

Literacy Practices of Vocational Engineering Pre-Teachers in Surveying and Mapping

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ABSTRACT

Surveys carried out in some countries show that more than half of labours have inadequate literacy skills to work in environments with knowledgeable society. Hence, as an institution orientating to workforce supply, vocational education is expected to instil a habit of literacy practice, which will encourage the improvement of graduates' literacy competence. This study aims to discuss literacy practice in vocational engineering education, which supports the mastery of engineering literacy. In this research, literacy practices focus in the surveying and mapping fields. This study was carried out using semi-structured interview. Participants in this study were three tutors were from the Vocational Engineering Education Department. Data collected were results of the interviews, students' fieldwork reports, and field observation. Findings from this study indicated that a habit of reading manuals or standards in engineering was considered low. Meanwhile, handwriting literacy habit was rare. Moreover, practical students tended to make detailed engineering design using computer applications. Communication ability to transfer information and ideas related to the results of vocational works was good, supported with technology-based presentation media..

Keywords: Engineering literacy, literacy practice, vocational education, surveying and mapping

INTRODUCTION

Literacy comprehension based on the field of expertise has not been significantly taken into account in vocational education in many developing countries. Surveys carried out in some countries depict that more than half of 25-64 year-old labourers with vocational upper secondary or post-

ARTICLE INFO

Article history:

Received: 01 December 2016

Accepted: 23 August 2017

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secondary non-tertiary education have few literacy competencies to work in environments with knowledgeable society (The Organisation for Economic Co-operation and Development [OECD], 2013, p. 51). Based on the findings of a research carried out by the World Economic Forum Global Agenda Council on Employment (Klosters, 2014), issues relating to skill, matching skill and skill mismatching still dominate problems in labour. The need to train workers to be skilful, critical, and familiar with the technology becomes an important issue in many countries to ensure that their citizens are competitive enough in the market in the globalisation era (Friedman & Friedman, 2007).

Vocational education is one type of education that focuses on the preparation of learners to have specific competencies, skills, behaviour and cooperative attitude, as well as social responsibility, and therefore enabling the young generation to take part in the economy, empower social cohesion, and become responsible citizens (Wang, 2012, p. 48). The characteristics of expected outputs from vocational education are: (1) to have professional vocational skills, (2) to have thinking ability, sensitivity, and art ability, and to show excellent moral commitment, (3) to have an ability to solve problems in real life, and (4) to have critical thinking ability and ability as an agent of change (Wagiran, 2012, p. 2601).

As a labour fulfilment-oriented educational institution, vocational education is expected to provide a broad range of skills, one of which is to strengthen numeracy and

literacy skills, which are often weak for students in vocational programmes and are increasingly important in the labour market (OECD, 2011). As such, this instalment in the learning environment is expected to encourage the improvement of graduates' literacy competencies, which later make them more ready to work and adapt to the working environment. This study aims to investigate the existing literacy practices in the vocational engineering field, which is necessary to guide tutors and authorities of education institutions in making efforts to help learners perform more literacy practices needed. The development of literacy in vocational field that increases learners' job-related and income-generating knowledge and skills, including essential elements of functional literacy and numeracy, can assure the social well-being of citizens (Popov & Manuel, 2016, p. 24). This paper sheds a light on the literacy practices of vocational structural engineering, especially in surveying and mapping. The constructs were developed based on the circumstances of one of the vocational engineering education institutions in Indonesia.

This paper is structured as follows. We begin by considering the literacy condition of society in general and then focusing on the practices in vocational engineering education. We, further, consider the model and dimension of the literacy in the vocational engineering education field. Since the literacy practices under question are in the field of engineering, the subsequent discussion focuses on literacy in the fields of surveying and mapping. We,

afterward, consider how the need for literacy in the field of engineering is reflected in students' written reports.

