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Validity of Research Based Book on Isolation, Amplification, and Visualization Material for Biotechnology Course in Higher Education

Chairany Rizka
Kiai Haji Ahmad Siddiq State Islamic University, Indonesia
Correspondence author, rizkachairany@gmail.com

Fauziyah Harahap
Program Pendidikan Biologi Pascasarjana, Universitas Negeri Medan, Indonesia

Syahmi Edi
Program Pendidikan Biologi Pascasarjana, Universitas Negeri Medan, Indonesia

Abstract Biotechnology is a discipline of biology that examines the use of methods or how to utilize living things and its components in terms of increasing the welfare of human existence. Biotechnology courses currently require instructional materials, particularly those pertaining to the application of DNA isolation and amplification. The aim of this study was to determine the level of validity of research based book on isolation, amplification, and visualization material for biotechnology course in higher education. The parameters measured were the validity of the research based book from the aspect of material, language, context, and design. This study uses developmental stage that followed Borg and Gall (1989) development model. The results of the validation by experts were obtained using a questionnaire instrument. The research based book on isolation, amplification, and visualization topic passed validation by materials experts, linguists experts, and design experts with scores of 84% (very good), 77% (very good), and 85%. (very good). It can be concluded that research based book on isolation, amplification, and visualization material product is feasible to use for learning in biotechnology course in higher education based on its validity.

Keywords: Research based book, Biotechnology, Higher education, DNA isolation, amplification, and visualization

INTRODUCTION

Biotechnology is a discipline of biology that examines the use of methods or how to utilize living things and its components in terms of increasing the welfare of human existence. One of the advancements is the discovery of PCR (Polymerase Chain Reaction) as a method or instrument for duplicating DNA segments that creates hundreds or even millions of DNA segments that can be replicated and even changed as required. Knowledge of the usage of PCR and its application is a skill that must be achieved by students in studying DNA isolation and amplification materials in the Biotechnology course.

Biotechnology is one of the required disciplines in the Department of Biology, State University of Medan. There are many limitations in Biotechnology courses such as the lack of media, textbooks, moreover there is no experiment and there is no practical guide and facilities and infrastructure that should support the creation of an ideal Biotechnology learning, making it difficult for students to learn Biotechnology material. Biotechnology course has a weight of 3 credits.

Competence in the Biotechnology course is that students are able to comprehend the fundamental concepts of Biotechnology and the application of Biotechnology in life and bioethics. One of the learning indicators to be reached is that students can grasp the principles of biology as a fundamental science and technology by employing applied science in the area of biology and are able to master natural phenomena with the approach of biotechnology and molecular biology. These learning markers can be accomplished if learning can be carried out correctly if it is aided by the availability of instructional resources. Biotechnology courses emphasis more on the procedures utilized to generate goods so that research-based teaching materials are required.

According to the findings of the preliminary research, which took the form of a questionnaire sent to students who have attended the course, the only accessible teaching materials are Biotechnology Handbook. Based on the findings of interviews, it was determined that as many as 90 percent of students had never conducted research in the area of contemporary biotechnology, and that students still need textbooks that explain everything about research and the most recent study. In addition, they said that the provided amenities were insufficiently accommodating. DNA isolation and amplification materials, electrophoresis, and the working mechanism of the polymerase chain reaction (PCR) are studies of modern biotechnology that 87 percent of students find difficult and have no knowledge of, despite the fact that all fields of science now employ a molecular biology approach.

The interview also revealed that the Biotechnology teaching method comprised presentations and discussions of student research findings from the handbook and journals, in addition to further explanations from the lecturers. There is also a greater emphasis on writing papers, but there are certain mini-research projects that are confined to traditional biotechnology. No research or internships have been conducted

on contemporary biotechnology subjects such as DNA isolation, DNA amplification, and electrophoresis.

Due to the lack of sufficient equipment, the high cost of the necessary supplies, and the length of time required for isolation, DNA isolation practicum in lectures is still difficult to do at this moment.

The development of research-based Biotechnology textbooks is one of the possible solutions to the aforementioned issues. The accessible textbooks only include notions that are abstract in nature, assembled from many sources, and do not represent the lecturers' actual experiences or research findings. Ideally, Biotechnology textbooks would provide not just fundamental ideas but also research-based data. Research-based instructional materials will be more contextual, in-depth, and engaging since they are based not just on ideas or notions, but also on scientifically-proven facts (Primiani & Susianingsih, 2009). Incorporating research findings into instructional materials improves learning since they are more practical and reflect modern characteristics (Parmin & Peniati, 2012). Consequently, the DNA Isolation and Amplification textbook was written based on the study done. This book is meant to promote students' drive and curiosity, their research skills, their desire to do research and think creatively, and their academic performance.

