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The potential of e-books to improve college students' self-directed learning in biology

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Abstract

Independence in learning is very necessary for the application of online learning. Students as learners must have Self Directed Learning. This study aims to develop independent learning resources to facilitate student learning independence. Development research using the ADDIE model is carried out until the development stage. Needs analysis is conducted on 49 Biology Education Students with data collection instruments using the SDL test consisting of 5 question indicators: 1) Identifying learning needs; 2) Set up study routines and discover concept mappings; 3) Using concept/outline mapping as a useful understanding various information; 4) Self-assessment, honing potential; 5) Can explore self-ability. The test results show that in indicator 1 there are 9 students (18.37%) and indicator 5 as many as 11 students (22.45%) who have SDL abilities. The results of the needs analysis become the basis for the development of interactive electronic books through features such as material summaries, images, animations, videos, references (links and barcodes), interactive exercises, keywords, interest facts, practice questions, formative tests, and reflections. It is hoped that this interactive e-book can increase the independence of undergraduate and PPG students in studying biotechnology material as a source of independent learning.

Abstrak

Kemandirian belajar sangat diperlukan dalam penerapan pembelajaran daring. Mahasiswa sebagai pembelajar harus memiliki kemandirian belajar (*Self Directed Learning/SDL*). Penelitian ini bertujuan untuk mengembangkan sumber belajar mandiri untuk memfasilitasi kemandirian belajar mahasiswa. Penelitian pengembangan menggunakan model ADDIE penelitian ini dilakukan sampai tahap *development*. Analisis kebutuhan, dilakukan pada 49 orang Mahasiswa Pendidikan Biologi dengan instrumen pengumpulan data menggunakan tes SDL terdiri dari 5 indikator pertanyaan: 1) Mengidentifikasi kebutuhan belajar; 2) Mengatur rutinitas belajar dan menemukan pemetaan konsep; 3) Menggunakan pemetaan konsep/garis besar sebagai metode yang berguna untuk memahami berbagai informasi; 4) Menilai sendiri, merefleksikan dan mengasah potensi; 5) Bisa mengeksplor kemampuan diri. Hasil tes menunjukkan pada indikator 1 sebanyak 9 orang (18,37%) dan 5 sebanyak 11 orang (22,45%) yang memiliki kemampuan SDL. Hasil analisis kebutuhan menjadi dasar untuk pengembangan buku elektronik interaktif melalui fitur-fitur barupa ringkasan materi, gambar, animasi, video, referensi (link dan barcode), latihan interaktif, *key word, interesring fact*, latihan soal, tes formatif dan refleksi. Diharapkan e-book interaktif ini dapat meningkatkan kemandirian mahasiswa S1 dan PPG dalam mempelajari materi bioteknologi sebagai sumber belajar mandiri.

A. Introduction

Higher education at level 6 requires bachelor's degree students to be graduates who excel in academics and the professional field. Students are expected to master scientific concepts, fundamental pedagogical principles, and the use of information and communication technology in the classroom. Students' characteristics as they transition from adolescence to adulthood are one of the factors of self-involvement in regulating and managing their academic and non-academic activities (Curran et al., 2019). Adult learning (andragogy learning) requires independence. Independence here means that students can carry out learning activities on their own without the help of a companion. According to Mok (2013), independent learning prepares students to face the very fast development of the times. Science is updated every year. So, independent learning is needed to enable students to survive for anything that cannot be predicted in the future.

Self-directed learning is an organizational concept for higher education. Thus, the students have greater control over themselves in terms of conceptualization, design, implementation, and evaluation of learning and determining ways to use learning resources for further learning (Brookfield, 2009). Students as independent learners practice to identify various problems that need to be studied further (investigation), know where to look for learning resources related to the problem, determine priorities and design the search for learning resources, can review the material contained in the learning resources, then connects the information that has been collected with the subject being studied (Smith, 2017).

Biology learning necessitates that students comprehend concepts and independently identify problems from various sources. An analysis of students' SDL ability requirements by utilizing multiple choice test instrument forms distributed to 49 respondents determined that 18.37% could identify their learning needs, and 22.45% could express their views or ideas. This is due to students' propensity to be recipients during the learning process. According to the material mastery survey conducted by Suryawati et al. (2017), students' abilities are still relatively low, with 37.6% completion in material related to biotechnology knowledge. There are four indicator questions concerning the biotechnology material being tested, which are as follows: 1) Describe the role of modern biotechnology in daily life. 2) Explain the role of biotechnology in the environment. 3) Examine the processes involved in genetic engineering technology. 4) Describe the principles underlying cloning technology.

Based on the analysis of the needs of students' SDL abilities by distributing multiple-choice test instrument forms to 49 respondents, some indicators are still low. Based on the findings of the analysis and the educational challenges that must be addressed now, using online learning in universities as a learning resource to support students' digital-based SDL abilities is critical. An electronic book, a digital version of a book, is one of them. Electronic books, also known as e-books, are files containing digital information in text, images, and audio. E-books can be accessed via a computer or other electronic device.

The availability of e-books can reduce the need for assistance from others, references that individuals use to add to or improve their understanding, and can be used whenever they want to learn (Mulyadi et al., 2019; Perdana et al., 2017). Android-based e-books can accommodate a variety of learning styles, including visual, auditory, and kinesthetic, allowing students to learn independently (Ahmar & Rahman, 2017). Android-based e-book applications can display material content, videos, quizzes, and feedback so students can assess their learning progress (Jengathe & Rojatkar, 2015). Furthermore, an Android-based e-book application that allows interaction between students and lecturers, such as a discussion column to question things that have not been understood, can be set up, making it easier for students to overcome the problems they face (Lu'mu, 2017). Therefore, this research aims to develop interactive e-books as a source of independent learning by integrating self-directed learning components to facilitate student learning independence.

