SCIENTIFIC LITERACY OF VOCATIONAL SCHOOL STUDENTS IN BUILDING CONSTRUCTION

**Riyan Arthur1, Daryati2, Arris Maulana3, Riki Febiansyah4, and Kinanti Kidung5**

12345Vocational Education of Building Construction, Faculty of Engineering State University of Jakarta

Email:daryati\_sr@unj.ac.id

**Abstract.** This study aims to determine the real condition of the competitiveness literacy ability of vocational school students in building construction. The study was conducted from January to February 2020. The research was conducted in 3 vocational schools that had competency in building construction in Jakarta. The results of the study concluded that most of the tenth-grade students of SMK did not have good scientific literacy and at the same time confirmed the 2018 PISA report. The results of this study will serve as the basis for an analysis of the literacy skills of vocational school students in the building construction, the quality of existing scientific literacy instruments and the development of scientific literacy instruments.

Keywords: Scientific Literacy, vocational school, students.

1. **Introduction**

Facing the industrial revolution 4.0 and demographic bonuses is an advantage and a challenge for the vocational education world in Indonesia, especially Vocational High Schools (SMK). Increasing productive age and changing industrial patterns mean that new jobs are needed while increasing the labor market. [1]. Therefore, SMKs should be able to play a more active role in preparing Human Resources (HR) who are not only able to work but also open jobs on a small scale. The level of vocational education is considered the most appropriate to answer the problem of unemployment due to the increasing productive age. SMK graduates have practical skills that are in line with the needs of society and industry, the relatively young age of graduates enables good productivity and has the creativity to open small businesses that are close to community needs such as workshops, electronic services, culinary, etc. [2]

Various studies show that technical skills that are in line with the needs of society and industry are not the only ones needed in this era. Soft skills such as communication skills and scientific literacy related to non-technical skills become needs that are in line with the required competencies. Scientific literacy is one of the keys to the successful development of competent and creative human resources [3]. Literacy is closely related to awareness, thinking ability and decision making in certain conditions. That is, vocational students are not only challenged to be skilled but also able to provide input on a good literacy-based decision [4]. In addition, scientific literacy also has a close relationship with the context of creativity in everyday life.. [5]. Various scientific phenomena can be better explained and operational in life using the formulation of various concepts, knowledge, questions, and explanations based on this scientific literacy. [6].

The OECD report, which took a sample of 15-year-old students, shows that Indonesian student literacy is still very weak. Even from period to period the results have never been encouraging for 7 consecutive periods[7]. If referring to the concept of literacy, then most students are only focused on memorization alone with a little understanding [8]. Literacy like this does not show that children can formulate concepts rather than analyze let alone make decisions according to the conditions at hand. This report on student literacy in Indonesia at the beginning of the 21st century can be seen in the following OECD report:

**Table 1. Indonesian students' scientific literacy scores and ranks based on PISA**

|  |  |  |
| --- | --- | --- |
| **Year** | **Score** | **Rank** |
| 2000 | 393 | 38 out of 41 Country |
| 2003 | 395 | 38 out of 40 Country |
| 2006 | 393 | 50 out of 57 Country |
| 2009 | 383 | 60 out of 65 Country |
| 2012 | 383 | 64 out of 65 Country |
| 2015 | 397 | 64 out of 72 Country |
| 2018 | 371 | 72 out of 77 Country |

Source: [6], [8], [9]

As we known, the age of 15 years in Indonesia is a transition period from basic education to high school or vocational education (SMA / K). Thus, when entering the secondary level, the input obtained by schools is students with weak literacy abilities on average. That is, some do have average literacy, and some are very weak. On the other hand, the selection path for vocational and upper education levels is still somewhat ambiguous. This situation is interesting to study further whether students who have an average literacy, weak or very weak who choose the vocational School?

