Exploring digital-age literacy among prospective science teachers in West Kalimantan, Indonesia

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Abstract. Digital-age literacy is one of the main skills of the 21st century to be considered in the future education program for prospective science teachers. This study aims to explore the digital-age literacy among prospective science teachers in West Kalimantan (Indonesia) based on the results of self-reflection and self-requirements and to identify the relationship between both variables in digital-age literacy. A sample of 180 prospective science teachers from three educational institutions for prospective science teacher programs in West Kalimantan (Indonesia) completed the survey using two forms of the questionnaires. Findings indicated that the self-requirements (M = 4.40; SD = 0.16) of prospective science teachers thinking on digital-age literacy are higher than the results of self-reflection (M = 2.65; SD = 0.29) on their abilities in digital-age literacy. This result also shows the relationship between digital-age literacy based on self-reflection and self-requirements to be at the medium level, where the correlation coefficient for both variables is 0.560 and value of the correlation is positive and significant. This is explain that if digital-age literacy based on self-requirements increases, then digital-age literacy based on self-reflection also increases.

1. Introduction

Today, education in the world is undergoing drastic changes that are greatly influenced by the rapid growing dynamics of information [1,2]. The students in many levels of education bombarded with visual messages from the media—message specifically targeted to tap into the billions of discretionary spending they control or influence [1,3]. Through a search engine, for example, a scientist can easily find the reference material that they want in real time for very cheap; by using electronic mail, scientists from various countries can collaborate effectively without having to leave the laboratory; and by accessing the video repository site, a student can see recorded lectures from various universities leading in the world. All of this is possible because the teaching materials and interaction process have been successfully digitalization by technology [4,5]. The explosion of information is also a message to us that what we learn today might quickly become obsolete tomorrow [6,7]. Furthermore, a report from the 21st Century Literacy Summit [8] stated that "the explosive growth of technology in every aspect of society offers us a unique opportunity to engage our citizens in economic and civic life.” This is the main challenge faced in the current and future generations of youth [9,10].
Related to this challenge, educational systems should be responsible for preparing students to face the global challenges of the 21st-century [11], not only with excellent academic achievements but also with the 21st-century skills needed in the working environment [1,4]. Students need many specialized skills to succeed in work and daily life[12-14]. It is underlining that the educational system necessitates a paradigm shift from plateaus of knowing to continuous cycles of learning [1], from a surface to an in-depth approach [15], from horizontal to loop knowledge [16], and from stand-alone education to e-learning and massive open online courses [17-19]. Additionally, the educational system should revolutionize the teaching-learning process and promote the need for teachers to be digitally literate, which in turn involves the use of Web 2.0 and digital media tools, the implementation of active methodologies, the acquisition and development of competencies, and the use of innovative strategies, styles, and approaches [20].

As the spearhead of the education system, teachers must become knowledgeable workers with 21st century skill sets. The problem: Are teachers prepared to provide teaching and learning to the demands of the 21st century? The answer falls on the option to prepare prospective teachers in the future to master 21st century skills. This problem is consistent with what was presented by The American Association of Colleges for Teacher Education, which stated that an educational program for pre-service teachers aims to prepare graduates to have the ability to teach and assess the knowledge and skills of the 21st century [21]. For this reason, prospective teachers should know what is meant by 21st century skills and how to use them in the classroom.

One of the central themes of 21st-century skills is digital-age literacy. Traditionally, literacy means an ability to read, write, listen, and communicate information orally [22,23]. In the digital age, literacy means much more than the reading of the text; it can be broader than that, including many forms that interconnect. Digital-age literacy is an umbrella theme that describes the forms of literacy skills in the digital age in a wide variety of ethical, social, and reflective practices that are embedded in work, learning, leisure, and daily life. These skills include basic, scientific, economic, technological, visual, information, and multicultural literacy and global awareness [1].