According to the findings of Oktaviana's et al. (2015) study titled Development of Teaching Materials Based on Research on Characterization of Sperm Membrane Proteins in Biotechnology Courses, teaching materials may be used as learning medium. Students are interested in reading research-based textbooks since they are straightforward and facilitate comprehension of the offered content. In accordance with this, Pambudiono et al. (2016) demonstrated in his study of Biology undergraduates at the State University of Malang that heavy metal bioremediation textbooks are based on research. created is classified as very valid and usable. The information offered in the textbook is current and applicable to future biotechnology advancements, namely the utilization of bacteria as bioremediation agents for heavy metals and the identification of possible genes in these bacteria.

Multiple studies have demonstrated that the availability of learning media has the potential to improve student learning results (Harahap et al., 2020; Hsieh & Huang, 2020; Harahap et al., 2019; Liu et al., 2019; Yow & Priyashri, 2019; Wood et al., 2018; Nasution et al., 2017; Irawan, 2017; Wu, 2016; Akbar et al., 2015; Chen et al., 2013; Leacox & Jackson, 2014). And many students truly appreciate books intended to facilitate them in their academics (Almunawaroh et al. 2021; Hadriyanto, 2020). It is believed that research-based learning can improve the quality of learning for students because research-based learning in the learning method will provide opportunities for students and lecturers to seek and collect information, analyze and draw conclusions that will be useful in terms of renewal of learning (curriculum enrichment) by integrating research results, active participation of students in conducting research, enriching insight and field experience, encouraging critical thinking, and fostering

creativity (Hafsah, 2015). The development of book products based on research is not a new or unique practice; a number of studies have utilized this methodology, and the resulting products are in high demand among students (Kartini et al., 2019).

Biology students still need texts for Biotechnology classes, particularly on DNA isolation and amplification tools. contextual ones. The designed textbooks will be attractively packed, comprehensive, well-organized, and supplemented with pertinent illustrations or photographs. This research will concentrate on the reliability of the DNA isolation and amplification textbooks, which were validated by materials, design, and education specialists.

METHOD

Research Design

This textbook was created as a result of previous research on the isolation and amplification of DNA. The research and development technique outlined in the used textbooks is based on the modified research and development design of the Borg and Gall (1989) development model. (1) Initial research and information gathering; (2) Planning; (3) Development of Initial Product Format; (4) Initial Trial; (5) Revision of Initial Trial Results; (6) Field Trial; (7) Product Revision; (8) Field Test; (9) Final Product Revision; and (10) Dissemination and Implementation. This research will concentrate on the validity of the DNA isolation and amplification textbooks, which were validated by materials, design, and education specialists. As illustrated in Figure 1, the research technique focuses on the revision of expert validation.

Figure 1. Design of research based book on biotechnology developmental research adapted from Borg and Gall (1989).

Preliminary Research and Information Collection

During this phase, preliminary research and data collecting are conducted through issue analysis, curriculum analysis, needs analysis, and theoretical study analysis. It is essential to do preliminary research or a requirements analysis in order to acquire initial information, particularly about the Biotechnology course's challenges. The outcomes of this preliminary investigation were examined and potential solutions were explored before being included into research materials.

This preliminary study was undertaken by distributing surveys, speaking with students, and monitoring the classroom to determine the field's actual circumstances. As a foundation for growth, a literature evaluation and the incorporation of relevant supporting material are essential. Then, it will be established what sort of product is appropriate and capable of resolving these issues.

Planning

Planning, which involves the ability to formulate, is a particular objective intended to define the sequence of content in textbooks that will be designed, tested, and implemented for students.

In this phase of planning, textbooks based on DNA isolation and amplification research are created. In addition, at this point, textbooks are designed based on the outcomes of DNA isolation and amplification research conducted in the laboratory.

Preliminary Product Development

The design of teaching materials for DNA isolation and amplification will be created based on the findings of the study using the table 1 design.

Table 1. The content components of learning media

Title of DNA Isolation and Amplification Book
Foreword
List of contents
list of Figures
List of Tables
List of Abbreviations
Chapter I Introduction
Chapter II DNA Isolation of GeneJet Buffer K0791, GeneJet Buffer K0721, CTAB Buffer and Simple Buffer
Chapter III DNA Amplification
Chapter IV Electrophoresis
Chapter V DNA Visualization
Chapter VI Research Results
Glossary
Bibliography
Writer biography

Content Material Research

The research is an experimental investigation employing three distinct plant species. Tomato (*Solanum lycopersicum*), Papaya (*Carica papaya*), and Orange (*Citrus sp*). The impact of four different extract buffers on DNA quality and quantity will be compared. DNA isolation and amplification research is conducted in the laboratory using diverse molecular biology equipment, such as *polymerase chain reaction* machines.

Product Development

This phase involves the creation of textbooks based on research to assist Biotechnology courses. The tasks performed include gathering materials or textbooks, creating graphics, typing, etc. The content offered in the textbook will be gathered and assembled for this first product development. The subject is delivered in straightforward terms so that students may readily comprehend it.

Expert Validation

Validation is performed to obtain a complete image of the quality of a lesson, and it is a process that tests the appropriateness of the learning instructional product with the fundamental learning competencies. Validation will be conducted by three experts: (a) Material Expert, two lecturers with expertise in DNA isolation and amplification material who will validate the developed product material; (b) Language and context Expert, two lecturers with expertise in language and context who will validate products based on language and context; and (3) graphic design experts who will validate the design of textbooks.

