JPPIPA 8(3) (2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Science Teachers' Attitudes, Knowledge, and Practices in Applying a Gender-based STEM Approach

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DOI: 10.29303/jppipa.v8i3.1704

Article Info
Received: May 31, 2022
Revised: June 30, 2022
Accepted: July 23, 2022
Published: July 31, 2022

Abstract: The STEM (Science, Technology, Engineering, and Mathematics) approach is one of the learning approaches that is able to answer the challenges of education in the era of globalization, which demands that human resources must have quality in order to compete globally. To achieve this, STEM-based learning can help, and to achieve successful learning with this STEM approach, the teacher is an important factor, because teachers as teachers and educators influence student learning outcomes and skills. The success factor of teachers in implementing STEM is influenced by backgrounds such as gender, therefore this study aims to see how the level of attitudes, knowledge, and practices of teachers in implementing the STEM approach. This research is a quantitative descriptive study using a survey method. This research was conducted in Aceh Province, Indonesia. The population of this study were science teachers (teachers who teach science, biology, chemistry, and physics). The total sample in this study was 267 samples, the number of samples of male teachers was 87 and the number of samples of female teachers was 180. The research data were processed using percentages. The results showed that male teachers and female teachers had the same level of attitude, knowledge, and practice, namely at a high level towards the STEM approach in learning.

Keywords: STEM; Attitude; Knowledge; Implementation; Gender

Citation: Nurfadilla, E., Halim, A., Supriatno, S., Yusrizal, Y., & Mursal, M. (2022). Science Teachers' Attitudes, Knowledge, and Practices in Applying a Gender-based STEM Approach. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1489–1494. https://doi.org/10.29303/jppipa.v8i3.1704

Introduction

The 21st century is marked by the massive use of information technology, which is also known as the era of globalization. The development of science and technology allows all information around the world to be displayed in real time at a glance. Therefore, as humans living in the 21st century, we do not avoid the reality of these developments, but we can work around it.

To answer the challenges of the 21st century, human resources must have superior seeds in all efforts and work results. The 21st century is an era where jobs require problem solving skills, critical thinking, teamwork and a willingness to learn something new (National Institute of Literacy and the Small Business Administration, 1999), therefore the output demands produced are graduates who ready to work more than the disciplines studied. So that education becomes increasingly important to ensure that students have the skills to learn and innovate, the skills to use technology and information media, and can work, and survive by using life skills. Nurhayati, (2016) says that 21st century national education aims to realize the ideals of the nation, namely a prosperous and happy Indonesian society, with an honorable and equal position with other nations in the global world, through the formation of a society consisting of quality human resources. namely individuals who are independent, willing and able to realize the ideals of their nation. As a result, the

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education curriculum used in the 21st century must prepare graduates who are able to integrate science as a whole, not in pieces.

Many models, strategies, approaches and methods can be used by teachers to achieve these goals, but the STEM approach is the most effective approach in this era of globalization. STEM stands for Science, Technology, Engineering, and Mathematics. The STEM approach is the integration of various disciplines as used in solving real-world problems (Labov et al., 2010; Sanders, 2009).

This perspective of STEM education involves several disciplines but is seen as a unit. Honey et al., (2014) have explained the definition of STEM components, namely scientific literacy is the ability to use science (physics, chemistry, biology, and earth sciences) and processes to understand nature and the ability to participate in making decisions to influence it (in the three main areas of science in life and health, science in the earth and the environment, and science and technology).

Technological literacy is knowledge of how to use new technologies, understand how new technologies are developed, and have the ability to analyze how new technologies affect individuals, society, nations, and the world, engineering (Design Literacy) is an understanding of how technology can be developed through the engineering process using the theme project-based learning by integrating from several different subjects to create relevant and real concepts for students, and encourage students to solve natural problems, Mathematical Literacy is the ability to analyze, reason, and communicate ideas effectively and from how to behave, formulate, solve, and interpret solutions to mathematical problems in different situations.

There are several types of STEM approaches that are often expressed but one of the most effective is Integrated STEM. Integrated STEM with the right method can give students the opportunity to experience learning in real situations and directly rather than learning bit by bit that is applied in the future (Moore et al., 2013). According to Sanders (2009) integrated STEM is a teaching and learning approach from knowledge content and practice that includes science and or mathematics through engineering practice by combining technology design.

The goal to be achieved with integrated STEM is the development of specific educational interventions. By paying attention to this goal, educators can plan the learning process. The framework of intraged STEM according to Honey et al. (2014) can be seen in Figure 1.