Considering the importance of current digital-age literacy in the 21st century, then preparing prospective science teachers with these skills are very important. As the notion of what constitutes the importance of digital-age literacy changes, the approaches to teaching literacy for prospective science teachers change as well [24,25]. However, the changes in these approaches should be based on a broad understanding of self-requirements and self-reflection in digital-age literacy because they need to have the autonomy to make decisions on teaching and learning in their classroom [26,27]. This fact leads this study to aim to explore digital-age literacy among prospective science teachers in Indonesia, especially in West Kalimantan, based on their self-reflection and self-requirements. Furthermore, this research also identified the relationship between both variables in digital-age literacy.

1.1 Digital Age Literacy
NCREL and Metiri Group [1]identified four main domains in the enGauge 21st-century skills that represent the fresh, serious, new perspective required in light of recent historical events, globalization, and the idiosyncrasies of the Digital Age. One of the four primary domains specified in the 21st century skills sets is digital-age literacy. The digital-age literacy domain includes eight indicators: (a) basic literacy – proficiency in the English language (writing, reading, listening, and speaking) and arithmetic to develop knowledge and experience in the digital age; (b) scientific literacy - the ability to use scientific knowledge and science process skills to acquire knowledge, make decisions, and participate in civic society; (c) economic literacy – the ability to identify economic changes and adapt to global economic challenges; (d) technological literacy – the ability to use technology efficiently and effectively, an apply it to acquire knowledge in the digital age; (e) visual literacy - the ability to create visual-messenger media and use a variety of visual media tools to advance thinking, communication, and collaboration; (f) information literacy - the ability to analyze information accurately, use information effectively, and evaluate information critically using technology, communication networks, and electronic resources; (g) multicultural literacy - the ability to understand and appreciate
the uniqueness of different cultures, religions, and beliefs; and (h) global awareness – the ability to recognize and understand various problems in the current global world.

2. Methods

This study employed quantitative research analysis to explore digital-age literacy among prospective science teachers in West Kalimantan, Indonesia, based on their self-reflection and self-requirements and the relationship between both variables in digital-age literacy. The study involved 180 first, second, and third year West Kalimantan students from three educational institutions for prospective science teachers, namely: Tanjungpura University, Muhammadiyah Pontianak University, and Kapuas University.

The instrument used for this study was a questionnaire that consisted of eight digital-age literacy indicators developed based in part on the domain in enGauge 21\textsuperscript{st}-century skills \cite{1}. The 66 question items in this study were divided into two parts, each part consisting of 33 question items with response choices ranging from strongly disagree or strongly incapable to strongly agree or strongly capable. In Part one, the instrument contains questions aiming to investigate digital-age literacy among prospective science teachers based on their self-reflection (s-ref). In Part two, the instrument contains questions that assess digital-age literacy among prospective science teachers based on their self-requirements (s-req).

| Indicators           | Var | Total of Questions | Sample questions                                                                                                                                 |
|----------------------|-----|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Basic Literacy       | S-ref | 8                  | I am able to read the text in English from various sources.                                                                                         |
|                      | S-req | 8                  | I think the ability to read text in English is a primary goal for prospective science teachers programs in the 21\textsuperscript{st}-century.        |
|                      | S-ref | 7                  | I can identify the natural phenomena of daily life.                                                                                               |
| Scientific Literacy  | S-req | 7                  | I think prospective science teachers should have a knowledge and understanding of the scientific concepts required for participation in a digital age society. |
| Economic Literacy    | S-ref | 3                  | I always follow the economic problems and situations in my state.                                                                                |
|                      | S-req | 3                  | I think understanding economic problems and situations is a critical skill for prospective science teachers in a knowledge society.               |
| Technological Literacy| S-ref | 4                  | I can create a media to visualize my ideas.                                                                                                       |
|                      | S-req | 3                  | I think the ability to use a variety of technology tools in effective ways is an essential skill for prospective science teachers in a society technologically driven by information. |
| Visual Literacy      | S-ref | 3                  | I think that the ability to share ideas using a media visualization has become an essential skill for prospective science teachers in the digital era. |
|                      | S-req | 3                  | I’m able to classify sources based on credibility and relevance.                                                                                |
| Information Literacy | S-ref | 3                  | I think that prospective science teachers must have the competence to prioritize sources based on credibility and relevance in the rapidly information-saturated media. |
|                      | S-req | 3                  | I can appreciate and accept similarities and differences in culture, beliefs, religion, and ethnicity in daily life.                           |
| Multicultural Literacy| S-ref | 3                  | I think that prospective science teachers should have the ability to overspread the importance of culture, beliefs, religion, and ethnicity in daily life. |
|                      | S-req | 3                  | I’m able to recognize significant trends and issues in global and local communities.                                                           |
| Global awareness     | S-ref | 2                  | I think that the attitude to be aware of the major trends and issues in global and local communities must be held by prospective science teachers. |
2.1 Validity and Reliability
To meet the criterion of face validity, the instrument in this study was developed with the help of education experts and then tested with 30 samples to obtain the reliability of the instrument using SPSS version 16. The result of the calculation of the Cronbach's alpha coefficient of reliability is 0.72, or eligible to be used. This result, similar to Nunnally & Bernstein [28], has a notion that a coefficient of reliability more than 0.7 is acceptable.

