EDUMASPUL
JURNAL PENDIDIKAN
Vol. 8 – No. 1, year (2024), page 923-929
| ISSN 2548-8201 (Print) | 2580-0469) (Online) |

Development of Teaching Materials on Vesicular-Arbuscular Mycorrhiza (VAM) Topic for Biotechnology Course in Science Education Undergraduate Program

Paula Nita Tandaju[1], Jovialine Albertine Rungkat[2*], Ester Caroline Wowor[3]
[1,2,3]*Department of Science Education, Universitas Negeri Manado, Indonesia.*

* Corresponding Author. E-mail: [2]jovialine_rungkat@unima.ac.id

Receive:17/01/2024	*Accepted: 27/02/2024*	*Published: 01/03/2024*

Abstrak

Penelitian ini bertujuan untuk mengembangkan bahan ajar topik mikoriza vesikular arbuskular (MVA) untuk mata kuliah bioteknologi di Jurusan Pendidikan IPA Universitas Negeri Manado yang layak digunakan. Jenis penelitian ini adalah penelitian dan pengembangan (R&D) model Borg & Gall. Langkah-langkah penelitian terdiri dari (1) potensi dan masalah, (2) pengumpulan data,(3) desain produk, (4) validasi desain, (5) revisi desain, (6) ujicoba produk (ujicoba kelompok kecil). Instrumen penelitian yang kami gunakan adalah angket yang terdiri dari angket validasi ahli materi, angket validasi ahli media, dan angket uji coba produk dalam kelompok kecil. Hasil validasi ahli menunjukkan ahli materi sebesar 93% dan ahli media sebesar 93%. Presentase yang diperoleh tersebut termasuk dalam kategori sangat baik, sehingga layak digunakan. Selanjutnya uji coba produk dalam kelompok kecil yang terdiri dari 7 mahasiswa di Jurusan Pendidikan IPA memperoleh hasil 92% termasuk pada kategori sangat baik. Dengan demikian, bahan ajar yang telah berhasil dikembangkan pada topik mikoriza vesikular arbuskular (MVA) untuk mata kuliah bioteknologi di Jurusan Pendidikan IPA Universitas Negeri Manado dinyatakan layak untuk digunakan dalam perkuliahan.

Kata Kunci: *Bahan Ajar, Mikoriza Vesikular Arbuskular, Bioteknologi*

Abstract

This research aims to develop teaching materials on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses in the science education undergraduate program at Universitas Negeri Manado that are suitable for use. This type of research is the research and development (R&D) model by Borg & Gall. The research steps consist of (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, and (6) product trial (small group trial). The research instrument we used was a questionnaire consisting of a material expert validation questionnaire, a media expert validation questionnaire, and a small group product trial questionnaire. The results of expert validation showed that the material expert was 93% and the media expert was 93%. The percentage obtained is included in the very good category, so it is feasible to use. Furthermore, the product trial in a small group consisting of 7 students in the Science Education Undergraduate Program obtained a result of 92%, including in the very good category. Thus, the teaching materials that have been successfully developed on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses in the Science Education Undergraduate Program at Universitas Negeri Manado are declared fit for use in lectures.

Keywords: *Teaching Materials, Vesicular-Arbuscular Mycorrhiza, Biotechnology*

Introduction

The development of information technology in recent years has developed very rapidly, so this development has changed the paradigm of society in finding and obtaining information (Fatwa, 2020; Golubev & Testov, 2015). One of the fields that has had a significant impact on this technological development is the field of education (Pobela & Rungkat, 2021; Wola, 2023). The development of increasingly sophisticated technology is essential to achieving more effective and efficient educational goals (Rungkat, Jeujanan, Wola, & Warouw, 2023; Tafonao, 2018). On the other hand, the demands of 21st century life in general and the implementation of the new curriculum in Indonesia demand that graduates who are competent to live in the 21st century be produced (Kindangen, Paat, Suryani, & Rungkat, 2023; Susilo, 2018).

