Analysis of the need to development an assessment integrated with STEM literacy

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Abstract. Facing the challenges in the 21st century and entering the 5.0 society era, education plays a major role in preparing quality students, students are required to have the competence to think creatively in dealing with various problems. STEM (Science, Technology, Engineering, and Mathematics) literacy is a new approach developed to support learning in the 21st century. This article aims to explore the perceptions of physics teachers in the development of an integrated assessment instrument with STEM Literacy. The type of research used is descriptive qualitative with purposive sampling technique. The main respondents of this study were five high school physics teachers. The data was collected through semi-structured interviews and analyzed through the thematic analysis approach. The main finding of this study is that teachers have different understandings of the STEM concept in learning. Teachers do not have experience in developing between assessment and STEM Literacy. Teachers are interested in developing assessments that are integrated with STEM Literacy.

1. Introduction

Education is an element of major in science and resource development day a man to be reliable, quality, and powerless competitiveness globally [1]. Modern learning challenges require students not only to master concepts but also to develop thinking skills [2]. The skills required in the 21st century generally cover a wide range of competencies, including critical thinking, problem solving, creativity, metacognition, communication, digital and technology literacy, being responsible for society, and having a global awareness [3]. In addition, in the era of Society 5.0, humans are required to have innovation as a necessary prerequisite and the main accelerator to solve sustainable problems in society [4,5]. So that Pedagogy, curriculum, and assessment are key factors in the development of 21st century skills which can be monitored directly [6] and ensure that the education system produces experts in areas that are needed in society [7].

During the last decade, attention has been increasingly focused on the STEM literacy crisis throughout society [8]. STEM literacy is vital for understudies to enter the universe of work, since it is the primary competency of 21st century laborers [9]. STEM proficiency contains the abilities to recognize and apply ideas from science, innovation, designing, and math to comprehend and take care of issues that can't be addressed with a solitary disciplinary area [10] and should have the option to introduce information, understanding and insightful abilities to manage matters. which is in the public interest [11]. STEM literacy is described by the capacity to utilize information, abilities and perspectives to tackle context oriented issues by applying different orders. Moreover, understudies likewise do designing cycles to tackle issues [12]. STEM literacy comprises of six components, in particular recognizing STEM issues, acquiring new information, applying STEM ideas, tackling issues utilizing
STEM, conveying STEM-related data, and having the option to settle on choices dependent on STEM [13] at that point STEM proficiency is partitioned into five classifications: STEM ideas, STEM rehearsing, STEM applications, STEM mentalities, and STEM-related settings [14].

One effort that can be made in improving the quality of human resources is more powerful competitiveness by formulating learning objectives and appropriate evaluation instruments [15]. Assessing student learning is a cornerstone of educational practice. Rating Air standards have assumed a significant part in the improvement of instructing, curricula and educational space [16]. Assessment helps us to understand what students know and can do after the learning cycle, it helps us understand which aspects of the curriculum are working well for students and which are not, and it provides us with evidence of how well students are achieving the learning goals [17].

Previous research has shown that the development of assessment that is integrated with STEM literacy is still a major obstacle for teachers. In particular, difficulties in the assessment of interdisciplinary occurs because current methods are largely focused on teaching and assessment of conceptual understanding in one discipline, with little attention given to the application of knowledge or how different knowledge integrated and contribute to solving the real problem [9]. Teachers consider that the absence of value appraisal instruments, arranging time, and information on STEM disciplines is both a test and a barrier to innovation with STEM [18,19]. Schools also do not prepare students to solve real-life problems, because the knowledge gained at school sometimes cannot be applied in everyday life. For example, students who have high mathematical abilities, it is not certain that their mathematical abilities can solve problems during the process of designing or designing an idea [20]. In the case of integrated STEM literacy, it has not received special attention by researchers, curriculum developers, or practitioners measuring the results of the integrated STEM experience in a reliable and valid way this is both a challenge and an opportunity for more indepth research into the relationship between STEM literacy and assessment [21].

The novelty in this research is to develop an assessment instrument that is integrated with STEM literacy that has been tested for validity and reliability so that it can help in science learning. For this reason, this needs analysis is very important to see the actual conditions in the field and determine the direction of further research. Needs analysis or assessment studies can help educators to develop teaching strategies that are meaningful to students. The findings of the study can be used to adjust the curriculum for better learning outcomes [22].

From the description above, the researcher tries to analyze the needs of teachers, especially the problems of teachers in learning with STEM literacy, teachers' understanding of STEM, teachers' experiences about assessment with STEM literacy and knows the needs and interests of teachers in developing integrated assessment instruments with STEM literacy.

