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Development of Tissue Culture Book Based on Research on Rooting Induction of *Dendrobium Sp.* Orchids In Vitro with Combination Media

Elvira Nanda Sari[1,*], Fauziyah Harahap[2], Mufti Sudibyo[3]

[1,2,3] Postgraduate Study Program in Biology Education, Medan State University
Jl. William Iskandar Ps. V, Kenangan Baru, Kabupaten Deli Serdang, Sumatera Utara, Indonesia

[*] *Elviranandasari118@gmail.com*

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Abstrak

Pengembangan buku kultur jaringan berbasis penelitian sangat diperlukan mengingat ketersediaannya yang terbatas. Penelitian ini bertujuan untuk menyediakan buku acuan tentang induksi akar anggrek Dendrobium sp. secara in vitro menggunakan beberapa media. Penelitian pengembangan ini menggunakan model 4-D (*Four-D*) pada pengembangan buku referensi yang merupakan suatu produk atau inovasi dari suatu hasil riset tertentu yang terdiri dari tahap *define, design, development* dan *disseminate.* Analisis data dilakukan dengan kuesioner skala likert untuk menganalisis ahli materi, ahli desain pembelajaran, ahli desain tata letak, tanggapan dosen, dan tanggapan mahasiswa. Analisis yang digunakan adalah analisis kuantitatif dan kualitatif. Hasil validasi menunjukkan bahwa kedua materi memperoleh skor 87,79% dengan kategori sangat baik, validasi ahli desain pembelajaran memperoleh skor 95,5%, validasi ahli desain tata letak memperoleh skor 95%, tanggapan dosen memperoleh skor 855, dan tanggapan mahasiswa yang dihitung dari uji coba perorangan sebesar 89,33% dan uji coba kelompok kecil sebesar 91,11%. Uji skor N-Gain menunjukkan bahwa buku tersebut dapat meningkatkan hasil belajar kognitif mahasiswa kultur jaringan. Ditetapkan bahwa buku kultur jaringan berbasis penelitian induksi akar anggrek Dendrobium sp. anggrek dengan campuran media dimungkinkan dan bermanfaat sebagai buku pendukung pembelajaran kultur jaringan.

Kata Kunci: Buku Pengembangan, Berbasis Riset, Kultur Jaringan , Anggrek *Dendrobium* sp.

Abstract

The development of research-based tissue culture books is very necessary considering its limited availability. This study aims to provide a reference book on in vitro root induction of Dendrobium sp. orchids using several media. This development research uses a 4-D (Four-D) model in the development of reference books which are a product or innovation from a particular research result consisting of the stages of definition, design, development and dissemination. Data analysis was carried out using a Likert scale questionnaire to analyze material experts, learning design experts, layout design experts, lecturer responses, and student responses. The analysis used was quantitative and qualitative analysis. The validation results showed that the second material obtained a score of 87.79% with a very good category, validation of learning design experts obtained a score of 95.5%, validation of layout design experts obtained a score of 95%, lecturer responses obtained a score of 855, and student responses calculated from individual trials of 89.33% and small group trials of 91.11%. The N-Gain score test showed that

the book could improve the cognitive learning outcomes of tissue culture students. It is determined that the tissue culture book based on research on root induction of Dendrobium sp. orchids with mixed media is possible and useful as a supporting book for learning tissue culture.

***Keywords**:* Development Book, Research Based, Tissue Culture, Dendrobium sp Orchid.

A. Introduction

Universities must constantly enhance education. Book ownership by students or participants may increase education quality. According to (Fadilah, R. E., Mohammad, A., dan Ummie, 2018) , books are beneficial to learning, and Law of the Republic of Indonesia No. 12 Article 41 Paragraph 1 supports this (Depdiknas., 2003). The essay stresses that colleges must enable, own, and supply learning materials like books in line with their study programs or sciences. Learning process activities include developing learning tools to promote continuous learning. Research-based learning is an additional learning process that applies the theories students have learned, expands and deepens the content of learning materials, and is tailored to each lecture at every university and school (Putro, S.D., Umie, L., dan Betty, 2016).

Provide pupils with subject-relevant learning tools to boost their cognitive ability. Books enhance education. (Kemendiknas, 2018) According to Regulation of the Minister of National Education Number 2 of 2018, Article 6, Paragraphs 2 and 3, students should read reference or enrichment books in addition to textbooks to gain knowledge. Quality biology reference books are still scarce (Permendikbud., 2014). Learning materials include reference books. Reference books improve student learning. Reference books differ from textbooks because they contain discussion materials that focus on one field of science, are organized by logic, and must meet the requirements of a complete written work without student characteristics or student learning activity plans. Therefore, these reference books will help increase learning success, knowledge, and understanding (Putri, D. R., & Nugraheni, 2022).

Reference books have several benefits: (1) they can be studied by students, lecturers, researchers, and readers interested in the book; (2) they can be used as reference material for conducting research on the subfield of science; (3) they can support courses taught; and (4) they can enrich knowledge, especially about research procedures. The biology department's teaching process requires learning aids like research books to help students apply the content. One course that requires application is tissue culture. Therefore, research-based reference books may assist students in investigating and understanding outcomes (Arianti, S. N., Wacniati., Muslimin., dan Suwastika, 2019).

Tissue culture helps preserve genetic variety and produce plants in vitro. Tissue culture can conserve and grow orchids and other plants. This research will aid in the creation of a reference book on the issue (Harahap, 2019). Tissue culture research also inspires investigations on hard-to-grow plants. This may lead to new agricultural and plant conservation understanding and development. State University of Medan Biology majors must take tissue culture. Tissue

culture courses use journal-based teaching materials and broad theoretical textbooks. Current textbooks do not include Dendrobium sp orchid roots induction using growth regulator medium and organic ingredients. This constraint suggests a research-based reference book that may supplement lectures with more detailed and relevant material (Suswina, 2018).

