Biology teachers and high school students perceptions about STEM learning

D Saptarani*, A Widodo and W Purwianingsih
Departemen Pendidikan Biologi, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*saptaranidwie@gmail.com

Abstract. STEM Learning is developed to prepare students into a scientific and technologically advanced society. Teachers should begin to be sensitive to taking a role in STEM learning. The success of STEM implementation can be seen from 3 criteria, namely STEM outcomes students, school type, and how or instruction in implementing STEM. Research that has been done more focused on STEM outcomes students. It is necessary to examine how students and teachers interest in STEM. This study describes teacher and student perceptions of STEM. This research uses descriptive method involving 47 high school students and one high school biology teacher. Data were obtained based on student and teacher response to questionnaire about STEM. Results showed that average 71% of students showed positive perceptions of STEM viewed from 68% of interest, 63% of difficulty, 71% of ability, 75% of readiness, 69% of influence, 73% of career and 77% of STEM benefits. On average 82% of teachers showed a positive perception of STEM viewed from 71% of interest, 82% of ability, 83% of influence, 86% of benefit, and 86% of career. Students and teachers consider STEM essential for future career development, so feel interested and challenged to learn it.

1. Introduction
In recent years the world of education is being thrown with the Science Technology Engineering and Mathematics (STEM). Initially, STEM was popular in America and was designed to prepare students in the face of global competition so as not to lose competitiveness with developing countries [1]. Concerns about the difficulty of getting a job in the future when the level of work began to vary, it is feared to cause students not able to compete and difficult to get a job, so over time other countries began to adopt STEM on learning systems in schools, including Indonesia.

STEM is considered able to resolve these concerns [2]. STEM learning actually focuses on project activities, which focuses on the ability of investigation by involving science, technology, engineering, and mathematics. STEM learning invites students to be closer to real life as a scientist or engineer [3]. Techniques involved directly in problem solving and innovation, given the economic importance of society, students must learn about techniques and develop some skills and abilities associated with the design process [4]. The success of STEM implementation can be seen from 3 criteria, namely students STEM outcomes, school type, and how the instruction in implementing the STEM [2]. Learning STEM contains opportunities and challenges [5]. The opportunity is to utilize the enthusiasm of learners and their desire to explore the STEM and the challenge is the difficulty of obtaining appropriate resources including the inadequate teacher readiness in teaching STEM [6]. To meet these opportunities and challenges, it is important to conduct preliminary research on teacher and student perceptions of STEM.
It aims to know the extent to which students and teachers are attracted to STEM so that it can be determined how the right way to be able to meet all the demands that exist in the STEM. Of course the success of STEM learning can be determined from how the interest of teachers and students about STEM.

2. Method
This study used descriptive method involving 47 students (19 female students and 28 male students), drawn from total of all 3 classes, and one Biology subject teacher who also taught to the class. The teachers and students involved in the research come from one of the private schools in Bandung.

This study uses one instrument, namely questionnaire. Questionnaires for students and teachers are distinguished. The teacher questionnaire consists of three parts, the first part contains the demographic profile, the second part about the teaching facilities and methods, then the last part contains teachers' perceptions about STEM. The questionnaire addressed to the students consisted of 49 items on the opinions, attitudes, and environment of students with STEM who then re-grouped from each item to interest, difficulty, ability, readiness, influence, career, and benefits. Questionnaire in the form of a questionnaire consists of a combination of open questions, closed and Likert scale. Types of questions tailored to the needs of measurement.

3. Result and discussion
3.1. Student perceptions of STEM
Student perceptions about STEM are analyzed based on several categories, namely interests, difficulty, ability, readiness, influence, career, and benefits. The categories are presented in 49 randomly distributed question items. The distribution of categories of each item can be seen in table 1 with the proportion of each item of the entire item.

