ICT literacy level of Indonesian senior high school mathematics teachers

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Abstract. Industrial revolution 4.0 nowadays needs ICT literacy to proceed with the technology used for mathematics teachers. Meanwhile, the ICT literacy of mathematics teachers in Indonesia is at a low level and under the other Asia countries. This article aims to look at the level category of ICT literacy among Indonesian Mathematics Teachers in Senior School background. The researcher employed a quantitative approach in the term of descriptive statistical measurement. The collected data were used in order to determine descriptive statistical analysis for each construct; then followed by measuring the mean score, frequently, and finally, interpretation into each construct was applied; in order to set the level of ICT literacy using Dakich category level. This study used the ICT literacy questionnaire consists of 21 items in the form of a 5-point Likert scale. The results show that the level of understanding of the operation and use of ICT, ICT-rich pedagogy, ICT for teaching and professional involvement, and social ecology of ICT life and teaching and as a whole is in the category of access to ICT. This level implied that ICT literacy as a combination of intellectual ability, basic concepts, and new skills possessed by teachers to navigate and use information and communication technology effectively. Also, the level of ICT literacy is based on technical literacy and information literacy, which contains technical questions and information processing skills questions in accessing ICT for teachers. This study contributes to the ICT literacy level, which provides views to mathematics teachers to improve the quality of teachers' ICT literacy in teaching mathematics.

1. Introduction
The Indonesian Central Statistics Agency launched the technology development of information and communication technology in Indonesia [1]. Based on data from the International Telecommunication Union (ITU), in Southeast Asia, Indonesia is just above Cambodia and Timor Leste [2]. Indonesia's technology development index is still low compared to Singapore, with a value of 8.05, Malaysia 6.38, Brunei Darussalam 6.75, Philippines 4.67, and Vietnam 4.43. The gap between Indonesia's western and eastern regions caused Indonesia's position to be 111 out of 176 countries with an index of 4.34.

Research from Sukmana [3] found that mathematics teachers in the Central Java region have a low level of ICT literacy, which is 65% of the total mathematics teachers. It harms the belief in the mathematical nature of the teacher. The low level of ICT literacy of mathematics teachers also has many negative effects, namely the belief in the role of technology in the Bengkulu region [4], the anxiety of teaching mathematics teachers in North Maluku [5], and the anxiety of mathematics in the Kendari
region [6]. In line with the findings of Wahyuni's study [7], mathematics teachers in North Sumatra have difficulty teaching mathematical technology, and this is because they are used to using traditional teaching. The low level of ICT literacy of teachers also affects the low level of technological knowledge they have [8].

The findings of Jumila's study [9] also provide an explanation of ICT literacy in the region of West Nusa Tenggara, technological content knowledge of mathematics teachers are difficult to develop due to low ICT literacy. Therefore, the teaching of mathematics is done less using technology. Mathematics teachers in Kediri region also experience other problems, the level of ICT literacy of teachers is not able to improve the quality of knowledge of technology content pedagogy technology [10].

According to Ainun [11], face-to-face meetings in the teaching of mathematics using ICT will be essential to assess and validate students' understanding through discussions with teachers, projects, and group activities with their peers. However, online virtual learning is also significant where students will get more information from their network - virtual teachers, virtual peers. Next, the teaching of mathematics using ICT requires teachers to be proficient in using ICT. ICT skills are closely related to the factors that influence them [12].

