Perspective of students' science communication in science learning: opportunity in developing makerspace STEM learning approach

Journal of Physics: Conference Series **1572** (2020) 012049 doi:10.1088/1742-6596/1572/1/012049

Perspective of students' science communication in science learning: opportunity in developing makerspace STEM learning approach

H Miranti[1*], Abdurrahman[2] and N Hasnunidah[2]

[1]Students of the Natural Science Teaching Graduate Program, FKIP, University of Lampung, Jl. Prof. Dr. Sumantri Brojonegoro, Bandar Lampung 35145, Indonesia
[2]Teaching Staff of the Natural Science Teaching Graduate Program, University of Lampung, Jl. Prof. Dr. Sumantri Brojonegoro, Bandar Lampung 35145, Indonesia

*hestimirantiazraf74@gmail.com

Abstract: The demands of the 21st century encourage education in Indonesia so that it is expected to create quality human beings who are able to compete in the global competition in the 21st century by having skills, one of them is science communication skills. This study aimed to describe and analyze the perceptions of students' science communication which is applied with learning that integrated with *Science, Technology, Engineering, and Mathematics* (STEM) approach. The study was conducted at junior high schools in Bandar Lampung involving 100 students. The method used in this study was a mixed method with *Sequential Explanatory Design*. The research instrument used a questionnaire containing 10 oral communication statements and 10 written communication statements that were used to analyze students' scientific communication profiles. The results showed that science oral communication was good (63.75%), but low (36.25%) in writing. In addition, learning with STEM approach in this context through practicum and project is preferred by students compared to discussion or traditional learning.

1. Introduction

The demands of the 21st century are increasing along with the development of science and technology, which causes each individual to be required to not only master cognitive abilities but also to have scientific experience [1]. The demands of the 21st century encourage every individual to have special skills better known as 21st Century Skills or known as "The 4Cs" - communication, collaboration, critical thinking, and creativity [2]. Work skills and professional skills have evolved since the 21st century, with an emphasis on creativity, design, and engineering processes that have emerged in educational contexts [3].

The importance of 21st century skills is also found in Minister of National Education Regulation No. 23/2006, that the standard of competence of junior high school graduates in science subjects is to be able to communicate and interact effectively and politely [4]. This means that students' science communication skills can be developed through science learning. Science is knowledge to develop scientific understanding through research activities, so students can explain, evaluate, and build scientific knowledge independently [5].

Scientific communication skill is how to communicate the scientific knowledge of findings and studies to various target groups for various purposes [6]. It is very important for students to actively search for and record information from many resources and activities, including experimenting and observing. The teacher must also support students to be actively involved in the process of building meaning and communicating their learning outcomes [2].

Communication skills have an important role in learning, especially science learning. Communication skills in learning science are needed to plan activities, share ideas to deepen understanding, and to present explanations that are easy to understand with a supportive environment [7]. Communication aims to communicate the process and results of research to various parties both oral and written [8]. Therefore, these skills must be developed in students.

Communication can be performed both in writing or orally by discussing and conducting experiments or preparing reports individually or in groups [9]. But in reality, science communication skills of Indonesian students are still relatively low, especially in the field of science. This can be seen from the results of world bank data showed that students who have completed their education had low communication skills below 70% [10]. During this time, more assignments are given to the practice of the questions contained in the student textbook, so that students' communication skills are not well trained [11].

Learning models to foster science communication skills that emphasize science and attitude skills, higher order thinking skills, and creative problem solving can be integrated with the STEM approach. In the current world climate, STEM innovation is considered important for the economic future of all countries [12]. The current curriculum in Indonesia provides opportunities for the STEM approach, especially in science and mathematics strands that focus on multidisciplinary approaches to developing 21st century skills [13]. Education in science, technology, engineering and mathematics (STEM) is widely recognized as an urgent country and national priority [14].