Literacy is the foundation of knowledge, critical thinking [10], and decision making [11] . Scientific literacy is basically closely related to reading, writing and communicating related to science so that students can become human beings who are cultured, humanist and can act according to personality in daily life and prepare themselves for the business and work [12] Scientific literacy can be seen as the ability to critically analyze and evaluate everything related to science and make decisions based on it [13]. Scientific literacy can be interpreted as a life value in order to solve practical problems, play a role in various social activities and understand that science is a product of cultural practices.[14]

Another opinion says that basically scientific literacy is not only tied to the ability of students in reading, writing and communicating related to science. More than that, scientific literacy wants students to have the ability to think, process information and make decisions by considering various aspects along with various derivatives. [15] Even scientific literacy plays a major role in preserving historical heritage objects in museums [16] Scientific literacy is not only intended for children, in adolescents and adults, but scientific literacy can also be triggered by various activities such as visits to scientific objects, involvement in various activities related to science [3]. In addition, scientific literacy is also important for teachers and prospective teachers so that in planning, facilitating and assessing learning can be in accordance with the themes and developments both related to the curriculum, training, courses, assignments in the classroom as well as fostering the ability of science to students [17]. Scientific literacy is also needed by teachers in terms of learning and developing various abilities in innovating in creating learning content [18].

There is not much scientific research focused on vocational education or vocational education in Indonesia. Generally, scientific literacy is studied at the junior high school level [19]. In fact, scientific literacy is closely related to applied disciplines (vocational), especially in technology and engineering. Science literacy has the potential to develop well in the workplace, academia, and society. [20] Thus, studies of scientific literacy in vocational education in technology and engineering expertise programs are indeed needed.

Scientific literacy has contributed to students' ability in problem-solving [21]. Therefore, the position of scientific literacy becomes important in improving student competence. Education at the vocational level of technology and engineering expertise programs, students are directed at the needs of technology-based industries [22]. On the other hand, the quality of education in Indonesia is still at number 94, as well as the competitiveness of its work training which is still ranked 64 out of 137 countries in the world. [23].

The dimension of scientific literacy in procedural and contextual processes is very much needed in SMK. scientific literacy does not only speak in the realm of science as a subject, but more than that scientific literacy is also a person's ability to apply science in the context of work related to science, industry/work and social society to the survival of life and the environment. [24]–[27]. Learning that is dissertated by various practicums is one example of how SMKs should really focus on the realm of process and contextualism [28]. Practicum is not only based on knowledge, memorizing the concept of technology. Practicum requires the implementation of the process through a series of procedures to form competencies and skills in accordance with the needs of the workforce [29]. ]. At its peak, students can implement the learning, so that they can replicate similar conditions in the wider environment in the world of work or industry, the environment and social awareness in society [30].

Contextual based learning refers to the needs of the business, work and industry [31] which is also a dimension of scientific literacy [32] should be taken seriously. That is, it takes a picture of the real conditions about how the scientific literacy of vocational students in technology and engineering expertise programs. Regarding the various limitations and breadth of technology and engineering expertise, this research will be limited to vocational students with Construction and Property Skills Competencies

1. **Methodology**

This research is descriptive narrative research that discusses the literacy of mechanical science. This research is basic research with a research design referring to a qualitative approach to the type of phenomenology in which the research subjects are vocational students in the competence of Construction and Property expertise in Jakarta & Bogor. The study was conducted in the range of January to February 2020 with research subjects in class X vocational students. The sampling technique is done by simple random sampling. The selected SMKs are SMKN 35 Jakarta, SMKN 26 Jakarta, and SMKN 1 Kemang Bogor, totaling 101 students. The instrument used in this study was a modification of the scientific literacy instrument developed by Mckeown [33] and Rusilowati et al [19] which included indicators of science as the body of knowledge, Science as the investigative tools of nature, Science as a way of thinking and Interaction of science, environment, technology and society [34] with 19 items as follows.

**Table 2. Distribution of items per indicator**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Science as the body of knowledge** | **Science as the investigative tools of nature** | **Science as a way of thinking** | **Interaction of science, environment, technolody and society** |
| **Item****Number** | 3, 6, 7, 12 | 2, 4, 10, 16, 19 | 1, 5, 9, 11, 13, 17 | 8, 14, 15, 18, |

1. **Conclusion**

The data obtained in this study are presented in the form of a proportion of correct answers from the 19 items given. The sample in this study amounted to 101 grade X students of SMK competency in construction and property expertise. Data is taken from the period of 20 January to 2 February 2020. The results can be seen in the table below:

**Table 3. Percentage of students answered correctly on scientific literacy instruments**

|  | **SMKN 26 Jakarta** | **SMKN 35 Jakarta** | **SMKN 1 Kemang Bogor** | **Total** |
| --- | --- | --- | --- | --- |
| Science as the body of knowledge | 55,41% | 47,79% | 64,17% | 55,45% |
| Science as the investigative tools of nature | 59,46% | 51,51% | 55,33% | 55,05% |
| Science as a way of thinking | 60,36% | 54,90% | 54,22% | 59,41% |
| Interaction of science, environment, technolody and society | 58,78% | 51,47% | 61,67% | 57,18% |
| Rata-rata  | 58,50% | 51,42% | 58,85% | 56,77% |