Education is a process of communication and information between educators and students containing educational information, with educators as a source of information, media as a means of presenting ideas, ideas, and educational materials, and students themselves (Husaini, 2014). Education, as a process in human life, aims to acquire the knowledge and skills needed for one to play a role in society. Education is a conscious effort made to develop the human resource potential of students by encouraging and facilitating learning activities (Santosa et al., 2021). In order to improve the quality of education, it is necessary to make updates at every level in accordance with the times that refer to increasing intelligence and developing the whole person. Education that is well implemented will have a good impact on national development.

A quality education process develops the potential and knowledge students possess (Amaliyah & Rahmat, 2021). The learning process in the classroom that has occurred so far always places students as objects that must be filled with a variety of information and several teaching materials piled up. This condition causes communication to occur only in one direction, namely between educators and students (Rasyid, Azis, & Saleh, 2016). This situation needs to be overcome by educators through various learning innovations.

One of the main tasks of educators is to plan learning carefully. According to Qosyim & Priyonggo (2017), good learning media can channel and facilitate students in receiving material in a lesson. One example of the main task of educators is to make teaching materials that are suitable for use (Rindayati, Putri, & Damariswara, 2022; Selamat, Rungkat, & Wowor, 2023). Teaching materials are a set of subject matter that refers to the curriculum used to achieve predetermined competency standards and basic competencies. Teaching materials include the main elements of the learning process to achieve the expected learning objectives (Sjawal, Rungkat, & Tumewu, 2023).

The topic of vesicular-arbuscular mycorrhiza (VAM) is part of plant biotechnology material that is important to learn. The utilization of indigenous VAM is one of the microbial technologies that may be developed to overcome the problem of drought and low soil fertility (Nurhalimah, Nurhatika, & Muhibuddin, 2014). VAM has several vital roles, including as a provider of nutrients in the soil, decomposing organic matter and forming humus to increase the availability of nutrients in the soil, as a controller of plant disrupting organisms (OPT), stabilizing soil aggregates, and remodeling chemical compounds in the soil (Febriyantiningrum, Oktafitria, Nurfitria, Jadid, & Hidayati, 2021). Root-associated mycorrhiza also plays a role in soil conservation. Forming a good soil

structure is an asset for improving the physical properties of the soil. Improvement of soil structure will also directly affect the development of plant roots (Rungkat, 2012).

Based on questionnaires distributed to undergraduate science education students who have taken biotechnology courses, it is known that many students do not understand the topic of vesicular-arbuscular mycorrhiza (VAM). This condition is due to the lack of teaching materials and limited explanation time. This condition needs to be given an immediate solution considering the topic of vesicular-arbuscular mycorrhiza, which is abstract to learn. The lack of teaching materials can undoubtedly affect the quality of learning (Arsanti, 2018).

Based on the above, this research aims to develop teaching materials on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses in the Science Education Undergraduate Program at Universitas Negeri Manado that are suitable for use. The products produced from this research are expected to overcome the gap in the need for teaching materials in biotechnology courses.

Method

The research used in this study is a type of research and development (research and development). Sugiyono (2015) states that research and development methods are used to produce specific products and test their effectiveness. The development procedure in this study used the model and development from Borg & Gall combined with the instructional design development steps from Dick and Carey. It was done because the model developed by Borg & Gall is a step used to develop a product (Tegeh, Jampel, & Pudjawan, 2014).

In this study, not all of these steps were carried out but limited to the sixth step, namely the initial product trial, because the teaching material products developed were only tested in limited classes. This research was conducted at the Science Education Department of Universitas Negeri Manado. The research implementation time was in the odd semester of 2021/2022.

The data analysis technique used in this research is descriptive analysis, carried out using descriptive statistics. The data analysis techniques used in this research are qualitative and quantitative. After obtaining the questionnaire data, statistical calculations were carried out using Equation 1.

$$\text{Percentage} = \frac{\sum \text{Answer} \times \text{Score for each option}}{n \times \text{Highest score}} x100 \qquad (1)$$

Where P is the percentage of respondents' answers, ∑ is the number of answers, and N is the total number of questionnaire items. Furthermore, the percentage obtained is interpreted in Table 1.