Data Collection Instruments

The validation sheet used to obtain data on the product developed in the form of research-based textbooks in the Biotechnology course is divided into three, which is further described as follows.

Content Expert Team Validation Sheet

Content expert team consist of 2 lecturers who are experts on DNA Isolation and Amplification materials. They are Dr. Saleha Hanum, M.Si and Mr. Eko Prasetyo, M.Si. The instrument grid can be seen in the table 2.

Table 2. Instrument grid for materials expert.

Aspect	Variable	Assessment Indicator	Amount
Content Eligibility	Quality of Learning Materials	Learning objectives	1
		Material coverage accuracy	1
		Material Concept	1
		The suitability of the material with the needs of students to study DNA Isolation and Amplification	1
		The suitability of the isolation and amplification material with the curriculum.	
		- DNA isolation	1

		- DNA amplification	1
		- Electrophoresis	1
		- DNA visualization	1
		Compatibility of insulation and amplification materials with the syllabus	
		- DNA isolation	1
		- DNA amplification	1
		- Electrophoresis	1
		- DNA visualization	1
		- DNA amplification	1
	Learning Delivery System	Electrophoresis	1
		DNA visualization	1
		Compatibility of insulation and amplification materials with the syllabus	1
		DNA isolation	1
		DNA amplification	1
		Electrophoresis	1
Presentation	Quality	DNA visualization	1
		The suitability of the material with the objectives/indicators of learning achievement	1
		Ease of describing the material of DNA Isolation and Amplification	1
		Ease of understanding the material of DNA Isolation and Amplification	1
Material Accuracy	Quality	Complete sentences/information needed by students	1
		Presentation of material is systematic	1
		Total	25

Linguists and Context Expert Team Validation Sheet

Linguists and context expert team consist of 2 lecturers. They are Mrs. Dr. Saleha Hanum, M.Si and Mr. Eko Prasetyo, M.Si. The instrument grid can be seen in the table 3.

Table 3. Instrument grid for linguists and context expert.

Aspect	Variable	Assessment Indicator	Amount
	Communicative	The language in the material contained in the textbook is easy to understand	1
		Conformity and accuracy of sentence structure with Indonesian language rules	1
		Good readability of the material	1
		The accuracy of using the rules in the language	1
Language	Straightforward	Sentences and words used do not have a double meaning	1
		Not long-winded in explaining a material	1
		The effectiveness of the sentences used in DNA Isolation and Amplification materials	1
		The effectiveness of the language used in DNA Isolation and Amplification materials	1
	Dialogic and	The language delivered is according to the student's	1

	Interactive	ability level The language conveyed has the ability to motivate students to learn	1
	Use of Terms and Symbols	Consistency in using terms and symbols	1
		Accuracy and effectiveness in the use of terms and symbols	1
		Total	12

Graphic Design Expert Team Validation Sheet

Graphic Design expert team consist of 2 lecturers. They are Dr. Rachmat Mulyana, M.Sc. and Mr. Prof. Dr. Muhammad Badiran, M.Pd. The instrument grid can be seen in the table 4.

Table 4. Instrument grid for linguists and context expert.

Aspect	Assessment Indicator	Amount
Design Aspect	The attractiveness of displaying images in textbooks can motivate student learning	1
	Good use of space in textbooks	1
	The attractiveness of delivering material in textbooks	1
	The sequence of sentence scenarios between pages is appropriate	1
	The size of the image on each page is appropriate	1
	The layout of each page is balanced	1
	Be creative in pouring the next idea/image into the textbook	1
	The color gradation of each page is appropriate	1
	The layout of each page of the textbook is right	1
	Attractive and precise cover design	1
	Total	10

Data Analysis Technique

The acquired information pertains to the condition of the textbooks used in the Biotechnology course. This research instrument in the form of a Likert scale that had been scored as described in Table 5 was handed to the expert validator.

Table 5. Likert scale scoring guidelines criteria.

No	Answer	Score
1	Very good	4
2	Well	3
3	Poor	2
4	Not Recommended	1

Then the data were analyzed using descriptive statistics by calculating the percentage score for each criterion in the developed book, with the formula:

$$\text{Score Percentage} = \frac{Number\ of\ indicator\ for\ each\ category}{Number\ of\ total\ indicator\ categories} \times 100$$ (Adisendjaja, 2008)

From the results of calculations using the formula above will produce numbers in the form of percent. The score obtained is then interpreted with a qualitative sentence, according to the Table 6.

Table 6. Likert scale scoring guidelines criteria.

No	Answer	Score
A	81 % ≤ X ≤ 100 %	Very good
B	61 % ≤ X ≤ 80 %	Well
C	41 % ≤ X ≤ 60 %	Moderate
D	21 % ≤ X ≤ 40 %	Poor
E	0 % ≤ X ≤ 20 %	Not Recommended

(Trianto, 2010)

Revision

After all the experts validate the product, the researcher will improve it and rearrange it according to the tips and suggestions from the material, design, and graphic experts.