Therefore, the aspect of ICT literacy is derived from the factors that influence ICT literacy, such as social factors and teaching ecology. As in the case of Dakich et al. [13] revealed aspects of ICT literacy to investigate their research: (1) Aspects of understanding the operation and use of ICT; (2) Pedagogical aspects and ICT-rich teaching environment; (3) ICT aspects for professional teaching and (4) Social-ecological aspects of living and teaching with ICT. The ICT literacy aspect of the teacher deals with integrating ICT into classroom teaching. According to Fook [14], they have a strong focus on developing and implementing ICT literacy strategies consciously, inclusion, and ethical behavior (moral and legal aspects), as well as health and safety-related issues when integrating ICT into teaching. It also includes teachers' familiarity with the use of ICT and its role in youth culture. We assess that mathematics ICT literacy of teachers can be determined from the factors that cause ICT literacy [13]. The ICT literacy construct in this study can be investigated into 4 sub-constructs: (1) understanding of the operation and use of ICT; (2) pedagogy rich in ICT and teaching environment; (3) ICT for teaching and professional involvement; and (4) social ecology of life and teaching with ICT.

Nurhabibah [15] stated there are two barriers to using ICT literacy in the process of teaching mathematics in Indonesia; external barriers and internal barriers. External borders consist of (1) lack of access, (2) lack of time, (3) lack of adequate training, and (4) technical problems. On the other hand, internal barriers consist of (1) lack of confidence, (b) resistance to change and negative attitudes, and (3) no perception of the advantages of ICT literacy in mathematics teaching. Both of these barriers play a significant role in shaping teacher competence and will ultimately influence student teaching achievement. Teacher competence affects student teaching achievement, especially in senior vocational schools. For achieving the educational goals, it is regulated in the National Education Standards, where educators must have academic qualifications and competencies as teaching agents, physical and mental health, to achieve national educational goals. The implications of teacher competence that need to be improved are pedagogical, personality, social, and professional competencies [16]. By using efficient ICT facilities, the government, through the Directorate of Vocational Development, has developed a Vocational Education Service Center for vocational senior school teachers. The information centre provides instruments for teachers to compare their competencies in ICT teaching. As of 2010, 431 vocational schools have been appointed as ICT service centers distributed in all urban areas in Indonesia.

Because every school can establish an ICT Vocational Service Center, Yusri and Goodwin [17] argue that mathematics teachers in Indonesia can develop ICT-based teaching and strengthen students. However, there are issues of teacher competence in achieving mastery of technology, such as their experience and knowledge of ICT facilities, websites, and teaching tasks. The five factors that influence teacher literacy in mastering technology are (1) teachers’ skills in using primary ICT in teaching, (2) ICT resources, (3) teachers’ attitudes towards the use of ICT in education, (4) technical support, and other needs, and (5) staff development in using ICT. Another opinion comes from Susanto [18]. The lack of teaching literacy in using ICT integration in the classroom can cause students' disbeliefs of
teachers. The integrity of ICT facilities depends on the ability of teachers to manage the teaching environment from traditional pedagogy to constructivism. Problems of teacher beliefs also influence the use of technology; as investigated by Maker, Jo, and Muammar [19], teacher ability has a significant influence on computer use, competence in classroom management, and ultimately pedagogical membership.

From the study mentioned above, it is concluded that ICT literacy has an essential role in the world of mathematics education. However, ICT literacy for mathematics teaching has not been fully disclosed Nurhabibah et al. [15]. There is a range of ICT literacy research in Asia explained by Khalid [8] and Tian [20] case study on the ICT literacy level of Mathematics Teacher Education in China and Malaysia. At the same time, in Indonesia, some factors influence ICT literacy for senior school teachers [10]. Therefore, this study focuses on the level of ICT literacy of mathematics teachers in Indonesia, especially to senior school teachers in Banyumas region.

2. Method

2.1. Respondents’ profile
This study uses a quantitative method of a cross-sectional survey [21]. This method provides a more detailed picture of a problem being studied [22]. The number of samples is 235 people consisting of 115 (48.94%) male teachers and 120 (51.06%) female teachers. A total of 107 (45.53%) teach in schools located in urban areas while 128 (54.47%) teach in schools located in rural areas. Based on the age of teachers, a total of 42 (17.87%) teachers aged less than 25 years, 64 (27.23%) people aged 25 to 29 years, 58 (24.68%) people aged 30 to 39 years, 71 (30.22%) people aged 40 to 49 years, and no teacher aged 50 to 59 years or even 60 years in this study. Next, based on the teacher’s teaching year, 53 (22.55%) people served for 1 to 3 years, 47 (20.00%) people for 3 to 5 years, 98 (41.70%) people for 5 to 10 years, and 37 (15.75%) people served more than ten years. In terms of experience using computers, a total of 67 people or 28.51% for 1 to 4 years, 111 people or 47.23% for 5 to 10 years, and 57 people or 24.26% have used computers for more than ten years. No teacher used a computer for less than one year in this study.