The integrated STEM approach is supported by the integration of two or more disciplines (science, technology, engineering and mathematics), and potentially with other fields of learning with a focus on problem solving or product creation [15]. The STEM approach can be applied by utilizing makerspace development. Makerspace in STEM is a deliberate position of student learning in a context that requires drawing skills and knowledge from the fields of science, technology, engineering, and mathematics to create, build, and criticize a product. Makerspace in the use of STEM directly is creative way to inspire students to plan, research, build, and create when they participate in projects [16]. Many scholars defined makerspace as the space, resources, and opportunities needed to make products wherein this research can be in the form of developing learning models or developing teaching materials [3,17,35-36].

There were several methods that can be used to measure communication skills, namely (1) using the checklist observation sheet during interactions, (2) surveying student experience in interaction climates, and (3) conducting tests in the form of oral tests, making essays, and providing interview questions. Therefore, the researchers used a survey in the form of a self-assessment questionnaire regarding student science communication and questionnaire regarding science learning [18].

2. Research Method

This research included into mixed method research. The mixed method strategy used Sequential Explanatory Strategy. The study was conducted in Junior High Schools in Bandar Lampung, research subjects in class VIII consisted of 100 students. Data collection used questionnaire instrument. There were two questionnaires given to 100 students. The first questionnaire about students' perceptions of science communication that they have, the second questionnaire contains statements to find out their perceptions about science learning with the STEM approach. Then the two questionnaires were analyzed quantitatively with interpretation value.

Table 1. Interpretation of Students' Perceptions of Science Communication and Science Learning with the STEM approach

Interval %	Answer
$80<x \leq 100$	Always
$60<x \leq 80$	Often
$40<x \leq 60$	Sometimes
$20<x \leq 40$	Rarely
$0<x \leq 20$	Never

Student science communication is divided into four aspects, where expression and evaluation are included in written communication, response and negotiation is included in oral communication. Each aspect consists of five indicators so that all aspects consist of 20 indicators. This science communication questionnaire was adapted from The Development Of A Competence Scale For Learning Science: Inquiry And Communication [19].

Table 2. Questionnaire Indicators of Students on Science Communication

No	Aspect	Indicator
1		I try to state the learning material in my own sentences
2		I recorded every detail of the concepts delivered by the teacher in learning
3	Expression	I describe the data in various ways
4		I describe the relationship between data
5		I always write down solutions to problems when discussing
6		I can understand the meaning of practicum data presented in various forms (graphs/diagrams/tables)
7	Evaluation	I can understand the contents of the material through a number of ways (discussion/practicum/book literacy)
8		I can show the truth of the data or opinions
9		I can distinguish facts and conclusions
10		I read articles or watch TV programs related to school assignments given by teachers
11		I can clarify data or statements that are ambiguous
12		I respond to other friends' statements that are not clear yet
13	Response	I will respect the opinions of friends during the discussion
14		Helping friends to understand the material will improve my understanding
15		I am happy when asked to come forward to solve practice questions
16		I can separate different ideas from myself and friends
17		I can draw general conclusions from discussions with groups
18	Negotiation	I can improve my own opinion based on input from friends
19		I can be well received by all members of the study group
20		When asked my opinion, I tend to agree with a friend's statement

(Adapted from [19])

3. Results and discussion

After students were asked to fill in the first questionnaire given, the results of percentage calculations related to students' perceptions of their communication skills (figure 1).