Plant Tissue Culture (Harahap, F., Jussuf, K., Poerwanto, R., Nusyirwan, Syarifuddin, 2018) is utilized by Medan State University Biology/Biology Education students and contains significant information. This book includes cell theory, tissue culture medium, hormone theory, in vitro plant breeding, somaclonal variety, secondary metabolite compound formation, germplasm preservation, plant acclimation, and mangosteen tissue culture. This study also focused on Dendrobium orchids due of their unique traits. Because of its distinctive forms, colours, and sizes, Dendrobium may be cultivated farther than other orchids. Orchid demand rises every year, but Indonesian orchid output is modest (Wattimena, G. A., L. W. Gunawan, N.S. Matjik, E. Sjamsudin, N. M.A. Wiendi, 2017). Tropical places like Indonesia and certain non-tropical areas contain orchids (Dendrobium sp). Orchid plants are attractive due to its form, size, arrangement, stalk, quantity of blooms per stalk, and blossom colour (Sakina, S., Anwar, S., & Kusmiyati, 2019). Proper orchid cultivation is necessary for high-quality blossoms. In vitro orchid growing is popular because it generates more high-quality seeds quicker than traditional cultivation (Basri, 2017).

In the author's examination of student needs in the Department of Biology, State University of Medan, 97% of students said they wanted research-based tissue culture reference books. 77% of students had never utilized research-based books, and 97% highly agreed with the production of such books on in vitro orchid root induction using several medium (Chaverri, J.P., Noemí, C.R., Marisol, O.I., Jazmin, 2018) . Thus, students' tissue culture textbooks still emphasize content rather than process, even though several research results are taught, but there is no research-based enrichment material, so they still struggle to develop knowledge and skills in tissue culture research independently. Based on the problem analysis and the above explanation, a research-based reference book on rooting induction of Dendrobium sp orchids in tissue culture courses is needed to help students learn and improve their experimentation skills. It may also provide students real-world experience and enhance their scientific views using the reference book's study findings. Based on the findings, the Dendrobium orchid rooting induction book was created. This development research aims to determine the needs of students for tissue culture books based on research on rooting induction of Dendrobium sp. orchids in vitro with a combination of media, the content of such books, and their feasibility.

B. Research Method

This research includes R & D (Research and Development) research using the 4-D (Four-D) model in the development of reference books which are a product or innovation from a particular research result (Sugiyono, 2018). In this study, the development model consists of the define, design, development and disseminate stages. This research was conducted by inducing rooting of Dendrobium sp orchids with a combination of these media carried out at the YAHDI Tissue Culture Laboratory on Jl. Ambung, Tanah Enam Ratus, Kec. Medan Marelan, Medan City, North Sumatra 20245. It was carried out in March - October 2024. Then the research on taking validation, responses from lecturers and students and effectiveness testing based on student learning outcomes was carried out at the Biology Department, State University of Medan, Jl. Wiliem Iskandar, Pasar V, Medan, North Sumatra, 20221. The subjects of taking responses to the needs analysis questionnaire on the development of tissue culture books based on research on rooting induction of Dendrobium sp orchids were 30 students from the Biology Department, State University of Medan who had taken tissue culture courses. This research design uses a 4D (four-D) development model consisting of 4 stages, namely; define, design, develop, and disseminate (Triagarajan & Sivasailan, 1974). The scheme and stages of the description of the 4-D model modification can be seen below:

Define

The define stage aims to determine and define the needs of the assessment of the developed book by analyzing the objectives and limitations of the material needed by students to be improved. The initial step taken is to determine the basic problem by conducting field observations and collecting supporting articles and journals. Then conduct a needs analysis of 30 students as the target of the development product. The development product carried out is aimed at undergraduate students of the Biology Department of Medan State University who are taking tissue culture courses. Then at this stage, an analysis of the concepts of the material and information that is considered important in providing an understanding of tissue culture will be carried out, especially regarding the induction of rooting of Dendrobium sp orchids with a combination of media.

Design

The purpose of this stage is to design a reference book that is developed, so that an initial product design is obtained from a research-based book on rooting induction of Dendrobium sp. Orchids. The book to be developed is designed in five chapters. Chapter one discusses the introduction which includes an introduction to tissue culture. Chapter two discusses plant tissue culture techniques and the process of working on tissue culture. Chapter three discusses the tissue culture laboratory. Chapter four discusses the manufacture of tissue culture media. Chapter five discusses the implementation of research on rooting induction of Dendrobium sp.

orchids with a combination of media. so that research results, selection of book media, selection of book formats and initial product design are obtained so that data from the results are obtained.

Development

At the development stage, the product will be assessed and revised by a team of material experts, a team of learning design experts, and a team of layout design experts. Then the product will be improved by researchers and validated again until it shows a good feasibility score. After that, the product will be assessed by the lecturer in charge of the tissue culture course. And student feedback will be collected from various groups, namely individual groups, small groups and limited groups. The assessment results will be used as a reference to revise the product again until the product is perfected.

Disseminate

The dissemination stage is carried out by disseminating the development products that have been made in the form of reference books, namely tissue culture books based on research on root induction of Dendrobium sp orchids by being tested in classes of undergraduate students who are currently teaching tissue culture courses at Medan State University. Classes are taken randomly from all classes of undergraduate students who are currently taking tissue culture courses to determine the control class and the experimental class. In both classes, pretest questions (initial tests) are then given with the same questions, to test students' initial cognitive abilities regarding tissue culture.

C. Result and Discussion

The 4-D approach from Thiagarajan is used to generate tissue culture books on Dendrobium sp orchid root induction. The definition, design, development, and dissemination phases are the four stages. Study outcomes are discussed below:

Define

Definition is the first step in creating a book, medium, or guide. Analyze and study tissue culture course material first. The tissue culture course emphasizes procedure, therefore this study covers Dendrobium sp orchid in vitro root induction research using a variety of media. Then, State University of Medan biology majors who completed the tissue culture course were given questionnaires to assess student requirements. After gathering evidence, alternate alternatives were explored. The implementation of the Indonesian National Qualification Framework (KKNI) curriculum at State University of Medan shows that research-based learning design is urgently needed based on student-learning environment analysis. Some KKNI courses involve mini-research. The course speaker recommends texts and articles for tissue culture learning.

