ASSESSING STEM LEARNING:  
A CASE STUDY OF DARUL HIKAM AND AL-MA’MOEN JUNIOR HIGH SCHOOLS

Fransisca Nur’aiini  
Policy Research Centre for Education and Culture, Agency of Research and Development,  
fransyusufhafidz@gmail.com

ABSTRACT

This study aims to gather information on the assessment methods used in assessing the learning process in STEM learning in Curriculum 2013 implementation. It is a qualitative descriptive study using in-depth interviews and a focus group discussion as data collection techniques. This study was conducted between March to June 2018. There were fifteen schools which already adapting STEM learning studied. Informants for this study were school teachers and principals. The result shows that in comparison with other schools, Darul Hikam and Al-Ma’moen Junior High Schools are the two most eligible schools in adapting STEM learning, as these schools fit most of the STEM criteria in comparison with the other thirteens. Additionally, these two schools also used assessment which is suitable for the nature of STEM learning that assess the collaborative and problem-solving skills adequately. Both Darul Hikam and Al-Ma’moen measure the three domains of learning, i.e. the cognitive, affective, as well as psychomotor. Both schools are using different tools of assessment such as rubrics, written essays, and observations. In terms of cognitive domain, both schools use written essay to measure it. An assessment model of Collaborative Problem-Solving can be use in assessing STEM learning due to the nature of STEM which requires collaboration and problem-solving skills. STEM learning in Darul Hikam and Al-Ma’moen Junior High are the two most prominent STEM approach in Curriculum 2013 implementation which satisfy the STEM criteria in STEM by Design in comparison with other schools. Assessing STEM learning is somewhat difficult but not impossible. STEM Assessment method used by Darul Hikam and Al-Ma’moen are still lacking in terms of the measurement of Cognitive Domain. Proposed Assessment Method for assessing STEM learning is the combination of CPS Assessment method add by the affective domain of learning (mandated by the Assessment Standards)

KEYWORDS

STEM learning, assessment, collaborative problem solving, cognitive, affective

1. INTRODUCTION

In terms of 21st century skills, Indonesian students are still struggling to achieve the competencies required for the 21st century. The low level of basic literacy achievement of Indonesian students, as indicated by the results of national and international surveys, shows that there still needed a lot of improvement in the education system. PISA 2012 and 2015 results show that Indonesian students’ achievement in terms of basic literacy are still lag behind their counterparts from neighboring countries such as Malaysia, Vietnam, Thailand, and Singapore.
Figure 1. PISA 2012 Results for Indonesia, Malaysia, Thailand, Vietnam, and Singapore

Source: PISA 2012 (https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf)

Singapore was ranked 2nd in Mathematics and 3rd in Reading and Science, while Vietnam got 8th in Science, 17th in Mathematics and 19th in Reading. Thailand ranked 50th in Mathematics but 48th in Reading & Science. Meanwhile, Malaysia ranked 52 in Mathematics, 59th in Reading and 53rd in Science. And unfortunately, Indonesia ranked 64th in Mathematics and Science and 61st in Reading.

Although in general the PISA scores increased in 2015, yet they were still below students from the neighboring countries (see Figure 2).

Figure 2. PISA 2015 Results for Indonesia, Singapore, Thailand, Vietnam, and OECD Average

Source: PISA 2015 (https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf)

Apart from the low achievement in international surveys, the results of the Indonesia National Assessment Program (INAP), a national survey conducted by the Center for Educational Assessment, has somewhat disappointed. The 2015 INAP result shows that among the students, there were 73.61% students categorized as low performers and 25.38% were middle performers (Nizam, 2016). This is quite similar with the PISA 2012 results, where 75.7% students were categorized as low performers and 24% as middle performers (Nizam, 2016). Thus, number of students who perform below average is considered to be quite high. It expresses that, our students are still lacking in their critical and analytical ability.

Additionally, the composition of the workforce in Indonesia which is still dominated by elementary school graduates or below also reflects that our workforce comprises more of laborers or blue-collar workers compared to experts / white-collar workers/ professionals (see Figure 3).
Thus, we have to ensure that Indonesian students in the future will master 21st century skills. Preparing children to be able to compete in the 21st century requires efforts from all stakeholders in the field of education. 21st century skills comprise of critical thinking and problem solving, creative, communication, and collaboration (P21 Framework, 2002 in Fadel & Trilling, 2012).