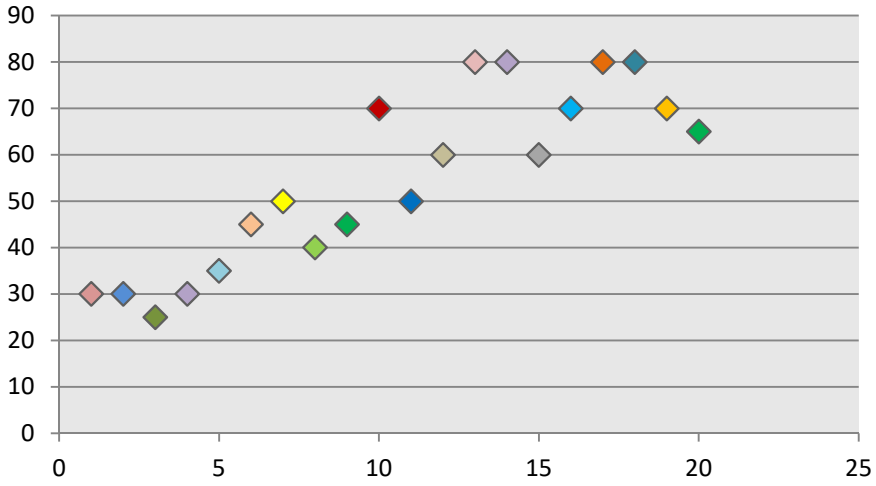

Figure 1. Results of Students' Perception on Science Communication Questionnaire per Indicator

If analyzed based on the type of science communication, students were better to communicate verbally (63.75%) compared to written communication (36.25%) as illustrated in figure 2.

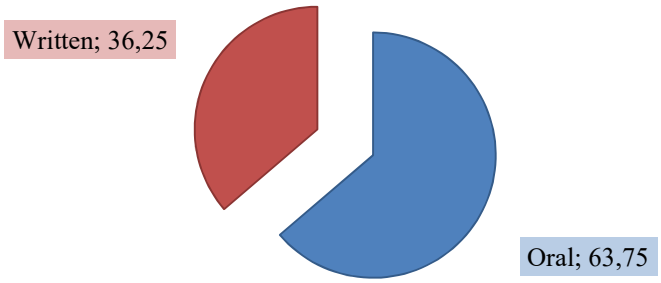

Figure 2. Results of Students' Perception on Written and Oral Communication Questionnaire per Indicator

Furthermore, the results of the second questionnaire obtained the percentage of students' perceptions on science learning with the STEM approach (table 3).

Table 3. Results of Students' Perception on Science Learning with STEM Approach

No	Statements	Never	Rarely	Sometimes	Often	Always
1	The teacher uses learning media when teaching	5% (n=5)	60% (n=60)	20% (n=20)	10% (n=10)	5% (n=5)
2	The teacher presents science material with discussion without group presentations	0%	10% (n=10)	13% (n=13)	72% (n=72)	5% (n=5)
3	The teacher presents science material with practicums accompanied by group presentations	5% (n=5)	73% (n=73)	17% (n=17)	5% (n=5)	0%
4	The teacher uses textbook only as teaching materials in the learning process	0%	0%	8% (n=8)	10% (n=10)	82% (n=82)

5	The teacher asks students to make products with mathematical calculations related to learning	16 % (n=16)	80% (n=80)	4% (n=4)	0%	0%
6	The teacher asks students to look for information from other literature (electronic media) about the learning/practicum being carried out	10% (n=10)	24% (n=24)	66% (n=66)	0%	0%
7	I understand the calculations in physics material delivered by the teacher	0%	68% (n=68)	24% (n=24)	8% (n=8)	0%
8	I like learning with practicum or creating a product	0%	0%	13% (n=13)	23% (n=23)	64% (n=64)
9	I like learning by discussion or direct explanation by the teacher	0%	0%	11% (n=11)	33% (n=33)	56% (n=56)
10	I like learning by watching and listening to videos related to the material obtained	0%	0%	5% (n=5)	23% (n=23)	72% (n=72)

Based on the results of the first questionnaire analysis of 20 indicators on science communication in Figure 1, the percentage graph of the 20 indicators showed the highest perception of the indicators which means that students are better to respond and negotiate, respond to the statements of other friends that are not clear, and respect the opinions of friends when discussing. But they are not happy when asked to come forward by teachers to solve practice questions and are still unable to clarify ambiguous data or statements because their teacher is not accustomed to training and growing their communication skills and confidence. This can be related to the results of the student questionnaire on the science learning that they experienced in table 3, that the learning process carried out by the teacher to them was more on class discussion without group presentations (72%, often) compared to learning with practicum followed by group presentations in front of the class (73%, rarely) so that students' science communication skills can be developed.