B. Material and Method

This research is a type of Research and Development where e-books are developed as an independent learning resource for prospective biology teacher students to improve their independent learning abilities. The e-book was developed using the ADDIE model stages (Analysis, Design, Development, Implementation, and Evaluation). This research was conducted at the Biology Education Masters Program, Faculty of Teacher Training and Education (FKIP), Riau University, and the time for carrying out this research was from October 2020 to November 2021. The population was also used as a sample in this study, with the total sample of undergraduate biology education students at FKIP UNRI who had

taken high school biology courses used as the sampling strategy.

Analysis

Needs analysis and material analysis are part of the research analysis, which includes as follows:

1) Analysis of student needs using SDL ability-based test questions for 49 Biology Education students, making observations about students' learning style in using technology in learning for the class of 2018 and class of 2016 for 30 students. According to the needs analysis, it can be determined that students' SDL abilities and how often students use information technology as a learning resource that suits students' needs.
2) Syllabus analysis is carried out to see the suitability of the material with the teaching materials to be developed. The next stage is to analyze the Course Learning Outcomes (from now on referred to as 'CPMK') and sub-CPMK, a syllabus analysis relating to material that is difficult for students to understand. This analysis includes biotechnology material in the high school biology course. In this phase, the biotechnology e-book's teaching materials are compared to CPMK and sub-CPMK to determine suitability).
3) Analysis of the availability of teaching resources includes analysis of the availability of learning resources in the learning process before this research was carried out, the advantages of the e-books being developed, the characteristics of the e-books being developed, and their relevance to student needs in developing learning resources.

Based on the results of data analysis, the next design formulation is carried out at the design stage.

Design

This design stage determines how the biotechnology e-book is designed in its entirety by the stated objectives. The contents of the biotechnology e-book are made by the CPMK and sub-CPMK in the syllabus. Furthermore, the design of biotechnology e-book learning resources consists of 4 discussion chapters. This stage is creating a biotechnology e-book using biotechnology material, carried out in several stages. In general, activities at the design stage include selecting content. Before starting to design learning resources, first design grids and materials in biotechnology e-books related to stimulating SDL abilities. Next, we collected blog themes, images and videos related to the material taken, namely biotechnology. This stage also includes designing the integration of SDL components through e-book features such as my goals, interactive exercises, mind maps, science processes, interesting facts, key points, resumes, reflections, and formative tests. Carry out the initial design for making an e-book using Photoshop CC, which consists of selecting a theme, setting the layout, setting the header and footer, selecting materials and images created by SDL, creating e-book formats, creating history boards, and designing validation sheets for material experts, media experts, pedagogy experts, and student response questionnaires.

Development

The product development results will be validated by four validators, namely three media experts, three material experts, and two pedagogy experts, to determine the validity and readability of the e-book designed by researchers based on the aspects assessed. After revisions are carried out, a prototype II will be produced. Then, a practicality test will be carried out to see the implementation of learning and user response to the e-book that has been developed. Based on the results of the practicality test, a prototype III will be produced, which will be implemented.

Testing is carried out using a validation sheet. The e-book was validated by four validators: material experts, pedagogy experts and media experts. The content Validity Index Approach (CVI) evaluates validity by involving a team of experts to determine whether each item in the scale is appropriate or relevant to the construct. Calculate the percentage of items considered suitable for each expert and then take the average of the percentages among the experts (Garick, 2003). Validation results are categorized according to Table 1.

Table 1 Validation Eligibility Criteria

Percentage	Category
81-100%	Very Valid
61-80%	Valid
41-60%	Fairly Valid
21-40%	Less Valid
0-20%	Very Invalid

C. Results and Discussion

Analysis of Needs and Materials

Initial data analysis was carried out to see how the Self Directed Learning (SDL) ability of Biology Education students from the Faculty of Teacher Training and Education, Riau University was

conducted with a test instrument consisting of 5 indicators of Self Directed Learning according to Williamson (Williamson, 2007). Aspects of Self Directed Learning that are measured include awareness, learning strategies, learning activities, evaluation, and interpersonal skills. The analysis results of the ability of Self Directed Learning Biology active students of FKIP Riau University were 42 (85.7%) female respondents and 7 (14.3%) male respondents. The results of the analysis of students' Self Directed Learning abilities can be seen in Figure 1.

The data results in Figure 1 show that students' self-directed learning abilities are still low in the aspect of awareness and learning activities. Students have difficulty in identifying learning needs and determining the best learning method. Of the 49 respondents, only 18.37% had good awareness. This is in line with the learning activities carried out by students and the lack of application of concept/outline mapping, which is one method for understanding the various information obtained.

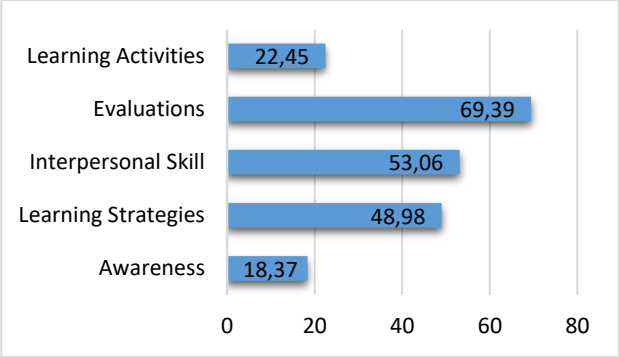


Figure 1 Student self-directed learning analysis

Furthermore, syllabus analysis is also implemented to see the suitability of the material with the teaching materials to be developed. The next stage is to analyze CPMK and sub-CPMK. This is an analysis of the syllabus for a course that students find challenging.

