The insight of biology student to current biotechnology issues

R Kurniati and Y Ahda*
Postgraduate of Biology Education Department, Padang State University, Padang, Indonesia

*ahdayuni@fmipa.unp.ac.id

Abstract. Based on the results of the semester examination, it is known that students' knowledge of the latest biotechnology is still low. One of the reasons is that students rarely read the results of research published in journals and other reading sources. This study aims to reveal the causes of students' low knowledge of biotechnology development. The type of this study is descriptive research. The participants of this study are 113 university students and four biotechnology lecturers. Data collection instruments used are questionnaires for the students and interview guidelines for the lecturers. The sampling method used is purposive sampling. Students have low potential in knowing the development of biotechnology. Students need to be supported by the availability of learning materials that develop materials by integrating the latest research findings related to biotechnology in various fields. In addition, students need to be assigned to read international journals so that the insights gained are broader and more up-to-date. These findings indicate that it is necessary to develop learning materials that are related to developing issues and provide learning materials supplemented by the latest research results.

1. Introduction

The development of natural science and technology (science and technology) is a challenge for a country to determine the future of the nation. The progress of a country also depends on an intelligent society to accept or reject the progress. Students as the future of the nation must have extensive knowledge about the development of science and technology. The development of science and technology can provide benefits if these developments are balanced with the knowledge of students that are also developing. In this case, education plays an important role in facilitating students to face the challenges of the science development [1]. According to [2], the knowledge given in the world of education is expected to equip students to overcome economic and social changes, caused by the development of biotechnology. Education that accommodates students to learn science is done in universities. Universities will provide facilities and infrastructure to support the success of students so that they can obtain maximum learning goals. One science that always develops along with the development of science and technology is biotechnology.

Biotechnology is a very broad field of science and technology. It covers many branches, ranging from techniques to improving crop productivity to human gene manipulation [3]. Biotechnology is one of the disciplines that are growing rapidly in science and technology and has great potential to improve human life [4]. Over the past decade, biotechnology has heralded a revolution in medicine, agriculture and industry [5]. Biotechnology has shown great hope over the past few decades in the agricultural and food industries. Therefore, an effort needs to be made so that biotechnology can be accepted by
students for a successful future. Students are the future of society, so it is crucial to equip students with broad knowledge [6].

The importance of biotechnology education has been recognized in a number of national curriculum frameworks in several countries. [7] states that the British National Curriculum for science combines ethical issues in the field of biotechnology. The New Zealand Curriculum Framework identifies the importance of biotechnology for the country [8]. Also, in Australia, the federal and state governments have been aware of the relevance of biotechnology in the curriculum [7].

2. Background of the study

2.1 Biotechnology Learning

In the era of rapid advancement in biotechnology, students need to develop their thinking ability and improve knowledge about the development of science and technology. The development of advanced biotechnology needs to be balanced with learning processes that support these developments. According to [9], there needs to be an interaction between educators in training students to have broad knowledge and develop students to be professionals in their fields in accordance with what is needed in the future. Biotechnology learning needs to address global issues that are related to the development of biotechnology [10].

Based on the results of the semester exam, it is known that students' knowledge of the latest biotechnology is still low. In 2015 and 2016, it is found that in average, students earn a C score. This indicates that the goal of biotechnology learning has not been maximized. One of the reasons is that students rarely read research results published in journals or other reading sources. Based on the research [11] the availability of learning materials that are less facilitated in learning will have an impact on the low grades of students. According to [12] the availability of adequate learning materials can obtain meaningful learning.

2.2 Student attitudes on biotechnology

Students' attitudes toward science will affect the cognitive level of students. [1] in their research results write that there is a positive correlation between attitudes and achievement. Based on the results of Tegegne's study (2013) of 792 respondents, it is found that 52% know about biotechnology, 3.9% know a lot about biotechnology and 44% do not know much about biotechnology. Seen from the benefits of biotechnology perceived by students, 71% state that biotechnology, especially genetic engineering material, is beneficial to human life. This indicates that generally students already understand biotechnology and its benefits for life.