The 2013 curriculum is an improvement from the previous curriculum, namely the Curriculum 2006. The 2006 Curriculum also known as a school-based curriculum (kurikulum tingkat satuan pendidikan / KTSP). KTSP is a curriculum compiled and implemented according to the characteristics of each education unit with the opinion of Khaerudin and Mahfud Junaidi (2007: 79). Curriculum 2013 revised in 2016 focuses on developing these 21st century skills, as well as increasing higher order thinking skills, advancing literacy, and character-building education (MOEC, 2016).

Standards for Curriculum 2013 implementation are Content Standards (includes Core Competencies and Basic Competencies), Process Standards (acknowledging learning principles), Assessment Standards (measuring three domains of learning: (affective, cognitive, and psychomotor), and Graduates’ Competence Standards (stressing on the mastery of the knowledge dimensions: factual, conceptual, procedural, and metacognitive). These standards are elaborated in MOEC Regulation Number 20, 21, 22, and 23 Year 2016.

The core competency (Kompetensi Inti/ KI) in the 2013 curriculum is the level of ability to achieve graduate competency standards that must be possessed by each student at each class level. While basic competency (Kompetensi Dasar/ KD) is the ability and minimum learning material that must be achieved by students for a subject in each education unit that refers to core competencies (MOEC Regulation Number 64 Year 2013). Both KI and KD must be understood correctly by each teacher.

STEM which stands for Science, Technology, Engineering, and Mathematics, was first introduced by the US National Science Foundation in the 1990s as an educational reform movement in the four disciplines. The aim of STEM becoming a learning approach is to foster the workforce of STEM fields, increase citizens’ knowledge about STEM, and enhance the global competitiveness of the United States in science and technology innovation (Hannover Research, 2011).

STEM education is not only meaningful in strengthening each subject of STEM separately; but also in developing an educational approach which integrates science, technology, engineering, and mathematics, by focusing education processes and problem-solving in real life (National STEM Education Center, 2014). STEM is an interdisciplinary approach in learning, where students integrate science, technology, engineering, and mathematics in real-life context. STEM connects between school, work, and a global world so that it could develop STEM literacy which makes students able to compete on the new economy era (Reeve, 2015 in Firman, 2018).

In Indonesia, STEM is not yet popular and has not been comprehensively integrated into learning, especially in Curriculum 2013 implementation. STEM learning has been introduced in
Indonesia since 2018 through workshops held by the SEAMEO and Agency of Research and Development, MOEC.

Agency of Research and Development (MOEC) conduct a focus group discussion about integrating STEM learning in Curriculum 2013. One of the challenges identified from the discussion was how to conduct an assessment for STEM learning so that it would suit with the Curriculum (STEM Workshop, 2018). What kind of assessment methods is the most appropriate according to the nature of STEM learning and Curriculum 2013?

The purpose of this study is to: (1) analyze the STEM learning implemented in the schools using the STEM Criteria; (2) gather information on the assessment methods used in assessing the STEM learning in Curriculum 2013 implementation; (3) propose an assessment method that can be use in assessing STEM learning in Curriculum 2013 implementation.

2. BODY OF PAPER

In analyzing the assessment used by the schools for their STEM learning, there are several steps conducted as part of analysis. First of all, defining which schools are representing STEM learning accordingly. Secondly, analyze the assessment method used by the most prominent schools for STEM learning.

2.1 STEM learning and fulfillment of the STEM criteria

Fifteen schools were selected for this study as they already implement STEM learning, they were analyzed according to the nature of their learning compared with the STEM criteria. STEM Criteria developed by STEM by Design comprise of 1) science and math contents is standards-based, grade-appropriate, and applied; 2) student-centered, 3) students’ collaboration, 4) teachers facilitate inquiry-based and project-based learning, 5) students focus on problem-solving in real-world, 6) an engineering design process is used to integrate science, math and technology, 7) failure is regarded as natural, and 8) students are introduced to STEM career (Jolly, 2016). These fifteen schools and their STEM learning characteristics according to the criteria are listed below in Table 1.

Based on the eight criteria, these fifteen schools implementing STEM learning can be categorized as four types: (1) schools that have fulfilled almost all criteria; (2) schools that could fulfill at least 6 out of 8 criteria; (3) schools that only fulfill at least 4 out of 8 criteria; (4) schools that only fulfill less than 4 criteria.