According to Honey et al. (2014) educational goals are closely related to outcomes, meaning that a successful or successful intervention must be associated with outcomes that are consistent with its goals. The results that students expect to get from the integrated application of STEM are to improve learning abilities and achievement, students are able to master 21st century competencies, increase their ability and desire to continue their education to a higher level, increase graduation rates, get STEM-related jobs, increase interest towards STEM, and have the ability to transfer understanding across STEM disciplines. The expected results obtained by teachers or education after implementing an integrated STEM approach are changes in teaching practices, and being able to increase knowledge of STEM content and knowledge of pedagogical content.

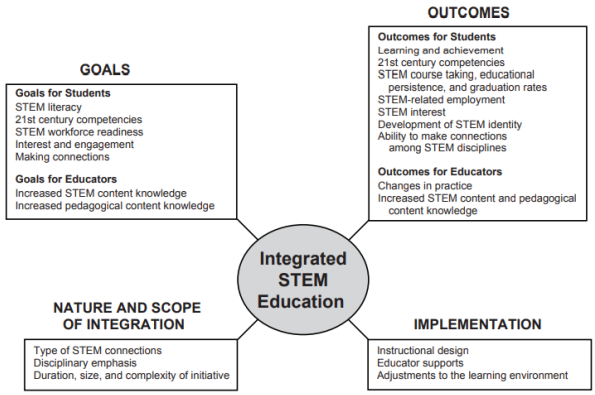

Figure 1. A Framework Showing Common Features and Subcomponents of Integrated STEM Education

In developing the framework, the results may be cognitive or affective, school commitment, or perhaps some combination of these. Typically, cognitive outcomes are determined through standardized measures of achievement, such as large-scale assessments (eg district, national, or international level), and can also be measured through summative tests designed to measure curriculum-related learning, academic achievement or specific skills.

The framework explains the fact that many educators will be affected by integrated STEM education, both for existing and prospective teachers. Outcomes for educators will be reflected in changes in practice for example increased use of teaching strategies that support student engagement with scientific inquiry or engineering design, in the hope of increasing their knowledge of lesson content and pedagogical content, on the other hand it can also increase attitudes of confidence, readiness, and trust. teacher in teaching. Other results can also be seen in an increase in student interest in STEM subjects or in the development of STEM-related identities among students. The extent and nature of integration have a direct bearing on the time and resources required on acceptance or rejection rates for students, educators, and administrators.

In Indonesia, there have been many educational studies conducted on STEM to see its level of effectiveness. From several studies on STEM, it shows

that there is a positive impact such as being able to increase mathematical creativity skills (Ismayani, 2016), students' scientific literacy (Afriana et al., 2016), learning outcomes (Susanti at al., 2018), creative thinking (Sumarni, 2019), scientific skills (Wibowo, 2018), and mastery of concepts (Rivai, 2018). The success in implementing the STEM approach in this school cannot be separated from the role of the teacher. Teachers are the main spearhead in the progress and success of education in Indonesia. Teachers are responsible for imparting learning materials to students as well as guiding and encouraging students to have better character.

Teachers play a central role in the teaching and learning process because the quality of education in schools is largely determined by the ability of teachers to carry out their duties. At the same time in terms of results if learning outcomes are achieved it is possible to change the behavior of most students towards mastery of skills. Therefore, teachers must be creative, professional, and provide fun learning. The role and success of a teacher can also be influenced by their normative condition as a man and a woman. There are different roles between them as social beings that create their status and role in the family field. This difference can also be felt from the way of education provided by each gender (Fakih, 2008). Likewise in the application of the STEM approach in science learning carried out in schools, of course the learning provided by the two genders of teachers is different, which can be seen from various aspects. The first is the attitude level, the second is the teacher's level of knowledge and the last is the teacher's experience in practicing the STEM approach in learning.

Method

This research is a quantitative descriptive study, namely research that describes the current state of the subject or object of research based on visible facts. Descriptive research describes research situations or events, does not seek or explain relationships, does not test hypotheses or make predictions. The researcher only acts as an observer, only makes behavioral categories, observes symptoms and records in his observation book (Rakhmat, 2004). While the method used is a survey method. The time used to distribute the questionnaires until the questionnaires are collected is approximately 6 weeks, starting from March 3, 2022 to April 13, 2022.