[13] conduct a study that concerns the students’ attitudes towards biotechnology. Based on the results of the study, it is found that there is a significant difference between biology education and the biology department. Students of the educational department show a positive attitude towards the application of biotechnology, while the biology department gets a lower attitude score. This finding reveals that the biology department is not too focused on the application of biotechnology in everyday life. If it is seen from the aspect of gender, there are no significant differences between men and women. Thus, through this study, an attempt is made to measure students’ attitudes towards biotechnology between biology students and biological education students. Questionnaires are used to assess students’ interest in biotechnology, obstacles faced during biotechnology learning, and the benefits of biotechnology in life.

2.3 Availability of learning materials

Learning materials are one of the important elements in learning. Learning materials will facilitate the lecturers in delivering the material as well as a source of independent learning for students. Biotechnology courses also require learning materials as a systematic and complete information delivery tool to achieve a competency [14]. Learning materials can improve the critical thinking skill; understand concepts and students’ attitudes towards learning [15]. Lecturers must be aware of the up-
to-date element of the material presented. Research conducted by [16] suggests that biotechnology requires research-based learning materials because it can make learning process more applicable and contextual. Learning materials that provide incomplete information can be a determinant in shaping low students’ attitudes and knowledge.

3. The aim of the present study
The purpose of this research is to know the potential of biology students in knowing the development of biotechnology science. Outcome of this study can be used as a guideline to improve the knowledge of students through the provision of adequate learning materials for learning continuity of biotechnology.

4. Methods

4.1 Participants
The participants of the study are 113 university students (81 biology education department and 32 biology department) who have taken or are taking biotechnology courses and 4 biotechnology lecturers. These subjects are taken from four universities in Padang City.

4.2 Instruments
The research instruments used in this study are interview guidelines for lecturers and questionnaires for students. Interview guidelines contain questions about biotechnology learning, availability of learning materials and students’ understanding of biotechnology materials. The questionnaire used in this study is about the biotechnology learning in the classroom, the availability of biotechnology learning materials, students' attitudes towards biotechnology learning, and the ideal biotechnology learning from students’ view. The questionnaire is given in the form of semi-closed that consists of two scales, namely "yes" or "no" accompanied by reasons. For this study, the questionnaire used is a positive item. According to [17], questionnaires that use negative sentence patterns can reduce the value of questionnaire validity.

4.3 Data analysis
The results of the study are analyzed by using descriptive statistical analysis.

5. Results and discussion

5.1 Result

5.1.1 Biotechnology learning in the class

| Table 1. Interview Result with Lecturer of Biotechnology |
|-----------------|-----------------|
| **Aspects of Questions** | **Interview Result** |
| Learning method. | Lecture and discus. |
| Media. | Power point and *textbook*. |
| Form of assignment. | National and international journal-based assignments. |
| Level of student understanding. | Students generally understand the material taught, but the students have not been motivated to read. |

Based on the interviews results with 4 lecturers of biotechnology, it is found that in general the methods used in the learning process are the lecture method (direct learning) and discussion. In addition, the availability of learning materials used in biotechnology learning is 75% use power point
slides and 25% use textbooks. In general, the lecturers assign students to look for references from articles such as national and international journals. This journal-based task aims to enable students to know about topics that are currently being discussed and obtain the latest knowledge. However, students are constrained in understanding the language of international journals because of having limited English language skills. Based on the data in Table 1, it is known that overall, students can understand biotechnology material well, but the potential of students in knowing the development of biotechnology is relatively low because they are not used to reading research articles containing the latest and global information.

5.1.2 Student Attitudes on Biotechnology

| Table 2. Results Questionnaire Student Attitudes on Biotechnology | Percentage (%) |
|---------------------------------------------------------------|-----------------|
| Aspect                                                        | Biology Education | Biology |
| Students interested in studying biotechnology                 | 95.1            | 96.88   |
| Students understand biotechnology essential for life          | 100             | 100     |
| Students know the benefits of biotechnology in life            | 100             | 100     |

Based on Table 2, it is found that students indicate a positive attitude towards biotechnology. Students are interested in studying biotechnology because they know the important role of biotechnology for human life and understand the benefits of biotechnology for people's lives. Based on the data, it is known that there is no difference between the biology education and biology department. Both of them show a positive attitude towards biotechnology.