This reason is reinforced by the statement that one of the activities that support students to master the concept easire, namely through the process of direct observation or experimental activities. Practicing science communication skills to students enables students to express their scientific ideas. Based on the results of the study [20], it can be said that an increase in the average mastery of concepts in students due to the influence of science communication skills. Science communication skills make it possible for students to obtain as much information as they can from observations so that it will make it easier for them to solve various problems in learning material.

Based on the results of the second questionnaire which stated that students sometimes understand calculations in the physics material delivered by the teacher (68%). The main problem in the study of Science (Physics), which until now has not received a comprehensive solution is the assumption to students that this lesson is difficult to understand. This is similar to the results of research conducted by [21] which showed that physics learning is irrelevant and does not benefit students.

The lowest percentage of science communication indicators is in point 1 to point 4 where the four points are students evaluating learning in writing. Students feel unable to evaluate learning materials because their teachers only use textbooks as teaching material in learning and do not use instructional media or other teaching materials such as student worksheets that contain competencies that can foster communication skills. As said that interesting teaching material has the potential to improve students' cognitive processes [22]. The effectiveness and efficiency of the learning process can be improved through the application of multimedia teaching materials [23].

In the research conducted [24], it was concluded that the higher the scientific attitude of students towards the lesson, the higher the student learning outcomes. Students who have a scientific attitude will tend to be more active in learning activities in class and tend to have high curiosity and be critical of the problems given by the teacher.

Another factor that allows students to communicate with science is still low, namely teachers still use textbooks and do not use other learning media while students really like learning by watching and

listening to videos related to the material being obtained. For example, the concept of liver function is more easily understood when students use multimedia graphics, while the blood circulation system is presented in text, video and animation [25]. Presentation of learning information through text, graphics, images, audio, video and animation is also related to the use of the five senses. Students' understanding will be better if the lesson is presented by integrating the senses of sight and hearing compared to using only the sense of sight [26].

The results showed a higher percentage of oral communication (63.75%) compared to written communication (27.25%) (figure 2) which indicated that students were more able to respond and negotiate than evaluate data on learning material and express learning material. This is supported by the results of the student questionnaire on learning that students have been learning through discussion or lecture methods while students like learning with practicum or creating a product.

In addition to the results of the questionnaire, research showed that factors that influenced the high level of oral communication of students in the classroom include teacher respect for students and supportive classroom environment [27]. Besides teacher expectations of students also influenced student activity in the classroom [28]. Effective oral communication skills will help students to improve their academic performance, increase work choices, increase professional competence, and increase personal effectiveness [29].

This fact is reinforced by the statement that science learning gives students the opportunity to use their logic, through activities such as class discussions, problem solving, and experimenting to find their own scientific concepts [30]. Science learning should be directed towards the active involvement of students with their environment through experiments and experiments. In conducting experiments students can develop their scientific process skills such as formulating hypotheses, conducting experiments, data collection, data processing and communication of experimental results verbally and in writing [31].

It is considered appropriate to solve the above problems by adopting a learning approach that encourages students to build scientific literacy. One solution is the STEM learning approach that gives teachers the opportunity to show students about concepts, principles, science, technology, engineering, and mathematics that are integrated into the development of products, processes, and systems used in their daily lives. The definition of STEM education as an interdisciplinary approach to learning is when students use science, technology, engineering, and mathematics in real context that related to school, work, and the global world, thus, developing STEM literacy enables students to compete in a new era of economics based knowledge [32].

There is hope that an integrated approach to STEM education can help the next generation of students to solve real-world problems by applying interdisciplinary concepts as well as critical thinking capacity, collaboration, and creativity through open-ended problem as a trigger in mastering science concept [33-34]. The STEM-based education process has the potential to create a different generation. Students will appreciate the process, it is not easy to take shortcuts, and want to work hard [35].