2.2. Data collection and analysis
Descriptive analysis was used to make a detail description of the demographic characteristics of teachers (age, teaching experience, school environment, gender factors, and experience using computers), level of confidence, level of anxiety, level of knowledge of content pedagogical technology, and level of ICT literacy—descriptive analysis using mean, frequency, and percentage indices [13].

The ICT literacy questionnaire consists of 21 items in the form of a 5-point Likert scale. This questionnaire contains four constructs: 1) understanding the operation and use of ICT, 2) pedagogy rich in ICT, 3) ICT for teaching and professional involvement, and 4) social ecology of life and teaching ICT. Each aspect is measured based on a 5-point Likert scale from 1 "strongly disagree" to 5 "strongly agree." To determine the category of ICT literacy, researchers have modified the mean value scale to four levels, according to Dakich et al. [13] as Table 1.

| Mean score | Level category               |
|------------|------------------------------|
| 1.00 – 2.00 | Basic ICT operation          |
| 2.01 – 3.00 | ICT use                     |
| 3.01 – 4.00 | Access to ICT               |
| 4.01 – 5.00 | ICT integration for instruction |

Table 1 shows the interpretation of mean scores and ICT literacy categories. The mean score of 1.00 to 2.00 indicates the basic level of ICT operations. A mean score of 2.01 to 3.00 indicates that teachers
have a high level of ICT use. ICT literacy level with a mean score of 3.01 to 4.00 shows that teachers have access to ICT. In comparison, the mean score of 4.01 to 5.00 teachers shows the level of ICT integration in teaching activities.

3. Result and discussion

The ICT literacy of senior school mathematics teachers studied in this study is divided into four aspects, understanding the operation and use of ICT, pedagogy rich in ICT, ICT for teaching and professional involvement, and social ecology of life and ICT teaching.

The ICT literacy level of senior school mathematics teachers is measured based on the interpretation of the mean score in Table 1. Interpretation of mean scores is divided into four categories: the basics of ICT operations, the use of ICT, access to ICT, and the integration of ICT in teaching activities. Table 2 shows the frequency and percentage of ICT literacy categories of senior school mathematics teachers.

Table 2. The level category of ICT literacy among Senior Mathematics Teachers

| Mean score | Frequency | Percentage | Level category          |
|------------|-----------|------------|-------------------------|
| 1.00 – 2.00 | 0         | 0          | Basic ICT operation     |
| 2.01 – 3.00 | 3         | 1.28       | ICT use                 |
| 3.01 – 4.00 | 162       | 68.93      | Access to ICT           |
| 4.01 – 5.00 | 70         | 29.79      | ICT integration for instruction |

Figure 1. The level category of ICT literacy among Senior Mathematics Teachers

It was found in Figure 1 that three people or 1.28% of senior school mathematics teachers have the category of ICT use, a total of 162 people (68.93%) have access to the ICT category, and the remaining 70 people (29.79%) have the category of ICT integration in teaching activities.

The following are described in detail in aspects of ICT literacy: the understanding of the operation and use of ICT, ICT-rich pedagogy, ICT for teaching and professional involvement, and the social ecology of ICT life and teaching. Overall, the level of ICT literacy of senior school mathematics teachers is in the category of access to ICT.