5.1.3 Availability of learning materials

| Table 3. Result Questionnaire Problem Analysis and Student Needs | Percentage (%) |
|---------------------------------------------------------------|-----------------|
| Aspect                                                        | Biology Education | Biology |
| Lecturers provide learning materials in the form of Power point slides | 83.95           | 75       |
| Learning materials help with learning                          | 66.7            | 75       |
| Students use other referrals                                   | 97.5            | 93.75    |
| Learning materials should be equipped with research results    | 96.3            | 96.88    |

Based on the data in Table 3, it is known that in general lecturers use learning materials in the form of Microsoft power point slides during biotechnology learning. This finding shows that there is no significant difference between the department of biology education and the department of biology. The learning materials provided are quite helpful for students both from the department of biology education and from the biology department. However, students still need other learning materials that are referred from the internet. The data show that almost all students use other references to obtain broader information about biotechnology material. This indicates that the material provided in Mic. power point has not been able to increase students' insight about the development of biotechnology because the Mic. power point contains only important concepts that must be known by students. Students need learning materials that provide information about the development of biotechnology in
5.2 Discussion
The development in science is a condition that cannot be bypassed. Students must enrich their knowledge about the development of science and technology that is developing. This needs to be done so that the development of science and technology can be beneficial to human life. Biotechnology is one of the disciplines that continues to grow with the times and has the potential to improve human life. The advancement of science and technology in the field of biotechnology has caused public anxiety in utilizing biotechnology products. According to [18], the lack of biotechnology knowledge is the main reason of the anxiety about Genetically Modified Organisms (GMOs).

This study shows the potential of biology students on the development of biotechnology. Based on data gained from interviews with lecturers of biotechnology in the city of Padang, it is known that the lecture method (direct learning model) and discussion are used in the teaching process. According to [19], direct learning is very important to promote scientific literacy because scientific literacy requires citizens to not only know the contents of science, but also to do the science. Biotechnology is a topic of biology that requires direct learning in order to fully learn and understand. Direct learning enables students to make connections between various science topics that are generally taught in disjointed ways [20]. Through direct learning, lecturers can also convey the latest issues regarding the development of biotechnology. This will trigger students' curiosity to explore further.

In addition, the lecturer also assigns students to read references from scientific articles. The recommended articles are national and international journals so that the information obtained is wider and up to date. In this case, students are constrained in using international journals because of having limited skill of English. Students tend to use materials from the internet whose validity level is still low. This shows that students’ knowledge of the biotechnology development is relatively low. The solution to this problem is to provide research-based learning materials. This learning material will present research related to the biotechnology development that makes it easy for students to understand it. According to [21], one effort that can be done to improve students’ understanding is to provide textbooks that are complemented by research results as a contextual example.

This study also obtains data related to the students’ attitudes toward biotechnology. Based on student questionnaires, it is known that students raise positive attitudes towards biotechnology. According to the Planned Behavior Theory, attitude is one of the main components to determine one's motivation to act in a certain way. Students who have extensive knowledge of biotechnology will always seek information about the latest development in science and technology. [22] cites a study by Todz and Gotz in 1998 about students’ attitudes toward biotechnology. From this, it is obtained that students have high curiosity.

Seeing from the availability of learning materials, it is known that biotechnology learning does not have adequate learning materials. Learning materials are one of the important elements in learning. Learning materials will facilitate the delivery of information and help students to study independently. [23] states that one obstacle faced in biotechnology learning is the lack of availability of learning resources and time. Biotechnology learning materials need to contain information about research results and recent findings that are beneficial to human life. [24] states that students should be able to build a new knowledge from research procedures. Research is an important means to improve the quality of learning. According to [25], academics need to share the research results as a form of knowledge transfer and the development of knowledge and learning at universities.

6. Conclusion
The rapid development of biotechnology requires biology students to increase knowledge in the field of biotechnology. Based on the results of the research that has been done, it can be concluded that students’ knowledge of the biotechnology development is still low. The low knowledge of students
about the biotechnology development is related to the unavailability of learning materials that can support the biotechnology learning. In addition, the learning material also has not been associated with the latest research. Based on the results obtained, it is necessary to develop research result-based biotechnology learning materials to improve students' knowledge about the development of biotechnology.

References

[1] Karpu dewan M and Chong K M 2017 The effects of classroom learning environment and laboratory learning on the attitude of learning science in the 21st-century science lessons. MJLI 25-45.

[2] Steele F and Aubusson P 2004 The challenge in teaching biotechnology Research in Science Education 34 365-387.