Design

At this stage, research was conducted on in vitro root induction of Dendrobium sp orchids with a combination of media and the preparation of a draft of a research-based book. This research-based book is compiled based on the results of research on in vitro root induction of Dendrobium sp orchids with a combination of media and also a review of literature relevant to the research results. The development of this research-based culture book is in accordance with the aspects of clarity and suitability of learning objectives with the book being developed. After conducting research on in vitro root induction of Dendrobium sp orchids with a combination of media. The design of the book draft begins with the selection of the book format, which consists of the selection of the paper size and type of font used. The paper size used in compiling the book based on research on in vitro root induction of Dendrobium sp orchids with a combination of media is A5 paper (14.8 x 21 cm) and the font used is Arial with a font size of 10 points. The next step is to design the initial draft of the research-based reference book. The design of the initial draft of the reference book consists of designing the book cover, the front of the book, the contents of the book and the end of the book.

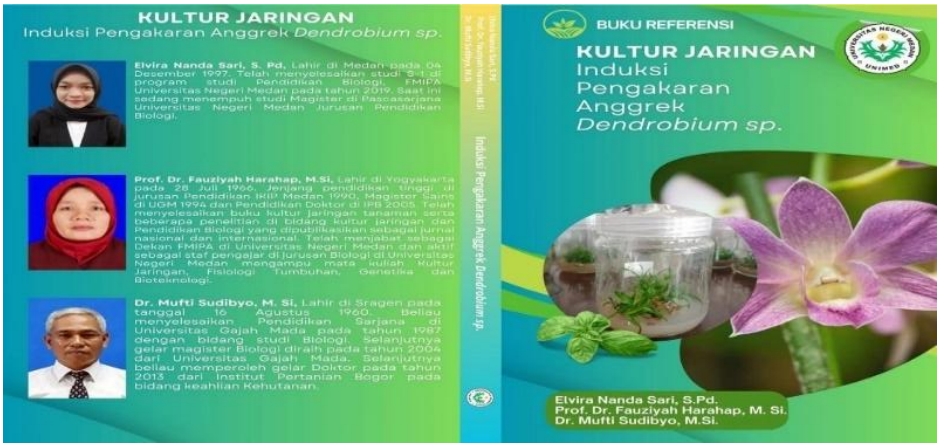


Figure 1. Cover of the Book Tissue Culture Induction of Rooting of Dendrobium sp Orchids In Vitro with a Combination of Media

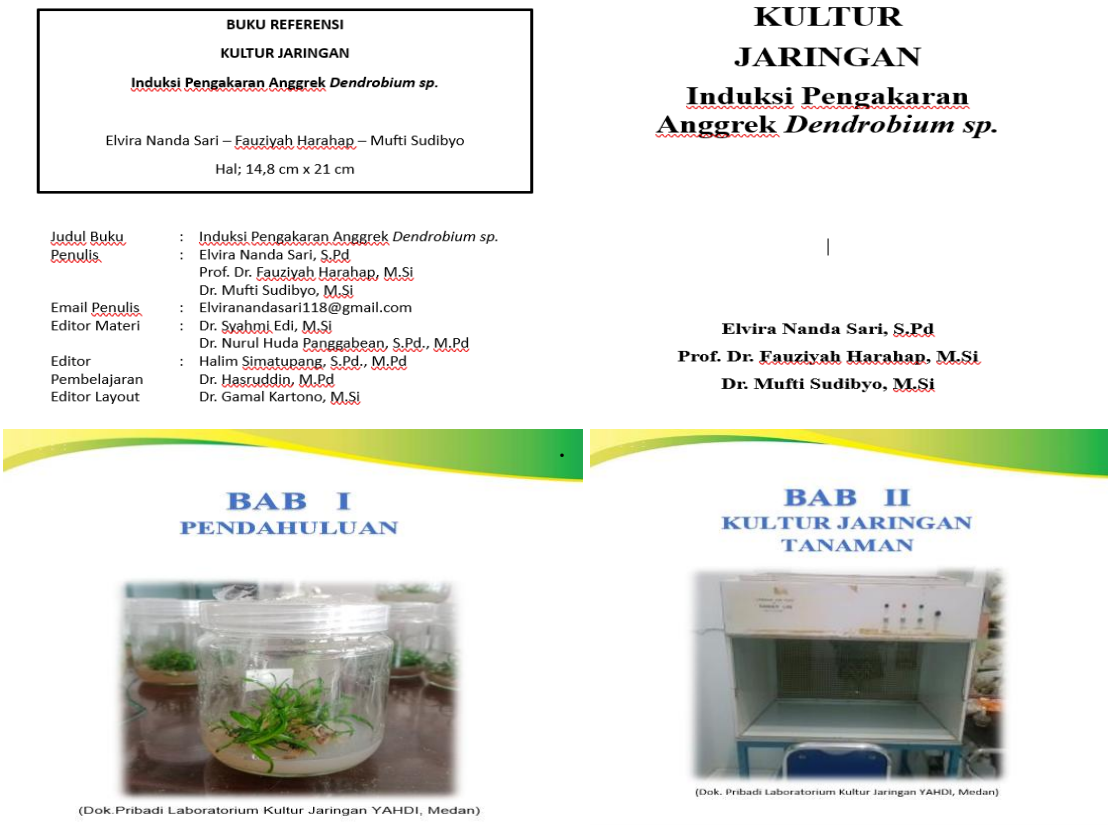


Figure 2. Content Section (Text Matter) of the Induction Tissue Culture Book

Develop

At this development stage, validation of tissue culture books was carried out based on research on in vitro root induction of Dendrobium sp orchids. Validation was carried out by several expert validators, namely material experts, learning design experts and layout experts to obtain input and suggestions for improving research-based tissue culture books that were developed and to improve the quality of books in terms of material, suitability for the student learning process and the beauty of the book's appearance.

Tissue Culture Material Expert Validation Results

Tissue culture books based on Dendrobium sp. orchid root induction were validated by material experts on content suitability (material suitability, accuracy, updates, supporting materials, and research-based components), presentation suitability (presentation techniques, material presentation, learning presentation, presentation completeness, and research-based presentation completeness), and readability. Figure 3 shows material expert validation findings.