First Category: Schools that have fulfilled almost all criteria specified by STEM by Design

- Darul Hikam international school and Al-Ma’moen Junior High School are both fulfill almost all criteria for STEM learning from STEM by Design. Both schools integrate Science, Math, Technology and Engineering as well as other subject matter accordingly with the Curriculum 2013 Basic Competencies.

Second category: Schools that fulfill at least 6 out of 8 criteria

- In this category there are Insan Cendekia Madani, Kharisma Bangsa, SMPN 15 Bandung, SMPN 52 Bandung. All these four schools does not meet the first criteria, since STEM implemented in their schools only focusing on Science as its core subject matter, thus the Math inside STEM learning is not necessarily standard-based and grade appropriate. Mathematics used in STEM learning in these schools merely graphic display and not directly according to Basic Competencies of Mathematics for Junior High School.
Table 1. List of Schools implementing STEM learning according to STEM criteria

| SCHOOLS                      | CRITERI A 1 | CRITERI A 2 | CRITERI A 3 | CRITERI A 4 | CRITERI A 5 | CRITERI A 6 | CRITERI A 7 | CRITERI A 8 |
|------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| SMPN 15 Bandung              | X           | somewhat    | √           | √           | √           | √           | √           | √           |
| SMPN 47 Bandung              | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| SMPN 52 Bandung              | X           | somewhat    | √           | √           | √           | X           | √           | √           |
| SMPN 29 Bandung              | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| SMPN 9 Bandung               | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| Darul Hikam Junior High      | √           | somewhat    | √           | √           | √           | √           | √           | √           |
| AlMa'moen Junior High        | √           | somewhat    | √           | √           | √           | √           | √           | √           |
| SMPN 5 Pasar Kemis           | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| SMPN 4 Tangsel               | X           | somewhat    | √           | √           | √           | √           | √           | X           |
| SMPN 8 Tangsel               | X           | somewhat    | √           | √           | √           | √           | √           | X           |
| Insan Cendekia Madani Junior High | X      | somewhat    | √           | √           | √           | √           | √           | √           |
| Muhammadiyah 22 Junior High  | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| Muhammadiyah 8 Junior High   | X           | somewhat    | √           | √           | √           | X           | √           | X           |
| Kharisma Bangsa Junior High  | X           | somewhat    | √           | √           | √           | √           | √           | √           |
| SMPN 6 Bogor                 | x           | somewhat    | √           | √           | √           | X           | √           | X           |

Source: Data Analysis

Third Category: Schools that fulfill at least 4 out of 8 criteria

The remaining schools are categorized in this third category. Many of these schools

Fourth Category

There are no schools in this category. One possibility that, the fifteen schools selected for this study are schools that already claimed to implement STEM learning and most of their teachers already taken part in STEM Workshop held by SEAMEO-MOEC.

Based on the data, it seems like from fifteen schools, only two that are eligible to be considered as fulfilling the STEM criteria, i.e. Darul Hikam International and Al-Ma'moen Junior High School. Both schools already implementing STEM accordingly to the eight criteria based on STEM by Design although teachers still provide general guidance throughout the process. Kharisma Bangsa and Insan Cendekia Junior High School although already implemented STEM learning to some extent, however it lacks in fulfilling the standards for Mathematics subject. STEM learning in Kharisma Bangsa and Insan Cendekia integrates only science’s subjects such as Biology and Physics, although they also use some Math in the process, but it not necessarily in the curriculum (in other word not grade appropriate). While Math involved in their STEM is not always based on the curriculum thus not fulfill the first criteria of STEM learning.
2.2 Assessing STEM Learning in Curriculum 2013 Implementation

Assessing STEM learning is somewhat difficult because STEM learning integrates science and mathematics in an engineering process using technology as a mean. Teachers should be able to capture all aspects, individual subject-matter, as well as the collaboration process. In terms of assessments, most of the schools listed above still uses separate assessment, for Science and other subjects. STEM learning considered merely as a hand-on practice but not as a holistic collaboration process. Based on their assessment.

2.2.1 Examples of STEM learning in Darul Hikam and the assessment methods used

Darul Hikam International Junior High School started to implement STEM learning since 2015, but only during 2016 that teachers started to collaborate with each other and STEM learning becoming a regularly project each semester. Brief description on Darul Hikam STEM learning is provided below.