3.1. Understanding of the operation and use of ICT

Table 3 shows the frequency and percentage of ICT literacy levels among senior school mathematics teachers.
Table 3. The level category of understanding operation and use of ICT

| Mean score | Frequency | Percentage | Level category       |
|------------|-----------|------------|---------------------|
| 1.00 – 2.00| 1         | 0.43       | Basic ICT operation |
| 2.01 – 3.00| 17        | 7.23       | ICT use             |
| 3.01 – 4.00| 158       | 67.23      | Access to ICT       |
| 4.01 – 5.00| 59        | 25.11      | ICT integration for instruction |

Figure 2. The level category of understanding operation and use of ICT

Based on Figure 2, overall shows that the majority of senior school mathematics teachers are 158 people or 67.23% have access to the ICT category, 59 people (25.11%) have ICT integration category in teaching activities, 17 people (7.23%) have usage category ICT and the remaining one person or 0.43% have the fundamental category of ICT operations. Overall, the level of understanding of the operation and use of ICT of senior school mathematics teachers is in the type of access to ICT (mean = 3.79, sp = 0.70). Next is described in detail the items that show the level of understanding of the operation and use of ICT of senior school mathematics teachers. We got the mean range of aspects of understanding the process and use of professional ICT is between 3.65 to 3.91. The findings of this study indicate the category of access to ICT. Therefore, the whole type of aspects of understanding the operation and use of ICT is on access to ICT.

3.2. Pedagogy rich in ICT and teaching environment

Table 4 shows the frequency and percentage of pedagogical aspects rich in ICT of senior school mathematics teachers.

Table 4. The level category of pedagogy rich in ICT and teaching environment

| Mean score | Frequency | Percentage | Level category       |
|------------|-----------|------------|---------------------|
| 1.00 – 2.00| 0         | 0          | Basic ICT operation |
| 2.01 – 3.00| 16        | 6.81       | ICT use             |
| 3.01 – 4.00| 134       | 57.02      | Access to ICT       |
| 4.01 – 5.00| 85        | 36.17      | ICT integration for instruction |
Based on Figure 3, overall shows that the majority of senior school mathematics teachers are 134 people or 57.02% have access to the ICT category, 85 people, or 36.17% have ICT integration category in teaching activities, and only 16 people or 6.81% have to use category ICT. Overall, the pedagogical aspect rich in ICT is in the category of ICT integration in teaching activities (mean = 4.02, sp = 0.71). Next is described in detail the items that show the pedagogical aspects rich in ICT of high school mathematics teachers. It was found that the mean range of pedagogical aspects rich in ICT is between 3.93 to 4.09. The findings of the study show that the pedagogy rich in ICT of teachers is in the category of ICT integration in teaching activities. Therefore, the whole pedagogical aspect rich in ICT of mathematics teachers is in the category of ICT integration for instruction.

3.3. ICT for teaching and professional involvement

Table 5 shows the frequency and percentage of ICT aspects for the teaching and professional involvement of senior school mathematics teachers.

| Mean score | Frequency | Percentage | Level category          |
|------------|-----------|------------|-------------------------|
| 2.01 – 3.00| 6         | 2.55       | ICT use                 |
| 3.01 – 4.00| 167       | 71.06      | Access to ICT           |
| 4.01 – 5.00| 62        | 26.38      | ICT integration for instruction |
Based on Figure 4, overall shows that the majority of senior school mathematics teachers are 167 people or 71.06% have access to the ICT category, 62 people, or 26.38%, have ICT integration category in teaching activities, and more than six people or 2.55% have ICT usage category. Overall, the pedagogical aspect rich in ICT is in the category of access to ICT (mean = 3.90, sp = 0.68). Next is described in detail the items that show the ICT aspects for the teaching and professional involvement of senior school mathematics teachers. It was found that the mean range of ICT aspects for teaching and professional involvement is between 3.65 to 4.07. Findings show that ICT for education and professional involvement is in the category of access to ICT. Therefore, all aspects of ICT for teaching and professional involvement are in the category of access to ICT.