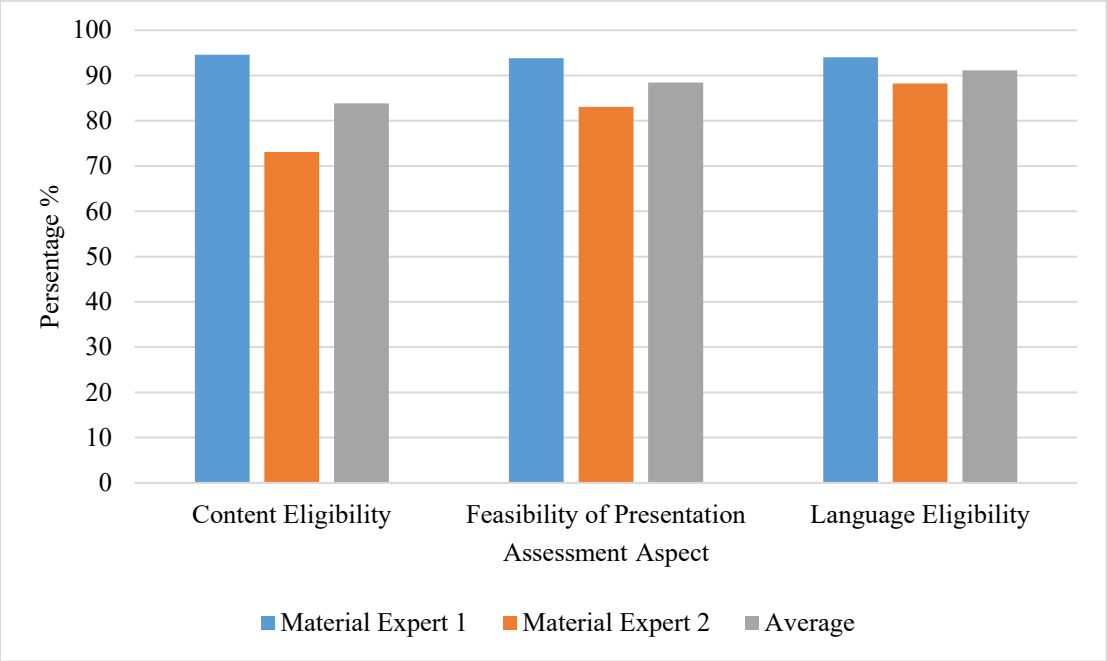
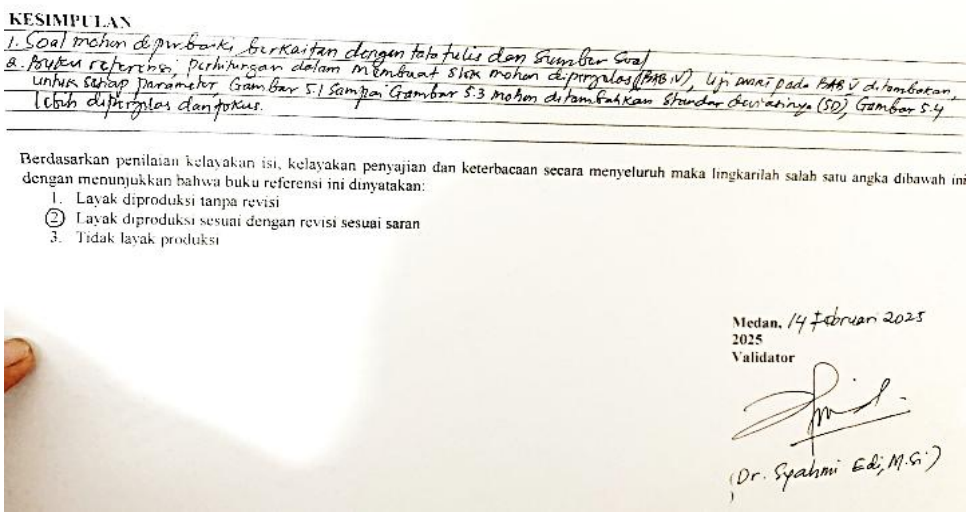


Figure 3. Validation Results of the Orchid Rooting Induction Book by Material Experts

According to Figure 3. the validation score findings for content feasibility are 83.83%, presentation feasibility is 88.43%, and language feasibility is 91.11%. The average Dendrobium sp. orchid root validation score is 87.79%. It seems that the Dendrobium sp. orchid root induction book is employed. Based on material experts' confirmation, the book resulting from Dendrobium sp. orchid root induction development should be altered to be materially feasible. You can see the authentic appearance of the material expert validator in Figure 4 below.


KESIMPULAN

1. Soal mohon diperbaiki berkaitan dengan tata tulis dan Gambar Soal
2. Buku referensi, perhitungan dalam membuat skor mohon diperjelas (BAB IV), Uji anari pada BAB V ditambahkan untuk setiap parameter Gambar 5.1 sampai Gambar 5.3 mohon ditambahkan Standar deviasinya (SD) Gambar 5.4 lebih diperjelas dan fokus.

Berdasarkan penilaian kelayakan isi, kelayakan penyajian dan keterbacaan secara menyeluruh maka lingkarilah salah satu angka dibawah ini dengan menunjukkan bahwa buku referensi ini dinyatakan:

1. Layak diproduksi tanpa revisi
2. Layak diproduksi sesuai dengan revisi sesuai saran
3. Tidak layak produksi

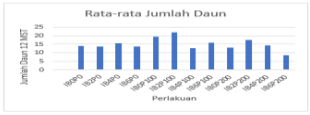
Medan, 14 Februari 2025
Validator

(Dr. Syahmi Edi, M.Si)

Figure 4. View of the material expert validator

The improvements are presented in Table 1.

