Navigation Lamp Model on Maritime Vocational Education Integrated With STEM Approach: Analysis and Design

I. Mustain1*, Abdurohman2, E. Iskandar3, and D. Nuryaman4

1,2,3Engineering Departement, Maritime Academy of Suaka Bahari Cirebon, Jend. Sudirman Street, 156. Cirebon
4Nautical Departement, Maritime Academy of Suaka Bahari Cirebon, Jend. Sudirman Street, 156. Cirebon

*iing.mustain@akmicirebon.ac.id

Abstract. The application of knowledge to practical in engineering maritime of vocational education for professional practice. Engineer faced the problems are intimately tied up with design. The aim of this research is develop navigation lamp model on the ship with STEM approach by engineer cadets. The research method was used analysis study and design for cadets applied in practice before on shipboard. Navigation lamp model built consist of anchor light, masthead light, towing light, and side light. Analysis of navigation light base on rules of COLREGs about light and shapes. Navigation lamp built as miniature model with source of energy from solar cell 50 WP and the electric usage controller added for charge and load of the lamp. Both charge and load are measured with digital volt/ampere meter. We obtained for the conclusion that engineering cadets understand of rules of COLOREGs about light and shapes which can built from miniature models with PV solar cell as source energy.

1. Introduction

National policy document has related to development of the future generation of STEM professionals including vocational education. Implementation of professional education refer to development student learning in vocational education future. STEM education support for innovation in daily living according to Partnership for 21st Century Skills[1][2]. STEM in vocational education as maritime education needs to integrate interdisciplinary themes and promote cooperative learning in real-world contexts. teachers will need a new and interdisciplinary content knowledge base [3].

STEM literacy as a core component of a comprehensive career and college ready agenda. For STEM, that agenda would work toward three key outcomes: (1) All students develop a core foundation within and across the STEM disciplines so that they can be active and engaged in a society that is scientifically and technologically rich, complex, and dynamic. (2) All students develop a strong conceptual and factual knowledge within and across the STEM disciplines to prepare them for postsecondary education pathways that will lead to rewarding family-wage earning careers with options for growth and mobility. (3) An increasing number and diverse group of students are motivated and encouraged to pursue STEM professions through rich, robust, and relevant learning experiences throughout their K12 experience[4].

Definition STEM literacy is the ability to identify, apply, and integrate concepts from science, technology, engineering, and mathematics to understand complex problems and to innovate to solve
them[5]. Engineering cadet of maritime education has important literacy in STEM for establishing such as energy [6], technology and engineering literacy[7].

Some problems faced by educator while students are studying is how to develop thinking not for individual but model thinking in group discussion[8] such as collaborative problem solving. In the context of K-16 STEM education and the workplace[9][10]. Graesser and his colleagues argue that collaborative problem solving (CPS) requires a set of cognitive and social skills that are different from traditional studies on an individual’s problem solving[11].

2. STEM Project-Based Learning (PBL)
PBL are not new concepts in science and mathematics and PBL’s prominence in the national educational standards. Additional the T (Technology) and E (engineering) as STEM(Science, Technology, Engineering, and Mathematics) naturally supports the project-based design ethos in the simple definition for STEM PBL. STEM Project-Based Learning (PBL) integrates engineering design principles with the K-16 curriculum. The infusion of design principles enhances real-world applicability and helps prepare students for post-secondary education, with an emphasis on making connections to what STEM professionals actually do in their jobs.

The following design principles impact the design of PBL[12] are making content accessible, making thinking visible, which includes using visual elements to help the learner and using learner constructed visual elements to assess learning, helping students learn from others, and promoting autonomy and lifelong learning.

Engineering applies concepts from mathematics, the sciences, and technology to solve complex problems in a systematic manner. How the engineering cadets do in their learning? There are many variations in practice today, they need to formulate the best solution possible in learning, and the act of following a design process builds problem solving skills and logic. They make a group of discussion and set a layout of navigation lamp based on COLREGs than build up the model navigation lamp.

3. Method
The learning resulting from engineering fits well with accepted learning cycles and instructional models. One widely used instructional model is the BSCS 5E model[13] which provides a structured sequence of learning steps. This paper uses the 3E model as Table 1 summarizes the steps of the 3E model and ties them to steps in the engineering design process.

| 3E step       | Design Process step                        |
|---------------|--------------------------------------------|
| Engagement    | Identify problem and constraints           |
| Exploration   | Analyze ideas; Communication; Discussion.  |
| Extension     | Design; Build                              |

4. Result
4.1 Engagement – Identify Problem and Constrain
First step that student identify the recent COLREGs accidents data to find what problem was happened. Recent reports indicate that more than 80% of marine collision accidents are caused by or related to human decision failures concerning the lack of situational awareness and failure to comply with the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs)[14].