The population in this study were all good science teachers who taught Thematic, Science, Biology, Chemistry, and Physics lessons at all levels of education from elementary to high school levels in Aceh Province, amounting to 22,817. The data was obtained from the Education Quality Assurance Institute for the Aceh region and the Ministry of Religion of the Aceh Province. There are two sampling techniques used in this study, namely, Cluster Sampling and Proportionate Stratified Random Sampling. The first is Cluster Sampling, the Cluster Sampling technique is used to determine the sample if the object being studied or the data source is very broad, for example the population of a country, province, or district. To determine which population will be used as a data source, sampling is determined in stages from the widest area to the smallest area. Once selected, then a new sample is selected at random.

In this study, districts in Aceh Province were created in the form of clusters (Sampling Areas) by combining several districts that are close together and have the same character such as ethnicity, language, culture, distance between districts, and mobility such as the number of teachers who teach in the district. close to where he lives.

The second sampling technique is Proportionate Stratified Random Sampling used when the population has members that are not homogeneous and proportionally stratified. The total population in this study is 22,817, so by looking at the table of Determining the Number of Samples from a Specific Population with an error rate of 10%, the total sample obtained is 267. After obtaining the total sample size, the next step is to determine the sample for each sampling area.

Table 1. Sampling for each sampling area

Sampling Area	Total Population	Sampling	Number of Samples
Area 1	2900	$\frac{2900 \times 267}{22817}$	34
Area 2	4778	$\frac{4778 \times 267}{22817}$	56
Area 3	3330	$\frac{3330 \times 267}{22817}$	39
Area 4	3118	$\frac{3118 \times 267}{22817}$	36
Area 5	3254	$\frac{3254 \times 267}{22817}$	38
Area 6	2194	$\frac{2194 \times 267}{22817}$	26
Area 7	2310	$\frac{2310 \times 267}{22817}$	27
Area 8	933	$\frac{933 \times 267}{22817}$	11
Total Sample			267

The data collection technique uses a questionnaire to collect data on attitudes, knowledge and practices of science teachers in applying the STEM approach which will be shared via google form. The item on the questionnaire on the attitude, knowledge and practice of science teachers in applying the STEM approach was adopted from Bevo Wahono and Chun – Yen Chang's research entitled Development and Validation of a Survey Instrument (AKA) towards Attitude,

Knowledge, and Application of STEM which was carried out in 2019. This questionnaire was re-validated by two experts and two teachers. Measurement of the questionnaire using a multilevel scale. The answers for each instrument using a graded scale, namely: Always, Often, Never, and Never. The answers to the attitude, knowledge and practice of science teacher questionnaires in applying the STEM approach will be calculated using the percentage formula, both as a whole and based on indicators.

Result and Discussion

Based on the results of the study, the samples that were collected were 308 samples, and 285 samples that could be used. However, based on the research method that has been designed, the number of samples required in this study was 267 samples with the description in Table 2.

Table 2. Description of the research sample

Information	Sum
Number of male samples	87
Number of female samples	180
Total	267

The data from the questionnaire obtained was processed according to the Likert scale first and then made in the form of a percentage. The results of the study in the form of the attitude, knowledge, and practice of science teachers in applying the STEM approach based on gender can be seen in Figure 2.

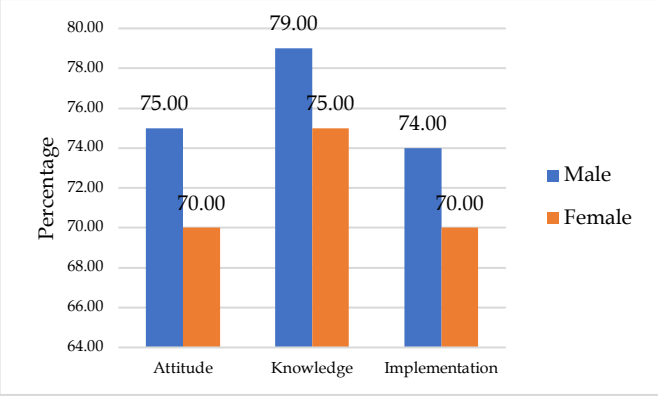

Figure 2. Percentage of attitudes, knowledge, and practices of science teachers in applying the STEM approach by gender

Based on the picture above, it can be seen that the science teacher attitude variable in the application of the STEM approach based on gender obtained a score for male teachers of 75.00%. Meanwhile, the score for female teachers is 70.00%. Then on the science teacher knowledge variable in the application of the STEM approach based on gender, the score for male teachers was 79.00%. Meanwhile, the score for female teachers is 75.00%. Finally, the science teacher practice variable in the application of the STEM Approach based on gender, the score for the male teacher was 74.00%. Meanwhile, the score for female teachers is 70.00%.

