

BIOMIND Module: A Quality Teaching and Assessment Media

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ABSTRACT

Teaching media is one essential factor that influences the success of teaching process. Therefore, this study was aimed to develop a science learning module namely BIOMIND Module in the form of portal and e-book. The study used research and development (R&D) method to create BIOMIND module developed from Hanafin and Peck model. The study involved five professionals, 20 teachers, and 98 students to assess the BIOMIND module. The results show that BIOMIND portal and e-book teaching media could be standardized and implemented for the teaching process. The existence of teaching media evaluation instrument was expected to develop a quality teaching media for innovative and efficient teaching and learning process.

Keywords: BIOMIND module; e-learning portal; e-book Biomind; BIOMIND Module Evaluation Instrument (BMEI)

INTRODUCTION

Nowadays, the development of education is strongly influenced by the formal development of science and technology (Tan 2003). Technological changes take effect almost daily; therefore, the education system is responsible for enabling the students to have a competitive advantage in the digital age, fluent in the language, and adept at controlling technology (NCREL 2003). Development of science and technology can influence the process and research by providing unlimited and easy-to-access information from the internet. The aspiration of the state is becoming the center of excellence in the field of science and technology, which is trying to be realized through the education system. This aspiration is shared with the new message, the impression of globalization, liberalization, mediation, and the development of information technology and communication (Diknas 2009).

The current information technology has been used by many people around the world (Tan 2003). Existing technological advances have changed the behavior of some or all of today's human lifestyles. As Douglas Rushkoff, *Playing the Future* (1996) says in NCREL (2003) "Students are natives to cyberspace, where the rest of us are immigrants". Children today have different views of the world from adults because they are raised with unrestricted access to information and ideas from interactive media.

According to John Naisbitt in NCREL (2003), a nation or state that excels in information technology will dominate the world. To anticipate the current trend of world development, the Indonesian government through the Ministry of National Education has composed and prepared the students to be able to compete more in the mastery of Information and Communication Technology (ICT) in the

teaching and learning process. The process of technological mastery becomes essential for students in using technology to obtain all required information (Diknas 2009; Vebrianto & Kamisah 2011; Nikitina 2006; Tan 2003; Norhayati et al., 2013).

Prensky (2001) states that children have access to computers, video games, digital music players, telephones and more equipment in the digital world since the early days. According to Mehmet (2009) all of those technologies become a part of children's lives, which is known as the term of 'New Millennium Learners'.

The education system of the 21st century needs to provide students with the understanding of concepts and various skills such as digital literacy aspect, critical thinking, creative and innovative, memorable communication, and the spiritual aspect (Osman et al., 2010; NCREL 2003; Vebrianto & Osman 2011; Chin & Chia 2004). The student's ability to accept a concept depends on the complexity of the concept and the level of cognitive development of the student. Therefore, each student must have a proper level of knowledge of various concepts in biology. This level of knowledge is essential for students to achieve meaningful learning to be applied in their daily life (Vebrianto et al. 2012; Chin & Chia 2004). The education system is not only responsible for improving the skills of students but also providing the correct understanding of the concept to meet the educational goals in the face of the challenge of the 21st century.

In general, schools in Indonesia do not have diverse and innovative teaching media. In the teaching and learning process in the classroom, teachers play an active role in conveying information without the use of various teaching media, usually only using lecture and story methods while the students listen and write down the teacher explanation (Kusnandar 2010 and Vebrianto et al 2012). Furthermore, teaching and learning focus only on mastering the subject content through simple learning media and do not emphasize on the understanding of concepts and skills. As a result, students become passive and do not master basic thinking skills that are essential in solving problems and lack conceptual understanding (Gonen 2008; Dokmea & Aydinlib 2009; Smeets 2005). Therefore, it is necessary to develop various teaching media that can provide

the correct understanding of concepts and improve various skills using problem-based learning (Tan 2004; Teri & Moore 2011).

Mastery of the concept of biology is essential for the students because they can apply the concepts, associate concepts with other concepts, and solve problems that he found. As a subject that has many concepts, biology is one of the subjects that is often rated difficult by students. This can be seen from the less satisfactory achievement of the students (learning outcomes) in the daily examination, and the final examination, and the National Examination (PPMP 2011). According to Yustina (2012) and PPMP (2011), the probable cause of the low score obtained by the students is the difficulty experienced by students in studying biology, especially in understanding and mastering the concepts of biology. Students who do not have misconceptions mean that they have the appropriate conceptual knowledge.