The Literacy Condition of Society

The notion of literacy is an ability to read, write and use arithmetic symbols. In reference to this definition, data from UNESCO (UIS UNESCO, 2015) revealed that the average literacy levels of people above 15 years old are 86.3% in the world, and 70.2% in Asia. Meanwhile, the literacy level of Indonesian people is reported to be higher, that is 99% for the 15-45 years old (BPS¹, 2016). However, a literacy test on the aspects of understanding, using and reflecting reading results in writing in 2012 put Indonesia in the 64th ranking with 396 points (The average score is 496) (OECD, 2013). The government has continuously made efforts to improve literacy competencies of its society. Through the Ministry of Education and Culture, the government has targeted an average literacy level of society of 96.10% and a PISA score of 414 in 2019 (The Ministry of Education and Culture of Indonesia, 2015, p. 50). To reach the target, the government has started the school literacy movement (*Gerakan Literasi Sekolah*, GLS) in educational institutions in order to develop them to become organisations for learning which make all members lifetime learners. This movement is carried out to foster learners' reading habits and improve their reading

skills, and therefore, knowledge can be mastered well (Direktorat Pembinaan SMK [DitPSMK], 2016, pp. 2-3). In the vocational education programme, improvement of literacy competence is considered as part of the basic competencies of working to meet industrial needs. These efforts are realised with language skill reinforcement of vocational school students as one of the strategic policies to achieve the programme of 'Indonesia Smart' (The Ministry of Education and Culture of Indonesia, 2015, pp. 32-33).

Literacy in the Vocational Engineering Field

The National Adult Literacy Survey (NALS) (Kirsch, 2001) defines literacy as an ability to understand and conduct written information in daily activities, whether at home, at the workplace, or in the society, in order to achieve the goals and develop the knowledge and potential of an individual. Literacy competencies, based on each discipline, need to be involved as competencies provided in vocational education (Bak, 2015, p. 50), which is later called 'vocational literacy'. Vocational literacy is defined as an activity orientating on the development of knowledge and skill according to the field of expertise. In order to master vocational literacy, an individual is required to learn how to read and follow an instruction; conduct, understand and communicate measurements; and develop knowledge and trading of the basic competencies (Popov & Manuel, 2016, p. 24).

¹Central Bureau of Statistics

Literacy competencies will have an effect on literacy levels by each discipline, one of which is literacy in the engineering field, which is known as engineering literacy. Engineering literacy is defined as an individual's ability to use, manage and master technology (Rhodes, 2003). Literacy related to the area of expertise needs to aim at developing learners' competencies to be involved in social, semiotic and cognitive practices in accordance with what experts have done in a certain field. Any attempts to develop literacy related to the certain field will further work at optimum when they are performed in learning contexts and environments which are suitable for each discipline (Zhi, 2014, p. 444).

Nonetheless, the literacy practice of vocational engineering education does not seem to receive much attention. A few prior studies have been done to investigate it in some areas. Among other, Parkinson and Mackay (2016) investigated the literacy practices of trades training in Carpentry and Automotive Technology. They identified that students were faced with spoken language practices, which differed from everyday language in being highly technical, and read a wide variety of texts, including complex professional texts. Hare and Kulog (2015) analysed the students' skill level of visual literacy in architectural education. They proved that visual literacy could be enhanced by means of other branches of art within the architectural education. Hallajow (2016) conducted a study to understand Syrian university students' electronic literacy practices and the factors influencing

these practices. The findings revealed that Syrian university students used a variety of languages in their electronic literacy practices and some technical issues were identified as the factors influencing these practices. In this study, literacy practices in the vocational engineering field, especially in surveying and mapping, were reviewed from four basic competencies as four models of literacy according to Freebody and Luke (2003).

Literacy Models and Dimensions in the Vocational Engineering Field.

Freebody and Luke (2003) postulated that effective literacy needs four basic competencies as four models of literacy. Those four competencies are equally important and do not have to be recognised respectively, or hierarchically. The first competency is beatable able to understand the context of the text, which involves recognising and using features like the alphabet, voice, spelling, conventions, and text pattern. The second competency is understanding and arranging meaningful text, which involves comprehending and arranging written, virtual, and oral texts in a certain culture, institution, family, society, country, etc., and describing a scheme. The third competency is using texts functionally, or for certain purposes. This is the ability to find out that texts have different cultural and social functions, both inside or outside educational institutions. This function is closely related to how text is composed, intonation for pronouncing text, the degree of formality of text, and the order of text components.