Table 1. Comparison of Before and After Revisions by Material Experts

Before Revision	After Revision
Subject Matter Expert I: Added DMRT further test in Chapter 5 after variance analysis.	 Gambar 5.2 Grafik Jumlah Daun Anggrek *Dendrobium* sp. Kemunculan daun diawali dengan pemunculan tunas. Tunas memanjang lalu tumbuh berkembang menjadi daun. Bersama-sama dengan auksin, sitokinin merangsang pembelahan sel dan mempengaruhi jalur diferensiasi, penambahan zat pengatur tumbuh dapat mempengaruhi metabolisme RNA yang berperan dalam sintesis protein melalui proses transkripsi molekul RNA. Kenaikan sintesis protein sebagai sumber tenaga yang digunakan untuk pertumbuhan. Jumlah daun yang terbentuk pada setiap eksplan yang ditanamdikendalikan oleh keseimbangan dan interaksi antara zat pengatur tumbuh yang baik yang terkandung dalam eksplan itu Induksi Pengakaran Anggrek *Dendrobium* sp | 94  **Tabel 5.8** Hasil DMRT Jumlah Akar Anggrek *Dendrobium* sp selama 12 Minggu Setelah Tanam (MST) Berdasarkan hasil data yang diperoleh bahwa rata-rata jumlah akar tertinggi terdapat pada perlakuan IB2P100 (IBA 2 ppm + Pisang 100 gr/L) yaitu sebesar 10,67 sedangkan jumlah akar terendah terdapat pada media IB6P200 (IBA 6 ppm + Pisang 200 gr/L) yaitu sebesar 2,67. Perlakuan pemberian bubur pisang 100 gr/L terhadap semua konsentrasi ZPT IBA menghasilkan rataan jumlah akar tertinggi yaitu 7,83. Hal ini menunjukkan dengan konsentrasi auksin yang rendah diduga dapay mengoptimalkan perkembangan akar. Arlianti dkk (2013) menyatakan inisiasi perakaran menggunakan cara in vitro dapat dipacu dengan menambahkan ZPT pada setiap media tanam. ZPT yang umum digunakan untuk mendorong perakaran adalah golongan auksin. IBA merupakan jenis auksin yang seringkali digunakan dibandingkan jenis auksin lainnya, dikarenakan kemampuannya yang tinggi dalam menginisiasi perakaran. Hal ini diperkuat lagi oleh Sitinjak dkk. (2015) penamhana auksin kedalam media kultur dapat meningkatkan konsentrasi zat pengatur tumbuh endogen didalam sel hinggamenjadi factor pemicu dalam proses BAB V Implementasi | 94

IBA	BUBUR PISANG			Rata-Rata
	0	100	200	
0	3,33de	7,00bc	8,67ab	6,33
2	6,00cd	10,67a	5,33cd	7,33
4	5,67cd	8,00bc	5,33cd	6,33
6	6,00cd	5,67cd	2,67e	4,78
Rata-Rata	5,25	7,83	5,5	

Learning Design Expert Validation Results

Validation of learning design consists of four subcomponents, namely the suitability of the material, systematic delivery of the material, efficiency of tissue culture books and language feasibility. Authentic evidence can be seen from the expert design validator in Figure 5 below.

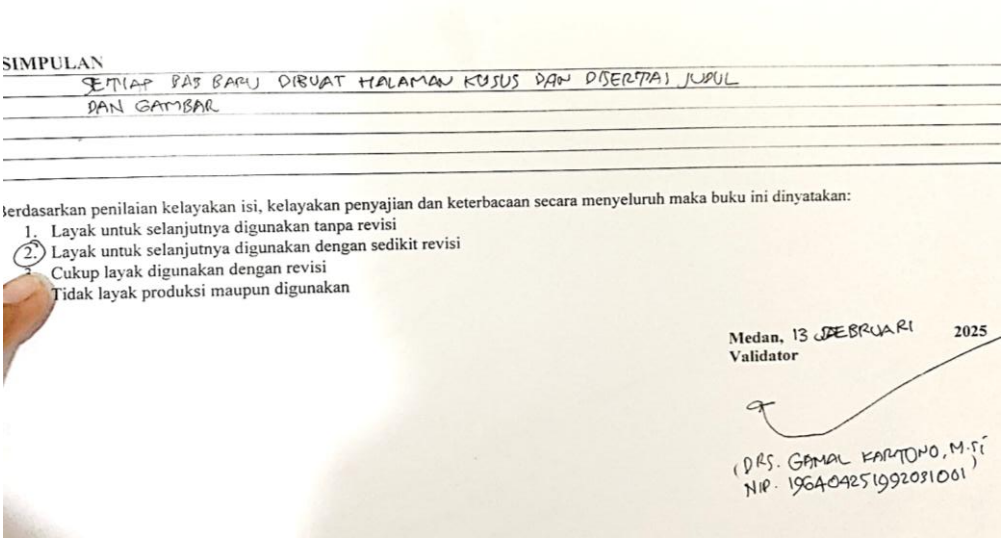


Figure 5. View of the design expert validator.

The results of validation by material alili can be seen in Figure 4.