3.4. The social ecology of life and teaching with ICT

Table 6 shows the frequency and percentage of ICT literacy levels among senior school mathematics teachers in terms of the social ecology of life and the use of ICT.

| Mean score | Frequency | Percentage | Level category |
|------------|-----------|------------|----------------|
| 2.01 – 3.00 | 8         | 3.40       | ICT use        |
| 3.01 – 4.00 | 150       | 63.83      | Access to ICT  |
| 4.01 – 5.00 | 77        | 32.77      | ICT integration for instruction |

Based on Figure 5, overall shows that the majority of senior school mathematics teachers are 150 people or 63.83% have access to the ICT category, 77 people or 32.77% have ICT integration category in teaching activities, and more than eight people or only 3.40% have category the use of ICT. Overall, the social-ecological aspects of life and the use of ICT are in the category of access to ICT (mean = 3.92, sp = 0.68). Next is described in detail the items that show the social-ecological aspects of life and the use of ICT of senior school mathematics teachers. It was found that the mean range of ICT aspects in classroom management is between 3.78 to 4.05. The findings of this study indicate the category of ICT integration in teaching activities. Therefore, the entire category of ICT aspects in classroom management is on access to ICT.

ICT literacy in this study is measured based on four aspects; understanding the operation and use of ICT, ICT-rich pedagogy, ICT for teaching and professional involvement, and social ecology of ICT life and teaching. The results show that the level of understanding of the operation and use of ICT, ICT-rich pedagogy, ICT for teaching and professional involvement, and social ecology of ICT life and teaching and as a whole is in the category of access to ICT. These findings are in line with some local studies [18, 23, 24] and foreign studies [25–27].
Alas [23] has studied the category of ICT literacy based on technical literacy and information literacy, which contains technical questions and information processing skills questions in accessing ICT for teachers in Bandung, West Java. Saleh [24] studied the category of integrated ICT literacy in computer literacy, mobile phone literacy and internet literacy in the Makassar region, South Sulawesi. The study obtained by Susanto [18] covers the category of ICT literacy in Indonesia in general, such as Sumatra, Kalimantan, and Bali. In contrast to overseas studies, ICT literacy studies of senior school mathematics teachers abroad use questions adapted from the American Institute for Research (AIR). However, the findings of the study from within and outside the country provide the same category of ICT literacy as the study conducted (mean score = 68.93%) that is the category of access to ICT (mean score = 59.3% [23]; mean score = 61.32% [24]; mean score = 71.4% [25]; mean score = 67.42% [26]).

Meanwhile, Mazalah et al. [28] conclude that the ICT literacy category is seen as access to ICT. 56% of respondents thought that ICT literacy as a combination of intellectual ability, basic concepts, and new skills possessed by teachers to navigate and use information and communication technology effectively. The category of ICT literacy in access to ICT is not encouraging even though the category resembles a moderate stage in studies from outside and within the country. ICT literacy is required to improve and show an excellent category of ICT ingenuity in teaching activities [29]. Several factors can influence this unfavorable category of ICT literacy. Tomljenović and Zovko [30], have divided the factors that contribute to ICT literacy into three elements; the factors of beliefs, anxiety, and knowledge.

These three factors can be improved through skills, training, and attitude change. From the belief factor, Fu [31], as well as Jimoyiannis and Komis [32] stated that there are three main problems identified to affect ICT literacy, namely basic teacher skills, motivation, and teacher thinking patterns. These three main problems are seen to be interrelated because basic teacher skills, motivation, and teacher thinking patterns are very important elements in improving teachers' ICT literacy. For example, teachers with low basic skills will cause teachers to have a lousy belief like mathematics while traditional teachers' thinking patterns can be useful in believing in traditional mathematics teaching [31]. Furthermore, low teacher motivation can result in ICT literacy possessed does not develop effectively [32].