Avoiding Collisions at Sea (ACTs) has important to understand for maritime vocational students. Studied of Faculty of maritime studies, University of Rijeka, Croatia on the project was to detect gaps
in knowledge, understanding and applying of COLREGs (International Regulations for Preventing Collisions at Sea 1972 - Rules) and to develop new way of teaching COLREGs. On their research found that e-COLREGs is innovative way of teaching COLREGs improved the understanding of the Rules [15].

4.2 Exploration – Analyze, Communication, and Discussion
The engineering cadet students with officer cadet students discuss in group to analyze the rule of light and shapes base on COLREGs 1972. Rule Part C of the COLREG’s (International Regulations for Preventing Collisions at Sea, 1972) about light and shapes said as rule 20 application:

- Rules in this part shall be complied with in all weathers.
- The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.
- The lights prescribed by these Rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.
- The Rules concerning shapes shall be complied with by day.
- The lights and shapes specified in these Rules shall comply with the provisions of annex I to these Regulations.
- Meanwhile, showed in figure 1 that the rule 21 definitions are:
  - Masthead light means a white light placed over the fore-and-aft centerline of the vessel showing an unbroken light over an arc of the horizon of 225° and so fixed as to show the light from right ahead to 22.5° abaft the beam on either side of the vessel.
  - Sidelights means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5° and so fixed as to show the light from right ahead to 22.5° abaft the beam on its respective side. In a vessel of less than 20 m in length the sidelights may be combined in one lantern carried on the fore-and-aft centerline of the vessel.
  - Sternlight means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135° and so fixed as to show the light 67.5° from right aft on each side of the vessel.
  - Towing light means a yellow light having the same characteristics as the sternlight defined in point C of this Rule.
  - All-round light means a light showing an unbroken light over an arc of the horizon of 360°.
  - Flashing light means a light flashing at regular intervals at a frequency of 120 flashes or more per minute.

![Figure 1. Navigation lamp base on rule 21](image)

4.3 Extension: Design and Build
From COLREGs rules than engineering cadet students with officer cadet students discuss in group to design the navigation lamp model. This design take for education in classroom teaching and learning simulation. So, model of visible light taken the example from small vessel less than 12 m in length. Rule 22: Visibility of lights

In vessels of less than 12 m in length are mentioned: a masthead light, 2 miles; a sidelight, 1 mile; a sternlight, 2 miles; a towing light, 2 miles; a white, red, green or yellow all-round light, 2 miles.
4.4 Build the navigation lamp model
Navigation lamp model built with solar energy as source of energy. The energy from solar panel hold on battery accumulator while charging process. We use the 50 WP of solar panel cell and the GS NS 35 AH of battery accumulator. Students set a layout of navigation lamp model for lighting as figure 2. For explanation of the navigationlighting, we refer to International Association of Lighthouse Authorities (IALA).

There is a pattern in which these lights are set up on the ships and boats in conjunction with the International Association of Lighthouse Authorities (IALA) Buoyage Systems. The pattern can be explained below:[16]

- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- Both the sidelights show an unbroken light over an arc of the horizon of 112.5 degrees such that from right ahead it can be viewed to 22.5 degrees shaft on either side.
- The mast of the boat also has to have night lights. The colour of this light is white. Two mastheads lights are in place, with the second one shaft of and higher than the first, when the length of the vessel is greater than 50 metres. Shows an unbroken light over an arc of the horizon of 225 degrees and so fixed to show the light from right ahead to 22.5 degrees abaft on either side.

![Figure 2. Layout of lamp navigation](image)

4.5 Charging and loading process
The process of charging electricity starts from a solar power source from a 50 Watt solar panel as show in figure 3. and then through the controller panel charging the voltage into the battery with a large electric current entering the battery. The charging process continues as long as the sun shines on the solar panels from 09.00 to 11.30 AM. Meanwhile, the process of removing the voltage is done by turning on the emergency lights and running lights. The loading process is measured the output voltage and electric current through a digital voltage and current indicator. The maximum charging process reaches 12.9 V with a maximum current of 4.07 Aduring peak times (see figure 4). And the output voltage and output current of the lamp reaches 12.9 V with an electrical current of 3.86 A(see figure 5).
5. Conclusion

Navigation lamp model built consist of anchor light, masthead light, towing light, and side light. The anchor light placed above the fore castle deck. Masthead lamp is placed one in front and one is placed behind both of them at the ships center line. From STEM approach that student can build navigation lamp for miniature model with source of energy from solar cell 50 WP and the electric usage controller added for charge and load of the lamp. Both charge and load are measured with
digital volt/ampere meter. We obtained that engineering cadets understand rules of COLOREGs about light and shapes which can be built from miniature models with PV solar cell as source energy.

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