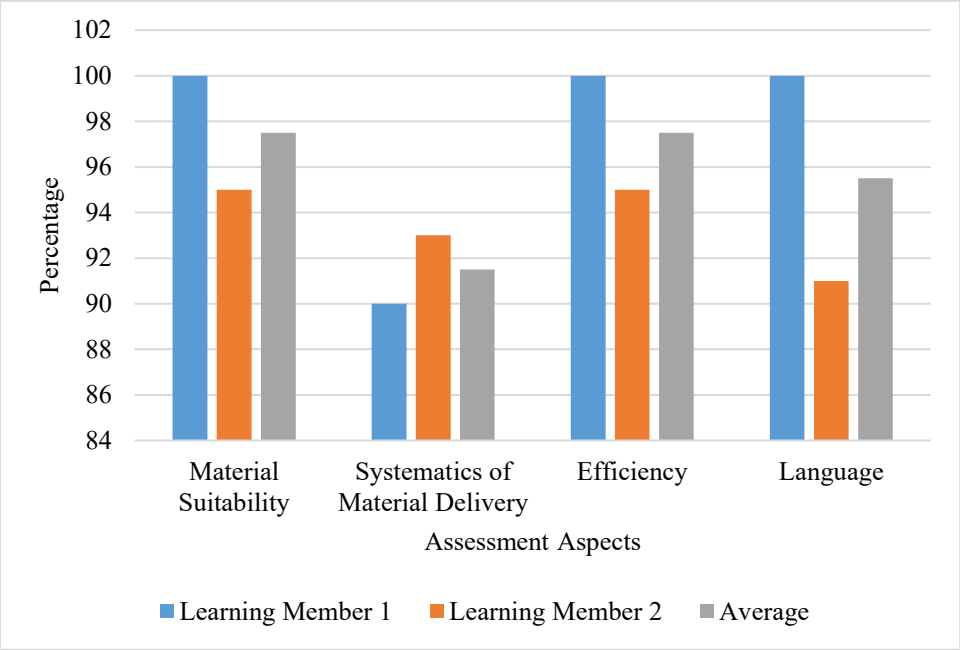


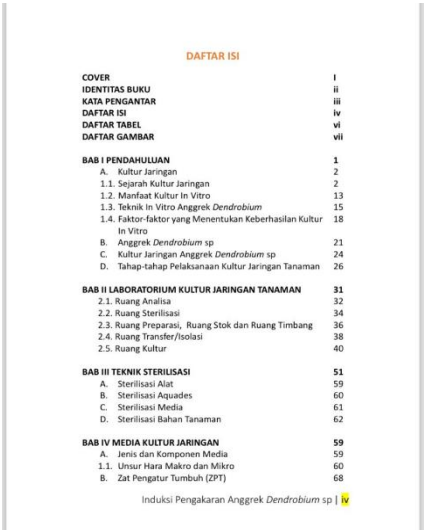
Figure 6. Results of Validation of Orchid Rooting Induction Book by Learning Experts

Based on Figure 6, the validation score results with the content feasibility aspect of 83.83% with a very good category, the presentation feasibility aspect of 88.43% with a very good category and the language feasibility aspect of 91.11% with a very good category. Overall, the average percentage of the Dendrobium sp. orchid root validation score is 87.79%. These results indicate that the Dendrobium sp. orchid root induction book is suitable for use in terms of material. In line with the validation process by material experts, there are things suggested by material experts to be revised so that the book resulting from the development of Dendrobium sp. orchid root induction is suitable for use in terms of material feasibility.

During the validation stage of the book by the expert validator of learning design, there were several things that needed to be revised in the tissue culture book based on this development research so that this book met all the indicators of learning design and was worthy of being used as a source of relevant information.

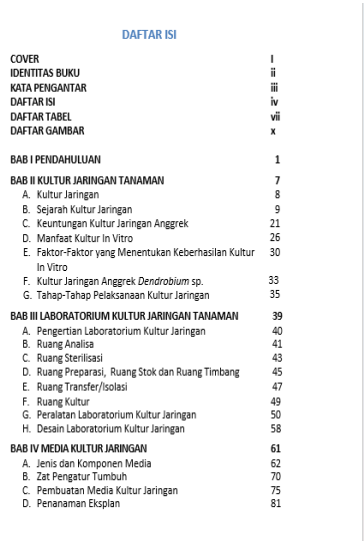
Table 2. Comparison of Revision Results Before and After by Learning Design Experts

Before Revision	After Revision
Learning Expert Improve the numbering system in the table of contents	



DAFTAR ISI

Induksi Pengakaran Anggrek *Dendrobium* sp | iv



DAFTAR ISI

Layout Design Expert Validation Results

Layout design expert validation is carried out by lecturers in the Fine Arts Department of Medan State University. Layout design validation is carried out to improve the quality of book design results from the Development. The reference book on tissue culture based on orchid root induction research is assessed on the Ema aspect, namely the size of the book, book cover design (layout and typography of the book cover), book content design (layout, typography and illustration, writing rules (book appearance, language use, book structure, readability and writing), and presentation feasibility (front, content and back).

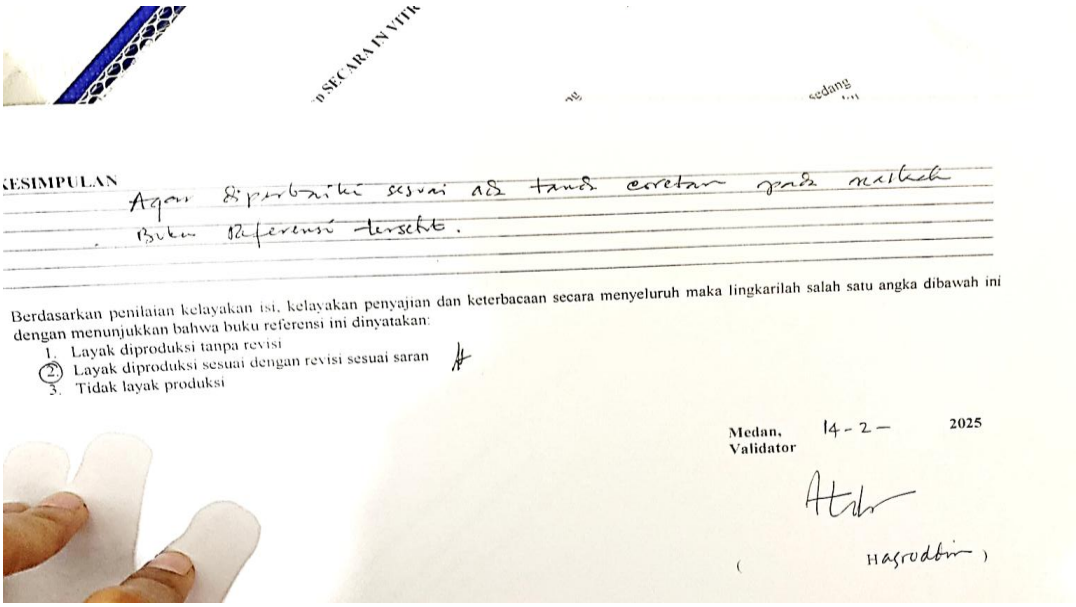


Figure 7. Authentic Evidence of Layout Design Expert Validation

The validation results can be seen in Figure 8.