Besides, Ibrahim and Wekke [33] and Sang [34] stated that the other two belief factors that are widely associated with the factors that influence ICT literacy are the workload of teachers and school facilities. Teachers who have much workload in school will find it challenging to think of quality teaching. Also, teachers who teach in rural areas have difficulty developing ICT literacy due to inadequate school facilities. Both of these factors should be problems that hinder the improvement of teachers' ICT literacy and make the goal of teaching mathematics unattainable.

The study of Sukmana [3] found that 89 mathematics teachers in Semarang region, Central Java showed a moderate level of ICT literacy. This level is in line with the category of access to ICT. Findings show that teachers in the region are 64.14% of teachers who have shared concerns about the teaching of mathematics. It is concluded that anxiety factors contribute to teachers' ICT literacy. Tomljenović and Zovko [30] also say that the three main problems in the anxiety factors of mathematical nature identified affect ICT literacy: mathematical attitudes, cognitive and mathematical teaching. For example, Afshari et al. [35], in his study, explained that cognitively weak teachers would harm the mathematical attitudes possessed and the high anxiety of mathematics teaching. All three problems make it difficult for teachers to develop their ICT literacy.

Another study found that 125 mathematics teachers in Kediri region, Central Java experienced ICT literacy problems caused by anxiety about teaching mathematics [10]. According to him, there are three things that teachers face, such as math, time, and social life exams. A total of 89% of mathematics teachers teach at the final level, with the main focus being passing students on the National Examination. It causes teachers to experience high anxiety when their students do not pass the math exam. The time that teachers have focused on educating students to be able to work on questions at the National Examination.

On the other hand, as many as 12% of teachers do not have a good social life because their attention focused on formal teaching. Teachers should also consistently identify the preparations that must make
before conducting traditional education. Until the time they have spent in school. Therefore, teachers
cannot improve ICT literacy due to the three main problems they have. Furthermore, Jackson [36] says
that ICT literacy of teachers needs to be honed and requires great attention. ICT literacy skills cannot
be possessed only with the experience they have while sitting in college. There needs to be continuous
training over time.

Another factor that can influence ICT literacy is knowledge [30]. A similar study found from Sonia
[37] revealed that mathematical guidance knowledge, mathematical management knowledge, and
mathematical integrity knowledge are the three main factors that influence ICT literacy. Teachers need
mathematical guidance from schools and the government to enhance the role of technology in the
Teaching of mathematics. Mathematical coaching activities are focused on adding technology to
classroom teaching. According to Sonia, ICT literacy can be a medium for teachers to enhance
technology activities in the classroom.

Furthermore, Aoibhinn [38] explains that TPACK can influence ICT literacy. Such knowledge is
derived from the availability of skills workshops in schools and adequate school facilities. Besides, the
development of technology has become an essential thing for teachers in learning ICT literacy. Othman
and Maat [39] said teachers must see the development of technology as a critical idea in practising
technology in the classroom. ICT literacy can play a crucial role in using such technology.

4. Conclusion
In conclusion, the overall results of the analysis have shown that mathematics teachers ICT literacy. It
brings about a picture of quality in teaching mathematics. The teachers and the parties at school
understood the level of ICT literacy and realized the level and how it contributes to improving their
competence. The level category of overall mathematics teachers' ICT literacy is access to ICT (68.93%),
followed by ICT integration for instruction (29.79%) and ICT use (1.28%). Moreover, the results show
the level of ICT literacy. Those are 1) understanding the operation and use of ICT; 2) pedagogy rich in
ICT and teaching environment; 3) ICT for teaching and professional involvement; 4) the social ecology
of life, and teaching with ICT aspects. For instance, access to ICT in the level category of ICT for
teaching and professional involvement (71.06%) is higher than in the level category of understanding
operation, and use of ICT (67.23%), whereas ICT integration for instruction in the level category of
pedagogy rich in ICT and teaching environment (36.17%) is higher than in the level category of the
social ecology of life and teaching with ICT (32.77%).

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