DESIGNING A MODEL HYPOTHESIS OF THE RELATIONSHIP BETWEEN CHALLENGE-BASED LEARNING AND CRITICAL THINKING SKILLS

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Abstract - The objectives of this research were 1) To design a model hypothesisofthe relationship between challenge-based learning and critical thinking skills; 2) To examine the validity of the model hypothesis by using Index of consistency(IOC).The results showed that process challenge-based learning was linked to critical thinking. The validity of the model hypothesis that assessment by 9 experts was agree(IOC=0.74).

Keywords - Challenge-Based Learning, Critical Thinking Skills

I. INTRODUCTION

It is well known that globalization is moving rapidly and inevitably affects the education system.Therefore, considering the promotion of learners with learning and innovation skills, the core skills of the 21stCentury.Learning and innovation skillsare extremely important in the school system [1]. These are widely known in education and are in line with the views of the World Economic Forum [2], which has defined critical thinking and problem-solving skills as the Core Competencies of 21st Century students. In addition, both of these higher-order thinking skills are essential aspects of fostering skills across all learning and innovation skills groups [3].

In this research, we focus on critical thinking skills(CT). By this, we mean the ability to use thought processes to make objective decisions about what to believe or not to believe. There is careful consideration of the information to make decisions and lead to reasonable conclusions. This is done in a step-by-step fashion by gathering and linking factors and facts [4-6]. These skills are considered the most critical and fundamental skills for learners in the 21st Century [2,3].

In keeping with this significantchange,Apple Inc. implemented the challenging-based learning approach(CBL) as a student-centred strategy. It aims to transform education in response to 21stCentury changes to engage students in active and authentic learning by creating a learning environment that helps students improve their understanding of the content of each subject area and expand their ability to solve problems creatively [7].

Several academic reports have pointed out that CBL is a learning management approach that fosters the core skills needed in the 21st Century, including critical thinking and problem-solving skills, creative and innovative thinking skills, collaboration skills, and communication skills [8-12].

From the importance of higher-order thinking skills like a CT and the CBL process mentioned above. Therefore, the researcher attempts to design a model hypothesis that can link the skills that arise during the learning process to clarify the description of the CT that affects the learners in the CBL process.

II. RESEARCH OBJECTIVES

1) To design a model hypothesisofthe relationship between challenge-based learning and critical thinking skills.
2) To examine the validity of the model hypothesis by using the Index of Consistency (IOC).

III. GROUNDED THEORY

3.1. Critical Thinking

Critical thinking skills (CT) refer to using thought processes to make objective decisions about what to believe or not to believe. There is careful consideration of the information to make decisions and lead to reasonable conclusions [4-6]. Consequently, many scholars have detailed the components of CT, including Ennis [13] mention the 10 steps of critical thinking include: 1) Judge the credibility of sources, 2)Identify conclusions, reasons, and assumptions, 3) Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence, 4) Develop and defend a position on an issue, 5) Ask appropriate clarifying questions, 6) Plan experiments and judge experimental designs, 7) Define terms in a way appropriate for the context, 8) Be open-minded, 9) Try to be well informed, And 10) conclude when warranted, but with caution.

This conforms with the work of the California Critical Thinking Skills Test (CCTST) [14]. They defined the eightsteps for the solution of critical thinking with: 1) Analytical skills are used to identify assumptions, reasons, themes, and the evidence used in making arguments or offering explanations. 2) Interpretation is the process of discovering, determining, or assigning meaning. 3) Inference skills enable us to identify reasons, evidence, observations, experiences, or our values and beliefs. 4) Evaluative reasoning skills enable us to assess the credibility of sources of information and the claims they make.5) Explanation is the process of justifying what we have decided to do or what we have decided to believe. 6) Deductive reasoning is rigorously logical and clear cut. 7) Inductive reasoning relies on estimating likely outcomes. And 8) numeracy refers to the ability to make judgments based on quantitative information in various contexts. In addition, the Cornell Critical Thinking Test [15] identified four issues in the students' critical thinking abilities as follows: 1) Induction 2) Deduction 3) Credibility and 4) Identification of Assumptions. The details about the components of critical thinking skills from many other sources can be synthesized, as shown in Table 1.