Materials from the high school biology course that includes biotechnology are included in this analysis. This stage looks at the suitability of CPMK and sub-CPMK with biotechnology material, which is being developed into teaching material in biotechnology e-books. Analysis of the availability of teaching resources includes analysis of the availability of learning resources in the learning process before this research was carried out, the advantages of the e-books being developed, the characteristics of the e-books being developed, and their relevance to students' needs in developing learning resources.

The needs analysis that has been carried out is strengthened by previous research on the influence of independent learning on the use of the internet as a learning resource, which, of course, is the basis for developing electronic books. Research conducted by Juwandi & Widyana (2019) aims to examine the impact of independent learning on using the internet as a learning resource. The subjects of this research involved 96 students from Paramadina University, Jakarta. Data were analyzed using the regression analysis method. The research results show that learning independence significantly influences the use of the internet as a learning resource, with a coefficient of determination value of 0.223. The t-test results show that the regression coefficient for learning independence has a significance of 5.195 ($p<0.005$), which indicates that learning independence significantly influences the use of the internet as a learning resource.

Furthermore, research conducted by Yunita & Hamdi (2019), the analysis of student independence in aspects of knowledge, skills, and learning styles shows that students have difficulty understanding physics concepts and connecting them with natural phenomena due to a lack of direct observation. They also have difficulty solving experimental problems, processing experimental data, and relating it to physics concepts. This is caused by a lack of use of learning resources that can increase motivation for independent learning and a lack of experience in overcoming learning problems independently. Even though students have the awareness to learn independently, they do not yet have effective independent learning strategies and do not utilize appropriate learning resources. Therefore, it is necessary to develop electronic books (e-books) for technological developments and student characteristics and integrate them with the environment or tourist attractions (edupark) to create independent, meaningful, enjoyable learning and improve student learning outcomes.

Design and Development of Biotechnology E-Books

Based on the needs analysis results, the researchers mapped the material to be developed. Then, they designed an interactive e-book draft to aid students in independent learning during the design stage. The strategy used in the development of this e-book is the provision of the material described in the presence of mind maps and learning videos that students can study independently, references in the form of links and barcodes, interactive exercises with feedback,

keywords, interesting facts, and students can reflect the extent of their mastery/understanding of the material. Providing materials, videos, immediate feedback, and mutual discussion can provide various alternative cognitive style approaches that are appropriate for each student rather than focusing solely on one cognitive style so that, in the end, they can generate motivation to study, understand, and evaluate success through the learning styles they have chosen (Prayekti, 2018). Adobe Indesign is a unique program for creating printed and digital/electronic book layouts that can be used to create interactive e-books. Figure 2 until Figure 7 depicts the developed e-book design.

Furthermore, the designed draft of an e-book is validated by material experts to determine the suitability of the material concept with learning outcomes. Table 2 shows the results of the validation on the material aspect.