The average of students who answered correctly from 19 test items overall was only 56.77% with students of SMKN 26 Jakarta at 58.50%, SMKN 35 Jakarta at 51.42% and SMKN 1 Kemang Bogor at 58.85%. If it is assumed that the minimum assessment standard is 70%, the results above indicate that none of the SMKs can meet the minimum standard. Likewise, if elaborated further per indicator, there is no one indicator that can be met by SMKN in Jakarta and Bogor. In fact, the SMKs taken as samples can be said to be quite good in terms of academic achievement at the provincial and national levels. That is, it can be concluded that the majority of class X vocational students do not have good scientific literacy.

Overall, the proportion of students at SMKN 26 Jakarta can answer correctly at 58.50%. If parsed per indicator the proportion answered correctly on the Science as the body of knowledge indicator is 55.41%, the Science as the investigative tools of nature indicator is 59.46%, the Science as a way of thinking indicator is 60.36% and the Interaction indicator of science, environment, technology, and society is 58.78%. The condition is not much different from the results in SMKN 35 Jakarta with the proportion of students answering correctly at 51.42%. If parsed per indicator the proportion answered correctly on the Science as the body of knowledge indicator is 47.79%, the Science as the investigative tools of nature indicator is 51.51%, the Science as a way of thinking indicator is 54.90% and the Interaction indicator of science, environment, technology, and society is 51.47%. Whereas in SMKN 1 Kemang Bogor the proportion of students answering correctly was 58.85%. If parsed per indicator the proportion answered correctly on the Science as the body of knowledge indicator is 64.71%, the Science as the investigative tools of nature indicator is 55.33%, the Science as a way of thinking indicator is 54.67% and the Interaction indicator of science, environment, technology, and society is 61.67%.

The above conditions at the same time confirm the 2018 PISA report [35], because students who were sampled in 2018 are currently sitting in class X of SMK. This result raises the suspicion that the cluster of junior high school outputs that become input for vocational high schools is a group with very weak scientific literacy. This means that input from construction and property vocational schools in Jakarta and Bogor is suspected to come from a cluster of junior high school students who have very weak scientific literacy. There are also junior high school students from clusters whose scientific literacy is weak, and the average is not entered vocational School on this skill competency or may be an input for high school.

The description of the results brings up something unique, SMKN students in Jakarta are on an overall average and per indicator lower than SMK students in Bogor. If the results are broken down per indicator of SMKN students in Jakarta, they are stronger in the Science as a way of thinking indicator and weakest in the Science as the body of knowledge indicator. In contrast, the SMKN in Bogor is the strongest in the Science as the body of knowledge indicator and the weakest in the Science as a way of thinking indicator. This condition also raises the suspicion that SMKN in Jakarta is more focused on ways of thinking and SMKN in Bogor is more focused on knowledge.

The data above also shows that in the Interaction of science, environment, technology and society indicators, the SMK in Bogor is also stronger than the SMK in Jakarta. In fact, SMK in Jakarta has better supporting facilities and teachers.[36] Even when the research was carried out by PNS teachers on the competence of construction and property expertise at SMK 1 Kemang Bogor, only 1 person remained the honorary teacher and was still considered a millennial generation (young teacher). Unlike the 26 and 35 SMKN which have more than 3 PNS teachers with an average teaching experience of more than 10 years (senior teachers).

On the other hand, if examined further related to the instruments used, there are unique things. Instrument items used are classified as very common. Materially, this scientific literacy instrument still covers things that discuss science subjects and does not reflect vocational material, especially competency in construction and property expertise. Very open possibility, under one of the factors causing the low scientific literacy of vocational students in this study lies in that section. Therefore, a more specific item is needed which animates most of the vocational students' competencies. One of the liveliest subjects is mechanical mechanics. Mechanical mechanics is a field of physics that studies the behavior of forces acting on a structure.[37] Mechanical mechanics is a subject that contributes so much to the field of construction [38]. Therefore, it is important to recommend developing a mechanical science literacy instrument for vocational students’ competency in construction and property skills.

1. **References**

[1] Kemendikbud, *Materi Pendukung Literasi Sains*. 2017.