STEM Project: Mini Fridge

This Mini-Fridge Project integrates Science, Math, and English subjects for seventh grade students. The basic competencies accordingly to the grade and the curriculum. For Science, the basic competency is “conduct experiments in order to investigate the effect of heat on changes in temperature and shape changes of objects”. As for Mathematics, the basic competency is “using the concept of comparison to solve real problems using tables and graphs”. Basic competency in English subject for this project is “Compile very short and simple texts of transactional oral and written interaction which involve giving and asking for information related to the comparison of the number and nature of people, animals,”

Darul Hikam Junior High using rubrics as well as written test in assessing STEM learning. Assessment measures three dimensions, i.e.: cognitive, psychomotor, as well as affective. Different rubrics are used in assessing psychomotor and affective domain, while a written essay is used to measure the cognitive domain. Psychomotor assessment assesses both teamwork and individual performances. Rubrics for assessing psychomotor domain has five dimensions including attitude, involvement, and teamwork for assessing teamwork performance, followed by design, and time (effectiveness) which assess the individual performance.

| CATEGORY | 91 – 100 | 81 - 90 | 71 – 80 | 61 - 70 |
|----------|----------|---------|---------|---------|
| Time (Effectiveness) | Can hold ice cream more than 60 minutes. Ice cream start melting at 45 minutes. | Can hold ice cream more than 45 minutes. Ice cream start melting at 30 minutes. | Can hold ice cream more than 30 minutes. Ice cream start melting at 15 minutes. | Can hold ice cream more than 15 minutes. Ice cream start melting less than 15 minutes. |
| Teamwork Performance | Functioned well | Functioned well | Un-functioned well | Un-functioned well |
| | Hand carry | Less hand carry | Less attractive | Less hand-carry |
| | Attractive | Less attractive | Original | Less attractive |
| | Original | Original | Expensive | Original |
| | Cheap | Cheap | Expensive | Expensive |
In terms of assessing the affective domain, Darul Hikam uses two aspects of character (following the Curriculum 2013 focus, which is to strengthen the character-building). The characters being assessed are discipline and *ihsan* (*ihsan* means to act piously). The rubric for the affective domain is shown in Table 2.2.1.2

**Table 2.2.1.2. Rubrics for Affective Domain**

| No | Character | Indicator | Score |
|----|-----------|-----------|-------|
|    |           |           | 1     | 2     | 3     |
| 1  | Discipline| Come to class and finish the activity on time Follow the instruction properly |       |       |
| 2  | *Ihsan*   | Try to finish the task as best as they could Do the task really carefully |       |       |
Darul Hikam Junior High School use written test essay to evaluate the cognitive domain. The questions contain higher order thinking skills as well as problem-solving skills, not merely asking about the concept but also analytical. List of questions for cognitive domain is shown at Figure 2.2.1.3.

**Figure 2.2.1.3. Written Test for Cognitive Domain**

| Assessment technique: Written test |
|-----------------------------------|
| 1. Describe the working principle of ice cooler! |
| 2. What can you tell about state of matter and its changing, analyze it based on your project? |
| 3. Please describe the function of an ice cooler! |
| 4. Please draw the design of an ice cooler! |

### 2.2.2 Example of STEM learning and assessment in Al-Ma’moen Junior High, Cianjur.

Al-Ma’moen Cianjur started to implement STEM learning since 2017. The pioneer was a science teacher who tried to implement what she gained from her college about STEM. As a science teacher, she tried to persuade other teachers to collaborate but it was difficult in the beginning. The first STEM project established was the Water Filter project. Below is the description of the project as well as the assessment methods that were used in assessing the project.

**STEM Project: Water Filter Project**

The Water Filter Project integrates Science, Maths, Bahasa, and Social Science. The core subject is science with the theme Characteristics of Substance for grade seven. Basic Competencies for each subject matter are as follow. Conducting mixture separation according to the chemistry and physical features are the basic competency for Science. “Analyzing correlation between data and how to present the data (tables and charts)” as well as “Presenting the data in tables or charts” are two basic competencies for Math. While for Bahasa, at least three basic competencies required to be achieved, i.e.: (1) Identify information from text report, observation report; (2) Summarize the report; and (3) the conclusion/summary of report. Social science’s basic competency for this project is “Understanding environmental concept and interaction between as well as the effect on human being”.

