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STEM education: Vocational teacher's perspective of 21st Century

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Abstract*--*STEM education is widely adopted and has a positive impact on developed countries. Constructive and focused on STEM education in Indonesia, starting in 2019. But STEM must be held in facing the challenges of the 21st century. This study aims to examine vocational teacher perceptions related to understanding STEM in Indonesia. A total of 157 vocational teachers were involved in the research questions (RQ). Open and closed questionnaires represent the expression of their perceptions when implementing STEM learning. The results of the study illustrate that STEM needs to be improved continuously and continuously. Researchers need to focus on vocational teachers as an essential role in the success of new learning reforms. However, the involvement of parties can accelerate positive thinking about STEM learning in the vocational field.

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I INTRODUCTION

The industrial era 4.0 has a significant impact on vocational education in the 21st century. Decisions in the concept of vocational learning require scientific and technological understanding to become increasingly dominant. This condition requires reform and transition to understand vocational learning with concepts and patterns that are more beneficial for students' lives in the future. Facts in the field of vocational teachers better complement the concept of learning individually without involving the role of the teacher in one scientific or cross-scientific discipline in the whole concept. In this context, the need for awareness of curriculum content in the academic and vocational fields has a strong attachment. It can be integrated into a complete science from various perspectives. For example, the academic fields of physics, chemistry, and mathematics so far have provided more concepts to instil scientific principles and not cross applied sciences following their vocational fields. The academic field, as a scientific basis, must provide an applied concept. The 21st Century and Industrial Era 4.0 eliminate individual interest in vocational learning and involve multidisciplinary science in the viewpoint of the same competence. This relation is encapsulated in the concept of STEM (Science, Technology, Engineering, and Mathematics). The goal is a richer student learning experience [1]. STEM-based vocational learning is referred to as meta-disciplinary or trans-disciplinary [2], which is required as an entity.

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STEM-based vocational learning is a new pattern applied in Indonesia. Through the professional development program, the STEM concept learning is given to vocational teachers in the form of planned training and mentoring for three years. This program began in 2019 as a form of training learning activities for vocational teachers. The presence of STEM is expected to be able to improve learning practices that have led to science in the revised 2013 curriculum. STEM complements the concept of thinking through changes in vocational teacher mindset. This is an effort to improve the quality of education in Indonesia. The teacher as a key in preparing students to teach STEM [3].

Vocational teachers must be able to understand STEM, package problems in the surrounding environment and incorporate elements of STEM into this problem. This concept can be carried out by a discipline that discusses the perspective of other scientific fields or involves teachers from various disciplines in the agreed-upon product. The aim of STEM learning is for students to explore, discover and solve problems [2]. The STEM implementation has several approaches including silos, embedded, and integrated. The STEM silo type approach is expertise teachers and academic teachers who carry out the involvement of each field. The disadvantage is that not all fields have complete integration. The embedded type of STEM approach is a teacher of expertise and an academic field who sit together discussing a particular project with specific mentoring and learning capacities. Weaknesses that arise are differences in Basic Competence and proper collaboration. Whereas the STEM integrated type approach is between inter-field teachers completing intact long-term work. Implementation of STEM-based learning is not an easy task, especially this concept sounds very foreign, besides that STEM can run if supported by curriculum and between teachers have the same understanding.

STEM education has been promoted in various developed countries (Japan, Korea, Australia, and UK) and even developing countries (Thailand, Singapore, Malaysia) and is seen as providing a change in learning. They emphasize a new understanding of multidisciplinary (science, technology, engineering, and mathematics) integrated into modern life [4]. STEM is seen as having an impact on long-term success on daily problems, problems in the world of work, the need for work skills, even to economic well-being [5], besides community development. Indonesia realizes the importance of STEM in the learning professional development program starting in the last 2019. However, learning in the 21st Century emphasizes multidisciplinary skills that are able to equip long-term skills in STEM education, Indonesia. This study aims to describe the perceptions of vocational teachers related to the existence of STEM programs conducted by survey data analysis.

II METHODOLOGY

Researchers adopt quantitative instruments. This research uses a survey approach with the aim of testing the perception of vocational teachers about the implementation of STEM education in strengthening 21st-century skills. Argues that this survey research was conducted to collect data with a certain time limit with the intention of obtaining information from questions according to the nature of the existing conditions [6]. The population in this study is vocational teachers with a level of participation in the development of professional learning in Yogyakarta, Indonesia. Purposive sampling is used in determining representative samples. A total of 157 vocational teachers in various schools in Yogyakarta were involved as respondents. Respondents came from three public schools and one private school.