Critical thinking's Components	[13]	[14]	[15]	[16]	[17]	[18]
Make rough assumptions about the problem.	✓	✓	✓	✓	✓	✓
Assemble reliable and diverse information to support various assumptions.	✓	✓	✓	✓	✓	✓
Create a concept or action guide based on the various assumptions that have been assessed.	✓	✓	✓	✓	✓	✓

Table 1. *Synthetization of critical thinking skills*

From Table 1, which is the result of the synthesis of the components of critical thinking skills gleaned from theories and academic articles, the researcher can conclude that the components of critical thinking skills consist of three elements:

1) Make rough assumptions about the problem. This refers to considering the issue and making assumptions about it.

2) Assemble reliable and diverse information to support various assumptions. This refers to searching for information for consideration and decision making from reliable sources.

3) Create a concept or action guide based on the various assumptions that have been assessed. This refers to using the information gathered and accepted by the credibility assessment, then bringingit to form a conclusion for decision making.

3.2. Challenge-based learning

Challenge-based learning (CBL) is a new approach based on the combination of teamwork, self-learning, real-world problem-solving learning through reflective thinking [19].This learning approach is based on constructivist theory like problem-based learning and also is very close to project-based learning [20].

CBL is a student-centred strategy that was taking place in a project hosted by Apple, Inc. It aims to transform education in response to 21st-century changes to engage students in active and authentic learning by creating a learning environment that helps students improve their understanding of the content of each subject area and expand their ability to solve problems creatively [7].

Academically, the benefits of CBL can foster relationships between students, or students and teachers. That is an opportunity for students to use teamwork and enhance soft skills development in many areas. Students also use the integration of knowledge intensely to delve into specific solutions [8-10].

Several academic reports have pointed out that CBL is a learning management approach that fosters the core skills needed in the 21st Century, including critical thinking and problem-solving skills, creative and innovative thinking skills, collaboration skills, and communication skills [10-12].

From the study of using CBL in learning activities existing researchis able to synthesize three steps of the learning approach,as shownin Table 2.

Process of CBL	[7]	[8]	[9]	[10]	[11]	[12]
Stage 1 Engage	✓	✓	✓	✓	✓	✓
Stage 2 Investigate	✓	✓	✓	✓	✓	✓
Stage 3 Act	✓	✓	✓	✓	✓	✓

Table 2. *Synthetization of CBL process*

From Table 2, which is the result of the synthesis of the CBL process from theories and academic articles, the researcher can conclude that the process of CBLphases [21] follow:

1) Engagement Phase

Students must work in groups to identify topics (challenges) drawn from a global issue (big idea) that are relevant to the community.

2) Investigation Phase

Students analyze the challenge, brainstorm strategies and identify appropriate resources to tackle it. A solution is eventually conceived after a series of

information searches and consultation with relevant experts in the community.
3) Action Phase

Students must test the effectiveness of the solution by implementing it in the community and evaluating its outcomes.

IV. RESEARCH METHODOLOGY

4.1. Research Experts

1) Three Lecturers (Ph.D.) in educational evaluation
2) Two Lecturers (Ph.D.) lecturers in educational Technology.
3) Two Lecturers (Ph.D.)in psychology.
4) TwoPsychiatrists with at least fiveyears of adolescent behavior research experience.

4.2. Research Instruments

In this research, the researcher used a validity assessment form,which nine experts validated. The assessment design was based on theIndex of Consistency(IOC) by using score +1 (correctconsistent), score 0 (Not sure if it's consistent), and score -1 (inconsistent).An item with a consistency index equal to or greater than 0.5 is considered valid and can be used for testing, but if the consistency index is less than 0.5, then that item is not available and must be eliminated or modified [22].

4.3. Research Methodology

Theresearch methodology was divided into three phases as follows**:**
1) Reviewing the literature on critical thinking skills and challenge-based learning.
2) Setting a model hypothesis of the relationship between challenge-based learning and critical thinking skills by linking the correlation based on observable actions.
3) Evaluating the validity ofmodel hypothesis.