Assessment methods used in Al-Ma’moen are rubrics, written test and observation. Three aspects being assessed include affective, psychomotor, and cognitive. Affective assessment measures 4 aspects: curiosity, rigorous, diligent and responsibility, as well as communication skills. Observation for affective assessment is shown in Table 2.2.2.1.

**Table 2.2.2.1. Observation for Affective assessment**

| No | Aspect                                               | Explanation of scoring                                             |
|----|------------------------------------------------------|-------------------------------------------------------------------|
| 1  | Curiosity                                            | 3: students show big curiosity, enthusiasm, and actively engaged in group-work |
|    |                                                     | 2: students show curiosity, not really enthusiastic, and actively engaged in group-work |
|    |                                                     | 1: students do not seem to be interested, less enthusiastic, and difficult to be engaged in group-work |
| 2  | Rigor and prudence in conducting experiments         | 3: students observe the experiment results rigorously, and be careful in the experiment |
|    |                                                     | 2: students observe the experiment results rigorously, and but less careful in the experiment |
|    |                                                     | 1: students observe the experiment results recklessly (not follow the procedures), and less careful in the experiment |
| 3  | Diligent and                                        | 3: students are diligent in accomplishing the assignment, try      |
Psychomotor domain is evaluated based on the steps of the project, from preparation, implementation, and Completion of the Task. Observation and scoring guide are listed below.

Table 2.2.2.2. Observation for Psychomotor domain

| No | Aspect of Skills   | Preparation                          | Implementation                  | Completion of the Task          |
|----|--------------------|---------------------------------------|----------------------------------|---------------------------------|
| A  |                    | 1 Preparing all the tools according to Students’ worksheet | 2 Grinding the ingredients       | 1 Clean the tools after finishing the assignment |
|    |                    | 2 Check the condition of materials    | 3 Pouring the powder ingredients |                                  |
|    |                    | 3 Clean the materials                 | 4 Closing the cup                |                                  |
|    |                    | 4 Preparing ingredients according to the worksheet | 5 Heating the ingredients according to the procedures in the worksheet | 2 Store the tools in the cupboard |
|    |                    |                                       | 6 Observe the low part of the cup |                                  |
|    |                    |                                       |                                  |                                  |
|    |                    |                                       |                                  |                                  |
|    |                    |                                       |                                  |                                  |
|    |                    |                                       |                                  |                                  |
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|    |                    |                                       |                                  |                                  |
|    |                    |                                       |                                  |                                  |
|    |                    |                                       |                                  |                                  |
| B  |                    |                                       |                                  |                                  |
| C  |                    |                                       |                                  |                                  |

Source: Adapted from Lesson Plan for STEM Project “Water Filtration” of Al-Ma’moen Junior High School

Cognitive domain is evaluate using written test, some of the questions asked in the written test are:

1) Describe the principles of mixture’s separation by using filtration method!
2) How could water be separated from the impurities?
3) Whether or not the more filtration materials being used will result in clearer water? Please give brief description!
4) Please draw the design of filtration tools used to separate water from its impurities

For these four questions, teacher provide scoring guide as a rubric. Score 15 for each question number 1 and 2, if the answer is right and comprehensive. Score is 25 for question number 3 if the answer is right and the steps explained well. Score is 25 for question number 4 if the drawings is accurate and complete with explanation.

2.2.3 Analysis of Assessment Methods in Darul Hikam and Al-Ma’moen using the Collaborative Problem-Solving Assessment Method

A collaborative process requires a collaborative assessment as well. Since STEM learning is a good example of a collaborative problem solving (CPS), thus it requires a CPS-type of assessment. Collaborative problem solving involves two different constructs—collaboration and problem solving. Collaborative problem solving has two main areas: the collaborative (e.g., communication or social aspects) and the knowledge or cognitive aspects (e.g., domain-specific problem-solving strategies). These two areas are often referred to as “teamwork” and “taskwork” (Fiore, et.al., 2017).
Collaborative problem solving requires partnerships as well as agreement to be reached on how the hypotheses be tested or the way team will work together (Griffin, 2017). One main difference between collaborative learning and collaborative problem solving is in the nature of the activity (Care, 2014). The nature of collaborative learning ensures students are provided with well-defined activities, explicitly informed of the goal and instructed to work together under the assumption that it will improve their learning and understanding. While some collaborative learning models introduce cognitive elements into the process such as decision making, the focus of collaborative learning is on the ability to learn from the interactive situation (O’Neil et al., 2014).