Table 1. Percentage of Achievement Level

Percentage	Scale	Interpretation
81% - 100%	5	Very Feasible
61% - 80%	4	Feasible
41% - 60%	3	Quite feasible
21% - 40%	2	Inadequate
0% - 20%	1	Very unfit

(Sugiyono, 2015)

Based on Table 1, the teaching materials developed are declared suitable for use if they meet the minimum requirements of 61% - 80% in the feasible category.

Results and Discussion

The product developed by the researcher is teaching materials on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses. The feasibility of the material/science content was assessed by a material expert, namely a lecturer. The results of the material expert validation can be seen in Table 2.

Table 2. Material Expert Validation

Aspect	Σ	N	%	Criteria
Content Feasibility	25	25	100	Very Feasible
Language Feasibility	35	40	87	Very Feasible
Self-Study	10	10	100	Very Feasible
Total	70	75	-	Very Feasible

Based on Table 2, the results of the validation and assessment of the material experts above the data obtained, the percentage is calculated by comparing the sum of the weight of each option with the highest weight, then multiplied by 100%. The calculation is as follows.

$$\text{Percentage} = \frac{\sum \text{Answer} \times \text{Score for each option}}{n \times \text{Highest score}} x100$$
$$= \frac{70}{75} \times 100\% = 93\%$$

From the above calculation, the feasibility percentage is 93%, and the percentage is in the very feasible category. Furthermore, the product is validated by media experts. The results of media expert validation can be seen in Table 3.

Table 3. Media Expert Validation

Aspect	Σ	N	%	Criteria
Attractiveness	167	175	95	Very Feasible
Material	191	210	91	Very Feasible
Language	101	105	96	Very Feasible
Total	459	490	-	Very Feasible

Based on Table 3, the results of validation and assessment from media experts, the percentage is calculated by comparing the sum of the weight of each option with the highest weight and then multiplied by 100%. The calculation is as follows.

$$\text{Percentage} = \frac{\sum \text{Answer} \times \text{Score for each option}}{n \times \text{Highest score}} x100$$
$$= \frac{56}{60} \times 100\% = 93\%$$

From these calculations, the feasibility percentage is obtained at 93%, which is very feasible.

After the product went through the content and media expert validation stage, the product was then improved and then tested in a limited small group. The small group trial consisted of 7 students who had contracted biotechnology courses the previous semester. This small group trial was conducted by operating the revised draft teaching materials and asking the respondents to complete the questionnaire. The results of the student response assessment can be seen in Table 4.

Table 4. Student Response Assessment

Aspect	Σ	N	%	Criteria
Book Size	8	10	80	Very Feasible
Cover Design	19	20	95	Very Feasible
Content Design	29	30	96	Very Feasible
Total	56	60	-	Very Feasible

Based on Table 4 above, the results of the student response questionnaire from 7 students who have contracted the data course obtained, the percentage is calculated by comparing the total weight of each choice with the highest weight then multiplied by 100%. The calculation is as follows.

$$\text{Percentage} = \frac{\sum \text{Answer} \times \text{Score for each option}}{n \times \text{Highest score}} x100$$
$$= \frac{459}{490} \times 100\% = 92\%$$

From the above calculation, the percentage of feasibility is 92%. The teaching materials in the form of books that researchers have developed have reached the criteria set, which is very good.

Development, according to KBBI, is the process of how the act of developing. In this development, teaching materials are developed that are well-used during the learning process. Teaching material development products are one of the learning media that help the learning process of both students and lecturers toward learning objectives. As Prastowo, (2014) says, teaching materials are all materials, information, tools, and texts that

are systematically arranged. These display a complete figure of the competencies to be mastered and used in the learning process to plan and review the implementation of learning. Furthermore, Rokhmawati, V.Y, & Pamungkas (2019) states that the development of teaching materials needs to be done because of the lack of learning information sources and the lack of independence of students to learn.

In developing this teaching material product, researchers use research and development steps, which are limited to 6 steps: potential and problems, data collection, product design, product validation, product revision, and initial product trials. Before designing/designing the product, researchers conducted an initial research stage, namely potential and problems. These potential problems were identified through observations in the Science Education Department. This observation stage collects initial information on using materials in learning activities for biotechnology courses, especially VAM material. After collecting data, the researcher developed a product design that began with finding references to teaching materials. Teaching materials developed using VAM material. Products in the form of teaching books that have been developed are validated by material experts and media experts. To conduct product validation, researchers use an assessment questionnaire covering the entire product. Researchers use an assessment questionnaire covering the whole product made to conduct product validation.