It had been described previously that the skills needed by students in the 21st century could be optimally achieved through STEM-based learning. The STEM model that was suitable to lead to the development of student skills was through the application of integrated STEM, while the nature of integrated STEM might be realized through makerspace STEM [36]. Makerspace in STEM is the provision of deliberate space or opportunity from student learning where students must combine skills and knowledge from the fields of science, technology, engineering, and mathematics to create, build, and criticize a product. Creative and practical ways to inspire students to plan, research, build and make when they participate in projects was through makerspaces at STEM including media or multimedia supporting [37-39]. The aspects that can be developed of STEM Makerspace which can be seen in figure 3.

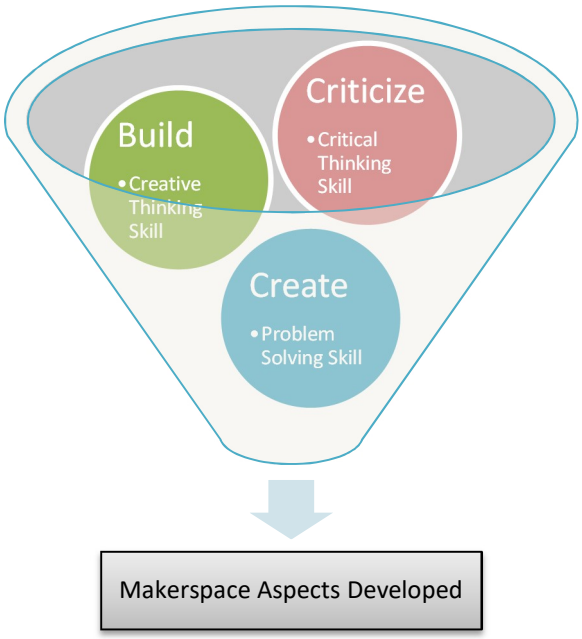

Figure 3. Makerspace Aspects that can be Developed in STEM Learning

4. Conclusion

Based on the results of the questionnaire analysis of students on the perception of science communication possessed and the perception of students towards learning science with the STEM approach showed that the oral communication skills of students had a high percentage (63.75%) compared to written communication (36.25%) and teachers still used textbooks only as teaching materials in the learning process and had not delivered science material with practicum accompanied by group presentations so learning with the STEM approach is needed to involve students in practicum by using teaching materials because students prefer learning science with practicum or creating a product.

5. References

[1] Haryanti, A dan Suwarma I. R 2018 *Jurnal Wahana Pendidikan Fisika* **3** 1
[2] Bybee, R. W 2013 *The Case for STEM Education - Challenges and Opportunities. Virginia: NSTA Press*
[3] Blackley, S., Rahmawati, Y., Fitriani, E., Sheffield, R. & Koul, R 2018 *Issues in Educational Research* **28** 1
[4] Litbang Kemendikbud 2013 *Retrieved from http://litbang.kemendikbud.go.id/index.php.index-berita-kurikulum/234-kurikulum-2013-pergeseran-paradigma-belajar-abad-21*
[5] Duschl, A. Richard., Schweingruber, A. Heidi., Shouse W. Andrew 2007 *Taking Science to School: Learning and Teaching Science in Grade K-8*
[6] Nurhayati, W dan Wardhayani S 2012 *Joyful Learning Journal,***1** 1
[7] Sasmito, A dan Suciati 2017 *Pancasakti Science Education Journal*, **2** 2
[8] Yusefni, W dan Sruyati, S 2016 *EDUSAINS Journal***8** 1
[9] Sinhaneti, K., & Fu, W 2015 *English skills for AEC communication: A challenge for Thai Universities*
[10] Mulia, K., & Krisanti, E 2014 *American Society for Engineering Education*
[11] Taryono 2016 *Penerapan Pembelajaran Berbasis Proyek Dan Pembelajaran Berbasis Masalah Pada Mata Pelajaran Fisika Untuk Meningkatkan Keterampilan Abad 21 (4cs) Siswa SMP*. Tesis. UPI