The fourth competency is analysing text critically, that is, understanding and acting based on the knowledge that texts are not neutral. Texts represent certain points of view and can influence people's ideas.

Literacy does not only focus on reading and writing but also on some ways in which people compose meanings by creating symbols, which they do by themselves through various modes and media. This literacy, using a multimodal approach, will make a symbol as a combination of meaning and form (Heydon, 2007). Literacy in the vocational engineering field has more tendencies to involve symbols related to the elements of technology and measurement.

Vocational engineering literacy covers three dimensions which are interdependent and inseparable, namely knowledge, critical thinking and problem-solving, and skill. The knowledge dimension includes recognition of a great use of technology for daily life, understanding of basic concepts and types of technology, and understanding that all types of technology have their risks. The critical thinking and problem-solving dimension comprises directing important questions related to the benefits and risks of technology usage and participating in decision-making related to the development and usage of technology. The dimension of skill consists of competency in operating devices and ability to identify and find solution for any problems dealing with technology (Becker, Hodge, & Sepelyak, 2010, p. 3).

METHODS

Research Design

In order to explore vocational engineering literacy practices, this research was carried out using semi-structured interviews in the Gadamerian hermeneutic approach (Gadamer, 1989). A hermeneutic approach was taken because the aim of this study was to explore the experiences of vocational engineering tutors with students' literacy practices.

Participants

Three tutors from the Vocational Engineering Education Department were nominated as the research participants. The tutors taking part in this study met the inclusion criteria: they had already taught in the vocational engineering field, especially in surveying and mapping, for 10 years at the minimum. We regard the tutors as expert informants, who, besides having teaching experience for a number of years, have also worked as professionals in surveying and mapping trades. They have both an expert's insight into the literacy, as well as a tutor's insight into the aspects of that literacy that are problematic for students. The research objectives were explained to the participants, who were later interviewed individually by the researcher.

The tutors are expected to provide information about all literacy tasks students engage in, some efforts which tutors have done to familiarise the students with literacy,

written, read, or spoken, as well as the difficulties which students faced in literacy.

Procedures

This research was interpretative. In-depth interviews were carried out with each tutor. Open questions were posed to the tutors in accordance with the character of hermeneutic inquiring, which is interpretive and not governed by predetermined questions (Geanellos, 1999, p. 24). This approach was selected to get a broad and inclusive idea of all the literacy tasks students engage in, in the first instance, without limiting the focus by referring to specific contexts or genres. This allowed the interviewer to ask more specific questions in response to the information that each tutor had provided.

The first interview focused on the educational background of each participating tutor, including working experience in engineering. Additional information included experiences in improving literacy, both general and particular engineering ones. The subsequent interview focused on tutors' experiences in observing students' literacy practices in the engineering field today. Literacy practices seen from reading and writing activities are related to particular tasks according to the learned engineering field. Information obtained related to students' difficulties in understanding literacy in the engineering field during learning and when practising in real working life.

Data Analysis

Data in this study were analysed using the model from Geanellos (2005). This model reflects Gadamerian philosophy and hermeneutic principles by using pre-understanding, the hermeneutic circle and "openness" (Johansson, Hanson, Runeson, & Wahlin, 2015, p. 244). Data from the interviews were transcribed. The transcripts of the interviews were repeatedly read in their entirety to appreciate the whole text (all interviews) in relation to its parts (individual interviews).

The first level of interpretation was the reduction, which was finding specific meanings from the whole texts. Several thousand words were thus reduced to several hundred specific meanings. Then, the second level of interpretation was integration. Here, common elements were identified and grouped into sub-themes. The third level was aggregation, in which sub-themes with shared meanings were clustered under themes. Finally, throughout all the interpretation, a reflection was engaged. A meta-theme was developed by simultaneously focusing on the fragments, sub-themes, themes and full texts (Geanellos, 2005).

The author also collected a small corpus of students' writing, including in particular, ten examples of the students' field notes and ten examples of students' final reports. These were transcribed and analysed for discourse features such as personal/impersonal language, mood, and students'

understanding of engineering literacy. Interactions between numbers, texts and diagrams, and sketches in the students' field notes and the final reports were also considered. The course books that students in the surveying and mapping course read were also studied. These data sources were supplemented by on-site observations.