V. RESULTS

Based on theoretical studies and research articles related to critical thinking skills and challenge-based learning, the researcher summarised the three components of critical thinking skills. These consist of: 1) make rough assumptions about the problem, 2) assemble reliable and diverse information to support various assumptions 3) create a concept or action guide based on the various assumptions that have been assessed.In addition, the researcher concluded that the CBL process consists of 3stages: 1) Stage 1 Engage — Students are required to work in groups to identify topics (challenges) drawn from a global issue (big idea) that are relevant to the community. 2) Stage 2 Investigate—Students analyze the challenge, brainstorm strategies and identify appropriate resources to tackle it. A solution is eventually conceived after a series of information searches and consultation with relevant experts in the community. 3) Stage 3 Act —Students must test the solution's effectiveness by implementing it in the community and evaluating its outcomes. This is a model hypothesis of the relationship between challenge-based learning and critical thinking skills. All of the above elements lead to creating amodel hypothesis of the relationship between challenge-based learning and critical thinking skills,as showninFig1.

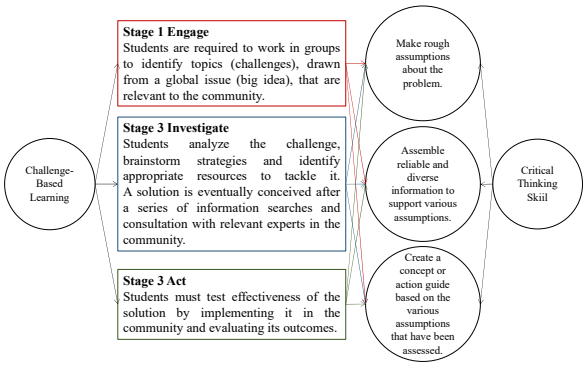


Fig.1. Model hypothesis of the relationship between challenge-based learning and critical thinking skills

To evaluate the validity of the model hypothesis of the relationship between CBL and CT by using the IOC with nine experts, the summarised results are shown in Table 3.

Item	IOC	Meaning
The classification of the CBL process was appropriately classified.	1.00	Agree
The classification of the critical thinking skillcomponentwas appropriately classified.	0.66	Agree
The alignment and linking within the model hypothesiswere appropriate.	0.55	Agree
Average	0.73	Agree

Table 3. *validity of model hypothesis*

From Table 3, the validity of the model hypothesis in this study wasan average scoreof 0.73 it mean agree[22].

VI. DISCUSSION

From the model hypothesis, validityevaluation results were found agreeable.Following the synthesis of literature review by usingthe University of Oregon Library'sguidelines,which contain 3 steps:[23] 1) Read your sources carefully and find the main ideas of each source. 2) Look for similarities in your sources.3) Use the worksheet or synthesis matrix to get organized.
In addition, the concordance of CBL and CTwas confirmed byCheung & etal.[24] that they had

experimental studies about using the CBL approach with computer science (CS) and information technology(IT) students. The result showed positive feedback for critical thinking and problem-solving skills. This alignswith Gabriel[25]who is also using CBL with biochemistry students. Furthermore, the results showed that after the experiment with initial problems that spur this approach,it can increase the efficiency of addressing complex problems, and the ability to analyze data is very strong.

On the other side,Rane & Robertson's[26] published research on challenging medical problems practice found that students have improved assessmentsskill of reliability and validity in the use of the tool, matchingskill forthe tool to the programming, identifying skillfor resource requirements at enough, as well as reviewing skill for the strengths and weaknesses of the tools used. This is in line withWeiss[27], outlined in her academic writing "Designing Problems to Promote Higher-Order Thinking" she thus concluded that the problems would challenge and motivate students. In addition, it will be able to create cognitive processes that promote higher-order thinking skills such as problem-solving and critical thinking.

VII. CONCLUSION

Although this research has found indication that CBL and CT are linked. This research also deserves a more in-depth study of each component's relative weight or factor loading using other advanced statistical methods.

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