FINDINGS AND DISCUSSION

Expert validation is conducted on three aspects of the validity of a textbook, namely material validity, language validity, and design validity, which are evaluated by each expert.

Material Expert Validation

Material expert validation was conducted by Mrs. Dr. Saleha Hanum, M.Sc., a biology lecturer at the University of North Sumatra who specializes in DNA Isolation and Amplification, and Mr. Eko Prasetya, M.Sc., a biology lecturer at the State University of Medan who specializes in DNA Isolation and Amplification. The evaluation conducted by the two specialists aimed to improve the quality of the textbook's content. Material specialists evaluate aspects such as the quality of learning materials, learning delivery systems, learning methodologies, and learning materials. Figure 2 depicts the results of the final evaluation of each of these factors by material specialists.

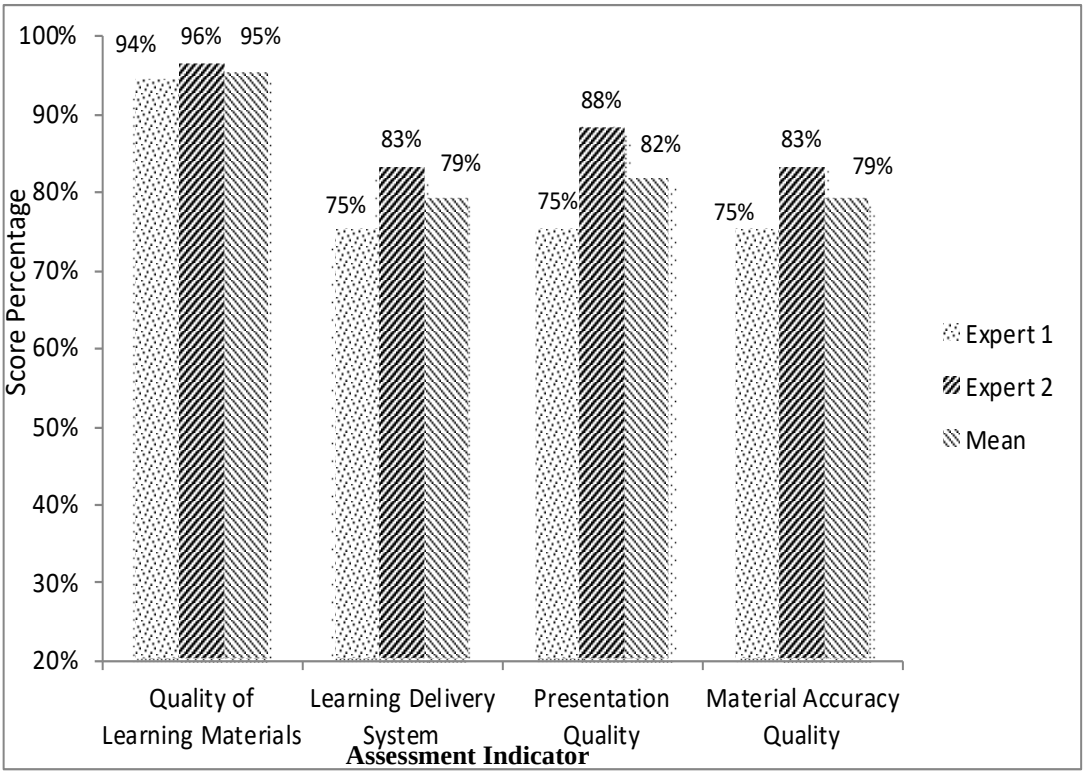
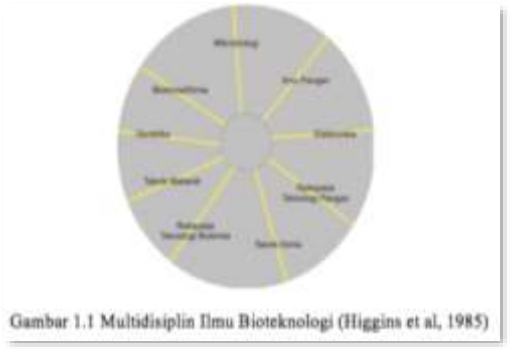
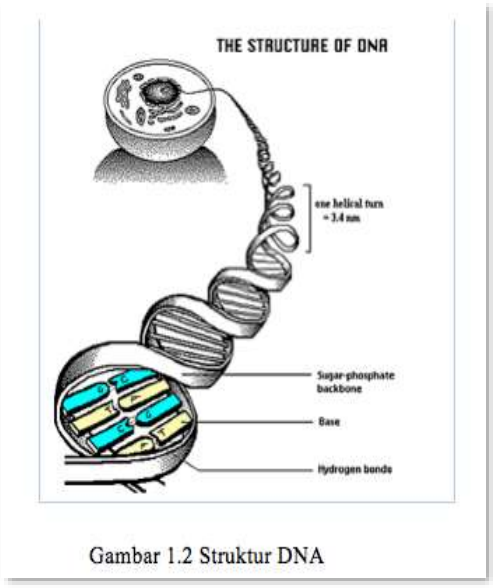
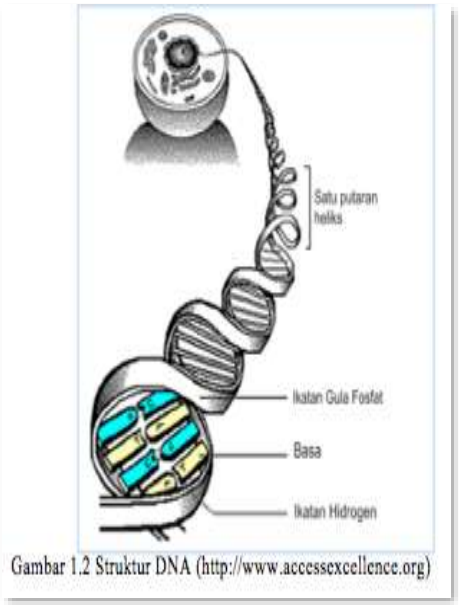