RESULTS

A thematic overview of the vocational engineering tutors' experiences with students' literacy practices is described in Figure 1 below.

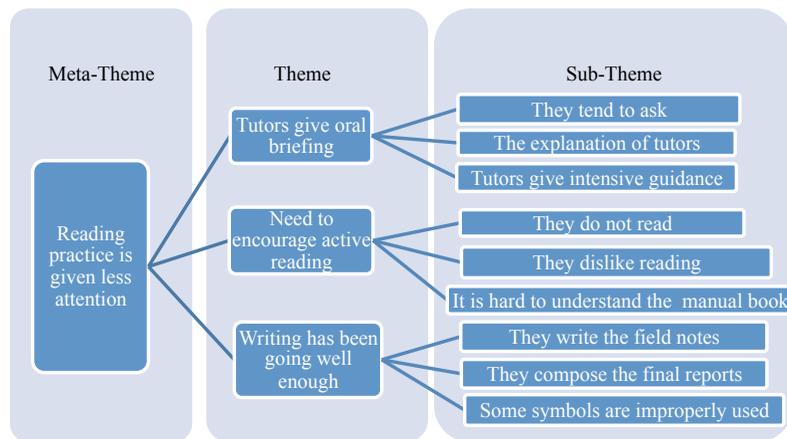


Figure 1. A thematic overview of the vocational engineering tutors 'experiences with students' literacy practices

Meanwhile, the relation between literacy dimensions for each basic literacy competence and their related activities

observed in this research was composed in Table 1.

Table 1
The relation of basic literacy competencies, literacy dimensions, and related activities

Basic literacy competence	Literacy dimension	Related activities (that support literacy practices)
Recognising and using text patterns and features	Knowledge	Reading course book, manufacturers' specifications, tools' manual book, work safety guidance, and to apprehend the concept of technology
	Critical thinking and problem-solving	Reading course books, manufacturers' specifications, tools' manual book, work safety guidance, to understand the uses and the risks of technology; and to solve problems related to technology
	Skill	Operating technology appropriately based on the text patterns listed in the tools

Table 1 (continue)

Basic literacy competence	Literacy dimension	Related activities (that support literacy practices)
Composing written and oral texts along with drawing schemes	Knowledge	Composing written field notes containing data, tables, and schemes by the purposes Composing written and oral work reports that show the procedures and products
	Critical thinking and problem-solving	Composing written field notes containing data, tables and schemes based on the available technologies to achieve the goals Composing written and oral procedures containing work implementation, problems, and solutions
	Skill	Composing written field notes containing data, tables, and schemes by employing technology Composing work reports in the forms of tables and schemes by employing technologies
Using texts for specific purposes	Knowledge	Understanding the meaning contained in the course book, manufacturers' specifications, tools' manual book, and work safety guidance according to their functions
	Critical thinking and problem-solving	Using texts in the field of vocational engineering based on their functions, i.e. for asking questions, making decisions, as well as solving problems related to surveying and mapping subjects in the vocational engineering field
	Skill	Using texts in the field of vocational engineering based on their functions in order to utilise vocational engineering technology
Analysing texts	Knowledge	Understanding the course book, manufacturers' specifications, tools' manual book, and work safety guidance in the field of vocational engineering based on the context of each technology
	Critical thinking and problem-solving	Asking questions related to technology and participating in problem-solving process related to the development and the utilisation of technology based on associated literature and standards
	Skill	Being able to operate, identify, and revise problems related to technology appropriately based on the available texts

Thus, vocational engineering students drew upon a wide range of sources in learning and using some activities to support basic literacy competencies achievement. Furthermore, the discussion focused on the current literacy practices in surveying and mapping which are described as themes

and sub-themes, as illustrated in Figure 1. The comments here are based not only on the interviews from Katty, Willy, and Bian (three of the surveying and mapping tutors) but also on a small corpus of 10 students' field notes and final reports.

