Information literacy

by Ariyadi Wijaya

STUDENTS' INFORMATION LITERACY: A PERSPECTIVE FROM MATHEMATICAL LITERACY

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Abstract

Information literacy is mostly seen from the perspective of library science or information and communication technology. Taking another point of view, this study was aimed to explore students' information literacy from the perspective of mathematical literacy. For this purpose, a test addressing Programme for International Student Assessment (PISA) mathematics tasks were administered to 381 eighth and ninth graders from nine junior high schools in the Province of Yogyakarta. PISA mathematics tasks which were used in this test had specific characteristics regarding information processing, i.e. containing superfluous information, having missing information, and requiring connection across information sources. An error analysis was performed to analyze students' incorrect responses. The result of this study shows that students did not acquire three characteristics of information literacy; i.e. *recognizing information needs, locating and evaluating the quality of information*, and *making effective and ethical use of information*. This result indicates students' low ability in information literacy.

Keywords: information literacy, mathematical literacy, Programme for International Student Assessment (PISA)

Abstrak

Selama ini literasi informasi lebih banyak ditinjau dari sudut pandang ilmu kepustakaan serta teknologi informasi dan komunikasi. Penelitian ini mencoba melihat literasi informasi dari sudut pandang literasi matematika. Untuk keperluan tersebut, penelitian ini menggunakan suatu tes yang menggunakan soal Programme for International Student Assessment (PISA). Sebanyak 381 siswa Kelas 8 dan Kelas 9 SMP di Provinsi Daerah Istimewa Yogyakarta terlibat dalam tes tersebut. Soal yang digunakan adalah soal PISA yang memiliki karakteristik terkait pemrosesan informasi; yaitu memuat informasi yang tidak relevan (*superfluous information*), memiliki informasi tersembunyi (*missing information*), dan membutuhkan koneksi antar sumber data berbeda (*connection across information sources*). Untuk analisis data digunakan analisis kesalahan (*error analysis*) pada jawaban salah siswa. Hasil penelitian menunjukkan bahwa siswa tidak mencapai tiga komponen literasi informasi, yaitu mengenali informasi yang dibutuhkan, menemukan dan mengevaluasi kualitas informasi, dan membuat informasi secara efektif. Hal tersebut menunjukkan literasi informasi siswa masih rendah.

Kata kunci: literacy informasi, literasi matematika, Programme for International Student Assessment (PISA)

INTRODUCTION

Several studies (Ananiadou & Claro, 2009; Organisation for Economic Co-operation and Development [OECD], 2013; Partnership for 21st Century Skills [P21], 2002) reported that modern society calls for more than content knowledge. To cope with the demands of modern life people need to acquire a number of skills which is often called as 21st century skills, such as critical thinking skill, communication and collaboration skill, social and cross-cultural skill, and information literacy. A key characteristic of the 21st century era is the massive use of information and communication technology

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which leads to an easy access to an abundance of information. Therefore, as noted by P21 (2002), to be effective in the 21st century, people need to master a range of functional and critical thinking skills related to information, media and technology. One of these skills is so-called information literacy.

The concept of information literacy has actually been a concern for decades as a response to the rapid development of information technology and information society. Rader (2002) reported that from 1973 to 2002 there were 5000 publications related to information literacy. In that period researchers and educators started to consider the evaluation of not only students' learning outcomes, but also students' acquisition of information skills. Information skills were seen as an important capacity that will enable students perform productively in their (future) work environment. Information literacy, according to American Library Association (1989), refers to individual's ability to recognize when information is needed and to locate, evaluate, and use effectively the needed information. Similarly, Kurbanoglu, Akkoyunlu, and Umay (2006), defined information literacy as the abilities to recognize when information is needed and to initiate search strategies designed to locate the needed information. With regard to 21st century skills, the Partnership for 21st Century Skills [P21] (2011, p. 3) defines information literacy as students' ability "to access and evaluate information effectively and use and manage that information purposefully for the issue or problem at hand."

An addition to the definition of information literacy, there are important elements or characteristics that build information literacy. In their work, Kurbanoglu et al. (2006) argued that information literacy includes evaluating, synthesizing, and using information appropriately and communicating and sharing the results of the information problem-solving efforts accurately and creatively. Based on the definition of information literacy, Catts and Lau (2008) formulize five elements of information literacy. First, *recognizing information needs* which relates to the awareness whether information is required to solve problems. This element differentiates information literacy from the passive reception of given information. The second element is *locating and evaluating the quality of information* which deals with individual's ability to find information and evaluate the relevance of this information for solving problems. Third, *storing and retrieving information* which means individual's ability to store or save information and to retrieve it when it is needed. The fourth element is *making effective and ethical use of information*. Effectiveness of information use and awareness of the ethical dimension of information use are important element of information literacy. The last element is *applying information to create and communicate knowledge*. An individual with good information literacy is not only able to use information to solve problems, but also able to apply the information to create (new) knowledge.