[2] S. Sutjipto, “Perancangan Kurikulum Sekolah Menengah Kejuruan Sebagai Pranata Budaya Kerja,” *J. Pendidik. dan Kebud.*, vol. 4, no. 1, pp. 102–126, 2019.

[3] J. H. Falk *et al.*, “Correlating Science Center Use With Adult Science Literacy: An International, Cross-Institutional Study,” *Sci. Educ.*, vol. 100, no. 5, pp. 849–876, 2016.

[4] C. E. Snow and K. A. Dibner, *Science literacy: Concepts, contexts, and consequences*. Washington DC: The National Academies Press, 2016.

[5] N. Y. Hidayat, Wardono, and A. Rusilowati, “Analisis Kemampuan Literasi Matematika Ditinjau Dari Metakognisi Siswa dalam Pembelajaran Synectics Berbantuan Schoology,” in *Prisma, Prosicing Seminar Nasional Matematika*, 2019, vol. 2, pp. 911–916.

[6] OECD, *PISA 2018 insights and interpretations*. Paris: OECD, 2019.

[7] D. Kastberg, J. Chan, G. Murray, and P. Gonzales, *Performance of U.S. 15-Year-Old Students in Science, Reading, and Mathematics Literacy in an International Context t: First Look at PISA 2015 (NCES 2017-048)*. Washington DC: U.S. Department of Education, 2016.

[8] B. Hayat and S. Yusuf, *Benchmark Internasional Mutu Pendidikan*. Jakarta: Bumi Aksara, 2011.

[9] OECD, *PISA 2015 Assessment and Analytical Framework (SCIENCE, READING, MATHEMATIC, FINANCIAL LITERACY AND COLLABORATIVE PROBLEM SOLVING)*, Revised. Paris: OECD, 2017.

[10] T. Chen, H. M. Hsu, S. W. Stamm, and R. Yeh, “Creating an instrument for evaluating critical thinking apps for college students,” *E-Learning Digit. Media*, vol. 16, no. 6, pp. 433–454, 2019.

[11] A. Crowell and C. Schunn, “Unpacking the Relationship Between Science Education and Applied Scientific Literacy,” *Res. Sci. Educ.*, vol. 46, no. 1, pp. 129–140, 2016.

[12] C. Greenhow, T. Gibbins, and M. M. Menzer, “Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application,” *Comput. Human Behav.*, vol. 53, no. December, pp. 593–604, 2015.

[13] D. M. Miller and D. A. C. Czegan, “Integrating the Liberal Arts and Chemistry: A Series of General Chemistry Assignments to Develop Science Literacy,” *J. Chem. Educ.*, vol. 93, no. 5, pp. 864–869, 2016.

[14] D. Ardianto and B. Rubini, “Comparison of students’ scientific literacy in integrated science learning through model of guided discovery and problem based learning,” *J. Pendidik. IPA Indones.*, vol. 5, no. 1, pp. 31–37, 2016.

[15] K. L. Wright, A. D. Franks, L. J. Kuo, E. M. McTigue, and J. Serrano, “Both Theory and Practice: Science Literacy Instruction and Theories of Reading,” *Int. J. Sci. Math. Educ.*, vol. 14, no. 7, pp. 1275–1292, 2016.

[16] A. Hine and F. Medvecky, “Unfinished science in museums: A push for critical science literacy,” *J. Sci. Commun.*, vol. 14, no. 2, pp. 1–14, 2015.

[17] J. Gropen, J. F. Kook, C. Hoisington, and N. Clark-Chiarelli, “Foundations of Science Literacy: Efficacy of a Preschool Professional Development Program in Science on Classroom Instruction, Teachers’ Pedagogical Content Knowledge, and Children’s Observations and Predictions,” *Early Educ. Dev.*, vol. 28, no. 5, pp. 607–631, 2017.

[18] M. I. S. Putra, W. Widodo, and B. Jatmiko, “The development of guided inquiry science learning materials to improve science literacy skill of prospective mi teachers,” *J. Pendidik. IPA Indones.*, vol. 5, no. 1, pp. 83–93, 2016.

[19] A. Rusilowati, L. Kurniawati, S. E. Nugroho, and A. Widiyatmoko, “Developing an instrument of scientific literacy asessment on the cycle theme,” *Int. J. Environ. Sci. Educ.*, vol. 11, no. 12, pp. 5718–5727, 2016.

