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Exploring Intellectual Capital

Infusing High Order Thinking Skills (HOTs) through Thinking Based Learning (TBL) during ECA to enhance students interest in STEM

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Abstract

Currently in 21st century, the extremely unique, vibrant and powerful work environment requires employees with fundamental abilities that blend with real life experiences and self-assurance. Many students whom failed to acquire these skills facing the risk of jobless as stated by a few recent reports. Thus, to be more innovative, have good creativity, ideal and imaginative, one should acquire HOTs skills to enhance their creative thinking and critical thinking skills. Therefore, this article emphasis how to inculcate HOTs through Thinking Based Learning (TBL) during extracurricular activities (ECA) to boost students' concern in Science, Technology, Engineering and Mathematics (STEM).
Keywords: High Order Thinking Skills (HOTs), Thinking Based Learning (TBL), Extracurricular Activities (ECA), STEM, Science education, Habits of mind.

Introduction

In this competitive era, the employers seeking for knowledge employees with soft skills and social skills to utilize resources and innovative thinking that can develop their business to next level. Extracurricular activities (ECA) help the students to grow their soft skills, social skills and also boost their self -confidence through their personal experiences gained during after school programs (Kleinert, Miracle, & Sheppard-Jones, 2007). There are hardly achieved in the typical indoor classroom setting (Snellman, Silva, Frederick, & Putnam, 2015).

Science, technology, engineering and mathematics (STEM) education plays a vital role in molding the culture and economic growth through innovation (Cooper & Heaverlo, 2013). Besides, Denson, Haily, Stallworth, and Householder (2015) emphasis that STEM education should be transformed to draw a more diverse labor force.

According to Denson, Haily, and Austin (2013), currently applied formal classroom setting fail to bring in capable students to pursue their career in STEM. Thus, low achievers usually will make a way into STEM careers. This article suggest how to inculcate high order

thinking skills (HOTs) through thinking based learning (TBL) in ECA to develop students' interest in STEM.

High Order Thinking Skills (HOTs)

(Anderson et al., 2001) define high order thinking skills (HOTs) as the extended use of mind to face new challenges through critical thinking and creative thinking. Both critical thinking and creative thinking are teachable and learnable components of HOTs. On the other hand, Marzano identifies eight variables in HOTs explicitly comparing, classifying, inducing, deducing, analysis, constructing, analysing perspectives and abstracting. These eight components of HOTs stated by Mazano almost similar to the extensively used Bloom's taxonomy in the cognitive domain such as Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

In terms of HOTs, Bloom's taxonomy widespread in developing the Malaysian curriculum standard (Centre, 2013). As revised from Bloom's Taxonomy, the four higher skills namely applying, analysing, evaluating and creating are categorized under HOTs (Anderson et al., 2001). The Malaysian Integrated Curriculum emphasis these four skills as a strategy to build up problem solving and decision making skills among Malaysians to meet daily life challenges (Ministry Of Education, 2013).

Thinking Based Learning (TBL)

Thinking Based Learning (TBL) is the infusion technique in teaching thinking skills to students through its three components namely thinking skills, habits of mind (HOM) and metacognition.

Thinking Skills

Thinking skills includes generating ideas, clarifying ideas and assessing the reasonableness of ideas. These thinking skills were shown in detail in Table 1.0 below.

Table 1.0: Types of thinking skills.
Source:(Swartz & Reagan, 1998)

Types of thinking skills	Components
Generating Ideas	**Alternative possibilities:-** i. Multiplicity of ideas ii. Varied ideas iii. New ideas iv. Detailed ideas **Combining idea:-** i. Anology/Metaphor
Clarifying ideas	**Analyzing ideas** i.Comparing/contrasting ii.Classification/definition iii.Parts/whole relationship iv. Sequencing **Analyzing Arguments** i.Finding conclusion/reasons ii. Uncovering assumption
Assessing the reasonableness of ideas.	Support of information i. Determine accurate observations ii. Determine reliable secondary sources Inference i. Use of evidence Causal explanation Prediction Generalization Reasoning by analogy ii. Deduction Conditional reasoning.

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Habits of Mind (HOM)

Habits of mind (HOM) are the second component in TBL. It consists of sixteen habits to inoculate among our students throughout ECA doing STEM project. Costa and Kallick (2000b) highlights the sixteen components of HOM namely persisting, managing impulsivity, listening with understanding and empathy, thinking flexibly, creating, imagining, innovating, responding with wonderment and awe, taking responsible risks, finding humor, thinking interdependently, remaining open to continuous learning, thinking about thinking, striving for accuracy, questioning and posing problem, applying past knowledge to new situation, thinking and communicating with clarity and precision and gathering data through all sense.

