction*. 7th ed. Boston: Allyn & Bacon. 2005, pp. 86-96.
- [42] F. Othman, and S. Rahman, "Kepentingan penyebatan kemahiran berfikir secara kritis dan kreatif (KBKK) dalam proses pengajaran dan pembelajaran," presented at the Pembentangan Seminar Serantau ke 5/2011, Riau, Indonesia, 2011.
- [43] L. W. Anderson, and D. R. Krathwohl, (Eds.) *A Taxonomy for Learning Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Addison Wesley Longman, 2001.
- [44] B. S. Bloom, *Taxonomy of Educational Objectives: The Classification of Educational Goals*. Handbook 1: Cognitive Domain. New York: David McKay Company, Inc, 1956.
- [45] W. Othman, K. Selamat, and R. Hashim, *Teaching Methods in Technical and Vocational Education*. Selangor: Open University Malaysia, 2010.
- [46] C. Milvain, "Thinking skills within the humanities discipline," *Ethos*, vol. 16, no. 4, pp. 6-10, 2008.
- [47] T. K. Tee, M. N. A. Azman, J. Md Yunos, M. H. Yee, M. M. Mohamad, and W. Ohman, "The implementation of thinking skills module for secondary school students," in *Proc. of International Conference on Social Sciences Research (ICSSR 2013)*, Kajang, Malaysia, 4-5 Jun 2013, pp. 1351-1356.
- [48] S. R. Subramaniam, "Metacognition in teaching," in *Proc. of the 14th International Conference on Thinking (ICOT14)*, Kuala Lumpur, Malaysia, 2009, pp. 23-35.
- [49] A. Masek, and S. Yamin. (2012, April 8). The impact of instructional methods on critical thinking: a comparison of problem-based learning and conventional approach in engineering education. *International Scholarly Research Network*. [Online]. pp. 1-6. Available: <http://www.isrn.com/journals/education/2012/759241/>
- [50] B. Miri, B. David, and Z. Uri, "Purposely teaching for the promotion of higher-order thinking skills: a case of critical thinking," *Res Sci Educ*, vol. 37, pp. 353-369, 2007.

Cognitive Abilities in Vocational Education (,2014), The Factors of Difficulty in Generating Idea among Malaysia Technical University Network Students (Batu Pahat, Johor: Universiti Tun Hussein Onn Malaysia, 2013), The development and evaluation of the qualities of thinking skills module (Batu Pahat, Johor: Universiti Tun Hussein Onn Malaysia, 2013), The Development And Implementation Of Buzan Mind Mapping Module (Elsevier Ltd, 2012), The Development And Evaluation Of The Qualities Of Buzan Mind Mapping Module (Elsevier Ltd, 2012), The Needs Analysis of Learning Higher Order Thinking Skills for Generating Ideas (Elsevier Ltd, 2012), The Level of Marzano Higher Order Thinking Skills among Technical Education Students (Singapore: International Association of Computer Science and Information Technology (IACSIT), 2011). Current and previous research intertests are learning styles, teaching styles, thinking styles and thinking skills.

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