| Category    | Number of Items | Items Number                  | Proportion of the entire item (%) |
|-------------|-----------------|-------------------------------|----------------------------------|
| Interest    | 11              | 1, 5, 8, 9, 10, 24, 25, 26,   | 22                               |
|             |                 | 27, 46, 47                    |                                  |
| Difficulty  | 4               | 2, 4, 34, 35                  | 7                                |
| Ability     | 2               | 6, 33                         | 4                                |
| Readiness   | 2               | 7, 45                         | 4                                |
| Influence   | 14              | 11, 12, 14, 15, 16, 28, 29,   | 28                               |
|             |                 | 30, 31, 32, 36, 37, 38, 39    |                                  |
| Career      | 7               | 3, 13, 17, 18, 19, 22, 23     | 15                               |
| Benefits    | 9               | 20, 21, 40, 41, 42, 43, 44,   | 20                               |
|             |                 | 48, 49                        |                                  |
| Total       | 49              |                               | 100                              |

Each item in table 1 is analyzed and a percentage of each category is taken. Generated percentage of student's interest, difficulty, ability, readiness, influence, career, and STEM benefits. The percentage of each category can be seen in figure 1.
Figure 1 shows, that 68% of students have an interest in STEM. The interest is shown by the interest of students studying subjects related to STEM. This can be seen from items that tend to have a high percentage chosen by students. Of the 11 items on interest, item number 5 has a high percentage. High school students tend to be interested in studying subjects related to STEM because the majors that are popular among high school students are science, so the subjects they take are certainly closely related to STEM, as the subjects they face daily at school.

63% of students expressed difficulties in STEM. The difficulty is based on the 4 items proposed, that students feel that subjects related to STEM are considered more difficult than other subjects, but students still take STEM related subjects in school. This is considered to be a challenge for high school students with mentally advanced.

A total of 71% of students stated that they were able and confident in studying subjects related to STEM. Readiness of students in facing STEM by 75%, means students are well prepared, even ready to learn STEM. This is shown by a caring attitude towards the development of education in the field of STEM.

Student interest and student perceptions arise of course not only from oneself but emerging from various parties. As many as 69% of these effects appear. The greatest influence comes from parents. Parents as people closest to students certainly contributed in all student perceptions about STEM. The main influence of parents is by motivation and encouragement to students to succeed in subjects related to STEM.

As many as 73% of students stated that STEM is related to career. This is demonstrated by the reasons for the students' interest in the STEM field as they relate to their future goals and careers. Students state that knowledge gained from STEM education is important for career development. Much of the work in the future will require a basic understanding of STEM, so this is what drives students interested in STEM. Students at high school level, have to start preparing life goals, one of them in choosing a career. Based on these data, it means students are more interested in choosing a career related to STEM. As well as previous studies of students’ perceptions of STEM, they have shown positive outcomes of interest in careers in STEM fields that correlate with creative trends, the importance of computers (for careers and schools, and learning motivation [7].

As many as 77% of students stated that STEM has benefits. Students contend that STEM and STEM related subjects are required in school learning. Basically the purpose of a living person is to provide benefits to others. Students consider STEM useful because people who study STEM are able to contribute to society. In addition, STEM education will produce a new generation of innovators, so
students consider STEM important and valuable to learn. Basically, basic knowledge of STEM related students is formed since primary education, but unfortunately this is not supported by the implementation of good [8], so when stepping on high school level it is clear the students feel STEM is something that is needed.

If an average of all student responses is taken on STEM, generally 71% of students show a positive perception of STEM.

3.2. Teachers perceptions about STEM
Teacher perceptions about STEM are categorized based on STEM's benefit, influence, interest, ability, and career. Teacher perceptions are explored through 31 items of questions that have been categorized in table 2.

Table 2. The teacher perception category about STEM based on teacher questionnaire.

| Category  | Number of Items | Items Number | Proportion of the entire item (%) |
|-----------|----------------|--------------|-----------------------------------|
| Benefits  | 8              | 1, 9, 12, 19, 20, 21, 22, 23 | 27 |
| Influence | 6              | 2, 3, 4, 7, 27, 31          | 20 |
| Interest  | 5              | 8, 10, 25, 29, 30           | 17 |
| Ability   | 7              | 11, 13, 14, 15, 16, 17, 18 | 14 |
| Career    | 5              | 5, 6, 24, 26, 28            | 22 |
| Total     | 31             |                           | 100 |

Each item in table 2 is analyzed and a percentage of each category is taken. Generated a percentage of the benefits, influence, interests, abilities, and career of STEM according to the teacher. The percentage of each category can be seen in figure 2.