Based on the analysis of product assessments by experts and students, researchers can determine the feasibility of the products that have been developed. Based on Table 2, regarding the recapitulation of validation data by material experts, the results of validation of the quality of the feasibility of textbooks on VAM material show a percentage of 93%, with the qualification very feasible. In Table 3, regarding the recapitulation of validation data by media experts, a percentage of 93% was obtained, with the qualification very feasible. This achievement indicates that the teaching materials developed have a quality that is feasible to test on students. Before becoming a final product ready to use, the teaching materials developed need to be revised by researchers based on comments and suggestions that both validators have given. According to comments and suggestions provided by validators, the results of product revisions made by researchers resulted in the final product of teaching materials on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses.

The final stage of this research and development is product testing. Product testing was carried out on a small group of seven science education undergraduate program students at this stage. They were asked to fill out a questionnaire to assess the feasibility of the product. Table 4 shows that the results of the student response questionnaire from 7 students with a percentage value of 92% are qualified as very good. This result is supported by Khairiyah (2019), who said that the student response questionnaire positively responded to the product developed. It shows that the development product that has been made can make students interested in learning the material. From the results of the percentage assessment, it can be concluded that the teaching materials on the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses that have been developed have reached the specified criteria. This result proves that the products developed by researchers are good quality and suitable

for use. Kosasih (2021) states that textbook concepts must be clear and related to the curriculum, attract readers' interest, motivate users, and encourage student learning activities.

Based on data analysis, teaching materials on vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses in the science education undergraduate program at Universitas Negeri Manado are suitable for use. The results of our research support various previous relevant studies. Research by Satriawan & Rosmiati (2016) successfully developed contextual-based physics teaching materials by integrating local wisdom with the results of validation data analysis and testing that the teaching materials developed showed "very feasible" criteria for use and to improve the acquisition of student physics concepts in introductory physics lectures. Zunaidah & Amin (2016) successfully developed teaching materials for biotechnology courses with the results of the average validation and trial results in the feasible category with a good predicate. Likewise, research conducted by Indriaty & Setyoko (2018) successfully developed problem-based learning-based animal ecology teaching materials with the results of material expert validation 76% good category (no need to revise), teaching material expert validation obtained 77% good category (no need to revise), and respondent validation by students obtained 79% qualification (no need to revise).

Conclusion

Based on the research we have done, the product developed in the form of teaching materials with the topic of vesicular-arbuscular mycorrhiza (VAM) for biotechnology courses through several stages, namely potential and problems, data collection, product design, design validation, design revision, and product trials (small group trials). The results of expert validation showed that the material expert was 93% and the media expert was 93%. The percentage obtained is in the excellent category, which is suitable for use. Furthermore, product trials in small groups of 7 students in the Science Education Undergraduate Program obtained a result of 92%, including in the excellent category. Thus, teaching materials successfully developed on vesicular-arbuscular mycorrhiza (VAM) topics for biotechnology courses in the Science Education Undergraduate Program at Universitas Negeri Manado are feasible for lecture use. This teaching material is the answer to the need for teaching materials in biotechnology courses.

References

Amaliyah, A., & Rahmat, A. (2021). Pengembangan Potensi Diri Peserta Didik Melalui Proses Pendidikan. *Attadib: Journal of Elementary Education*, *5*(1), 28–45. https://doi.org/10.32507/attadib.v5i1.926

Arsanti, M. (2018). Pengembangan Bahan Ajar Mata Kuliah Penulisan Kreatif Bermuatan Nilai-Nilai Pendidikan Karakter Religius Bagi Mahasiswa Prodi PBSI, FKIP, UNISSULA. *KREDO: Jurnal Ilmiah Bahasa Dan Sastra*, *1*(2), 69–88. https://doi.org/10.24176/kredo.v1i2.2107