Dimensions of collaborative problem solving comprise of social and cognitive dimensions (Griffin, 2017). Social Dimension include participation skills, perspective-taking skills, and social regulation skills. While the cognitive domain of CPS comprises of Task regulation skills, and knowledge-building skills. Each of the aspects of domain has its own element. Further description on both social and cognitive domain of CPS is elaborated on Table 2.2.4.1.

Table 2.2.4.1. Framework of Cognitive Skills for Collaborative Problem Solving

| Cognitive Skills          | Low Level                          | Medium Level                        | High Level                          |
|---------------------------|------------------------------------|-------------------------------------|-------------------------------------|
| Task Regulation Skills    |                                    |                                     |                                     |
| Problem-analysis          | Takes problem at face value         | Divides problem into subtasks       | Identifies necessary sequence of subtasks |
| Goal-Setting              | Sets general goal such as task completion | Sets goals for subtasks             | Sets goals that recognize relationships between subtasks |
| Resource Management       | Uses own resources                  | Allocates own resources to partner   | Decides on use of joint resources to complete task |
| Flexibility Skills        | Inaction ambiguous situations       | Explores ambiguous situations       | Uses ambiguity to inform decision making |
| Collecting Data           | Takes problem at face value         | Searches for and interrogates information | Organizes Information |
| Systematicity             | Takes problem at face value         | Strategic sequence of actions       | Systematically exhausts possible solutions |
| Knowledge Building Skills |                                    |                                     |                                     |
| Relationship within the Data | Focuses on isolated pieces of information | Links pieces of Information           | Identifies patterns among multiple pieces of information |
| Contingencies             | Activity is undertaken with little or no understanding of consequence of action | Identifies sequences of cause and effect | Plans strategy based on a generalized understanding of cause and effect |
| Hypotheses                | Tests hypothesis                    | Modifies hypothesis                 | Reconstructs and reorganizes understanding of the problem |

Source: Griffin, 2017
The social dimension in collaborative problem-solving comprise of participation, perspective-taking, as well as social regulation skills. Each of the elements has its own behavioral indicators.

| Element                          | Behavioral Indicator                                      |
|---------------------------------|-----------------------------------------------------------|
| **1. Participation Skills**     |                                                           |
| 1.1. **Action**                 | Activity within environment                              |
| 1.2. **Interaction**            | Interacting with, prompting and responding to contributions of others |
| 1.3. **Task completion**        | Undertaking and completing a task or part of a task individually |
| **2. Perspective-taking**      |                                                           |
| 2.1. **Adaptive responsiveness** | Ignoring, accepting, or adapting contributions of others |
| 2.2. **Audience awareness (mutual modelling)** | Awareness of how to adapt behavior to increase suitability for others |
| **3. Social Regulation**        |                                                           |
| 3.1. **Negotiation**            | Achieving a resolution or reaching compromises           |
| 3.2. **Self-evaluation**        | Recognizing own strengths and weaknesses                  |
| 3.3. **Trans-active memory**    | Recognizing the strengths and weaknesses of others        |
| 3.4. **Responsibility initiative** | Assuming responsibility for ensuring parts of the task are completely by the group |

Griffin (2017) elaborates that in order to be able to assess both dimensions of CPS, a rubric could be used to describe social and cognitive dimensions with their elements and indicators. Griffin and Robertson (2014) in Griffin (2017) define rubrics as a combination of performance indicators and series of quality criteria and most suitable for assessing CPS. The nature of STEM learning requires collaborative problem solving. If we analyze the assessment method use in STEM learning previously, we can examine similarities and differences between the CPS Assessment and the STEM assessment used by the two schools examined.

Darul Hikam and Al-Ma’moen both measure three domains of knowledge, i.e. cognitive, affective, and psychomotor for their STEM learning. These three domains are accordingly to the Assessment standard in the Curriculum 2013 (MOEC Regulation Number 23 Year 2016). CPS Assessment Model proposed by Griffin (2017) assesses two dimensions, cognitive and social. The social dimension measured in Griffin’s CPS Assessment Model already include both affective as well as psychomotor domain.