Metacognition

Metacognition is the thinking about one's thinking or cognition that aimed to improve learning through metacognition and cognitive strategies in two levels. One will apply the cognitive strategy to solve a problem is the first level while will select and monitor the effectiveness of the strategy used via metacognition in second level (Wilson & Conyers, 2016).

Extracurricular Activities (ECA)

All the activities that students participate after usual curriculum school time in schools including sports, clubs, governance, student newspaper, music, art and drama are known as extracurricular activities (ECA).

ECA offer wide experiences that unable to gain through formal lessons in classrooms. Besides, it let students to relate the knowledge that they have educated in other classes and obtain concepts of democratic life (Lunenburg, 2010). ECA provides a lot of advantages in shaping the students including reinforcing learning, supplementing the required and elective curriculum, integrating knowledge and carrying out the objectives of democratic life (Barbieri, 2009; Hill, 2008; Jones, 2011).

Science Technology Engineering and Mathematics (STEM)

Suits to its acronym's name, science, technology, engineering and mathematics are the four discipline in STEM (Meng & Noraini, 2014; Meng, Noraini, Eu, & Mohd Fadzil, 2013).

Conversely, many intellectuals feel that STEM education should be acknowledged as separate subjects (Bybee, 2010; Fadzil & Saat, 2014). Educational curriculum associate the four dissimilar subjects into one under the integrative approach (Science, 2014; Venville, Wallace, Rennie, & Malone, 2000). Some empirical studies proved that the integrated STEM learning has the potential to generate competitive upcoming labor force with the 21st century skills (Apedoe, Reynolds, Ellefson, & Schunn, 2008) and also provide positive impacts to develop students' concern and accomplishment(Venville, Rennie, & Wallace, 2004; Wang, Moore, Roehrig, & Park, 2011).

ECA plan in infusing HOTs to gain students interest in STEM

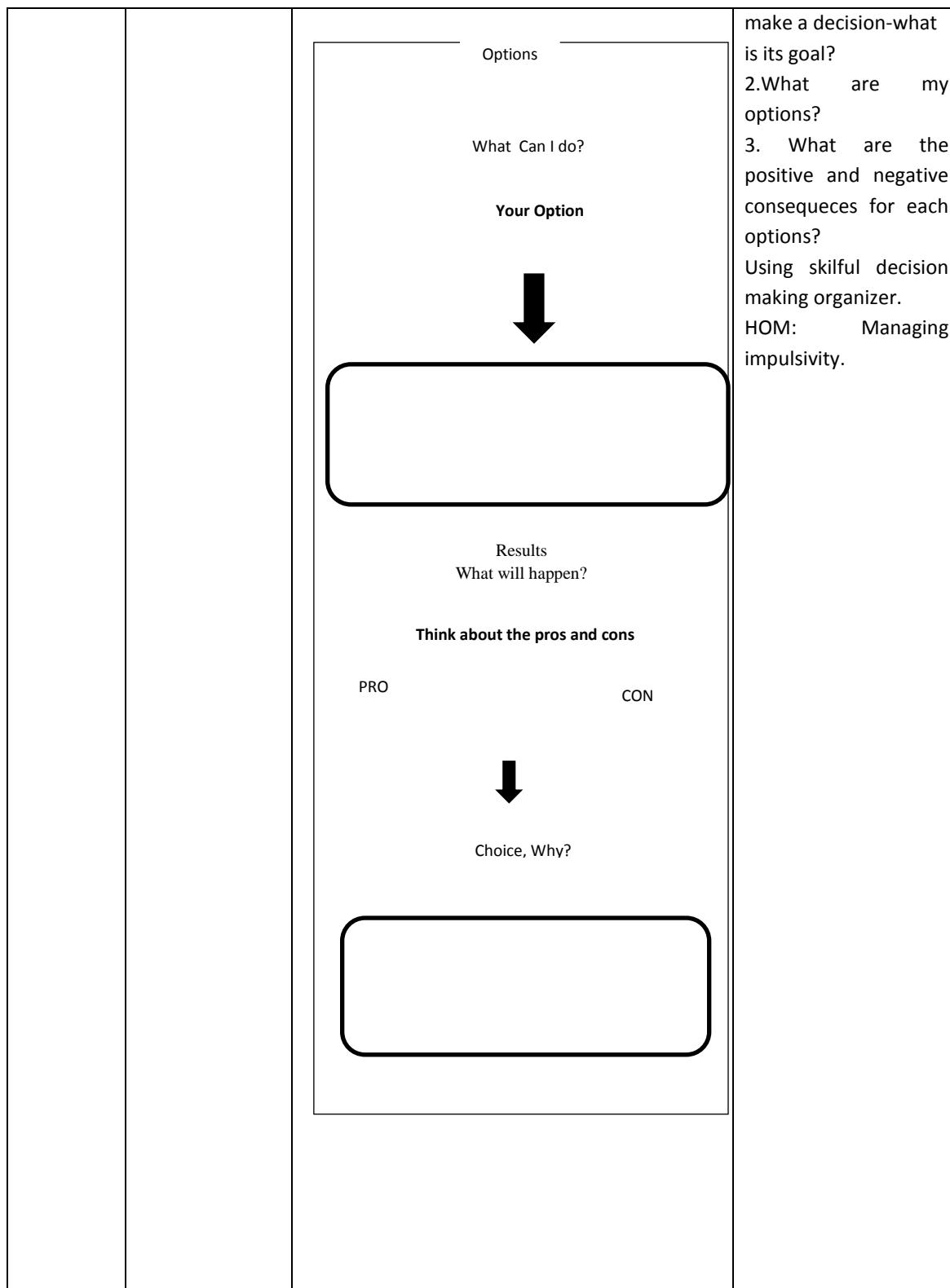The activity plan below can be utilize during ECA in infusing HOTs to enhance students interest in STEM.