Recognising and Using Text Patterns and Features

Learning activities in the current vocational field put the emphasis more on skill mastery than practical activities. Meanwhile, literacy mastery was sometimes ignored. According to Katty, one of the surveying and mapping tutors, in the Surveying and Mapping practical course, basic literacy competencies in utilising text features and patterns in the dimension of knowledge and critical thinking were implemented in reading the course book, manufacturers' specifications, tools' manual book, and work safety guidance, to apprehend the concept of technology. Detailed working steps of taking land data and procedures for operating surveying devices were explained in the course book. Meanwhile, the dimension of skill was implemented in the measuring process by reading needles on the measuring instrument. Unfortunately, most students think of a vocational course as merely a practical course, so they maintained that reading was not sufficient in the vocational course.

Willy: "Most practical students obtained information from the explanation of tutors on the procedures for using devices. They did not read directly from the course book. Through intensive guidance and training, most of the practical students could set and operate field measuring device well. It needs more efforts and appropriate strategy from tutors to encourage active reading and aid understanding of their students."

Composing Written and Oral Texts along with Drawing Schemes

Based on the interviews with tutors, characteristics of the Surveying and Mapping course were done by taking land's data first (surveying stage), followed by composing the sketch of a map based on the data (mapping stage).

Bian: "Students practicing their abilities in composing written texts by arranging written fields notes and final reports on the results of the survey, both in tables and pictures. Pictures in field notes usually were drawn manually, while pictures in the final reports were drawn with the help of computer application. They also constructed their ability in composing oral texts by presenting the results of the survey."

Oral presentations on the implementation and the results of work were done at the end of learning activities. Through these activities, practical students were accustomed to communicating actively and effectively by using technical and sub-technical vocabulary that professional surveying workers use. Therefore, having the ability to talk like a professional has a function of being able to communicate both on-site while working, and in more informal situations (Parkinson & Mackay, 2016, p. 41).

Furthermore, the results of field measurements were manifested into images as media for presentation. Numeric field data were not easily understood. Therefore,

images could help ordinary people with limited engineering literacy understand the results of surveying and mapping. To be a master in vocational literacy, a student needs the ability to conduct, understand and communicate measurements. Holmes and Woodhams (2013) examined learning processes taking place at a construction site. Practical students interacted with and learned directly from various parties involved in the construction process including construction workers (bricklayers), foremen, and supervisors. In such an interactive learning process, students involved visual means like detailed engineering design, diagrams, and tables.

Using Texts for Specific Purposes

Based on the in-depth interviews with the surveying tutors, related activities that support basic literacy competence of using texts for specific purposes in the dimension of knowledge and critical thinking were performed in the activity of understanding the meaning contained in surveying manufacturers' specifications and tools' manual book, as well as course books, according to their functions. These books consist of many symbols or patterns which are specially applied in surveying and mapping technologies. Being literate in surveying fields means that students have the ability to break the written code of a system of symbols specific to these fields (Bhola, 1995, p. 4).

Bian: "I always told to students to read the manual book and course book before entering course class. There

are so many symbols and pattern that used in surveying and mapping. Worse understanding of that symbols will bring difficulties in surveying process as well as mapping. However, most students showed that they disliked reading. Only a few members of them that read course book and almost no student read tools manual book. Tutors have to give oral briefing dealing with the process of surveying, tools operation procedures, till mapping procedures. If there is information needed, they tend to ask either the instructor or the peer."

Willy indicates that students' literacy practice in writing has been going well enough. Students were familiar with composing written reports, both reports of field data and scientific writing papers. Calculations and sketches of calculation results were written in the reports. However, when composing, they were still dependent and required intensive guidance. Some symbols in surveying and mapping were used improperly. Improper utilisation of measuring devices was a crucial factor in surveying and mapping. Mistakes in using measuring devices would automatically generate false data, and hence, the measurement results would not meet the real conditions in the field.

Analysing Texts

The interviewees noted that the ability to analyse texts in the dimension of knowledge, critical thinking and problem-solving was carried out through activities in understanding the course book,

manufacturers' specifications, tools' manual book, and work safety guidance in the field of vocational engineering based on the context of surveying and mapping technology. Meanwhile, the ability to analyse texts in the dimension of skill was carried out through interpreting data of the results of measurement into sketch pictures of the location. Activities like interpreting data, calculating distances and angles, and drawing the sketch based on calculated distances and angles were also performed.