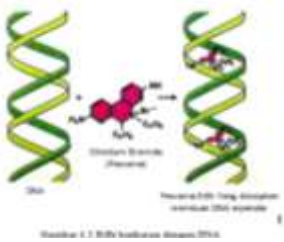
Figure 2. The results of the validation of the isolation and amplification of DNA textbooks by a team of material experts. Percentage is the average result of the assessment based on a questionnaire using a Likert scale of 1-4. The average assessment of the two experts on the aspect of the quality of learning materials is 95% (very good), the learning delivery system is 79% (very good), the quality of learning strategies is 82% (very good), and the quality of learning materials is 79% (very good).

The average rating of the two experts is 84% and is considered to be excellent. Based on the evaluation results, the material expert team determined that the book was of high quality and worthy of use. The book has been revised based on material expert suggestions on this aspect, presented in the table 7 below.

Table 7. Comparison of the results of the revision before and after by material experts.

No	Before Revision	After Revision
1.	 Gambar 1.1 Multidisiplin Ilmu Bioteknologi (Higgins et al, 1985)	 Gambar 1.1 Multidisiplin Ilmu Bioteknologi (Higgins et al, 1985)
	Revisions are made to Figure 1.1 on page 3 by recreating the image without destroying the original image source.	
2.	Sodium dodecyl sulfate (SDS) is the most commonly used detergent in the lysis of cell membranes.	Sodium dodecyl sulfate (SDS) is a cationic detergent capable of dissolving lipid components and damaging the structure of cell membranes (Kesmen, 2009). The DNA isolation method with SDS is better known as the phenol-chloroform method. After the cell structure is damaged, the components in it such as RNA, DNA, lipids and carbohydrates will come out.
	Revisions are carried out by reviewing all the usage of definitions and concepts offered in the book and making corrections if there are still shortcomings in the definitions and concepts.	
3.	 Gambar 1.2 Struktur DNA	 Gambar 1.2 Struktur DNA (http://www.accessexcellence.org)

	Revisions are produced by adding Indonesian captions to 1.2 of the book's images, so converting their original English text to Indonesian.	
4.	To separate cells from their tissues or separate cells from one another, mechanical techniques are generally used, namely by crushing or vortexing and then adding saline solution, then adding detergent. the membrane is removed.	The process of breaking or destroying cell walls and membranes is carried out to remove cell contents and obtain DNA. There are several ways that can be used, namely, physically (mechanically), chemically and enzymatically. Physically by grinding using a mortar and pestle with liquid nitrogen, and can also be done by freezing-thawing and irradiation.
	In publications describing the DNA isolation procedure, the word order and use of non-standard loanwords have been modified, and simple language has been reinstated. Several paragraphs on page 6 are revised by correcting, modifying, and rewriting language that are good and easy to grasp.	
5.		The amplification process by PCR aims to duplicate or multiply DNA sequences/pieces in a short time and in large quantities. PCR or polymerase chain reaction involves the polymerase enzyme which is carried out repeatedly.
	Adding an overview of the amplification process, which will be detailed in the book's introduction chapter, because the amplification process was not initially explained in the introductory chapter.	
6.	The addition of other reagents such as Tris-HCL, NaCl, EDTA and 2-mercaptoethanol is common when using CTAB buffer. Polyphenol compounds need to be removed in order to obtain good DNA quality. Polyphenols can also inhibit the reaction of the taq polymerase enzyme during amplification.	The addition of other reagents such as Tris-HCL, NaCl, EDTA and 2-mercaptoethanol is common when using CTAB buffer. NaCl functions to remove polysaccharides while -mercaptoethanol functions to remove polyphenols in plant cells by forming hydrogen bonds with polyphenolic compounds which will then separate from DNA (Lodhi et al., 1994). Polyphenol compounds need to be removed in order to obtain good DNA quality (Moyo et al., 2008). Polyphenols can also inhibit the reaction of the Taq polymerase enzyme during amplification. In addition, polyphenols will reduce the yield of DNA extraction and reduce the level of DNA purity (Porebskiet al., 1997).
	Enhance the understanding of the function of NaCl, mercaptoethanol, and buffer solutions in the DNA separation procedure, particularly in the destruction of cell walls and membranes.	