Al-Ma’moen and Darul Hikam both uses written test for assessing cognitive skills and rubrics for affective and psychomotor. However, both Al-Ma’moen and Darul Hikam have not use rubric in assessing the cognitive domain. While in CPS Assessment Model, cognitive domain assessed using rubrics with indicators elaborated in Table 2.2.4.1. The assessment used in both schools for cognitive neglecting the cognitive skills of collaboration, and only specific for subject content. It is unlikely to measure students’ capability in terms of knowledge building skills and task regulating skills only with written test given. Griffin (2017) proposed a framework of cognitive domain including their indicators with the form of a rubric for that will provide comprehensive information on how the cognitive process happen between individual within teamwork in order to be able to solve the problems as well as reasoning skills employed in the given task. In this framework, teacher should be able to observe students’ capabilities in terms of their cognitive skills in solving the problems.

Psychomotor rubric assessment used by Al-Ma’moen merely hands-on activities, and have not described the three elements of social domain in CPS model, i.e.: participation, perspective-taking, and social regulation skills. Psychomotor rubric assessment used by Darul Hikam still lack in Social regulation skills. In The CPS Assessment Model proposed by Griffin, Social Domain describes the social skills of participants, i.e.: participation, perspective-taking, as well as social regulation skills.
2.2.4 Proposed Assessment Methods for STEM learning

The Assessment Standards in MOEC Regulation Number 23/2016 mandates the measurement of three domains of knowledge, the Affective, Psychomotor, and Cognitive.

The proposed Assessment Method for assessing STEM learning is the combination of CPS Assessment method and the affective domain as required by the MOEC Regulation Number 23 Year 2016. For Cognitive domain, the PS Cognitive domain is added by the element of the knowledge mastery of the subject.

Table 2.2.4.1. Cognitive Assessment Element and Indicators for Assessing STEM Learning

| Cognitive Skills                          | Low Level                           | Medium Level                          | High Level                           |
|------------------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|
| Task Regulation Skills                   |                                     |                                       |                                      |
| Problem-analysis                         | Takes problem at face value          | Divides problem into subtasks         | Identifies necessary sequence of subtasks |
| Goal-Setting                             | Sets general goal such as task completion | Sets goals for subtasks                | Sets goals that recognize relationships between subtasks |
| Resource Management                      | Uses own resources                  | Allocates own resources to partner     | Decides on use of joint resources to complete task |
| Flexibility Skills                       | Inaction ambiguous situations        | Explores ambiguous situations          | Uses ambiguity to inform decision making |
| Collecting Data                          | Takes problem at face value          | Searches for and interrogates information | Organizes Information                |
| Systematicity                            | Takes problem at face value          | Strategic sequence of actions          | Systematically exhausts possible solutions |
| Knowledge Building Skills                |                                     |                                       |                                      |
| Relationship within the Data             | Focuses on isolated pieces of information | Links pieces of Information            | Identifies patterns among multiple pieces of information |
| Contingencies                            | Activity is undertaken with little or no understanding of consequence of action | Identifies sequences of cause and effect | Plans strategy based on a generalized understanding of cause and effect |
| Hypotheses                               | Tests hypothesis                     | Modifies Hypothesis                   | Reconstructs and reorganizes understanding of the problem |
| Subject Knowledge Mastery                | Understanding the given concept (factual and conceptual knowledge) | Proficient in applying the steps and procedures in the project | able to use the concept to analyse the problem |

Psychomotor domain is assessed using the CPS assessment model and could also be combine according to the school’s objectives. While for the affective domain is leave for the school to develop. Affective assessment used by the Al-Ma’moen and Darul Hikam can be examples of it.
3 CONCLUSION

3.1 STEM learning in Darul Hikam and Al-Ma’moen Junior High are the two most prominent STEM approach in Curriculum 2013 implementation which satisfy the STEM criteria in STEM by Design in comparison with other schools.

3.2 Assessing STEM learning is somewhat difficult but not impossible. STEM Assessment method used by Darul Hikam and Al-Ma’moen are still lacking in terms of the measurement of Cognitive Domain

3.3 Proposed Assessment Method for assessing STEM learning is the combination of CPS Assessment method add by the affective domain of learning (mandated by the Assessment Standards)

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