[12] Hackling, M., Murcia, K., West, J. & Anderson, K 2014 *Optimising STEM education in WA schools Part 1: Summary report. Perth, WA: Edith Cowan Institute for Education*
[13] Hadinugrahaningsih, T., Rahmawati, Y. & Ridwan, A 2017 *AIP Conference Proceedings*
[14] Honey, M., Pearson, G., & Schweingruber, H 2014 *National Academy of Engineering*
[15] Sanders, M 2009 STEM, STEM education, STEMmania. *The Technology Teacher*
[16] Cooper, J 2013 *Designing a School Makerspace Retrieved*
[17] Sheffield, R., Koul, R., Blackley, S. & Maynard, N 2017 *Educational Media International* **54** 2
[18] Duffy, F.D., dkk 2004 *The Kalamazoo II Report. Academic Medicine*, **79** 6
[19] Por Chang, H., Chen, C. C., Guo, G. J., Cheng, Y. J., Lin, C. Y., & Jen, T. H 2010 *International Journal of Science and Mathematics Education 9*
[20] Pujiati 2013 *Jurnal Pembelajaran Fisika***1** 4
[21] Breakspear, S 2012 *The Policy Impact of PISA: An Exploration of the Normative Effects of International Benchmarking in School System Performance. OECD Publishing*
[22] Koning, de B.B., Tabbers, Rikers RM & Paas, F 2009 *Learning and Instruction* **20** 2
[23] Siagian, Sahat, Mursid & Wau, Yasaratodo 2014 *Educational Technology Pos Graduate*
[24] Kusuma, M.D 2013 *Jurnal Online FKIP Universitas Lampung***1** 2
[25] Brunken, Roland., Plass, L.Jan & Leutner, Detlev 2003 *Direct Measurement of Cognitive Load in Multimedia Learning*
[26] Mayer, E. Richard 2001 *Multimedia Learnin*g. New York: Cambridge University Press.
[27] Goss, P., Sonnemann, J., & Griffiths, K 2017 *Engaging Students: Creating Classrooms that Improve Learning*
[28] Papageorge, N., & Gershenson, S 2016 *Do Teacher Expectations Matter*
[29] Crebert, G., Patrick, C. J., Cragnolini, V., Smith, C., Worsfold, K., & Webb, F 2011 *Teamwork Skills Toolkit*.
[30] Rachayuni 2016 *Jurnal Scientia Indonesia* **1** 1
[31] Abrari, N.A.I., Meti, I., dan Riezky, M.P 2012 *Jurnal Pendidikan Biologi* **4** 2
[32] Afriana, J., Permanasari, A., & Fitriani, A 2016 *Jurnal Inovasi Pendidikan IPA***2** 2
[33] Burrows, A., & Slater, T 2015 *Teacher Education & Practice* **28** 2
[34] Romli S, Abdurrahman, and Riyadi B 2018 Journal of Physics: Conference Series 948 012050
[35] Abdurrahman, Ariyani F, Achmad A, and Nurulsari N 2019 *Journal of Physics: Conference Series* **1155** 012087
[36] Abdurrahman A 2019 *J. Phys. Conf. Ser.***1155** 012002
[37] Cooper J 2013 *Retrieved from http://www.edutopia.org/blog/maker-movement-moving-intoclassrooms-vicki-davis*
[38] Sulistiyowati, S., Abdurrahman, A & Jalmo, T 2018 *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah***3** 1
[39] Khoiriah K, Jalmo T, and Abdurrahman A 2016 *Jurnal Pendidikan IPA Indonesia* **5** 75

Acknowledgement
Thanks to supervisor Dr. Abdurrahman, M. Si who has involved the author in the National Strategic Applied Research funded by the DPRM research grant Ministry of Research, Technology and Higher Education Republic of Indonesia with contract No: 065 / SP2H / LT / DPRM / 2019 and Dr. Neni Hasnunidah, M. Si, who has supervised the author in completing this research.