Problem issues:

Your corporation gets a tender to construct a strong bridge. Construct the prototype of that bridge using Popsicle stick to illustrate them the replica and the plan in your proposal.

Table 2.0: ECA Plan.

Week	Phase	Activity	HOTs & TBL
1	Engage	Make a project schedule. Use graphic organizing. <table><tr><td>Week \ Phase</td><td>1</td><td>2</td><td>3</td><td>Notes</td></tr><tr><td>Engage</td><td></td><td></td><td></td><td></td></tr><tr><td>Explore</td><td></td><td></td><td></td><td></td></tr><tr><td>Explain</td><td></td><td></td><td></td><td></td></tr><tr><td>Engineering</td><td></td><td></td><td></td><td></td></tr><tr><td>Enrich</td><td></td><td></td><td></td><td></td></tr><tr><td>Evaluate</td><td></td><td></td><td></td><td></td></tr></table>	**TBL** Using graphic organizer to make project schedule. Generating ideas and combining ideas. **HOM:** Questioning and posing problems. Thinking interdependenly. **HOTs:** Creative in schedule their plan.
2	Explore	Do library research. Determine the length of the bridge. Estimate the amount of popsicle sticks that you need to use. List down the materials you need to buy. Use decision making graphic organizer to decide which bridge that the best one to build. Choosing	**HOTs:** Be creative and critical thinking. Be problem solver in make decision using graphic organizer. **TBL:** Skilful decision making: 1.Why do I have to

Options

What Can I do?

Your Option

Results
What will happen?

Think about the pros and cons

PRO   CON

Choice, Why?

make a decision-what is its goal?
2.What are my options?
3. What are the positive and negative consequeces for each options?
Using skilful decision making organizer.
HOM: Managing impulsivity.

Week	Phase	Activity	HOTs & TBL
3	Explain	Present your plan to others group Sharing your ideas. Use communication skills to explain the information to others in community.	**HOTs:** Gathering information. **TBL:** Cultivating classroom talk, dialogue and collaborative thinking.
4	Engineering	Sketch the bridge. List down the criteria that bridge should have. Constructing the bridge.	**HOTs:** Critical thinking. Creative thinking. Creating **TBL:** Cultivating thinking deposition.
5	Enrich	Test the strength of your bridge. Make adaptation to your bridge.	**Hots:** Critical thinking Creative thinking **TBL:** Habits Of Mind: Thinking independently in solving the problem.
6	Evaluate (Metacognition)	Think about their thinking.	**HOTs:** Be critical thinking in writing the reflective journal. **TBL:** Think about their thinking. Make reflective thinking in what have they done.

Conclusion

The proposed ECA plan to be used during ECA had increase students interest in STEM as stated in Table 1.0. Therefore, the teachers and private educators are encouraged to create classroom environments that can involve students to participate actively in lessons to identify and solve problems (Marino et al., 2014). Still, there are some scholars propose that effective informal STEM learning environment should promote understanding of engineering, provide academic

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enhancement, have qualified and capable instructors and be maintained by the educational system of the student participants (Chubin, May, & Babco, 2005).

In addition, Jolly (2017) underlined the seven compelling reasons to involve students in STEM. STEM lesson will improve students' understanding of important science and mathematics concepts. Thus, students turn into innovative critical thinkers and can make good decisions wisely. It is because students understand how to approach and solve problems when they acquired the STEM skills. It also develops a sense of ethics and social conscience among students. STEM helps the students to develop good collaboration skills and become more technologically literate. Lastly, STEM promotes students to understand how their STEM coursework will enhance their future careers.

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