Studies on information literacy are mostly seen from the perspective of library science (see e.g. Lai, 2011; McGuinness, 2006; Owusu-Ansah, 2003) and information and communication technology (see e.g. Katz, 2007; Kong & Li, 2009; Usluel, 2007). It is understandable because the concept of information literacy was developed from library orientation (Rader, 2002) and was triggered by the

massive development of ICT (Catts & Lau, 2008; Campbell, 2004). At the beginning information literacy related to librarians' focus on developing information skills, i.e. how to train library users to access the vast quantities of information provided in libraries. Nevertheless, nowadays research on information literacy starts to cover other disciplines such as mathematics. The Organisation for Economic Co-operation and Development (OECD) also consider that new millennium learners should acquire good information literacy. OECD highlights that new era requires new skills for accessing, evaluating, and organizing information. Furthermore, "it is not enough to be able to process and organize information, but also to be able to model and transform it to create new knowledge or to use it as a source for new ideas"(Ananiadou & Claro, 2009, p. 9). OECD specifies information literacy into two sub-dimensions, i.e. information as a source and information as a product. When information is seen as a source the focus is searching, selecting, evaluating and organizing information. Within this sub-dimension student needs to: (1) understand and clearly define the information needs on the basis of a problem or task; (2) knows how to identify information sources; and (3) knows how to search and select the required information effectively by considering the problem to be solved "(Ananiadou & Claro, 2009). Attention to information literacy in a specific field is also given by the Partnership for 21 Century Skills [P21] (2011) that has included information literacy as a learning outcome of mathematics learning. According to P21, as a preparation to cope with the demands of the 21st century era, mathematics learning should facilitate and develop students' ability to "identify sources of data, access data, critically evaluate it, and then use it to explore significant questions about our world" (p. 5).

A number of studies suggest how classroom activities could facilitate the development of information literacy. According to OECD (Ananiadou & Claro, 2009), problem solving can develop information literacy because it mostly involves defining, seeking, evaluating, selecting, organizing, analyzing, and interpreting information. P21 (2011) points out that information literacy is in line with mathematical practices that involves constructing arguments and critique the reasoning of others and looking for and express regularity in repeated reasoning. A kind of mathematics problems that fit the suggestion of OECD and P21 regarding information literacy is context-based mathematics tasks or also referred as 'word problems' (see, e.g. Verschaffel, Greer, & De Corte, 2000; Verschaffel, Van Dooren, Greer, & Mukhopadhyay, 2010), or 'modeling tasks' (see, e.g. Blum, 2011; Maass, 2006). Such problems require students to understand the real problem and to set up a model based on reality for which a set of competencies are needed. These competencies include the ability to recognize quantities referred by or included in the situation and to look for available information and to differentiate between relevant and irrelevant information (Maass, 2006), which are clearly characteristics of information literacy. Interestingly, such competencies are also characteristics of mathematical literacy (see OECD, 2003). It indicates how information literacy and mathematical literacy have common characteristics. Considering a commonality between these two literacy, the

present study was aimed to investigate (Indonesian) students' information literacy from the perspective of mathematical literacy.

METHOD ← 11pt, bold, UPPERCASE

Participant

The participants of this study were 381 eighth and ninth graders from nine junior high schools in the Province of Yogyakarta. The selection of these grades was in accordance with the target group of the Programme for International Student Assessment (PISA) study, i.e. 15 years old. In order to get a wide range of students' academic level and background the schools were selected from rural and urban areas.

Test

The objective of the present study was to investigate students' information literacy from the point of view mathematical literacy. For this purpose, a test addressing PISA mathematics tasks was administered. PISA mathematics tasks were used because these tasks are used in PISA to measure students' mathematical literacy. In order to explore students' information literacy the test included PISA tasks which have specific characteristics, namely:

- tasks that contain superfluous information and, therefore, require students to identify and to select relevant information. For example, the mathematics unit Staircase (see Figure 1). This task provides the depth of the staircase, i.e. 400 cm, which is not needed to determine the height of each step of the staircase.

- tasks which do not provide all the required information or called as 'tasks with missing information'. For such tasks students need to get the missing information either by using a multistep procedure or by estimation. For example, the mathematics unit Rock Concert (see Figure 2). In order to solve this task, students need to estimate the number of people who can occupy 1 m^2 of arena.