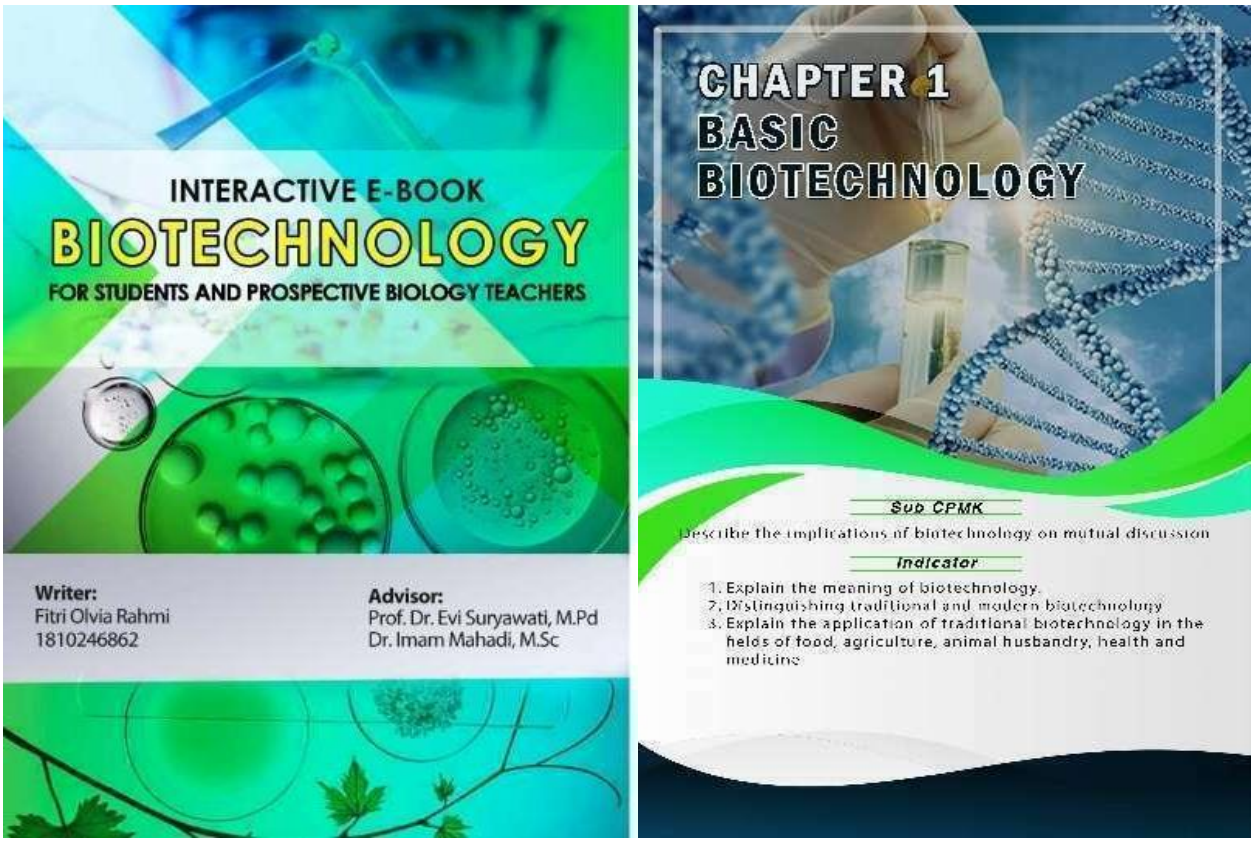


Figure 2 Biotechnology interactive e-book cover

Table 2 E-book Validation Result by Material

No.	Aspect	Indicator	Score (%)	Category
1	Content	Content conformity with sub-CPMK Indicators	83,3	Very Valid
		Content actuality	87,5	Very Valid
		Presentation of content	83,3	Very Valid
		Hirarchy of content	75,0	Valid
2	Question	Clarity of question formulation	83,3	Very Valid
		Completeness of the questions	83,3	Very Valid
		Correctness of the concept of question	83,3	Very Valid
		Providing balnese feedback on evaluation results	87,5	Very Valid
3	Language	Accuracy of use of language and terms	87,5	Very Valid
		Language communicativeness	91,7	Very Valid
4	Implementation	Determine learning needs	91,7	Very Valid
		Make decisions	91,7	Very Valid
		Hone your skills	91,7	Very Valid
		Evaluate	83,3	Very Valid
		Reflection	91,7	Very Valid
Average			**86,38**	**Very Valid**

Based on the validation results by material experts, an average of 86,38 indicates a very valid category. The highest rating on the language aspect used in the presentation/explanation of the material is very valid. The lowest assessment on the aspect of content with a valid category is because some images in the e-book have low quality, so the images look less apparent. The suitability of what is to be achieved with the presentations displayed in material descriptions, questions, pictures, and videos demonstrates that what is expected from a book or teaching material can be conveyed and complete knowledge obtained following what is expected (Lau et al., 2019). Language aspects that are clear, unambiguous, and simple to understand are declared valid so that the language in the e-book can help students understand the intent and meaning of what is being studied (Panjaitan et al., 2021).

Creating interactive e-books on biotechnology materials is expected to be a source of independent learning for students; however, to achieve this goal, e-books must include components supporting students' self-directed learning. Self-directed learning is the key to academic success indicators (Chou, 2012).

1. Awareness

The component in the e-book that directs students to be able to identify learning needs and choose learning strategies is contained in the "My Goals" feature, which can stimulate students to design learning needs and strategies that will be used. When students are interested in self-study or independent learning, they are more likely to set goals, plan knowledge searches, participate in, and evaluate knowledge gained from learning activities (Silamut & Petsangsri, 2020). According to Rusman, Kurniawan, D., & Riyana, (2012), learning will be meaningful if students have the opportunity to participate in determining the learning objectives to be achieved based on their learning conditions and needs, in determining the learning materials they want to learn and how to learn them, in having the freedom to learn at their own pace, and in participating in determining the grading criteria. Self-directed learning allows a person to plan and determine their own learning objectives (Lee et al., 2014).

2. Learning Strategies

Students can direct their learning strategies in understanding the material in the chapter being studied by looking directly at the references listed in the form of links or barcodes. Students as educators who have the characteristics of their respective learning styles apply their learning strategies in finding information, for example, those who have a visual learning style will undoubtedly prefer to see an explanation from the video display with reference options in the form of links and videos, and they can adapt their strategies and learning styles as independent learners. Self-Directed Learning (SDL) is an approach in the education of learners who are responsible for themselves by increasing their knowledge, self-directing with knowledge management, and according to personal learning styles (Sawatsky et al., 2017). The "interesting fact" feature can provide students with additional information and increase their interest in understanding the material being studied, as can the "key points" feature, which can help students remember concepts or basic knowledge related to the material.