[20] Kok-Sing Tang and K. Danielsson, *Global Developments in Literacy Research for Science Education*. cham: Springer Berlin Heidelberg, 2018.

[21] T. Schulte, *Desirable Science Education*. Berlin: Springer Nature, 2017.

[22] S. Thanuskodi, *Literacy Skill Development for Library Science Professionals*. Hershey PA: IGI Global, 2019.

[23] K. Schwab, *The Global Competitiveness Report The Global Competitiveness Report 2017-2018*, vol. 5, no. 5. 2017.

[24] K. A. Lawless *et al.*, “Promoting students’ science literacy skills through a simulation of international negotiations: The GlobalEd 2 Project,” *Comput. Human Behav.*, vol. 78, no. January, pp. 389–396, 2018.

[25] F. Fakhriyah, S. Masfuah, M. Roysa, A. Rusilowati, and E. S. Rahayu, “Student’s science literacy in the aspect of content science?,” *J. Pendidik. IPA Indones.*, vol. 6, no. 1, pp. 81–87, 2017.

[26] G. O. Sørvik and S. M. Mork, “Scientific literacy as social practice: Implications for reading and writing in science classrooms,” *Nord. Stud. Sci. Educ.*, vol. 11, no. 3, pp. 268–281, 2015.

[27] C. Drummond and B. Fischhoff, “Individuals with greater science literacy and education have more polarized beliefs on controversial science topics,” in *Proceedings of the National Academy of Sciences of the United States of America*, 2017, vol. 114, no. 36, pp. 9587–9592.

[28] J. Hordern, “Differentiating knowledge, differentiating (occupational) practice,” *J. Vocat. Educ. Train.*, vol. 68, no. 4, pp. 453–469, 2016.

[29] A. Draaisma, F. Meijers, and M. Kuijpers, “The development of strong career learning environments: the project ‘Career Orientation and Guidance’ in Dutch vocational education,” *J. Vocat. Educ. Train.*, vol. 70, no. 1, pp. 27–46, 2018.

[30] R. Grytnes, M. Grill, A. Pousette, M. Törner, and K. J. Nielsen, “Apprentice or Student? The Structures of Construction Industry Vocational Education and Training in Denmark and Sweden and their Possible Consequences for Safety Learning,” *Vocat. Learn.*, pp. 1–23, 2017.

[31] B. Persson and B. Hermelin, “Mobilising for change in vocational education and training in Sweden – a case study of the ‘Technical College’ scheme,” *J. Vocat. Educ. Train.*, vol. 6820, pp. 1–21, 2018.

[32] N. Allum, J. Besley, L. Gomez, and I. Brunton-Smith, “Disparities in science literacy,” *Science (80-. ).*, vol. 360, no. 6391, pp. 861–862, 2018.

[33] T. R. Mckeown, *Validation Study of the Science Literacy Assessment: A Measure to Assess Middle School Students’ Attitudes Toward Science and Ability to Think Scientifically*. 2017.

[34] A. Rusilowati, S. E. Nugroho, and S. M. Susilowati, “Development of Science Textbook Based on Scientific Literacy for Secondary School,” *J. Pendidik. Fis. Indones.*, vol. 12, no. 2, pp. 98–105, 2016.

[35] OECD, *OECD Multilingual Summaries PISA 2018 Results What Students Know and Can Do Hasil PISA 2018 (Volume I)*. Paris: OECD, 2019.

[36] S. B. Raharjo, “Kontribusi Delapan Standar Nasional Pendidikan Terhadap Pencapaian Prestasi Belajar,” *J. Pendidik. dan Kebud.*, vol. 20, no. 4, pp. 470–482, 2014.

[37] T. Wardoyo Tunggul Cipto, “Pengembangan Media Pembelajaran Berbasis Video Animasi Pada Mata Pelajaran Mekanika Teknik di SMKN 1 Purworejo,” *E-Journal Pendidik. Tek. Sipil Dan Perenc.*, vol. 3, no. 3, pp. 1–7, 2015.

[38] M. D. Basito, R. Arthur, and D. Daryati, “Hubungan Efikasi Diri terhadap Kemampuan Berpikir Tingkat Tinggi Siswa SMK Program Keahlian Teknik Bangunan pada Mata Pelajaran Mekanika Teknik,” *J. Pensil*, vol. 7, no. 1, pp. 1–14, 2018.