When we met with the teacher ($n = 6$) in Pekanbaru and interviewed them ($n = 4$), we found that some biological topics require high analysis that is very difficult for the students. Therefore, misconception often occurs and students need a suitable model to learn the material. One of the most difficult topics in biology subjects includes animal physiology, which requires high analysis and synthesis of the students (Vebrianto et al., 2012). Skills of analyzing and synthesizing are essential for students to develop various skills required in the workplace or their social life. Hence, in this study, we worked with other parties to develop a new PBM approach to be applied in teaching and learning process.

Thus, it is essential to improve the teaching and learning process in which the involvement of the students, the teaching process, and the teaching media are improved. Therefore, it can improve student skills and expand their knowledge. With a variety of skills, students could have a better life and finding or creating a job. Meanwhile, the appropriate knowledge enables students to be competent in dealing with problems encountered in their life. Therefore, we developed a teaching media in the form of portals and e-book named 'BIOMIND'. It was based on PBM introduced by Hanafin and Peck to improve the 21st-century skills and conceptual knowledge of students so that they can be excellent future leaders.

PBM learning is a model based on the principle of using the problem as a starting point for the procurement of new knowledge. This model places the teacher as a facilitator in which teaching and learning process is aimed to make the students active. The learning activities can improve students' ability to understand the correct concepts, use reasoning, solve problems, propose ideas, have an ability to work together, and improve the skills of 21st-century students (Sungur & Tekkaya 2006.). The learning process that engages students actively individually or in groups will be more meaningful.

Gasser (2011) suggests five processes in learning to improve and achieve 21st-century skills: learning based on problems, finding solutions from students, taking risks, fun processes, and being able to work together in groups. Duran et al. (2011) argue that a PBM learning is essential to improve the skills of the 21st century, where the 21st-century skills are integrated into the subjects. Furthermore, Nikitina (2006) explains that learning with problem-based issues is very appropriate to enhance enthusiasm and apply science and technology. This learning model also enables students to discover and implement social science to create new products that are more beneficial or build policies for social change.

Several previous studies have explained the benefits and advantages of using online teaching and learning processes (websites or portals) and e-books as follows.

Chin and Chia (2004) conducted a study in the middle school discussing food related to the science of physiology. The results show that the PBM model has a systematic work to address a problem. Therefore, the students had better performance in applying knowledge, communication, and creating their learning process. Nearly all students gave a positive response to the PBM model because it encourages them to work hard and think deeply to resolve the issues. However, four students still preferred the teacher-centered learning.

In relation to students' readiness in online learning, Artino (2010) states that students are more willing to take online lessons. They are very flexible and have greater confidence to learn online and feel more satisfaction in their online learning experience. The results of the regression analysis indicate that each online

learning expert was estimated to have more efficacy and satisfaction, and lower assignment value.

Meanwhile, Ming et al. (2011) say that the use of e-learning depends on the gap between scarcity and experience after use. The study also found that the usability response, regarded as after-use expectations and symbols of causes, have a great impression on the intentions and the implementation of the web or online based learning. Research conducted by Lee et al. (2007) also showed that the benefits of internet-based encourage students to use it.

Moreover, the decision analysis run by Ying et al. (2012) indicates that the online access is a critical factor to promote satisfaction in the web-based learning environment. A study with appropriate learning environment content may link short-term experiences to the individual long-term experience. The online learning also makes learning process to be more active.

Recent trends in higher education show that online learning will continue to be an important part of learning in modern times. In every global economic change, participation in learning is now required for modern workers hoping to equip their skills and competitive advantages (Tan 2003). Therefore, an important implication of online teaching is that teachers may have an impact on the students so that the teaching process can be improved by first addressing the students own beliefs and effectiveness in using online learning (Artino 2010: Rovai, 2007).

In addition, it is important in the e-learning that the teachers step from teaching to the learning perspective. In e-learning, teachers provide and help create learning situations for students where they may interact in the teaching and learning process (Jonsson 2005). However, in its implementation in web-based learning, it is not easy to be implemented by the faculty or school as each school has different facilities, even though it provides easier access for students to gain knowledge (Clark et al., 2011).

Online learning can improve knowledge and skills, as explained by Caballé (2010). The study shows that online learning may improve the knowledge and skills of students as a whole during the interaction.