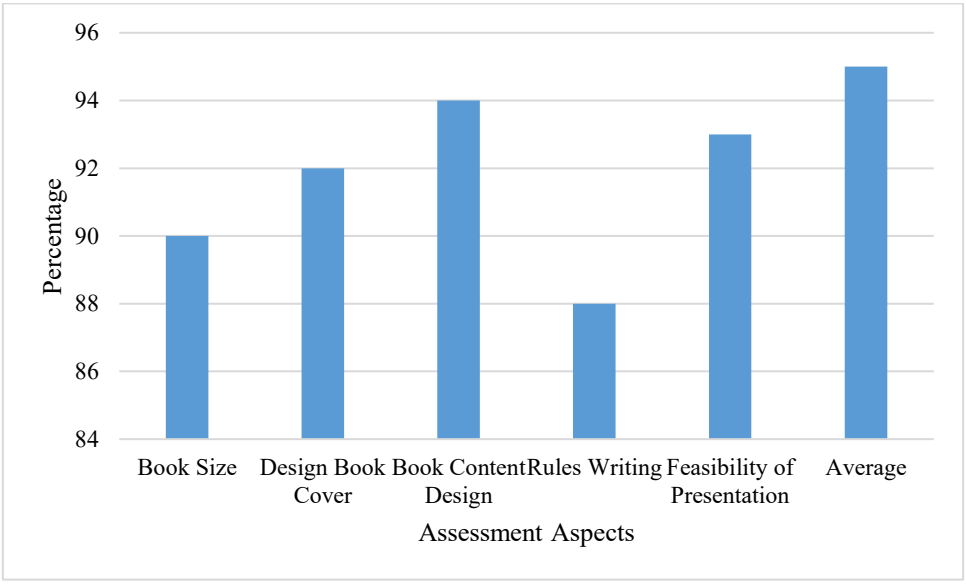
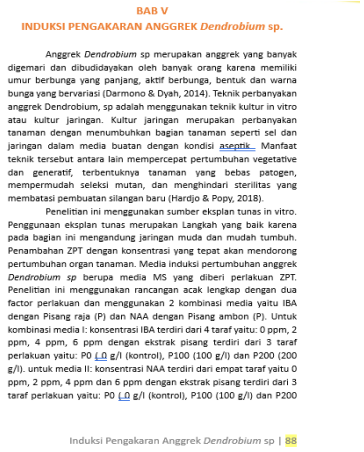


Figure 8. Validation Results of the Orchid Rooting Induction Book by Layout Design Experts

Figure 8 shows that the Dendrobium sp orchid root induction book validation findings in vitro average 95% and are extremely excellent. So, this book might provide essential information. This book satisfied the layout design evaluation components of book size 90%, cover design 92%, content design 94%, writing rules 88%, and presentation feasibility 93%. This research-based tissue culture book needs various adjustments to make it more communicative and neater and more beautiful. Layout design specialists must approve it before it can be used. Table 3 compares the root induction book before and after modification.

Table 3. Comparison of Revision Results Before and After by Layout Design Expert

Before Revision	After Revision
Adding images on every first page of every new Chapter	



BAB V

INDUKSI PENGAKARAN ANGGREK *Dendrobium* sp.

Anggrek *Dendrobium* sp merupakan anggrek yang banyak digemari dan dibudidayakan oleh banyak orang karena memiliki umur berbunga yang panjang, aktif berbunga, bentuk dan warna bunga yang bervariasi (Darmono & Dyah, 2014). Teknik perbanyakan anggrek Dendrobium, sp adalah menggunakan teknik kultur in vitro atau kultur jaringan. Kultur jaringan merupakan perbanyakan tanaman dengan menumbuhkan bagian tanaman seperti sel dan jaringan dalam media buatan dengan kondisi aseptik. Manfaat teknik tersebut antara lain mempercepat pertumbuhan vegetative dan generatif, terbentuknya tanaman yang bebas patogen, mempermudah seleksi mutan, dan menghindari sterilitas yang membatasi pembuatan silangan baru (Hardjo & Popy, 2018).

Penelitian ini menggunakan sumber eksplan tunas in vitro. Penggunaan eksplan tunas merupakan Langkah yang baik karena pada bagian ini mengandung jaringan muda dan mudah tumbuh. Penambahan ZPT dengan konsentrasi yang tepat akan mendorong pertumbuhan organ tanaman. Media induksi pertumbuhan anggrek *Dendrobium sp* berupa media MS yang diberi perlakuan ZPT. Penelitian ini menggunakan rancangan acak lengkap dengan dua factor perlakuan dan menggunakan 2 kombinasi media yaitu IBA dengan Pisang raja (P) dan NAA dengan Pisang ambon (P). Untuk kombinasi media I: konsentrasi IBA terdiri dari 4 taraf yaitu: 0 ppm, 2 ppm, 4 ppm, 6 ppm dengan ekstrak pisang terdiri dari 3 taraf perlakuan yaitu: P0 (0 g/l (kontrol), P100 (100 g/l) dan P200 (200 g/l). untuk media II: konsentrasi NAA terdiri dari empat taraf yaitu 0 ppm, 2 ppm, 4 ppm dan 6 ppm dengan ekstrak pisang terdiri dari 3 taraf perlakuan yaitu: P0 (0 g/l (kontrol), P100 (100 g/l) dan P200

Induksi Pengakaran Anggrek *Dendrobium* sp | 88

BAB V

INDUKSI PENGAKARAN ANGGREK

Dendrobium sp.

Disseminate

After several validation experts and a feasibility test have revised and declared the root induction book feasible with a very good category, the dissemination stage tests the Normalized Gain to determine its effectiveness. Pretest and posttest data are compared for the N-Gain test. This stage uses pretest-posttest control group design. One class is experimental and the other is control in this design. The experimental and control classes are randomly selected from all undergraduate tissue culture classes at the Biology Department, State University of Medan. Both courses take a pretest with tissue culture-style questions. Pretests determine starting skills before experiments. The control group was then taught using tissue culture books or e-books they already possessed, not the Dendrobium sp. Orchid Root Induction Tissue Culture Book. The experimental group was taught utilizing tissue culture manuals, e-books, and the Dendrobium Sp Orchid Rooting Induction Tissue Culture Book.

Descriptive statistics are statistical data used to describe clear and easy-to-understand data information that describes the general research results of the characteristics of each research variable that can be seen from the mean (average), maximum value and mode of research data obtained from student learning outcomes. The analytical descriptive research data are presented in Table 4 below.