Table 1: Vocational Teacher Demographic Data in the STEM Perception Survey

Number of Respondents	:	157
Type of school		
Public school	:	118 (75.16%)
Private school	:	39 (24.84%)
Gender		
Male	:	105 (66.88%)
Female	:	52 (33.12%)
Age		
23-30 years	:	37 (23.57%)
31-40 years old	:	65 (41.40%)
41-50 years old	:	12 (7.64%)
> 51 years old	:	43 (27.39%)

A series of questionnaires in the form of open and closed question items about teacher perceptions and understanding of STEM education in strengthening 21st-century skills. The instrument was developed by considering expert testing. The experts are STEM researchers from VEDC BOE Malang.

Questions in the instrument are as follows:

1. What do you know about STEM education (RQ1)?
2. What do you know the skills needed in the 21st century (RQ2)
3. Is STEM Education able to improve students' skills in facing 21st-century challenges (RQ3)?
4. Does the school support the learning process that uses STEM (RQ4)?
5. Are you with other teachers in determining STEM-based learning goals (RQ5)?
6. Are you having difficulty describing competencies that have the potential to be passed down to STEM (RQ6)?
7. What method do you use in STEM-based learning (RQ7)?
8. Do you understand higher-order thinking skills (RQ8)?

The responses from the teacher were analyzed using interpretative methods to be interpreted and grouped based on characteristics. The statistical method is used to analyze several factors involved in the instrument. Qualitative content analysis is done by looking at alternative answers. Each aspect of the question is coded according to the STEM education's descriptive and constructive point of view in the program.

III RESULTS AND DISCUSSION

The results of the survey conducted to vocational teachers in the STEM learning professional development program in Yogyakarta, Indonesia on the perception of STEM education and 21st-century skills are presented in the following figure:

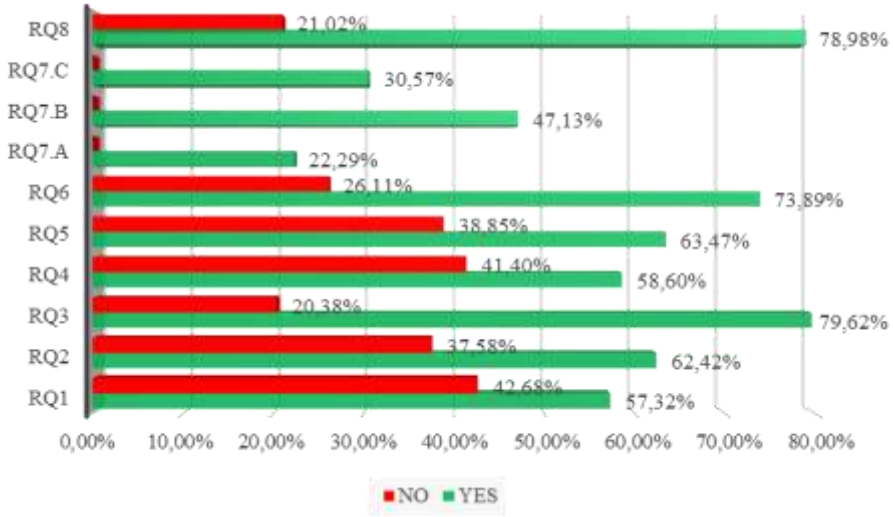

Figure 1: Vocational teacher perceptions of professional development in STEM learning and 21st century STEM skills

Figure 1. Explains that most vocational teachers care about STEM education in 21st-century skills. Question items with "yes" answers dominate. In the statements RQ4 and RQ1 the argument that the answer "no" is quite high, ie above 40% is related to understanding STEM and school infrastructure. Understanding STEM is interpreted as learning with limited to the final product, this is a misunderstanding. While the infrastructure has been explained because this is the basis of the program carried out in the current semester and the delivery of material has been done well in advance, so the limitations in submitting practice material outside the proposed program.

The RQ1 about the definition of STEM (N = 157) as much as 57.32% describes a cooperative explanation by involving all your disciplines according to their area of expertise. The rest 42.68% lack of interest in STEM education. Most of them are over 50 years old and their abilities are limited to multidisciplinary about STEM [7]. They are more accustomed to learning discussion. As a result, experiencing misconceptions in understanding STEM integrated with several disciplinary areas of expertise in achieving the curriculum [8]. The data, the researcher recommends that STEM is set in clear rules to be applied.