8.	Untuk mengukur konsentrasi DNA digunakan rumus sebagai berikut: **[DNA] = Å260 x 50 x faktor pengenceran** $Å_{260}$ = Nilai absorbansi pada λ 260 nm 50 = larutan dengan nilai absorbansi 1.0 sebanding dengan 50 ug untai ganda DNA per ml (dsDNA) **[RNA] = Å260 x 40 x faktor pengenceran** 40 = 40ug/ml untai tunggal RNA (ssRNA)	yang terlebihkan didalam sampel. Untuk mengukur konsentrasi DNA digunakan rumus sebagai berikut: **[DNA] = Å260 x 50 x faktor pengenceran** $Å_{260}$ = Nilai absorbansi pada λ 260 nm 50 = Konstanta (setiap larutan DNA yang mengandung nilai absorbansi 1.0 sebanding dengan 50 ug DNA per ml (dsDNA) **[RNA] = Å260 x 40 x faktor pengenceran** 40 = Konstanta (setiap larutan RNA yang mengandung nilai absorbansi 1.0 sebanding dengan 40ug/ml RNA (ssRNA)
	Corrected the description of the DNA concentration calculation formula.	
9.		Ethidium bromide itself is a fluorescent dye that can infiltrate nucleic acid bases so that nucleic acid fragments can be detected in the gel (Sharp et al. 1973; Boffey 1984; Lodge et al. 2007; Harrington, 1993, Lane et al. ., 1992). The gel from the electropheresis was exposed under an ultraviolet lamp. Then the image produced on the gel by UV light is taken using a polaroid or digital camera. The resulting image can be black and white or reddish orange. 
	EtBr was added to the DNA electrophoresis concept to make it visible under UV light.	
10	 	
	Complete the research tools and materials and arrange them in the order in which they are used.	

Language and Context Expert Validation

Mrs. Dr. Saleha Hanum, M.Sc., a biology lecturer who specializes in DNA Isolation, Amplification, and Visualization at the University of North Sumatra, and Mr. Eko Prasetya, M.Sc., a biology lecturer who specializes in DNA Isolation, Amplification, and Visualization at the State University of Medan, conducted the validation of linguists. The objective of the evaluation by the two specialists was to enhance the linguistic quality of the book Isolation, Amplification, and Visualization of DNA. Linguists evaluate communicative, plain, dialogical, and interactive aspects, as well as the use of terminology and symbols. Figure 3 is a diagram depicting the outcomes of the linguists' final evaluations of each of these factors.

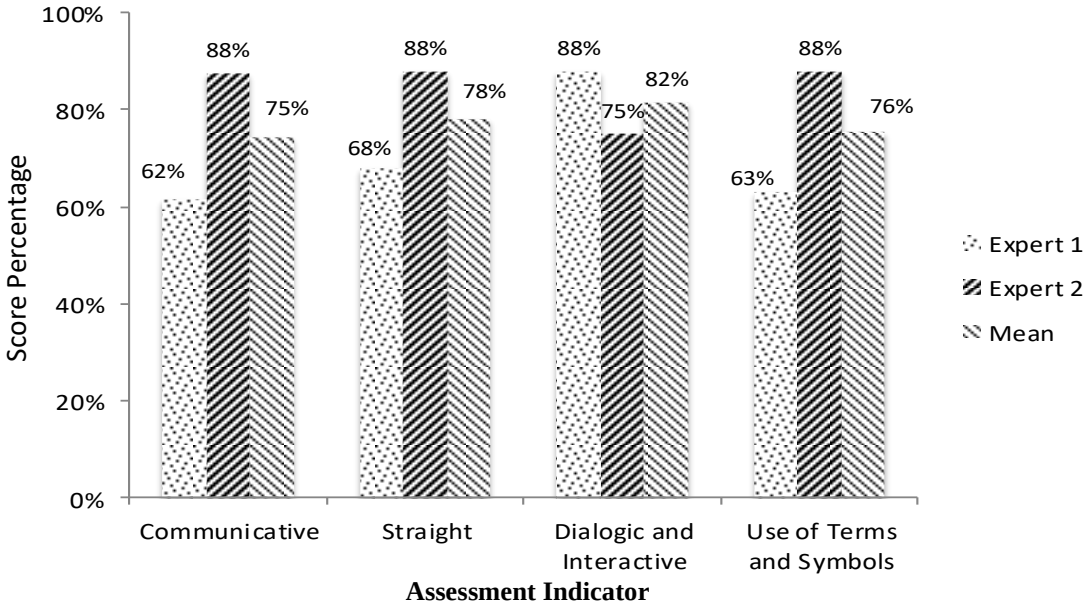
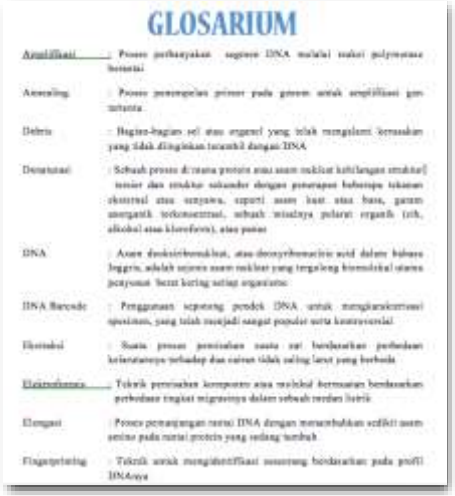
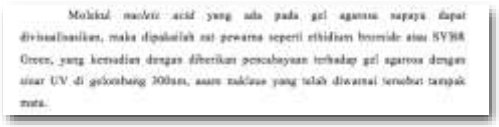
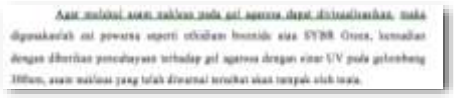
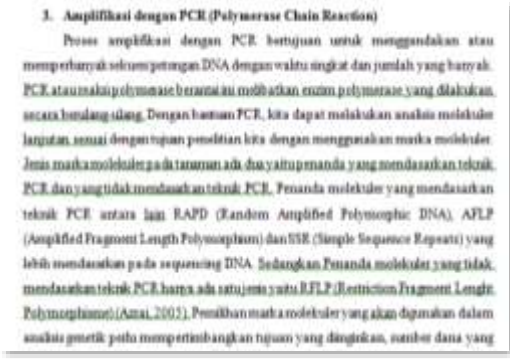
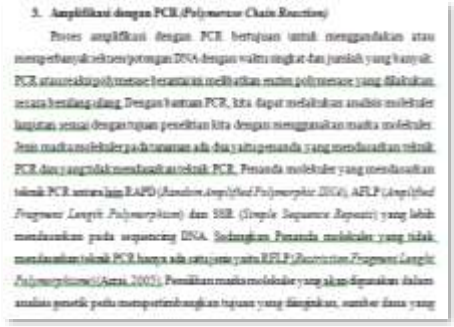