Fatwa, A. (2020). Pemanfaatan Teknologi Pendidikan di Era New Normal. *Indonesian Journal of Instructional Technology*, *1*(2), 20–30. Retrieved from https://journal.kurasinstitute.com/index.php/ijit/article/view/37

Febriyantiningrum, K., Oktafitria, D., Nurfitria, N., Jadid, N., & Hidayati, D. (2021). Potensi Mikoriza Vesikular

Arbuskular (MVA) Sebagai Biofertilizer Pada Tanaman Jagung (Zea Mays). *Biota: Jurnal Ilmiah Ilmu-Ilmu Hayati*, *6*(1), 25–31. https://doi.org/10.24002/biota.v6i1.4131

Golubev, O., & Testov, V. (2015). Network Information Technologies as a Basis of New Educational Paradigm. *Procedia - Social and Behavioral Sciences*, *214*, 128–134. https://doi.org/10.1016/j.sbspro.2015.11.604

Husaini, M. (2014). Pemanfaatan Teknologi Informasi dalam Bidang Pendidikan (E-education). *MIKROTIK: Jurnal Manajemen Informatika*, *2*(1), 1–5. Retrieved from https://ojs.ummetro.ac.id/index.php/mikrotik/article/view/314

Indriaty, I., & Setyoko, S. (2018). Pengembangan Bahan Ajar Ekologi Hewan Berbasis Problem Based Learning di Program Studi Pendidikan Biologi Universitas Samudra. *JIPI (Jurnal IPA & Pembelajaran IPA)*, *2*(1), 29–35. https://doi.org/10.24815/jipi.v2i1.10813

Khairiyah, U. (2019). Respon Siswa Terhadap Media Dakon Matika Materi KPK dan FPB pada Siswa Kelas IV di SD/MI Lamongan. *Jurnal Studi Kependidikan Dan Keislaman*, *5*(2), 197–204. https://doi.org/10.53627/jam.v5i2.3476

Kindangen, C. R., Paat, M., Suryani, N. W., & Rungkat, J. A. (2023). Pengembangan Multimedia Interaktif Menggunakan Model Problem Based Learning Pada Mata Pelejaran IPA Kelas VIII SMP Katolik Kembes. *SOSCIED*, *6*(2), 361–372. https://doi.org/10.32531/jsoscied.v6i2.712

Kosasih, E. (2021). *Pengembangan Bahan Ajar*. Jakarta: Bumi Aksara.

Nurhalimah, S., Nurhatika, S., & Muhibuddin, A. (2014). Eksplorasi Mikoriza Vesikular Arbuskular (MVA) Indigenous pada Tanah Regosol di Pamekasan, Madura. *Jurnal Sains Dan Seni ITS*, *3*(1), E30–E34. https://doi.org/10.12962/j23373520.v3i1.5526

Pobela, S. R., & Rungkat, J. A. (2021). Pengaruh Media Pembelajaran CD Interaktif Melalui Pembelajaran Daring di Era Pandemi Covid-19 Terhadap Hasil Belajar IPA. *SCIENING : Science Learning Journal*, *2*(1), 36–41. https://doi.org/10.53682/slj.v2i1.854

Prastowo, A. (2014). *Panduan Kreatif Membuat Bahan Ajar Inovatif*. Yogyakarta: DIVA Press.

Qosyim, A., & Priyonggo, F. V. (2017). Penerapan Media Pembelajaran Interaktif Menggunakan Flash untuk Materi Sistem Gerak Pada Manusia Kelas VIII. *Jurnal Penelitian Pendidikan IPA*, *2*(2), 38–44. https://doi.org/10.26740/jppipa.v2n2.p38-44

Rasyid, M., Azis, A. A., & Saleh, A. R. (2016). Pengembangan Media Pembelajaran Berbasis Multimedia dalam Konsep Sistem Indera Pada Siswa Kelas XI SMA. *Jurnal Pendidikan Biologi*, *7*(2), 69–80. https://doi.org/10.17977/um052v7i2p69-80