Figure 2. Comparison of teachers perception categories about STEM

Based on figure 2, it was found out that 86% of teachers said STEM was useful. The most prominent benefit expressed by teachers that STEM can help human life. Teachers make STEM learning a top priority in schools, because schools that emphasize STEM education are likely to produce new generation innovators. This should be supported by schools that place more emphasis on STEM teaching and skills. Support and influence of factors closely related to STEM showed a percentage of 83%. Teachers argue that the most important influence comes from the school.
The influence of various factors will certainly generate interest in STEM. The results in chapter 2 show that as many as 71% of teachers have an interest in STEM. Teachers assume that STEM education is useful for students, but the most dominant is in the technology section, because teachers assume students today have more skill and creativity in technology. The teacher also assumes that he has a less important role in influencing students’ interest in STEM, although the teacher is still interested in joining STEM training because the STEM field must be studied to be able to become professional teachers and to encourage students and motivate students to be more interested in the STEM field.

As many as 82% of teachers feel able to teach STEM to students. Teachers know how to apply STEM-related skills, know how to explain concepts, know how to find information to help students learn, and know how to help students develop ideas and skills related to STEM. Teachers argue that there are three skills that must be possessed by students to be able to face challenges in the future, namely creativity, the ability to coordinate with others, and have good emotional intelligence. All three skills must be developed by the students well. Of course everything is not always smooth, one of the challenges in integrating STEM education into school curriculum according to the teacher is the lack of adequate time. Based on previous research, it was revealed that the real challenge a teacher has in implementing STEM learning is the lack of teacher readiness to teach STEM itself [9].

STEM education is considered to help students prepare for future careers, as most future work requires understanding of STEM. Based on the results in Figure 2, it shows that as many as 86% of teachers stated that STEM is related to careers. STEM is considered important to support a career, because work in the field of STEM produces an attractive and useful salary for humans. Similarly, in students’ perceptions, students express STEM essential for career development. When compared to the percentage of students’ perceptions of careers related to STEM, teachers’ perceptions have a higher percentage but with a margin that is not too far away. This is in line with previous research, that students and teachers do not have a significant difference in career perceptions of STEM [10].

If an average teacher response is taken from STEM, as many as 82% of teachers show a positive perception of STEM.

4. Conclusion
Researchers conclude that students have a positive perception of STEM by 70%. This is evident from the attitude of students who show their interest in STEM, positive opinions about STEM, and the environments that support students to be interested in STEM. The teacher also showed positive perception of 82%, that is, teachers and students basically assume that STEM is important and needed to support the career in the future because of good career with attractive salary offer mostly in STEM field. Most importantly that STEM is considered to help human life. From the resulting percentage difference can be concluded also that the teacher has a more positive perception of STEM compared with the students but with the difference that is not too big.

Acknowledgments
We would like to thank the teachers and students who participated in this research.

References
[1] Breiner J M, Johnson C C, Harkness S S and Koehler C M 2012 What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships School Science and Mathematics 112(1) 112-135
[2] Committee on Highly Successful Schools for Programs for K-12 STEM Education 2011 Successful K-12 STEM Education (Washington D C: National Academic Press)
[3] English L D and King D T 2015 STEM learning through engineering design: fourth-grade students investigations in aerospace International Journal of STEM Education
[4] Bybee R 2010 What Is STEM Education? 329
[5] Abrams E, Southerland S A and Silva P (Eds.) 2007 Inquiry in the classrooms: Challenges and opportunities (Greenwich CT: Information Age)
[6] Turner K B 2013 *Northeast Tennessee educators’ perception of STEM education implementation* (Doctoral dissertation, East Tennessee State University).

[7] Nadelson L S, Callahan J, Pyke P, Hay A, Dance M and 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

[8] Knezek G, Christensen R and Tyler Wood T 2011 Contrasting perceptions of STEM content and careers *Contemporary Issues in Technology and Teacher Education* 11(1) 92-117

[9] Williams H 2011 Examining the Effects of Recycling Education on the Knowledge, Attitudes, and Behaviors of Elementary School Students *Outstanding Senior Seminar Papers* Paper 9: 1-42

[10] Tyler-Wood T, Knezek G and Christensen R 2010 Instruments for assessing interest in STEM content and careers. *Journal of Technology and Teacher Education* 18(2), 345-368