2.2 Data Analysis
Data in this study were analyzed using descriptive statistics such as mean and standard deviation and inference statistics such as Pearson correlation analysis using the same application. First, the data obtained were scored and then converted to the five scales. The data were tested using descriptive statistics and interpreted using the criteria in Table 2[29]. Second, to identify the relationship of the digital-age literacy based on self-reflection and digital-age literacy self-requirements, the data were tested using Pearson correlation analysis.

### Table 2. Interpretation of the mean scores on a Likert five scale

| Mean Score | Interpretation |
|------------|----------------|
| 1.00 - 2.49 | Low            |
| 2.50 – 3.49 | Medium         |
| 3.50 – 5.00 | High           |

3. Result and Discussion
3.1 Digital-age literacy among prospective science teachers based on self-reflection and self-requirements
In the 21st-century, one of the most critical skill sets required for prospective science teachers is the digital-age literacy domain, as defined by enGauge 21st century skills [1]. Based on the data collected, Table 3 reveals that the mean score of digital-age literacy among prospective science teachers based on self-requirements is at a high level (M = 4.40, SD = 0.18), while digital-age literacy among prospective science teachers based on self-reflection is at a medium level (M = 2.65, SD = 0.29). It indicates that the self-requirements of their thinking about digital-age literacy are higher than the results of self-reflection on their abilities on digital-age literacy. These findings demonstrate that prospective science teachers need to have or develop a high level of digital literacy while simultaneously learning how to use a range of technologies within the digital pedagogies [30-32].

### Table 3. Descriptive statistical analysis of digital-age literacy based on self-reflection and self-requirements

| Variables          | Mean | Standard Deviation | Interpretation |
|--------------------|------|--------------------|----------------|
| Self-Reflection (S-Ref) | 2.65 | 0.29               | Medium         |
| Self-requirements (S-Req)  | 4.40 | 0.18               | High           |

The results of the further data analysis presented several outcomes that are associated with digital-age literacy among prospective science teachers from each indicator based on the result of their self-reflection and self-requirements (Table 4). First, the digital-age literacy based on the result of their self-requirements of all indicators is at a high level. Second, the digital-age literacy based on the result of their self-reflection shows a range that varies from a low to medium-level. Third, the interpretation of mean score comparison between digital-age literacy based on the result of their self-reflection and self-requirements for basic, scientific and information literacy is at the low-high level, while in the economic, technological, visual, and multicultural literacy and global awareness are at a medium-high level.

This study found that for basic, scientific, and information literacy, prospective science teachers recognized that their abilities based on the results of their self-reflection were still relatively weak compared to their digital-age literacy based on self-requirement at the high level. Prospective science
teachers know that the lack of English proficiency, such as reading, writing, speaking, and listening, and the lack of Mathematical reasoning and problem-solving still need to be improved. The lack of English proficiency and Mathematical skills among prospective science teachers has an effect on the difficulty in reading, understanding, and translating the quality of information they need. This is observable in the low results of their self-reflection on information and scientific literacy indicators. The lack of both indicators impacts on their ability to determine what information they need to know in advance and when to access that.