In the issues related to whether ebook can be a meaningful learning media, Lam et al.

(2009) conducted a study on 12 students of The Chinese University of Hong Kong. The study shows that the use of ebooks is not appropriate and not practical for academic learning. The study participants state that the features and functions in the ebook are easy to learn, but it is difficult for learners to find and load the ebook they need. They also say that they had problems with the equipment used, as it was difficult to read using the reading materials used in the study. The features and functions in the ebook that can be improved include screen, text, text highlighting, and so on. The equipment also needs to be updated continuously. However, the advantages of the ebook expressed in the study are it can be carried and accessed everywhere, simply, and may load many electronic books in one-on-one PPC.

Regarding the advantages of printed books compared to e-book, Stephen (2010) states that the printed books are still favored by the reader for several reasons: they are visible and have better packaging, easy in sharing, advertising, second-use, safety, privacy, ease of reading, provision, results of technology, and for collection purposes. Meanwhile, the e-book offers advantages in the form of customized exposure, availability of audio translations, interactivities, reading history, the book loading, the positive effect on the environment, the privacy, the social feature, it is easy to create and retrieve notes, it can work as a dictionary, it can be integrated with Twitter and Facebook, the ease of finding a topic, navigation, and can be used as a scientific reference or to help a librarian.

Furthermore, Tan (2003) states that the use of PBM as educational innovation will not be complete without a discussion of e-learning. Chen and Tan (2002) found that we have been flooded with rapidly evolving statements and information through a change in information technology. The development of this new generation of technology enables the integration of learning processes and ICT. The advantages of ICT regarding communications and access to information (e.g., e-mail, portal, World Wide Web, telecommunication internet, and video conference) can help improve students' knowledge and skills. The use of PBM provides the freedom to students with access to knowledge and an ability to classify knowledge, knowledge distribution, and knowledge enterprise through the use of learning

management system based on web learning and internet communication

Therefore, we developed a BIOMIND e-learning module and BIOMIND e-book module that integrates ICT with steps in PBM both online and offline to improve 21st-century skills and address misconception on the topic of motion system and circulatory system.

The aim of this research was to develop and assess the proposed teaching media named BIOMIND Module. The presented teaching media was in the form of e-learning portal and e-book of BIOMIND module, which integrate ICT based on PBM developed from Hanafin and Peck in the form of online and offline in the subject of biology.

METHOD

The method used in this study was research and development (R&D) to develop an innovative learning media in the form of BIOMIND Module developed from Hanafin and Peck model.

This study involved five experts, 20 biology teachers, and 48 high school students in Riau. Samples were selected by purposive sampling to select a top school that with excellent information technology facilities, and appropriate school level and location for implementing the proposed media.

The teaching media was in the form of e-learning portal and e-book of BIOMIND module, which integrate ICT based on PBM developed from Hanafin and Peck in the form of online and offline. The product of the study was a CD-ROM titled CD of E-learning BIOMIND Module Based on PBM in Science Subject.

To produce an innovative, efficient, and technologically advanced teaching media to provide excellent teaching material, it required inputs from the experts, who were qualified and experienced teachers and students as the media users. To assess the suitability of BIOMIND Module, we conducted an initial study developed from studies of Chuang and Yang (2005), Fadilah et al. (2012), and Sidek and Jamaludin (2005). We used SPSS18 to observe the Alpha's Cronbach value of the module. The results show that the BIOMIND module portal and e-book had the Alpha's Cronbach value of 0.95 and 0.875, respectively. The results mean that the BIOMIND portal and e-book were feasible to be used in the following study.

RESULTS AND DISCUSSION

Results

Development of BIOMIND Teaching Media. This study presented two types of BIOMIND module in the form of WordPress portal (online) and e-book in pdf format (offline). In the development process, the BIOMIND module was adapted from the Hanafin and Peck (1988) model that discussed strategies and curriculum, pedagogy theories, learning tools and educational networks, and elements of the principle in the development of modules to meet the objectives and development goals. The module assessment involved four experts, 20 teachers, and 48 students. Discussion about the assessment and display of the developed BIOMIND module are explained in the following subsections.