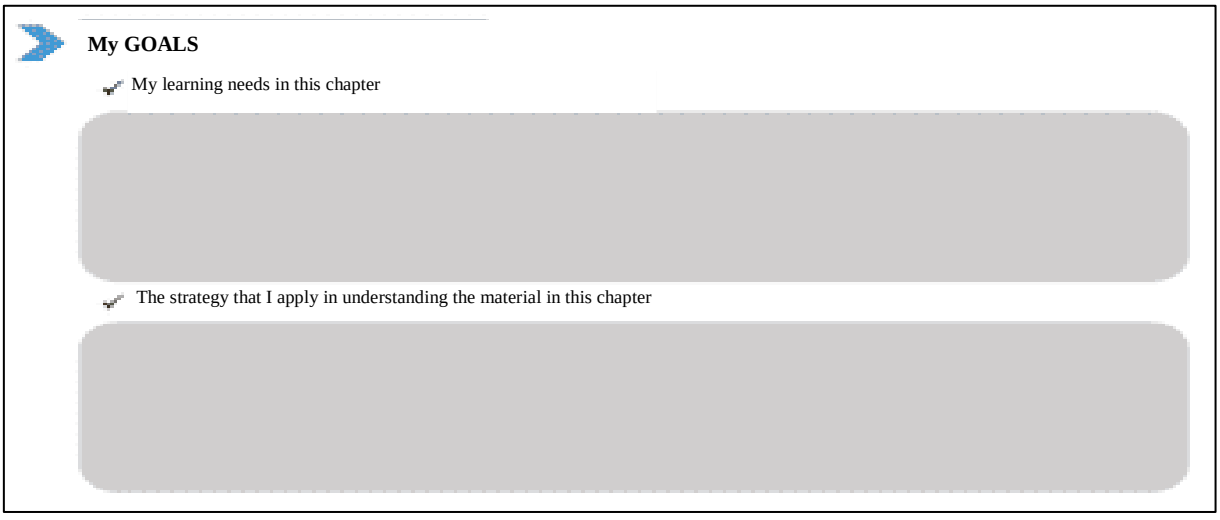


Figure 3 Example of integration of awareness aspect in ebook

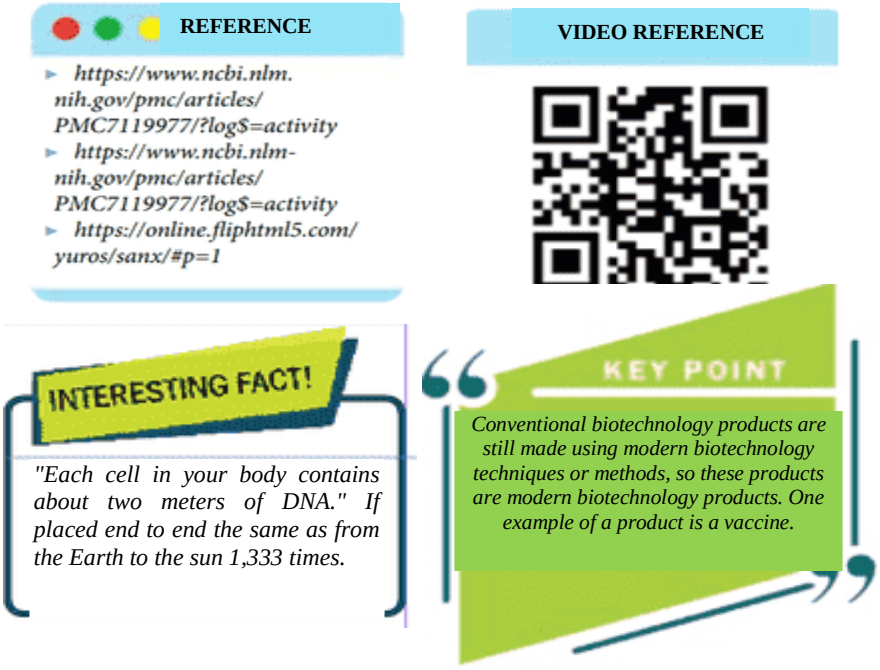


Figure 4 Examples of integrating aspects of learning strategies in ebooks

3. Learning Activities

Students, as independent learners, implement their plans through learning activities such as searching for information on the internet using the references provided, practicing prior knowledge and selecting the resources required to achieve goals. Students can benefit from concept maps/outlines to help them think more systematically. Motivation is required in independent learning, and interactive exercises can stimulate motivation and sharpen students' knowledge. Motivation is an important factor in increasing achievement (Alsancak Sirakaya & Ozdemir, 2017). Based on research conducted by Steinmayr et al., (2019) that students with higher motivation have higher levels of achievement. Based on research conducted by Diansah & Asyhari, (2020) the difference in understanding of concepts in the two classes where the experimental class using electronic modules has a higher percentage than the class that uses printed books. This happens because when viewed from learning, it is known that in the experimental class the learning using electronic modules is more interesting and interactive with a deeper explanation of the material through pictures, videos, and interactive exercises.