The RQ2 and RQ3 statements reveal the knowledge of vocational teachers involving 21st-century skills in the concept of learning. Overall the question of learning trend in the challenges of the 21st century has been well defined, namely 4C skills and ICT involvement. These results describe that the STEM approach is able to answer 21st-century skill needs. STEM education is an effective medium in applying skills in the 21st century [9]. Researchers argue that STEM is able to equip students to have good analytical skills and be able to solve problems around, besides being able to prepare for future skills needs. Sharpened the understanding that STEM is able to provide increased problem-solving skills and critical and analytical thinking. The primary skill that students prepare is the global economic challenge [10], [11]. The researcher concludes that the driving driver in the success of STEM is the teacher in mastering disciplinary competence.

The RQ4 statement regarding STEM learning infrastructure needs to be reviewed. 41.40% stated that they were not fulfilled or inadequate. This statement is dominated by public schools, meaning that public school infrastructure is less flexible in meeting learning needs. However, private schools are more supportive in spending on learning

needs. Learning strategies need to be prepared as early as possible to anticipate the success of the teaching and learning program. The characteristics of each educational institution must have authority over STEM.

The RQ5 question about the involvement of other teachers in STEM learning. Current needs, learning consists of several integrated competencies. Thus, one teacher with another teacher forms a new discipline in completing existing competencies. In the field of technology and engineering, of course, it is independent and is approved by strong science and mathematics. 38.85% still work independently. STEM can be applied with three patterns, namely silos, embedded, and integrated. Vocational teachers can complete one competency with STEM-based learning. As a vocational teacher has implemented STEM well while partial interaction. Because STEMs are incomplete, two or three are represented by each other.

The RQ6 questions about difficulties in describing STEM competencies. As many as 73.89% experienced difficulties in tracking down potential STEM competencies. A strong consideration arises that STEM has not been integrated with the existing curriculum. So it needs a new understanding in seeing the potential of STEM can be applied. For example, C1-C2 on this concept of knowledge will make it difficult to produce STEM products. But C4 (analysis) to C5 (creating) can easily produce concepts, procedures, flow, to the product. The researcher recommends that vocational teachers with MGMP, deputy headmasters in the curriculum, and even the education office need to review the basic competencies of learning.

The RQ7 questions about methods that are compatible with STEM. Vocational teachers provide three alternatives according to their understanding and interpretation. RQ7a, namely problem based learning by 22.29%; RQ7b namely Engineering product design by 47.13%; and RQ7c, which is project-based learning at 30.57%. Vocational teachers describe that STEM-EDP has a preferred learning phase. Their reason is that in the final phase of learning students present their products and evaluate product failures. STEM learning is not limited to product success but the causes of STEM failures need to be involved. This is important in their understanding, what mistakes are made and how in the future does not happen again (conceptual and constructive learning). All literacy approaches to the STEM method have a positive impact on learning. Among them, STEM-PjBL is able to increase scientific literacy, motivation, and creativity [12]–[14].

The RQ8 questions about higher thinking skills (HOTS) of 78.98%. This shows that vocational teacher's concern for HOTS skills is well planned. HOTS has a good positive impact on students for the development of their education [15]. Studies show that HOTS in the STEM learning discipline is able to produce increased motivation and achievement [16].

The Indonesian government has a high concern for improving the quality of learning. STEM became a program through P4TK which was conducted for three years. 2019 is the year of STEM program introduction and implementation and 2020 is the year of STEM expansion. The researcher concludes that STEM with positive impact will increase gradually.

Triangulation

This stage is carried out in interpreting the documentation of research findings and data interpretation. Researchers found that STEM literacy is still limited and there is a need to improve the ability of teachers through a number of programs and the desire to improve the quality of learning by education observers. The relationship of teacher perception represented by research questions with theory and success was not found. Vocational teachers

in STEM involvement in improving 21st-century skills are not yet optimal. This happened to all schools in the study sample.

IV CONCLUSION

The study of vocational teacher perceptions of STEM education in 21st-century skills requires observers from all parties to be involved in a series. The education office in policy, the school in the facility and the teacher in the facilitator must have a supportive relationship. Researchers believe that STEM as a new reform in learning requires vocational teacher awareness. The suggestion is that STEM education must synergize with all education observers so that the quality of education increases.