Figure 3. The results of the validation of the isolation and amplification of DNA textbooks by a team of language and context experts. Percentage is the average result of the assessment based on a questionnaire using a Likert scale of 1-4. The average assessment of the two experts on the communicative aspect is 75% (very good), the straightforward aspect is 78% (very good), the dialogical and interactive aspects are 82% (very good), and the use of terms and symbols is 76% (very good).

The average score on the language element from the two experts was 77%, indicating that, from a language perspective, the expert team deemed the book to be of high quality and usable. The book has been updated based on linguists' recommendations, as shown in Table 8.

Table 8. Comparison of the results of the revision before and after by language and context experts

No	Before Revision	After Revision
1.		 Added glossary and index.
2.	 Molekul nucleic acid yang ada pada gel agarosa supaya dapat divisualisasikan, maka dipakailah zat pewarna seperti ethidium bromide atau SYBR Green, yang kemudian dengan diberikan pencahayaan terhadap gel agarosa dengan sinar UV di gelombang 300nm, asam nukleus yang telah diwarnai tersebut tampak nyata.	 Asam nukleat asam nukleus pada gel agarosa dapat divisualisasikan, maka digunakanlah zat pewarna seperti ethidium bromide atau SYBR Green, kemudian dengan diberikan pencahayaan terhadap gel agarosa dengan sinar UV pada gelombang 300nm, asam nukleus yang telah diwarnai tersebut akan tampak sich nyata. Improve the use of sentences that are less effective.
3.	 3. Amplifikasi dengan PCR (Polymerase Chain Reaction) Proses amplifikasi dengan PCR bertujuan untuk menggandakan atau memperbanyak sekuens potongan DNA dengan waktu singkat dan jumlah yang banyak. PCR atau reaksi polymerase berantai ini melibatkan enzim polymerase yang dilakukan secara berulang ulang. Dengan bantuan PCR, kita dapat melakukan analisis molekuler lanjutan, sesuai dengan tujuan penelitian kita dengan menggunakan marka molekuler. Jenis marka molekuler pada tanaman ada dua yaitu penanda yang mendasarkan teknik PCR dan yang tidak mendasarkan teknik PCR. Penanda molekuler yang mendasarkan teknik PCR antara lain RAPD (Random Amplified Polymorphic DNA), AFLP (Amplified Fragment Length Polymorphism) dan SSR (Simple Sequence Repeats) yang lebih mendasarkan pada sequencing DNA. Sedangkan Penanda molekuler yang tidak mendasarkan teknik PCR hanya ada satu jenis yaitu RFLP (Restriction Fragment Length Polymorphisme) (Azrai, 2005). Pemilihan marka molekuler yang akan digunakan dalam analisis genetik perlu mempertimbangkan tujuan yang diinginkan, sumber dana yang	 3. Amplifikasi dengan PCR (Polymerase Chain Reaction) Proses amplifikasi dengan PCR bertujuan untuk menggandakan atau memperbanyak sekuens potongan DNA dengan waktu singkat dan jumlah yang banyak. PCR atau reaksi polymerase berantai ini melibatkan enzim polymerase yang dilakukan secara berulang ulang. Dengan bantuan PCR, kita dapat melakukan analisis molekuler lanjutan, sesuai dengan tujuan penelitian kita dengan menggunakan marka molekuler. Jenis marka molekuler pada tanaman ada dua yaitu penanda yang mendasarkan teknik PCR dan yang tidak mendasarkan teknik PCR. Penanda molekuler yang mendasarkan teknik PCR antara lain RAPD (*Random Amplified Polymorphic DNA*), AFLP (*Amplified Fragment Length Polymorphism*) dan SSR (*Simple Sequence Repeats*) yang lebih mendasarkan pada sequencing DNA. Sedangkan Penanda molekuler yang tidak mendasarkan teknik PCR hanya ada satu jenis yaitu RFLP (*Restriction Fragment Length Polymorphisme*) (Azrai, 2005). Pemilihan marka molekuler yang akan digunakan dalam analisis genetik perlu mempertimbangkan tujuan yang diinginkan, sumber dana yang Consistent usage of terminology and symbols, as well as slashes for foreign terms, then proofread and correct.