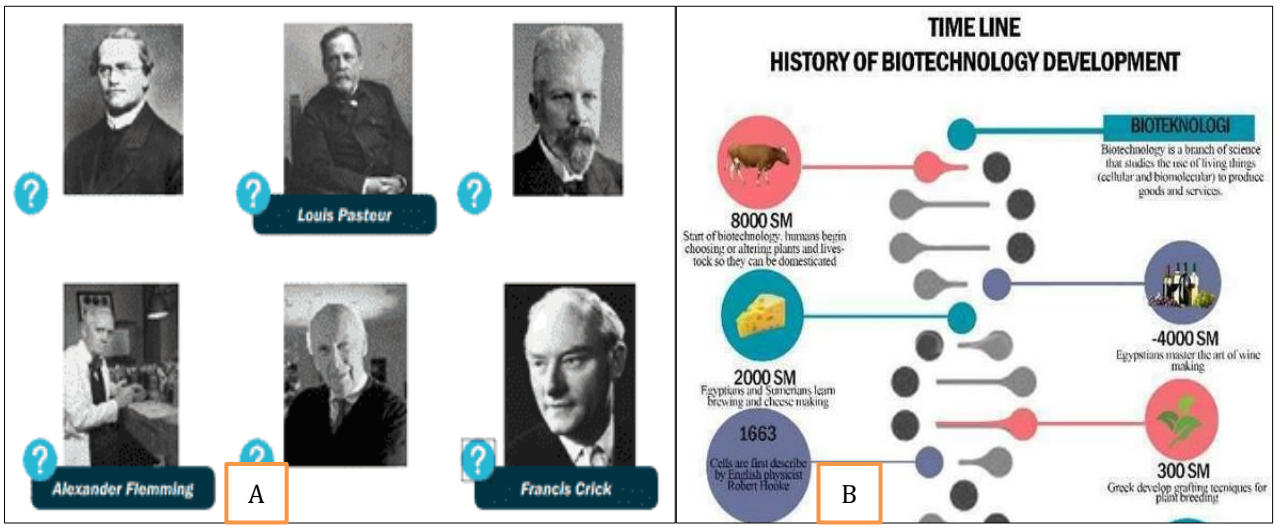
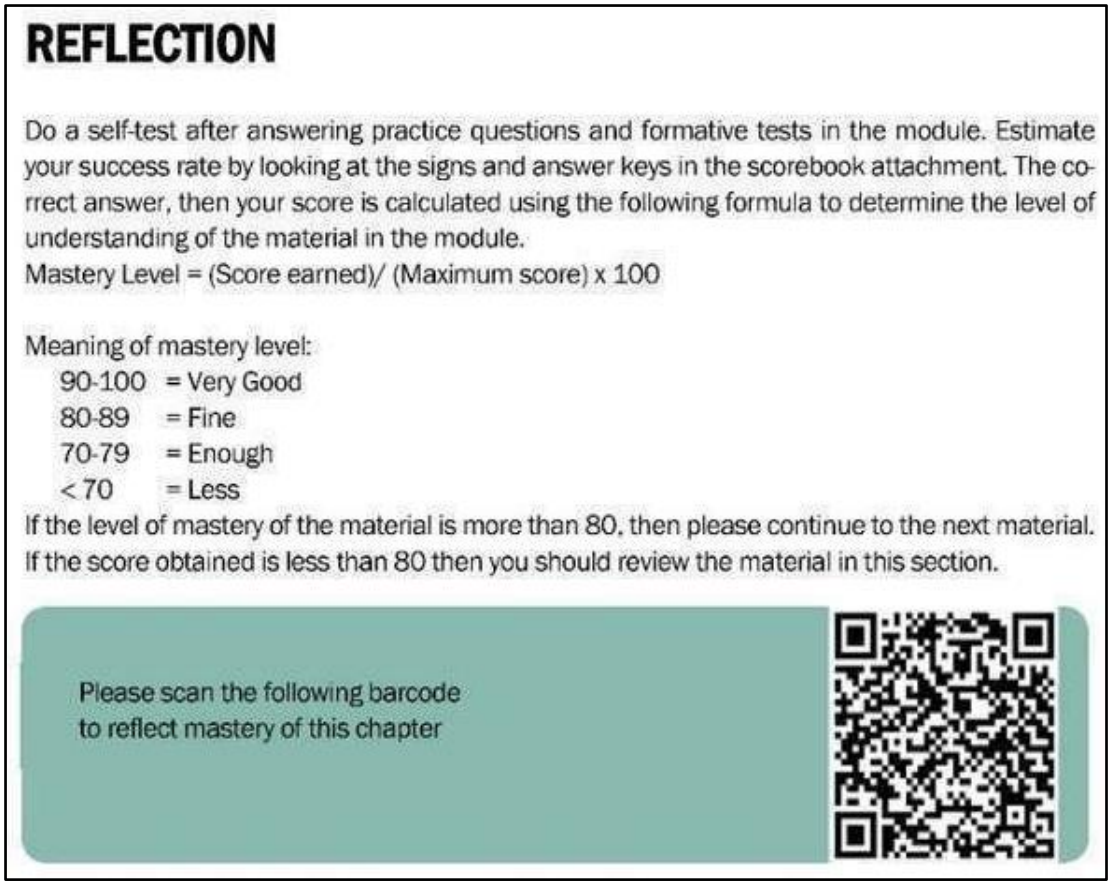


Figure 5 Example of integration of aspects of learning activities in ebook (A) and (B)



REFLECTION

Do a self-test after answering practice questions and formative tests in the module. Estimate your success rate by looking at the signs and answer keys in the scorebook attachment. The correct answer, then your score is calculated using the following formula to determine the level of understanding of the material in the module.

Mastery Level = (Score earned)/ (Maximum score) x 100

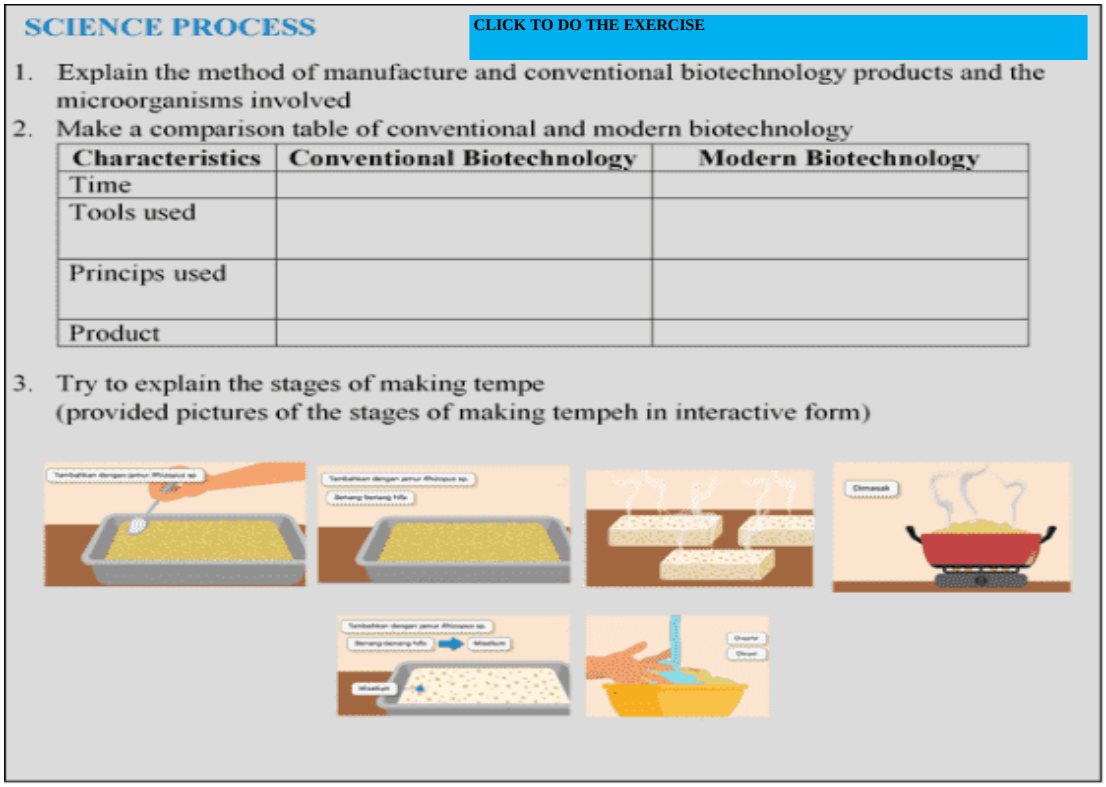
Meaning of mastery level:

90-100 = Very Good
80-89 = Fine
70-79 = Enough
< 70 = Less

If the level of mastery of the material is more than 80, then please continue to the next material. If the score obtained is less than 80 then you should review the material in this section.

Please scan the following barcode
to reflect mastery of this chapter

Figure 6 Example of integration of evaluation aspects in e-books



SCIENCE PROCESS

CLICK TO DO THE EXERCISE

1. Explain the method of manufacture and conventional biotechnology products and the microorganisms involved
2. Make a comparison table of conventional and modern biotechnology

Characteristics	Conventional Biotechnology	Modern Biotechnology
Time		
Tools used		
Princips used		
Product		

3. Try to explain the stages of making tempe
(provided pictures of the stages of making tempeh in interactive form)

Figure 7 Example of integration of self-ability aspects in ebook

4. Evaluations

Students can evaluate and reflect on their understanding of the chapter's material by filling out the "to-do list" and barcode links to reflect, and they can also track their learning progress. The availability of direct feedback on their success in answering quiz questions can encourage students to seek out new information, correct their learning strategies, and seek out new strategies to improve their performance (Geng et al., 2019). Reflective learning enables students to identify and construct their knowledge and make certain generalizations and experiences that will assist them in applying the learning in future situations. Furthermore, it allows students to integrate their new knowledge. Independent assessment can also prompt students to reflect on their education, allowing them to determine the effectiveness of their learning strategies (Aydeniz, 2013).

Developing a biotechnology e-book that is integrated with various features contained in the e-book is expected to improve the Self-Directed Learning of prospective biology teacher students. Naturally, to test the potential of this e-book, implementation and evaluation stages will be carried out on the biotechnology e-book that has been developed. The resulting scientific impact can be a basis for future researchers to see the influence of e-book learning resources on student learning independence.

D. Conclusion

Based on the needs analysis results, students' self-directed learning abilities are still low. Therefore, it is necessary to have learning resources that can support independent learning by student learning styles. The development of interactive e-book learning resources has the potential to improve students' self-directed learning by integrating self-directed learning components into the features found in e-books, such as the "My Goals" feature, references in the form of links and barcodes, pictures, videos, mind maps, interesting facts, keywords, interactive exercises, reflection, and evaluation.

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F. References

Ahmar, A. S., & Rahman, A. (2017). Development of teaching material using an Android. *Global Journal of Engineering Education*. https://doi.org/10.26858/gjeev19i1y2017p7376

Alsancak Sirakaya, D., & Ozdemir, S. (2018). The effect of a flipped classroom model on academic achievement, self-directed learning readiness, motivation and retention. *Malaysian Online Journal of Educational Technology, 6*(1), 76-91. DOI: https://www.learntechlib.org/p/188665/

Aydeniz, M. (2013). Using self-assessment to improve college students' engagement and performance in introductory genetics. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, *7*(2), 1–17. DOI: https://doi.org/10.12973/nefmed200

Brookfield, S. D. (2009). Self-directed learning. In *International handbook of education for the changing world of work: Bridging academic and vocational learning,* (pp. 2615-2627). Dordrecht: Springer Netherlands. DOI: https://doi.org/10.1007/978-1-4020-5281-1

Chou, P. N. (2012). The relationship between engineering students self-directed learning abilities and online learning performances: A pilot study. *Contemporary Issues in Education Research (CIER), 5*(1), 33-38. https://doi.org/10.19030/cier.v5i1.6784

Curran, V., Gustafson, D. L., Simmons, K., Lannon, H., Wang, C., Garmsiri, M., Fleet, L., & Wetsch, L. (2019). Adult learners' perceptions of self-directed learning and digital technology usage in continuing professional education: An update for the digital age. *Journal of Adult and Continuing Education*, *25*(1), 74–93. https://doi.org/10.1177/1477971419827318

Diansah, I., & Asyhari, A. (2020). Effectiveness of physics electronic modules based on Self Directed Learning Model (SDL) towards the understanding of dynamic fluid concept. In *Journal of Physics: Conference Series,* (Vol. 1572, No. 1, pp. 1-9). IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/1572/1/012024

Garick, S. (2003). Measurement of nursing outcomes. *CIN: Computers, Informatics, Nursing*, *1*(2), 57-58. DOI: https://doi.org/10.1097/00024665-200301000-00017