### 2. Method

This research uses a qualitative descriptive research framework that aims to capture and present facts, realities, symptoms and events to be accurately presented [23]. Qualitative descriptive research is to systematically record the overall picture of detailed topics or activities [24]. Resource persons came from 5 middle school physics teachers in the Solo Raya residency. Detailed data of the respondents can be seen in Table 1.

| Respondent code | Gender | Teaching experience | Educational Background | Institution               |
|-----------------|--------|---------------------|------------------------|----------------------------|
| A               | Male   | more than 10 years  | Master                 | Senior High School in Surakarta |
| B               | Male   | 5 to 10 years       | Bachelor               | Senior High School in Karanganyar |
| C               | Male   | more than 10 years  | Master                 | Senior High School in Klaten  |
The research process is shown in Figure 1. The data collection tool in this study is an online survey followed by semi-structured interviews. Questions about the difficulties and experience encountered in conducting STEM literacy-based assessments, and then teachers’ interest and needs for assessments based on STEM literacy. Then use topic analysis technology to analyze the collected data, which includes the process of reading the entire transcription, coding, identifying subtopics, and classifying the main topics of the data [24].

![Figure 1. Research procedure.](image)

### 3. Result and Discussion

3.1. The Understanding of STEM Literacy in Learning

The first discussion in this study is the teacher's view or understanding of STEM in learning. This difference in understanding usually occurs because of the different educational backgrounds and teaching experiences of the teachers [25]. Teachers’ practices are strongly affected by teachers’ perceptions [26].

| Respondents | Responses |
|-------------|-----------|
| A           | STEM is an approach to learning using 4 main areas, namely science, technology, engineering and mathematics. |
| B           | STEM combines understanding of the concept and its application in everyday life |
| C           | STEM provides a new approach to learning that so far only physics concepts are taught with only one teaching |
Respondents  |  Responses
--- | ---
D | STEM in learning supports teachers in delivering material to students in a more interesting way and students will understand and understand the usefulness of this learning
E | STEM is the answer to facing challenges in the global era where we are required to understand the concept and its application in depth

Different points of view on the importance of STEM add further intricacy to decide the degree to which logical exercises can be classified as STEM education. Table 2 shows the teacher's response to their understanding in interpreting STEM concepts in learning. Although there are different views about STEM, teachers mean the same that STEM is the link between science, technology, engineering, and mathematics. Another view given by respondents was that STEM is an integration between the concept of physics and its application in various phenomena in everyday life. STEM provides variations in learning that has been taught through classical methods [27].

3.2. Teacher Experience in Developing Assessment Integrated with STEM Literacy

The teacher’s experience in making assessments is useful to see the extent to which the assessment can measure what the teacher wants to measure [18]. Assessment integrated with STEM literacy is seen as a problem in much of the literature [19,28,29] and is very important in the interpretation of teachers’ experiences in developing assessment.

**Table 3.** Teacher responses related to experience in developing assessment integrated with STEM literacy.

| Respondents | Responses |
|---|---|
| A | In making assessments for exams I have never integrated it with STEM literacy. Although there was training on STEM in the past. |
| B | The assessment I made didn't fully use all of the areas in STEM. I still find it difficult to make this assessment. |
| C | In the past, I received training on STEM-based assessment, namely about the PjBL model in learning. But in the course of time the problem is the lack of time for the preparation of these instruments. |
| D | I have never made a STEM integrated assessment. In making instruments I often take them from printed books. |
| E | I have no experience in making assessments that are integrated with STEM literacy. |

Table 2 shows the teacher's response to his experience in making assessments. From the various teacher opinions, most teachers have no experience in making STEM literacy-based assessments. This may be due to several factors such as the relatively short time and training that does not have follow-up so that teachers still have difficulty in preparing assessments. In one study, teachers considered that the lack of quality assessment tools, planning time, and knowledge of STEM disciplines were challenges and barriers to applying STEM concepts in learning [30] and more than 40% of the teachers felt there was a lack of assessments for STEM programs [31].
3.3. Teachers' Interests and Needs in Developing Assessment Integrated with STEM Literacy

Teachers' interest and need for developing assessment based on STEM literacy is used to improve the effectiveness and results of learning so that it is hoped that the assessment can be well planned [32]. The needs of teachers in developing this assessment also try to fill in the gaps and provide experience to teachers in making integrated assessments with STEM literacy.