Table 4. Descriptive Statistical Analysis

Class	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test Experiment	22	23.33	46.66	36.3459	6.56261
Post-Test Experimer	22	76.66	100.00	87.6791	7.76734
Pre-Test Control	22	20.00	43.33	31.9659	7.02655
Post-Test Control	22	43.33	70.00	61.3464	7.60162
Valid N (listwise)	22				

a. Pretest and Posttest Results of Experimental Class

Based on Table 4, the pretest results of the experimental group before using the reference book on tissue culture based on Dendrobium sp orchid root induction research had quite large variations. The highest value was 46.66 and the lowest value was 23.33 and the average pretest value was 36.34 with a standard deviation of 6.56. After using the reference book, in the posttest results of the experimental group, the average learning outcomes increased to 87.67 with a standard deviation of 7.76. The highest value achieved was 100 with the lowest value of 70.

b. Pretest and Posttest Results of the Control Class

In the control group, the pretest results showed a variation in values from 20.00 to 43.33. The average pretest value of the control group was 31.96 with a standard deviation of 7.02. After going through the learning process without using a tissue culture reference book based on the research of Dendrobium sp orchid root induction, the posttest results showed a range of values between 43.33 to 76.66. The average posttest value of the control group was 61.34 with a standard deviation of 7.60.

Normalized Gain Test Data (N-Gain)

The increase in student learning outcomes can be seen from the comparison of pretest and posttest scores using the normalized gain test (N-Gain). Based on the results of the N-Gain score using the IBM SPSS Statistics version 27 application, the data obtained were in the form of percentages and descriptive data, so a summary of Table 42 of the results of the N-Gain test calculation can be made as follows.

Table 5. Results of N-Gain Test Calculation

No	Data Centralization and Spread	Experimental Class	Control Class
1	Mean (N-Gain) score	80,39	43,14
2	Median	82,85	44,99
3	Maximum value (Max)	100	59,09
4	Minimum value (Min)	58,81	22,73
5	Range	41,19	36,36
6	Standard Deviation	12,77	9,51

According to table 5, the average N-gain value for the experimental class (using the Dendrobium sp. orchid root induction book) is 0.80 (0.80> 0.70) or 80.39%, a high and effective category. with In tissue culture classes, the Dendrobium sp. orchid root induction reference book improves cognitive results. Without the Dendrobium sp. orchid root induction reference book, tissue culture students' cognitive results are less improved. N-Gain ranges from 0.59 (59%), to 1.00 (100%). The control class without reference books has an average N-Gain of 0.43 ($0.30 \leq 0.43 \leq 0.70$), placing it at 43% in the moderate and ineffective group. N-Gain ranges from 0.36 (36%), to 0.59 (595). Reference books on tissue culture based on in vitro Dendrobium sp orchid rooting research improve students' cognitive performance in tissue culture courses. It does not improve students' cognitive performance in tissue culture courses without employing reference materials based on in vitro Dendrobium sp orchid rooting research.

Discussion

Interaction with teachers is not the main source of student learning. However, learning resources interact with several sources to create learning outcomes. Besides contacts with teachers, e-books supplement textbooks. Students need different sources since textbooks aren't always adequate. Students may overcome their tissue culture knowledge gap by using research-based reference books. This reference book is based on State University of Medan's Biology Department tissue culture textbook. The reference book for tissue culture of in vitro root induction of Dendrobium sp orchids with a mix of media incorporates lab research. This book provides some key tissue culture materials. The results of research on the induction of root formation in Dendrobium sp orchids are induction (introduction, understanding, and application areas of tissue culture), tissue culture media, propagation techniques, Dendrobiumi sp tissue culture, tissue culture laboratory (distribution) of plant tissue culture laboratory space, equipment, and In Dendrobium sp orchid stem regeneration, 100 gr/L banana fruit works best (Hartati, I., Sucianti, I., Wahyuni, 2021) also found that banana extract boosted orchid embryo shoot development. According to (Khairuddin, 2020) IBA treatment did not affect Dendrobium sp orchid shoot numbers. Exogenous auxin hormone (IBA) did not substantially affect orchid plantlet shoot numbers. High cytokinin and low auxin help produce shoots and leaves. If applied at the correct concentration, both growth regulators promote tissue growth. Giving bananas boosts plant metabolism. According to ((Rosmaina, Zulfahmi., Probo, S., Ulfiatun., 2017). Banana pulp boosts orchid leaf development and length. High carbohydrate and sugar content in bananas provides metabolic energy for development.

Shoots precede leaf emergence. The shoots lengthen and become leaves. Cytokinin and auxin increase cell division and differentiation, but growth regulators may impact RNA metabolism, which affects protein synthesis via RNA transcription. Increased growth energy from protein synthesis. Each explant's leaf formation depends on the balance and interplay of endogenous growth regulators and media-absorbed ones. In low doses, auxin may expand cells. Combine IBA with banana extract containing cytokinins to grow shoots and leaves. Low auxin concentrations may improve root growth. ZPT in each planting media speeds up in vitro root start, according to (Wulandari, P., Widianingrum. & Setiati, 2017). Auxin-group ZPTs encourage rooting. Due of its great rooting capacity, IBA is employed more than other auxins. Adding auxin to the culture medium increases endogenous growth regulators in cells, triggering tissue growth and development. Auxin content, application technique, period of addition, plant part, and tissue age affect plant roots (Suswina, 2018).

D. Conclusion

This research concludes, based on the issues formulated: According to the student needs analysis, students require research-based tissue culture reference books, have never used them, and actively support their growth. According to the book on Dendrobium sp. orchid rooting in vitro using a mix of medium, feeding IBA and banana pulp increased root number, leaf breadth, and root length. The NAA-banana pulp interaction significantly affected plant height, leaf breadth, and root length. The tissue culture book based on research on the induction of rooting of Dendrobium sp. orchids in vitro using a mix of media based on material, learning design, and layout design experts' validation findings is very excellent. The book on tissue culture based on research on inducing Dendrobium sp. orchid roots in vitro using a mix of conditions based on lecturer and student reactions is extremely practical. According to research on the induction of Dendrobium sp. orchids in vitro with a combination of media based on the N-Gain test calculation, the book on tissue culture improves biology students' cognitive outcomes in tissue culture courses.

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