Display of the BIOMIND Portal. The BIOMIND module portal can be accessed at <http://modul-BIOMIND.myprofil.info>. The portal consists of eight main menus for teachers and students. The menus have the following sections and objectives: (1) 'Competency' menu is used to check the required competencies of teachers and students, and user guide for the portal. This menu consists of an introduction, competency standards, basic competencies, indicators, and user guide. (2) 'Teacher Guide' menu is used to help teachers understand learning instrument and the implementation of PBM learning. This menu consists of the annual and semester program, syllabus, Learning Implementation Plan, and PBM Module. (3) 'Material' menu is used to help teachers and students to understand the material or topic lessons to be taught. This menu consists of concept maps, material descriptions, bioinfo, summary, and glossary. (4) 'Case' menu is used for the group discussion in the problem-based learning. This menu consists of the main and additional cases. (5) 'Training' menu is used to improve student understanding and skills. This menu consists of exercise and reflection. (6) 'Answer Key' menu contains the correct answer key for every question. This menu consists of answer key of main questions and exercises. (7) 'Games' menu is a learning menu that uses games as entertainment while improving students knowledge using scientific puzzles, concept maps, and matching games. This menu consists

of scientific puzzles, concept maps, and matching games. (8) 'Window' menu is a menu that contains the links to get additional information. This menu is consists of bio-web and links to search engines, electronic textbook, and e-video.

Some displays of the BIOMIND e-learning portal can be seen in Figures 1 to 4.



Figure 1. Competency Menu in the BIOMIND Module

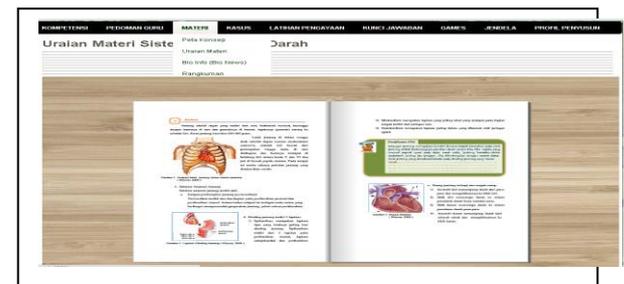


Figure 2. Material Menu



Figure 3. Case Menu



Figure 4. Games Menu



Figure 5. Window Menu

Display of the BIOMIND E-book. E-book BIOMIND module is the offline media in the form of pdf and printed. It is equipped with Student Activity Sheet. In developing the BIOMIND module, we focused on strategies and curriculum, pedagogical theories, learning tools, and educational networks. There were three e-books used in the study, which were 'PBL Application in Biology', 'Innovation of BIOMIND Module in PBM-based Learning', and 'Student Activity Sheet'. The items contained in the Innovation of BIOMIND Module in PBM-based Learning were as follows. (1) 'Concept Map'. This item provides the brief explanation of all topics to be learned. (2) 'Introduction'. This item provides early knowledge, which is a brief reminder of previous lessons. (3) 'Learning Topics'. This item helps teaching and learning process by providing the content of the biology topics to be learned. (4) 'PBM Approach'. This item is used to introduce the problems in accordance with the learned topics. (5) 'Bio News'. This item provides knowledge and information related to recent issues in biology related to the learned topic. (6) 'Scientific puzzle'. This item aims to provide the fun way of learning and answering questions. (7) 'E-video'. This item provides the link of video containing additional information related to the learned topics. (8) 'Bio Web'. This item provides links to access webpage related to the learned topics or problems. (9) 'Glossary'. This item helps students understand the terms in Latin. (10) 'Conclusion'. This item helps students to summarize and remember the key items in the learned topics. (11) 'Skills Exercise'. This item is used to improve the 21st-century skills of the students. (12) 'Exercise'. This item is used to improve students' knowledge and application of PBM concepts. (13) 'Reflection'. This item helps students to

analyze the learned topics by answering the given questions.

Some displays of the BIOMIND e-book are displayed in Figures 6 and 7.

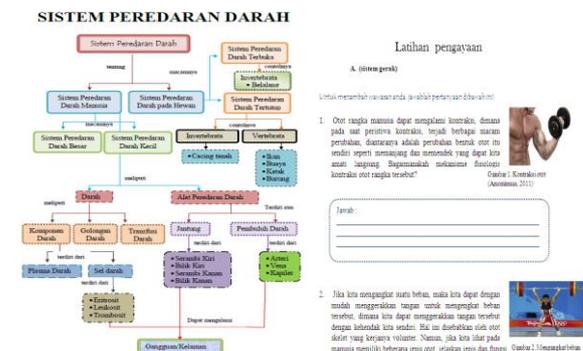


Figure 6. Concept Map and Exercise Items

Figure 7. Learning Topic, PBM Approach, and Bio News Items

Assessment. The developed BIOMIND media was assessed by the experts, teachers, and students. The results of formative and summative assessments of the BIOMIND portal are given in Figures 8 to 10.