- tasks which requires connection across information sources, such as table, graph, and picture. For example, the mathematics unit Export (see Figure 3). Information which is needed to solve this task is provided in the bar diagram and the pie chart; therefore students need to connect both information sources.

MATHEMATICS UNIT 22: STAIRCASE

QUESTION 22.1

Total height 252 cm

Total depth 400 cm
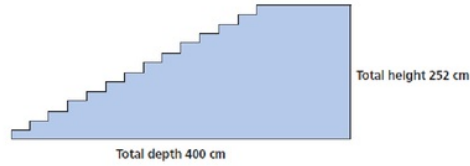
The diagram above illustrates a staircase with 14 steps and a total height of 252 cm:

What is the height of each of the 14 steps?

Height: ....cm.

Figure 1. A task containing superfluous information

MATHEMATICS UNIT 48: ROCK CONCERT

QUESTION 48.1

For a rock concert a rectangular field of size 100 m by 50 m was reserved for the audience. The concert was completely sold out and the field was full with all the fans standing.

Which one of the following is likely to be the best estimate of the total number of people attending the concert?

A. 2 000

B. 5 000

C. 20 000

D. 50 000

E. 100 000

Figure 2. A task with missing information

MATHEMATICS UNIT 13: EXPORTS

The graphics below show information about exports from Zedland, a country that uses zeds as its currency.

Total annual exports from Zedland in millions of zeds, 1996 to 2000

Distribution of exports from Zedland in 2000
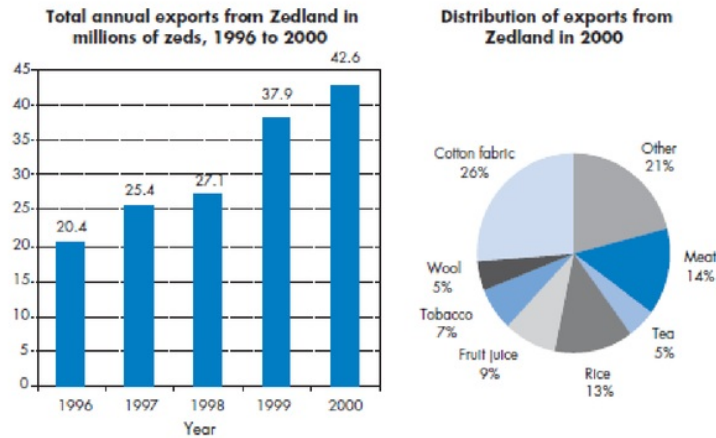
QUESTION 13.2

What was the value of fruit juice exported from Zedland in 2000?

A. 1.8 million zeds.

B. 2.3 million zeds.

C. 2.4 million zeds.

D. 3.4 million zeds.

E. 3.8 million zeds.

Figure 3. A task requiring connection across information sources

Analysis

In this study information literacy was investigated from the perspective of mathematical literacy. Students' information literacy was measured on the basis of students' responses to tasks with the abovementioned characteristics (see Figure 1, Figure 2, and Figure 3). Students' incorrect and partially correct responses to such tasks were analyzed by using an analysis framework developed by Wijaya, Van den Heuvel-Panhuizen, Doorman, and Robitzsch (2014) which comprises four types of students' error: comprehension error, transformation error, mathematical processing error, and encoding error (see Table 1).

Table 1. Framework to analyze students' errors (Wijaya et al., 2014)

Types of error	Sub-types of error
Comprehension error: errors in comprehending a context-based problem	- misunderstanding the instruction - misunderstanding keyword(s) - error in selecting information -
Transformation error: error in transforming a context-based problem into a mathematical problem	- procedural tendency - wrong mathematics - taking too much account of the context - treating a graph as a picture -
Mathematical processing error: error in carrying out mathematical procedures	- algebraic error - arithmetical error - measurement error, etc.
Encoding error: error in interpreting mathematical solution in terms of the original context of the problem	--

As shown in Table 1, one of the sub-types of comprehension error is 'error in selecting relevant information'. This sub-type matches to the definition of information literacy which is considered in this study. Therefore, a further analysis was conducted on students' responses which contained error in selecting relevant information. This analysis was aimed to investigate specific difficulties encountered by students regarding information literacy.