[3] Bartoszek A, Agata B and Jordi B 2006 Managing innovations in biotechnology european project semester.

[4] Altoparmak M and Nigda N Y 2010 Practical materials designs within team activities in learning biotechnological concepts & processes Procedia Social and Behavioral Sciences 2 4115-4119.

[5] Edmonston J 2000 The biotechnology revolution: Distinguishing Fact from Fantasy and Folly ?. Australian Science Teachers' Journal 25 45.

[6] Tegegne F, Ahmad N A and Hiren B 2013 Awareness of and attitudes towards biotechnology by tennessee state university students with different backgrounds and majors Journal of Biotech Research 5 16-23.

[7] Solomon J 2001 Teaching for scientific literacy: What could it mean School Science Review 82 93-96.

[8] Conner L 2000 The significance of an approach to the teaching of societal issues related to biotechnology Paper Presented at Annual Meeting of the American Educational Research Association.

[9] Booth J M and Garrett J M 2004 Instructors' practices in and attitudes toward teaching ethics in the genetic classroom Genetics 168 1111-1117.

[10] Montgomery B L 2003 teaching the principles of biotechnology transfer: a service-learning approach Electronic Journal of Biotechnology 6.

[11] Dipuja D A, Lufri L and Ahda Y 2018 Development biology worksheet oriented accelerated learning on plantae and ecosystems for 10th-grade senior high school students IOP Conf. Series: Materials Science and Engineering 335 012088.

[12] Jefriadi J, Ahda Y and Sumarmin R 2018 Validity of students worksheet based problem-based learning for 9th grade junior high school in living organism inheritance and food biotechnology. IOP Conf. Series: Materials Science and Engineering 335 012088.

[13] Kahraman S and Evrim O 2011 Attitudes of university students towards biotechnology and its applications Energy Education Science and Technology Part B: Social and Educational Studies 1 1501-1510.

[14] Prastowo A 2012 Panduan kreatif membuat bahan ajar inovatif: menciptakan metode pembelajaran yang menarik dan menyenangkan. Jogjakarta: Diva Press.

[15] Darussyamsu, R and Muhyiatul F. 2017 The effect of reading, questioning and answering strategy toward student creative thinking on evolution course at biology department FMIPA Universitas Negeri Padang Bioeducation Journal 1 2354-8363.

[16] Pambudiono A, Endang S and Mohamad A 2016 Pengembangan buku ajar bioteknologi berbasis penelitian bioremediasi logam berat kadmium untuk mahasiswa S1 Biologi Universitas Negeri Malang Jurnal Pendidikan 1 1077-1085.

[17] Schriesheim C A and Hill, K D 1981 Controlling acquiescence response bias by item reversals: the effect on questionnaire validity Educational Psychological Measurement 41 1101-1014.
[18] Anunda H 2014 An evaluation of stakeholders' knowledge and attitude on the benefits and risks of agricultural biotechnology International Journal of Agricultural and Food Science 4 64-72.

[19] Bigler A L 2010 Student content knowledge increases after participation in a hands-on biotechnology intervention Dissertations Brigham Young University, Provo.

[20] Kirkpatrick G, Orvis K and Pittendrigh B 2002 A Teaching model for biotechnology and genomics education Journal of Biological Education Vol 37 31-35.

[21] Nuha U, Mohamad A and Umie L 2016 Analisis kebutuhan buku ajar berbasis penelitian materi filogenetik molekuler untuk mahasiswa S1 pendidikan biologi Universitas Jember berdasarkan model pengembangan addie Seminar Nasional Pendidikan dan Sain 753-757.

[22] Gillian K C 2008 Asking Students: What key ideas would make classroom biology interesting ?. Teaching Science 54 34-38.

[23] Utomo A P, Aris S B and Erlia N 2017 Development of learning materials of biotechnology topic based on steam-lw approach for secondary schools in coastal area International Journal of Humanities Social Sciences and Education, 4, 121-127.

[24] Poonpan S and Siriphan S 2005 Indicators of research-based learning instructional process: a case study of best practice in a primary school Paper Presented at the AARE Annual Conference Parramatta.

[25] Senaratne and Dilanthi A. 2006 A knowledge transfer perspective, Second Annual Built Environment Education Conference (BEECON 2006).