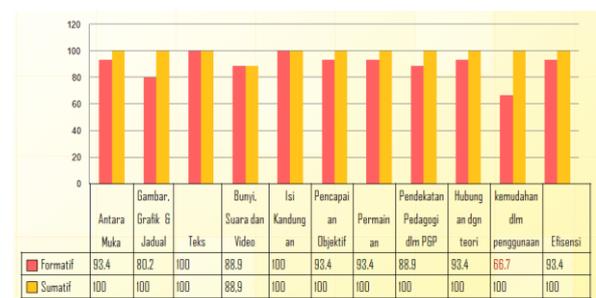


Figure 8. Assessment of BIOMIND Portal by Experts

Figure 8 shows that the lowest score of formative assessment of BIOMIND portal by experts was obtained by 'Ease of use' item, with the score of 66.7%. After the flaw was repaired,

nearly all of the result of the summative assessment by experts reached 100% (strongly agree).

The results of teachers' assessment of BIOMIND portal are shown in Figure 9.

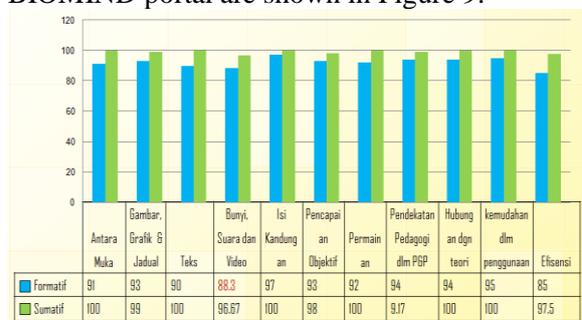


Figure 9. Assessment of BIOMIND portal by teachers

Figure 9 shows that the lowest score of formative assessment of BIOMIND portal by teachers was obtained by 'Audio and Video Sound' item, with the score of 88.3%. After the flaw was repaired, nearly all of the result of the summative assessment by teachers reached 100% (strongly agree).

The results of students' assessment of BIOMIND portal are shown in Figure 10.

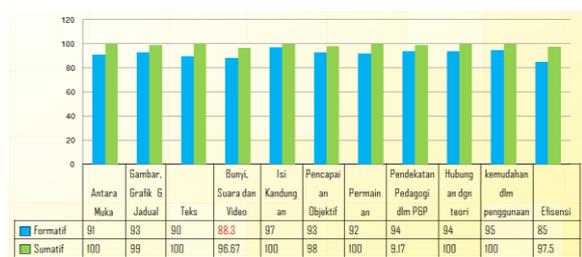


Figure 10. Assessment of BIOMIND Portal by Students

Figure 10 shows that the lowest score of formative assessment of BIOMIND portal by students was obtained by 'Audio and Video Sound' item, with the score of 88.3%. After the flaw was repaired, nearly all of the result of the summative assessment by students reached 100% (strongly agree).

The results show that some items of BIOMIND portal required improvement in the formative assessment. Meanwhile, in the summative assessment, nearly all assessors felt strongly agree that the developed BIOMIND portal is suitable for the teaching and learning process to improve the students' 21st-century skills and avoid students' misconception.

The results of formative and summative assessments of the BIOMIND e-book by

experts, teachers, and students are given in Figures 11 to 13.

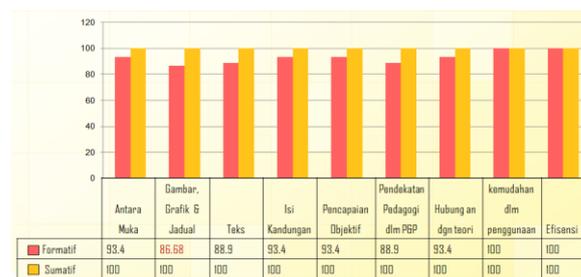


Figure 11. Assessment of BIOMIND E-Book by Experts

Figure 11 shows that the lowest score of formative assessment of BIOMIND e-book by experts was obtained by 'Figures, Graphs, and Titles' item, with the score of 86.88%. After the flaw was repaired, nearly all of the result of the summative assessment by experts reached 100% (strongly agree).