Geng, S., Law, K. M. Y., & Niu, B. (2019). Investigating self-directed learning and technology readiness in blending learning environment. *International Journal of Educational Technology in Higher Education*, *16*(1), 1-22. DOI: https://doi.org/10.1186/s41239-019-0147-0

Jengathe, G., & V. Rojatkar, D. (2015). Use of

android in education system. *International Journal of Electrical and Electronics Research*, *3*(4), 133–137. Retrieved from http:// www.researchpublish.com/ download.php?file=Use of Android in Education System-2514.pdf&act=book

Juwandi, J., & Widyana, R. (2019). Pengaruh kemandirian belajar terhadap pemanfaatan internet sebagai sumber belajar. *Jurnal Spirits, 10*(1), 49-64. DOI: https://doi.org/10.30738/ spirits.v10i1.6536

Lau, X. C., Wong, Y. L., Wong, J. E., Koh, D., Sedek, R., Jamil, A. T., Ng, A. L. O., Hazizi, A. S., Ruzita, A. T., & Poh, B. K. (2019). Development and validation of a physical activity educational module for overweight and obese adolescents: CERGAS programme. *International Journal of Environmental Research and Public Health*, *16*(9), 1-16. DOI: https://doi.org/10.3390 /ijerph16091506

Lee, K. S., Tsai, P. S., Chai, C. S., & Koh, J. H. L. (2014). Students' perceptions of self-directed learning and collaborative learning with and without technology. *Journal of Computer Assisted Learning*, *30*(5), 425–437. DOI: https://doi.org/ 10.1111/jcal.12055

Lu'mu, L. M. (2017). Learning media of applications design based android mobile smartphone. *International Journal of Applied Engineering Research, 12*(17), 6576-6585. Retrieved from https://www.ripublication.com/ijaer17/ijaerv1 2n17_38.pdf

Mok, M. M. C. (2012). Assessment reform in the Asia-Pacific region: The theory and practice of self-directed learning oriented assessment. In *Self-directed learning oriented assessments in the Asia-Pacific*, (pp. 3-22). Dordrecht: Springer Netherlands. DOI: https://doi.org/10.1007/ 978-94-007-4507-0_1

Mulyadi, M. A., Efi, A., & Syah, N. (2019). Development of pastry learning e-modules in the Hospitality Study Program of Community Academy Padang Pariaman. *International Research Journal of Advanced Engineering and Science*, *14*(1), 91–96. Retrieved from http://irjaes.com/wp-content/uploads/2020/ 10/IRJAES-V4N1P114Y19.pdf

Panjaitan, R. G. P., Titin, T., & Wahyuni, E. S. (2021). Kelayakan booklet inventarisasi tumbuhan berkhasiat obat sebagai media pembelajaran. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *9*(21), 11–21. DOI: https://doi.org/10.24815/jpsi.v9i1.17966

Perdana, F. A., Sarwanto, S., Sukarmin, S., & Sujadi, I. (2017). Development of e-module combining science process skills and dynamics motion material to increasing critical thinking skills and improve student learning motivation senior high school. In *International Journal of Science and Applied Science: Conference Series*, (Vol. 1, No. 1, pp. 45-54). DOI: https://doi.org/10.20961 /ijsascs.v1i1.5112

Prayekti, P. (2018). The influence of cognitive learning style and learning independence on the students' learning outcomes. *Higher Education Studies*, *8*(2), 37-46. DOI: https://doi.org/ 10.5539/hes.v8n2p37

Rusman, R., Kurniawan, D., & Riyana, C. (2012). *Pembelajaran berbasis teknologi informasi dan komunikasi: Mengembangkan profesionalitas guru.* Jakarta: Rajawali Pers.

Sawatsky, A. P., Ratelle, J. T., Bonnes, S. L., Egginton, J. S., & Beckman, T. J. (2017). A model of self-directed learning in internal medicine residency: a qualitative study using grounded theory. *BMC medical education, 17*(1), 1-9. DOI: https://doi.org/10.1186/s12909-017-0869-4

Silamut, A. A., & Petsangsri, S. (2020). Self-directed learning with knowledge management model to enhance digital literacy abilities. Education and Information Technologies, 25(6), 4797-4815. DOI: https://doi.org/10.1007/s10639-020-10187-3

Smith, K. (2017). *Teachers as self-directed learners: Active positioning through professional learning.* Singapore: Springer. DOI: https://doi.org/ 10.1007/978-981-10-3587-6

Steinmayr, R., Weidinger, A. F., Schwinger, M., & Spinath, B. (2019). The importance of students' motivation for their academic achievement–replicating and extending previous findings. *Frontiers in psychology, 10,* 1-11. DOI: https://doi.org/10.3389/fpsyg.2019.01730

Suryawati, E., Linggasari, M. N., & Arnentis, A. (2017). Technological pedagogical and content knowledge of biology prospective teachers. *Biosaintifika: Journal of Biology & Biology Education, 9*(3), 498-505. DOI: https://doi.org /10.15294/biosaintifika.v9i3.11270

Williamson, S. N. (2007). Development of a self-rating scale of self-directed learning. *Nurse researcher, 14*(2), 66–83. DOI: https://doi.org /10.7748/nr2007.01.14.2.66.c6022

Yunita, R. A., & Hamdi, H. (2019). The practicality of integrated high school physics edupark ebook Sarasah Kajai waterfall destinations with a scientific approach to the industrial revolution 4.0. *Jurnal Penelitian Pembelajaran Fisika*, *5*(2), 172–179. DOI: https://doi.org/10.24036/jppf. v9i1.121455