From the results of the percentage of the three research variables, namely the attitudes, knowledge and practices of science teachers in the application of the STEM approach based on gender, we can see that male teachers tend to have better levels of attitudes, knowledge, and practices compared to teachers who are male. female gender, but the percentage figures for the three variables in both sexes are at a high level, and it can be seen that the percentage figures for the two sexes are not much different. This shows that there is no significant difference in the level of attitudes, knowledge, and practice of science teachers, both male and female, towards the STEM approach. This also proves that male and female teachers have the same perception and ability towards the STEM approach. This is due to the essence of the STEM approach itself, because the STEM approach has in essence been implemented by teachers in the classroom and also learning from a long time ago, but the teachers themselves do not realize that it is STEM (Johnson et al., 2016).

In terms of attitude variables, male and female teachers have the same enthusiasm for the STEM approach in learning, there is no difference in the attitudes of male and female teachers in applying STEM (Edu et al., 2012; Ilgan et al., 2013; Mustafa et al., 2012). The attitude referred to here is more directed to the teacher's willingness to use the STEM approach. The general definition of attitude that is often used is attitude as a positive, negative or neutral assessment of something (Ajzen 2000). Therefore, if the teacher has a positive attitude or a high level of attitude towards the STEM approach, it means that he or she has high confidence in a learning context (van Aalderen-Smeets et al. 2012) as well as the STEM approach. The attitude component measured here is the teacher's honesty towards the STEM approach and the teacher's effort to apply the STEM approach. With rapid technological advances in today's era, it is not surprising that all teachers can easily find sources regarding the STEM approach in learning, even more so in schools that have qualified internet access, so it is not surprising that both male and female teachers have a high level of attitude. high on the application of the STEM approach in learning.

Then from the knowledge variable, every teacher should have the same level of knowledge about the latest learning approaches or methods, because each subject teacher has its own professional development working group. According to Keraf (2001) knowledge is all thoughts, ideas, ideas, concepts, and human understanding. With a high level of belief or attitude

towards the STEM approach, this is a trigger for teachers to gain a lot of knowledge about the STEM approach. This is reflected in the research results which show that both male and female teachers have high knowledge of the STEM approach.

Finally, the practice variable, what is meant by practice here is the actual application or use of an idea, belief, or method (Wahono & Chang, 2019) related to theory. It is appropriate for teachers who already have good knowledge of the STEM approach to apply it in learning. Teachers who have good beliefs and knowledge about STEM tend to be more confident in applying it in the learning process (Margot & Kettler, 2019; Nadelson et al., 2012; Nadelson et al., 2013), because when teachers' attitudes and knowledge of STEM high, then the percentage of teachers in implementing STEM will also be high. On the other hand, in fact, science teachers practice this STEM which is integrated with only two or more components, both consciously and unconsciously by the teacher. In fact, teachers who teach physics and chemistry always practice the Science approach with mathematics and even certain technologies and engineering to achieve the objectives of a lesson. Then teachers who teach science and biology basically always practice science and technology approaches and techniques in carrying out certain practicums.

Conclusion

Based on the results and discussion of the research, it can be concluded that both male and female teachers have the same level of attitude, knowledge, and practice in applying the STEM approach in learning.

Acknowledgements

Thank you to all science teachers in Aceh for giving me the opportunity and time to do research. Thank you to the supervisor who has guided in completing this article.

References

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project-based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 202-212. https://doi.org/10.21831/jipi.v2i2.8561

Ajzen, I., & Fishbein, M. 2000. Attitudes and the Attitude–Behavior Relation: Reasoned and Automatic Processes. *European Review of Social Psychology*. 11(1). :1-28. https://doi.org/10.1080/14792779943000116

Edu, D. O., Edu, G. O., & Kalu, I. M. (2012). Influence of academic qualification and gender on teachers' perception of difficult concept in primary science in Ikom educational zone of Cross River State, Nigeria. *Greener Journal of Educational Research*, 2(2), 021–026. https://doi.org/10.15580/GJER.2012.2.GJER1211

Fakih, M. (2008). *Analisis Gender dan Transformasi Sosial*, Yogyakarta.

Honey, M., Pearson, G., & Schweingruber, H. (Eds.) (2014). *STEM Integration in K-12 Education Status, Prospects, and Agenda for Research.* Washington: The National Academic Press.

Ilgan, A., Seyfettin Sevinc, O., & Ari, E. (2013). The perception of teachers' towards professional attitude contemporary teachers' qualification. *Ondokuz Mayis University Journal*, 32. https://doi.org/10.7822/egt255

Ismayani, A. (2016). Pengaruh penerapan STEM project-based learning terhadap kreativitas matematis siswa SMK. *Indonesian Digital Journal of Mathematics and Education*, *3*(4), 264-272.