The results of teachers' assessment of BIOMIND e-book are shown in Figure 12.

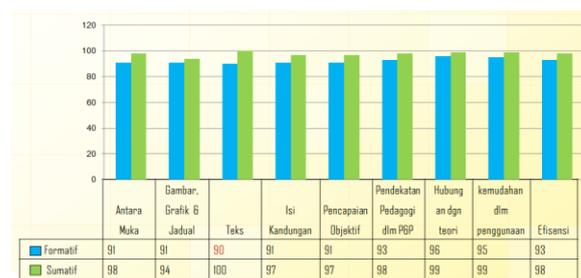


Figure 12. Assessment of BIOMIND E-Book by Teachers

Figure 12 shows that the lowest score of formative assessment of BIOMIND e-book by teachers was obtained by 'Text' item, with the score of 90%. After the flaw was repaired, nearly all of the result of the summative assessment by teachers reached 100% (strongly agree).

The results of students' assessment of BIOMIND e-book are shown in Figure 13.

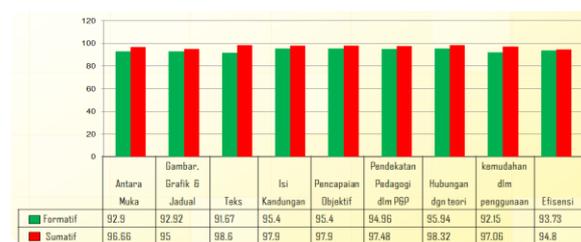


Figure 13. Assessment of BIOMIND E-Book by Students

Figure 13 shows that the lowest score of formative assessment of BIOMIND e-book by students was obtained by 'Text' item, with the score of 91.6%. After the flaw was repaired, nearly all of the result of the summative assessment by students reached 100% (strongly agree).

The results show that some items of BIOMIND e-book required improvement in the formative assessment. Meanwhile, in the summative assessment, nearly all assessors felt strongly agree that the developed BIOMIND e-book is suitable for the teaching and learning process to improve the students' 21st-century skills and avoid students' misconception.

Packaging. The study presented a CD-ROM titled CD of E-learning BIOMIND Module Based on PBM in Science Subject. It contains all information including BIOMIND portal and three e-books of 'PBL Application in Biology', 'Innovation of BIOMIND Module in PBM-based Learning', and 'Student Activity Sheet'. The CD also contains students' testimonials after using the BIOMIND module and documentation of student activities. A module equipped with new technology is one form of innovation in the teaching and learning process in the 21st century (Tan 2003: Terry & Moore 2011). The results of the packaging can be seen in Figure 14.



Figure 14. The Learning CD

Discussion

In the BIOMIND portal development process, we found that expert, teacher and student assessment of the BIOMIND portal agreed that it could be used for students in senior high school (2nd grade). There were 11 items of assessment, which were interface, figures, graphs and tables, text, audio and video sound, content, objective achievement, games,

pedagogical approach, relationship with learning theory, ease of use, and efficiency.

In the assessment process, each expert, teacher, and student gave both formative and summative assessments. In terms of formative assessment by the experts, teachers, and students, there were some aspects of BIOMIND portal that need to be improved. The suggestions include providing additional instructions or directions for each video about the given problem and a brief introduction to the BIOMIND portal, the images used need to be brighter and slightly identical to biology, adding the option of audio settings and video user guide, providing clear feedback or direction of the assignments, more diverse games, more search engines other than Google, adding places for interactions within the BIOMIND portal, asking multimedia experts to speed up the loading process, and fixing the order in the menu. These suggestions were used in the improvement of the BIOMIND portal.

Meanwhile, the summative assessment was done after the BIOMIND portal was improved. The summative assessment also conducted by the experts, teachers, and students. The assessment results show that nearly all experts agree on the proposed BIOMIND portal. Meanwhile, some teachers and students disagreed with the developed module, even though the number was insignificant. It can be concluded that the BIOMIND portal is suitable for students in senior high school (2nd grade).