REFERENCES

1. F. J. Figliano, 'Strategies For Integrating STEM Content: A Pilot Case Study', 2007.
2. S. Ceylan and Z. Ozdilek, 'Improving a Sample Lesson Plan for Secondary Science Courses within the STEM Education', *Procedia - Soc. Behav. Sci.*, vol. 177, pp. 223–228, Apr. 2015, doi: 10.1016/j.sbspro.2015.02.395.
3. C. R. Rinke, W. Gladstone-Brown, C. R. Kinlaw, and J. Cappiello, 'Characterizing STEM Teacher Education: Affordances and Constraints of Explicit STEM Preparation for Elementary Teachers', *Sch. Sci. Math.*, vol. 116, no. 6, pp. 300–309, 2016, doi: 10.1111/ssm.12185.
4. J. Radloff and S. Guzey, 'Investigating Preservice STEM Teacher Conceptions of STEM Education', *J. Sci. Educ. Technol.*, vol. 25, no. 5, pp. 759–774, 2016.
5. D. Herro and C. Quigley, 'Innovating with STEAM in middle school classrooms: remixing education', *Horiz.*, vol. 24, no. 3, pp. 190–204, Jan. 2016, doi: 10.1108/OTH-03-2016-0008.
6. L. Cohen, L. Manion, and K. Morrison, *Research methods in education*, 6th ed. London ; New York: Routledge, 2007.
7. J. M. Breiner, S. S. Harkness, C. C. Johnson, and C. M. Koehler, 'What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships', *Sch. Sci. Math.*, vol. 112, no. 1, pp. 3–11, 2012, doi: 10.1111/j.1949-8594.2011.00109.x.
8. G. H. Roehrig, T. J. Moore, H.-H. Wang, and M. S. Park, 'Is Adding the E Enough? Investigating the Impact of K-12 Engineering Standards on the Implementation of STEM Integration', *Sch. Sci. Math.*, vol. 112, no. 1, pp. 31–44, 2012, doi: 10.1111/j.1949-8594.2011.00112.x.
9. L. Halim, *Pendidikan sains dan pembangunan masyarakat berliterasi sains*. Penerbit Universiti Kebangsaan Malaysia, 2013.
10. K. Becker and K. Park, 'Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis', p. 15, 2011.
11. N. C. Siregar, R. Rosli, S. M. Maat, and M. M. Capraro, 'The Effect of Science, Technology, Engineering and Mathematics (STEM) Program on Students' Achievement in Mathematics: A Meta-Analysis', *Int. Electron. J. Math. Educ.*, vol. 15, no. 1, p. em0549, Aug. 2019, doi: 10.29333/iejme/5885.

12. M. Nurtanto, H. Sofyan, M. Fawaid, and R. Rabiman, 'Problem-Based Learning (PBL) in Industry 4.0: Improving Learning Quality through Character-Based Literacy Learning and Life Career Skill (LL-LCS)', *Univers. J. Educ. Res.*, vol. 7, no. 11, pp. 2487–2494, Nov. 2019, doi: 10.13189/ujer.2019.071128.
13. M. Nurtanto, P. Pardjono, Widarto -, and S. D. Ramdani, 'The Effect of STEM-EDP in Professional Learning on Automotive Engineering Competence in Vocational High School', *J. Educ. Gift. Young Sci.*, vol. 8, no. 2, pp. 633–656, Jun. 2020.
14. R. E. Islami, I. J. Sari, S. Sjaifuddin, M. Nurtanto, M. Ramli, and A. Siregar, 'An Assessment of Pre-service Biology Teachers on Student Worksheets Based on Scientific Literacy', *J. Phys. Conf. Ser.*, vol. 1155, p. 012068, Feb. 2019, doi: 10.1088/1742-6596/1155/1/012068.
15. Y. M. Heong, J. M. Yunos, W. Othman, R. Hassan, T. T. Kiong, and M. M. Mohamad, 'The Needs Analysis of Learning Higher Order Thinking Skills for Generating Ideas', *Procedia - Soc. Behav. Sci.*, vol. 59, pp. 197–203, Oct. 2012, doi: 10.1016/j.sbspro.2012.09.265.
16. C. M. Cunningham and C. P. Lachapelle, 'Designing engineering experiences to engage all students', *Eng. Pre-Coll. Settings Synth. Res. Policy Pract.*, pp. 117–140, Jan. 2014.