Keraf, A.S. & Dua, M. (2006). *Ilmu Pengetahuan Sebuah Tinjauan Filosofi,Konisius*, Yogyakarta

Labov, J. B., Reid, A. H., & Yamamoto, K. R. (2010). Integrated biology and undergraduate science education: a new biology education for the twenty-first century?. *CBE – Life Sciences Education*, *9*(1), 10-16. https://doi.org/10.1187/cbe.09-12-0092

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration: A systematic literature review. International Journal of STEM Education, 6(2). https://doi.org/10.1186/s40594- 018-0151-2

Moore, T. J., Miller, R. L., Lesh, R. A., Stohlmann, M. S., & Kim, Y. R. (2013). Modeling in engineering: The role of representational fluency in students' conceptual understanding. *Journal of Engineering Education*, *102*(1), 141-178. https://doi.org/10.1002/jee.20004

Mustafa, M., Acisli, S., & Kolomuc, A. (2012). Attitude of elementary prospective teachers towards science teaching. *Procedia - Social and Behavioral Sciences*, 46, 2004–2008. https://doi.org/10. 1016/j.sbspro.2012.05.418

Nadelson, L.S., Callahan, J., Pyke, P., Hay, A., Dance, M., & Pfiester, J. (2013). Teacher STEM perception and preparation: Inquiry-based STEM professional development for elementary teachers. *The Journal of Educational Research*, 106(2), 157–168. https://doi.org/10.1080/00220671.2012.667014

Nadelson, L. S., Seifert, A., Moll, A. J., & Coats, B. (2012). i-Stem Summer Institute: An integrated approach to teacher professional development in stem. *Journal of STEM Education*, 13(2), 69–83.

National Institute of Literacy and the Small Business Administration. (1999). *21st Century Skills for 21st Century Jobs.* Washington, DC: U.S. Department of

Commerce, U.S. Department of Education, U.S. Department of Labor.

Nurhayati, A.S. (2016). Peran Media Jejaring Sosial Dalam Pembelajaran Abad 21. *dalam Prosiding Temu Ilmiah Nasional Guru (TING) VIII. Jakarta: Penerbit UT* [Universitas Terbuka]. Retrieved from http://repository.ut.ac.id/6506/

Rakhmat, J. (2004). *Metode Penelitian Sosial*. Bandung: PT Remaja Rosdakarya.

Rivai, H.K., Yuliati, L., & Parno. (2018). Penguasaan konsep dengan pembelajaran stem berbasis masalah materi fluida dinamis pada siswa SMA. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 3(8). 1080—1088. http://dx.doi.org/10.17977/jptpp.v3i8.11481

Sanders, M. (2009). STEM, STEM education STEM mania. *The Technology Teacher*, 68(4). 20–26.

Sumarni, W., Wijayati, N., & Supanti, S. (2019). Kemampuan kognitif dan berpikir kreatif siswa melalui pembelajaran berbasis proyek berpendekatan STEM. *Jurnal Pembelajaran Kimia OJS*, 4,(1). 18-30. http://dx.doi.org/10.17977/um026v4i12019p018

Susanti, L.Y., Hasanah, Y., & Khirzin, M.H. (2018). Penerapan media pembelajaran kimia berbasis science, technology, engineering, and mathematics (STEM) untuk meningkatkan hasil belajar siswa sma/smk pada materi reaksi redoks. *Jurnal Pendidikan Sains (JPS),* 6(2). 32-40. https://doi.org/10.26714/jps.6.2.2018.32-40

van Aalderen-Smeets, S.I., Walma van der Molen, J.H., & Asma, L.J. (2012). Primary teachers' attitudes toward science: A new theoretical framework. *Science education*, *96*(1), 158-182. https://doi.org/10.1002/sce.20467

Wahono, B., & Chang, C. Y. (2019). Development and Validation of a Survey Instrument (AKA) towards Attitude, Knowledge and Application of STEM. *Journal of Baltic Science Education*, *18*(1), 63-76. http://dx.doi.org/10.33225/jbse/19.18.63

Wibowo, I.G.A.W. (2018). Peningkatan Keterampilan Ilmiah Peserta Didik dalam Pembelajaran Fisika Melalui Penerapan Pendekatan STEM dan elearning. *Journal of Education Action Research*, 2(4). 315-321. https://doi.org/10.23887/jear.v2i4.16321