Katty: "Many students said that it was hard to understand the specification or manual books. That is why they dislike reading that books."

Willy: "Oral briefing given by tutors in the front of course session. This briefing gives students information about how to operate tools, take data measurements, and compose a location drawing sketch base on that data. However, in fact, in the stage of reports preparation, students still need intensive guidance to interpreting data measurements and translate them to be a sketch of a map. When students were asked to read a sketch of the map from a measurement, they can read but not fully understand the meaning of the sketch."

DISCUSSION

Literacy is now seen as the foundation for life skills ranging from basic oral and written communication to the ability to solve complex scientific and social problems. Globalisation today has become the entrance gate of the promulgation of technology

around the world. Technology is a means to facilitate humans' activities. However, in order to make use of technology properly and effectively, users would have to understand the working procedures of technology which are put in manuals, whether in the forms of words, pictures, the combination of words and pictures, or videos. Here, good literacy competence, in the context of literacy in the engineering field, is required in order to understand the manuals.

Manual books, as well as standards book, are usually written in the highly condensed language, which needs experience and insider knowledge to decode and understand. The manual books also impose challenges to students because they were written in a foreign language, or even translated into Indonesian, while and some might have been poorly translated. These often make students reluctant to make use of the manuals and standard books as their source of information, and prefer asking questions and getting explanation from their tutor, whereas in the real work field they should be able to solve the problem of tools or calculation methods through the standard books.

The main finding from this research was that reading practice has been given less attention among vocational engineering students while reading skill plays an important role in making someone a lifelong learner that will enable them to adapt to any working environment. In order to enhance the literacy skill of vocational students, efforts to help students perform more literacy practices through their daily

learning activities are necessary. The relevant parties that can be involved in these efforts are tutors, education institutions, and the government. The involvement of each party is crucial in the effort to develop literacy reading habits, as listed in Table 2:

Table 2
The involvement to develop literacy reading habits

Government	Educational institution	Tutor
Policy (e.g., school literacy movement)	Implementing the government's policy	Instructing students to read the literature before giving explanations
Providing facilities and infrastructure	Providing facilities and infrastructure that support reading habits	Referring students to the corresponding literature
Monitoring the implementation of the policy		Monitoring and evaluating students' activities in literacy

After improving students' reading habits, what needs to be done next is to improve their ability to understand the text. Being able to read a text does not mean that a student can understand it. The student needs the ability to analyse text to find the meaning. Parkinson and Mackay (2016, p. 42) recognised that reading involves more than being able to decode the words. Being able to understand and communicate measurements is one ability that should be learned to master vocational literacy (Popov & Manuel, 2016, p. 24). Literacy practice which enables students lead to their fuller participation in economic and civic life could be reached through the application of a literacy programme that imparts not only reading and writing skills but also professional and technical knowledge (Bhola, 1995, p. 12).

The skills of speaking, literacy, and counting would be useful for workers' career development. Skilful workers who

want to develop their career need to do various and more complex tests. These tests require the skills of speaking, literacy, and counting. Technology and safety standard improvements also need good literacy skills. Literacy skills affect the safety and security of the workplace. People with a low level of literacy are high-risk as they cannot read and understand the safety and security instructions, particularly at high-risk workplaces such as farming, manufacture, and transportation constructions (Campbell, 2008, p. 3).

CONCLUSION

The research findings on literacy practices in surveying and mapping show that the basic competencies in recognising and utilising text patterns and features through reading habituation of literature related to technology have rarely been implemented. The ability to compose written texts and use them for specific purposes in three literacy

dimensions has been well implemented through activities in composing written field notes and final reports. Practices dealing with the ability to analyse texts in the dimension of knowledge and critical thinking have been implemented in some activities like searching for information relevant to workplaces which will be produced through course book and other sources. In addition, interpreting data resulting from measurement activities has also been carried out. However, the dimension of skill still has to be improved, especially in making students familiar with solving problems related to technology through available texts like manuals.

ACKNOWLEDGEMENT

We acknowledge the time, thought, experience and insight of the tutors interviewed in this study.

Note: All names quoted are pseudonyms.

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