Table 4. Teacher responses related to interest in developing integrated assessment with STEM literacy.

| Respondents | Responses |
|-------------|-----------|
| A           | I am very interested and need an assessment that is integrated with STEM literacy. This is very good developed and can help physics teachers in making assessments. |
| B           | It is very good if this assessment is developed, I find it difficult to make an assessment like this. I feel it would be helped if the campus did a development like this |
| C           | I am interested and need an assessment based on STEM literacy. Honestly speaking, I hope that this kind of assessment can make physics more meaningful and can actually measure students' skills. |
| D           | If this assessment is developed I would be very interested in using it. my weakness is that there is no innovation in making assessments and I need an assessment like this |
| E           | I am interested if there is an integrated assessment with STEM literacy developed. I do have difficulties in making an assessment like this and I hope that when the assessment is ready it can be distributed in schools. |

Table 4 shows that the response of the teachers to the development of this instrument was very good. All teachers are interested in developing STEM literacy-based assessments, but because of the lack of time and experience, this makes it difficult to do this alone, so it requires the participation of the organization that can develop good assessment.

4. Conclusion

Based on the findings and discussions, it can be concluded that the teachers have different perceptions in interpreting STEM. Then the experience of teachers in developing assessment based on STEM literacy shows that there is no sufficient experience even though some teachers have attended training. They felt there was not enough time in development, and a lack of a deep understanding of the concept of STEM literacy itself. So that teachers are interested in developing this assessment and need help from higher education institutions in the preparation of assessments that are integrated with STEM literacy.

5. References

[1] Fakhriyah F, Masfuah S, and Mardapi D 2019 J. Pendidik. IPA Indones. 8 482
[2] Batlolona J R, Baskar C, Kurnaz M A, and Leasa M 2018 J. Pendidik. IPA Indones. 7 273
[3] Mcgunagle D and Zizka L 2020 High. Educ. Ski. Work. Learn. 10 591
[4] Poto V 2021 Kybernetes 50 794
[5] Fukuda K 2019 Int. J. Prod. Econ. 19 104933
[6] Kim S and Seidman E 2019 Res. Comp. Educ. 2 1
[7] Voogt J and Roblin N P 2012 J. Curric. Stud. 44 299
[8] Bicer A, Capraro R M, and Capraro M M 2017 Eurasian J. Math. Sci. Technol. Educ. 13 3959
[9] Falloon G, Hatzigianni M, Bower M, Forbes A, and Stevenson M 2020 J. Sci. Educ. Technol. 29 369
[10] National Research Council 2014 STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research. (Washington, DC: The National Academies Press)
[11] Ledbetter M L S 2012 Life Sci. Educ. 11 216
[12] Utami A, Rochintaniawati D, and Suwarma I R 2020 J. Phys. Conf. Ser. 1521 042048
[13] Techakosit S 2018 Int. J. Emerg. Technol. Learn. 13 230
[14] Chamrat S, Manokarn M, and Thammapratee P 2019 AIP Conf. Proc. 2081 030013
[15] Putranta H and Supahar 2019 J. Educ. Gift. Young Sci. 7 747
[16] Laverty J T and Caballero M D 2018 Phys. Rev. Phys. Educ. Res. 14 10123
[17] Suprapto N 2016 J. Turkish Sci. Educ. 13 75
[18] Hermayawati 2020 Int. J. Learn. Teach. Educ. Res. 19 186
[19] M. Mohr-schroeder 2015 Stem Education : Understanding the Changing Landscape A Practice-based Model of STEM Teaching STEM Students on the Stage (SOS) TM Alpaslan Sahin (Rotterdam: Sense Publisher)
[20] Chen Q, Zhu G, Liu Q, Han J, Fu Z, and Bao L 2020 Phys. Rev. Phys. Educ. Res. 16 20120
[21] Persaud-Sharma D 2012 Int. J. Sci. Math. Technol. Learn. 19 1
[22] Abraham X R R 2018 Adv. Physiol. Educ. 42 482
[23] Widarti H R, Rokhim D A, and Syafruddin A B 2020 J. Pendidik. IPA Indones. 9 309
[24] Jayadi K and Abduh A 2020 Int. J. Innov. Creat. Chang. 11 482
[25] Khuyen N T T 2020 Sustain 12 4
[26] Thi N, Khuyen T, Van Bien N, Lin P, and Lin J 2020 Sustain. 12 1
[27] Jackson C 2021 Int. J. STEM Educ. 38 1
[28] Li Y, Wang K, Xiao Y, and Froyd J E 2020 Int. J. STEM Edu. 7 1
[29] Redman C 2017 Theory Pract. 56 318
[30] Margot K 2019 International Journal of STEM Education 6 1
[31] Nadelson L S and Eifert A 2013 Teach. Educ. Pract. 26 242
[32] Grant J 2002 Br. Med. Journa 324 156