This study also developed a BIOMIND e-book BIOMIND that is slightly different with the portal. The e-book can be used offline, and it has no video, animation, and games. In the BIOMIND e-book development process, we found that expert, teacher, and student assessment of the BIOMIND e-book agreed that it could be used for students in senior high school (2nd grade). There were 9 aspects with 41 items of assessment, which were 5 items of interface, 5 items of figures, graphs and tables, 3 items of text, 5 items of content, 5 items of objective achievement, 5 items of pedagogical approach, 5 items of relationship with learning theory, 4 items of ease of use, and 4 items of efficiency.

In the assessment process, each expert, teacher, and student gave both formative and summative assessments. In terms of formative assessment by the experts, teachers, and students, there were some aspects of the

BIOMIND e-book that need to be improved. The suggestions include adding more figures related to students daily life, the images used need to be brighter and slightly identical to biology, the graphs should be clearer, the text should be tidied up, no missing letters, the text should be in Times New Roman font, some texts should be shortened to be better understood, the words used should be adjusted to the students level.

There were also suggestions to add more examples of PBM approach, some of the exercises and the contents are difficult and require longer time to be solved, add more Latin translation, explain the steps of PBM solutions, make the learning objectives clearer and more guided, provide a sheet for steps of solving the given problems, give clearer instruction to solve the problems or link to experts to the field, the need of smartphones, laptops, or computers to access the e-book, and provide the printed version of the exercise. These suggestions were used in the improvement of the BIOMIND e-book.

Meanwhile, the summative assessment was done after the BIOMIND e-book was improved. The summative assessment also conducted by the experts, teachers, and students. The assessment results show that nearly all experts agree on the proposed BIOMIND e-book. Meanwhile, some teachers and students disagreed with the developed module, even though the number was insignificant. It can be concluded that the BIOMIND e-book is suitable for students in senior high school (2nd grade).

It was expected that the developed teaching media could improve the students' skills and motivation and provide the better understanding of the learned concepts. Feng et al. (2010) and Osman and Vebrianto (2013) state that using web-based learning to solve problems could improve student problem solving skills. We found that the development of BIOMIND portal and ebook was an example of creative, innovative, and efficient learning implementation. The BIOMIND module is equipped by a complete menu to help students understanding and cooperation, especially with the Game menu that was expected to provide knowledge and skills in a fun way (Syamsul & Norshuhada 2010). Meanwhile, Woltering et al. (2009) explain that in the web-based learning, students can improve their cooperation and use

the web independently to gain more knowledge. Furthermore, Norhayati et al. (2013) explain that there is a high students' perception of the teaching and learning process using animations.

Moreover, Herlinton et al. (2007) state that through the freedom and creativity of the simulation on the Internet, the provided scenario can be made to match the real world closely. The exercise also can be made more relevant, more memorable, more explicit, and, if appropriate, more enjoyable. In fact, game-based simulation represents one of the most viable segments of the e-learning industry. Virtual reality technology allows simulations that are very realistic and can act spontaneously and automatically to the environment so that the users feel that they experience the real thing.

This module was expected to improve students' understanding of the various learned concepts. The digital literacy skills could improve the teaching and learning processes by helping students to gain information and use the inventive thinking skills so that they can exchange ideas in solving a scientific and professional problem. It will also improve the communication skill that leads to increased productivity. This teaching and learning process will develop a student with good moral value and character.

Stephen (2010) states that the printed books are still favored by the reader for several reasons: they are visible and have better packaging, easy in sharing, advertising, second-use, safety, privacy, ease of reading, provision, results of technology, and for collection purposes. Meanwhile, the e-book offers advantages in the form of customized exposure, availability of audio translations, interactivities, reading history, the book loading, the positive effect on the environment, the privacy, the social feature, it is easy to create and retrieve notes, it can work as a dictionary, it can be integrated with Twitter and Facebook, the ease of finding a topic, navigation, and can be used as a scientific reference or to help a librarian.

CONCLUSION AND SUGGESTION

A new approach to problem-based learning can make the teaching and learning process more meaningful. The developed conceptual framework that was expected to provide the proper concept understanding and 21st-century skills such as digital age literacy

skills, inventive thinking, impressive communication, high productivity, and good moral values for the students. The use of proper ICT teaching media could help the students to be successful. The study presented several essential issues of a teaching media in the form of portals and e-books. The results show that the BIOMIND portal and e-book could be used in the teaching and learning process. The developed module was expected to provide meaningful and efficient teaching and learning process. Hence, the students can be excellent future leaders using the obtained 21st-century skills.

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