Rindayati, E., Putri, C. A. D., & Damariswara, R. (2022). Kesulitan Calon Pendidik dalam Mengembangkan Perangkat Pembelajaran Pada Kurikulum Merdeka. *PTK: Jurnal Tindakan Kelas*, *3*(1), 18–27. https://doi.org/10.53624/ptk.v3i1.104

Rokhmawati, A., V.Y, I. A., & Pamungkas, A. S. (2019). Pengembangan Bahan Ajar Rainbow Book Pada Materi Bangun Datar Kelas IV. *SJME (Supremum*

Journal of Mathematics Education), *3*(2), 85–94. https://doi.org/10.35706/sjme.v3i2.1780

Rungkat, J. A. (2012). *Pemanfaatan Mikoriza Vesikular Arbuskular (MVA) Ketela Pohon untuk Meningkatkan Produksi Kedelai (Glysine max (L) Merril) dan Penerapannya dalam Pendidikan Masyarakat di Kabupaten Malang*. Universitas Negeri Malang.

Rungkat, J. A., Jeujanan, A., Wola, B. R., & Warouw, Z. W. M. (2023). Development of STEM-based Science E-Module on the Human Excretory System Topic. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6548–6556. https://doi.org/10.29303/jppipa.v9i8.4437

Santosa, T. A., Razak, A., Lufri, L., Zulyusri, Z., Fradila, E., & Arsih, F. (2021). Meta-Analisis: Pengaruh Bahan Ajar Berbasis Pendekatan STEM Pada Pembelajaran Ekologi. *Journal of Digital Learning and Education*, *1*(1), 1–9. https://doi.org/10.52562/jdle.v1i01.24

Satriawan, M., & Rosmiati, R. (2016). Pengembangan Bahan Ajar Fisika Berbasis Kontekstual dengan Mengintegrasikan Kearifan Lokal untuk Meningkatkan Pemahaman Konsep Fisika Pada Mahasiswa. *JPPS (Jurnal Penelitian Pendidikan Sains)*, *6*(1), 1212–1217. https://doi.org/10.26740/jpps.v6n1.p1212-1217

Selamat, A. I., Rungkat, J. A., & Wowor, E. C. (2023). Pengembangan Bahan Ajar IPA Berbasis E-Book Materi Sistem Pernapasan Pada Manusia Pada Siswa Kelas VIII di SMP Negeri 2 Siau Timur Selatan. *SOSCIED*, *6*(2), 514–520. https://doi.org/10.32531/jsoscied.v6i2.721

Sjawal, T. G., Rungkat, J. A., & Tumewu, W. A. (2023). Pengembangan Bahan Ajar dalam Bentuk Media Komik Materi Sistem Ekskresi Pada Siswa Kelas VIII SMP Negeri 3 Tompasobaru. *SOSCIED*, *6*(2), 331–337. https://doi.org/10.32531/jsoscied.v6i2.695

Sugiyono. (2015). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: ALFABETA.

Susilo, S. V. (2018). Refleksi Nilai-Nilai Pendidikan Ki Hadjar Dewantara dalam Upaya Upaya Mengembalikan Jati Diri Pendidikan Indonesia. *Jurnal Cakrawala Pendas*, *4*(1), 33–41. https://doi.org/10.31949/jcp.v4i1.710

Tafonao, T. (2018). Peranan Media Pembelajaran dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, *2*(2), 103–114. https://doi.org/10.32585/jkp.v2i2.113

Tegeh, I. M., Jampel, I. N., & Pudjawan, K. (2014). *Model Penelitian Pengembangan*. Yogyakarta: Graha Ilmu.

Wola, B. R. (2023). Literasi Digital Calon Guru Sekolah Dasar di STKIP Persada Evav Tual Pasca Pandemi COVID-19. *PEDAGOGIKA: Jurnal Pedagogik Dan Dinamika Pendidikan*, *11*(2), 244–255. https://doi.org/10.30598/pedagogikavol11issue2page244-255

Zunaidah, F. N., & Amin, M. (2016). Developing The Learning Materials of Biotechnology Subject Based on Students'need and Character of Nusantara PGRI University of Kediri. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *2*(1), 19–30. https://doi.org/10.22219/jpbi.v2i1.3368