| Table 4. Descriptive statistical analysis of digital-age from each indicator |
|-------------------------------------------------|
| Indicators          | Variables | Mean Score | SD  | Interpretation |
|---------------------|-----------|------------|-----|----------------|
| Basic Literacy      | S-Ref     | 2.33       | 0.70| Low            |
|                     | S-Req     | 4.54       | 0.34| High           |
| Scientific Literacy | S-Ref     | 1.75       | 0.65| Low            |
|                     | S-Req     | 4.44       | 0.41| High           |
| Economic Literacy   | S-Ref     | 2.80       | 0.63| Medium         |
|                     | S-Req     | 4.12       | 0.55| High           |
| Technological Literacy | S-Ref   | 3.43       | 0.42| Medium         |
|                    | S-Req     | 4.37       | 0.42| High           |
| Visual Literacy     | S-Ref     | 3.08       | 0.60| Medium         |
|                    | S-Req     | 4.27       | 0.64| High           |
| Information Literacy | S-Ref    | 2.46       | 0.60| Low            |
|                    | S-Req     | 4.32       | 0.61| High           |
| Multicultural Literacy | S-Ref   | 3.49       | 0.40| Medium         |
|                    | S-Req     | 4.37       | 0.52| High           |
| Global awareness    | S-Ref     | 2.93       | 0.56| Medium         |
|                    | S-Req     | 3.55       | 0.53| High           |

3.2 The relationship between digital-age literacy among prospective science teachers based on self-reflection and self-requirements

To identify the relationship between two variables in digital-age literacy (i.e., self-reflection and self-requirements), the Pearson correlation test was employed. Data shown in Table 5 indicated that the relationship between digital-age literacy based on self-reflection and self-requirements is at the medium level as defined by Agunbiade & Ogunyinka [33]. The correlation coefficient for both variables is 0.560. This result also explained that the value of the correlation is positive and significant and that if digital-age literacy based on self-requirements increases, then digital-age literacy based on self-reflection also increases.

| Table 5. Pearson correlation analysis of digital-age literacy based on self-reflection and self-requirements |
|-------------------------------------------------|
|                                                                 |
| Self-reflection Pearson Correlation 1 0.560**       |
| Sig (2-tailed) 0.0000 180 180                      |
| Self-requirements Pearson Correlation 0.560** 1    |
| Sig (2-tailed) 0.0000 180 180                      |

** Correlation is significant at the 0.01 level (2-tailed)

4. Conclusion
This study confirms that prospective science teachers in West Kalimantan (Indonesia), have a high awareness of the digital-age literacy that they need in the 21st-century. This is indicated by their high
level of self-requirements for digital-age literacy. Prospective science teachers also understand that their digital-age literacy abilities need to improve, which can be seen in the medium level of digital-age literacy expressed in their self-reflection. Many students in practicum classes are unfamiliar with or lack competence in ICT use. This skill complicates the matter for prospective science teachers, as they often have a wide range of digital literacy and familiarity with new technologies in their classes [25]. Students’ abilities also indicate that the prospective science teachers may have difficulty reading and understanding simple words, phrases, numbers, or quantities or may have some difficulty drawing inferences and making use of quantitative information in texts [34-35].

Similarly, the results of further analysis of the economic, technological, visual, and multicultural literacy and global awareness indicators showed the same tendencies for digital-age literacy between self-reflection and self-requirements at the medium-high level. It is helpful to explain that the relationship between digital-age literacy based on self-reflection and digital-age literacy based on self-requirements is a positive correlation and that correlation value for the variables is at the medium level. Due to the lack of competition for prospective teachers in these areas, the need for educating pre-service science teachers on digital-age literacy is not only significant but also urgent. Furthermore, our curricula, philosophies, assessments, and teaching methods must be designed to meet the current demands [36]. This, then, becomes the basis for the change of curriculum structure, which is a starting point for rethinking the instruction in literacy courses in colleges and universities to prepare literacy teachers [37]. An understanding of these requirements will be helpful in determining the appropriate program for enhancing digital literacy for prospective science teachers.

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