RESULT AND DISCUSSION

Out of 1947 possible responses, 1099 were correct (56.45%), 123 were partially correct (6.32%), 487 were correct (25.01%), and 238 were missing (12.22%). An error analysis was carried out for 610 incorrect and partially correct responses which resulted in 1248 errors[1] comprising 550 comprehension errors (44.07%), 407 transformation errors (32.61%), 243 mathematical processing errors (19.47%), and 48 encoding errors (3.85%). As the purpose of this study was to investigate students' information literacy, the analysis was focused on the responses containing comprehension

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[1] One incorrect or partially correct response could be coded with more than one type of error; therefore the total number of errors was greater than the total number of incorrect and partially correct responses.

errors. There were three sub-types of comprehension errors and the analysis revealed that 'error in selecting information' was the majority, i.e. 71.64% of the comprehension errors (see Table 2).

Table 2. Sub-types of comprehension errors

Sub-type of comprehension error	Frequency	Percentage
Misunderstanding the instruction	99	18%
Misundertanding keyword(s)	57	10.36%
Error in selecting information	394	71.64%
Total	**550**	**100%**

In order to investigate students' information literacy a further analysis was carried out for students' errors in selecting information. This investigation revealed three kinds of mistake made by students when dealing with selecting information. The first mistake was students' tendency to use all numbers provided in the task without analyzing the relevance of the information to solving the task. This kind of mistake was found on students' responses to task with superfluous data; for example the Staircase task which contains an irrelevant data, i.e. the depth of the staircase (see Figure 1). When solving this task, many students included 400 cm, which is the depth of the staircase, in their calculation (see Figure 4). This finding is in agreement with the study of Cummins, Kintsch, Reusser, & Weimer (1988) which revealed that many students often struggled with selecting relevant information. Furthermore, this result indicates that the students did not acquire two elements of information literacy which are formulized by Catts and Lau (2008), i.e. *recognizing information needs* and *locating and evaluating the quality of information*.
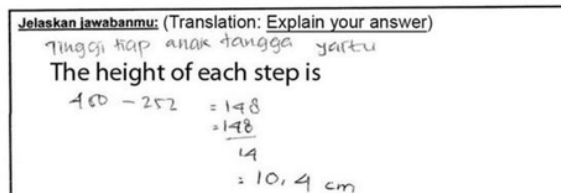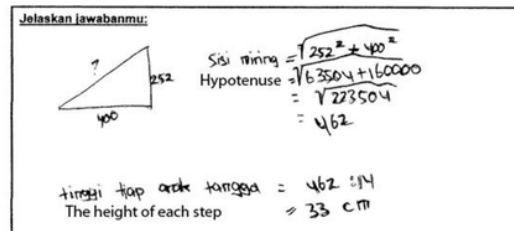

Figure 4. Students' inability to select irrelevant information

The second type of students' mistake was inability to gather information from different sources. This mistake appeared in students' responses to task which provide several representations

or sources of information; for example is the Export task (Figure 3). This task provides information in bar diagram and in pie chart. To find the total export of fruit juice in 2000, students need to combine information gathered from these two sources. However, many students did not use any data or information from the bar diagram. Instead, some students used 2000 in their calculation (see Figure 5). This finding shows how students struggle with locating information and evaluating the relevance of this information for solving problems; see e.g. Catts and Lau (2008).

Figure 5. Students' inability to gather information from different sources

The last type of mistake was students' inability to find or estimate missing information. This mistake was observed when students solved task which had missing information; for example the Rock Concert task (see Figure 3). .Many students chose 5.000 (B) as the answer to the task. Such answer indicates that students (merely) calculated the area of the concert field; i.e. 100 × 50. The students only focused on calculating the area and did not make any estimation about the number of people can occupy every $1 m^2$. Furthermore, this result shows that students have low ability to locate information and evaluate the relevance of this information for solving problems (see e.g. Catts & Lau, 2008). This finding is in line with the study of Verschaffel, Greer, and De Corte (2000) that revealed how students tend to ignore their daily life knowledge and experiences when solving context-based tasks. Approximation of the number of people that can occupy a certain area is an example of information that can be obtained from daily experiences or knowledge.

CONCLUSION

Identifying and selecting relevant information is an essential aspect of solving context-based task. It shows not only the mathematical literacy of students, but also the information literacy. The results of this study shows students did not acquire some of Catts and Lau's (2008) components of

information literacy. First, *recognizing information needs* which is indicated by students' tendency to include irrelevant information in their calculation. Second, *locating and evaluating the quality of information* which is indicated by students' inability: to select relevant information, to connect information from different sources, and to estimate missing information. Lastly, students also not acquired the third element, i.e. *making effective and ethical use of information*. Students did not use information effectively. Before designing strategy to develop and/or improve students' information literacy, it might be beneficial if a further study concerns on identifying possible reasons for students' low information literacy. This can be done by, for example, investigating classroom practices and analyzing textbooks.

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