Language and Context Expert Validation

The validation of the book design expert was conducted by Dr. Rachmat Mulyana, a lecturer in educational technology and a book expert at Medan State University, and Drs. Sriadhi, M.Pd., M.Kom., Ph.D., also a lecturers in educational technology and book experts at Medan State University. The objective of the evaluation conducted by the two specialists was to enhance the quality of the generated book's layout. The book

Isolation, Amplification, and Visualization of DNA was validated by a team of media design specialists based on four criteria: leather design, leather typography, content design, and content illustration. Figure 4 is a graphical representation of the final results of the evaluation of the two validators.

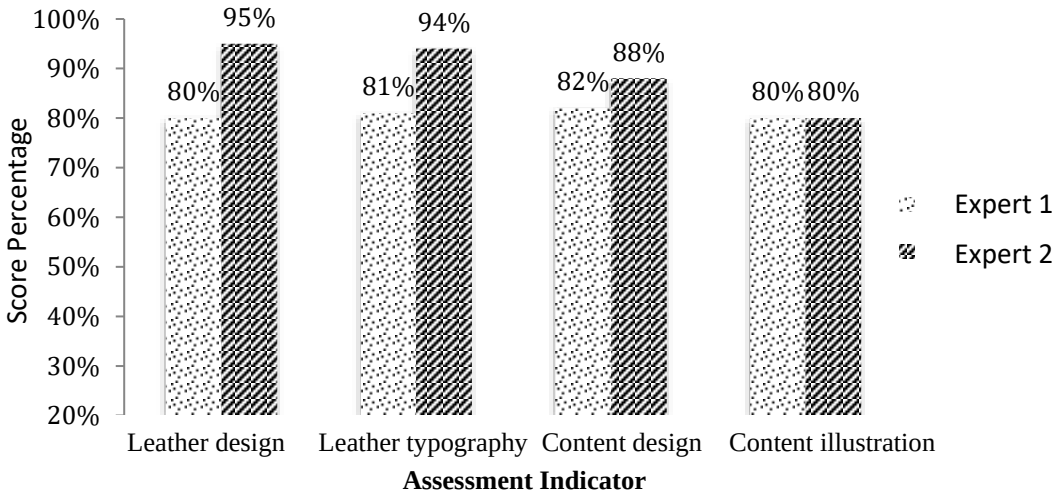
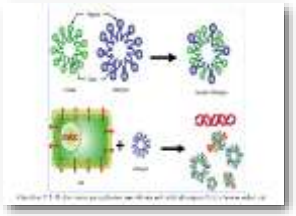
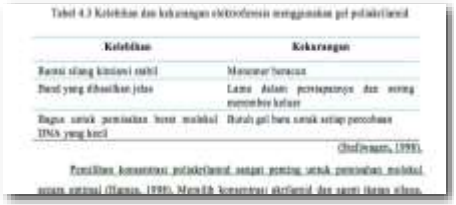


Figure 4. The results of the validation of the isolation and amplification of DNA textbooks by a team of design experts. Percentage is the average result of the assessment based on a questionnaire using a Likert scale of 1-4. The average rating of the two experts on the leather design aspect is 88% (very good), leather typography 88% (very good), content design 85% (very good), and illustration content 80% (very good).

The average score of the two experts is 85 percent, which is regarded as excellent. The evaluation results indicate that, from the standpoint of a design expert, the team of experts deemed the book to be of high quality and worthy of use. Table 9 displays the book revisions made by design experts.

Table 9. Comparison of the results of the revision before and after by design experts.

No	Before Revision	After Revision
1.		
	Change the placement of the table title to the top of the table and the source citation to the bottom.	

2.	
	Listing the source for each image
3.	 
	Improve the color scheme to make it more engaging.
4.	An arrangement of color gradients. So that it is not predominately gray
5.	
	Fixed citation formatting.
6.	Add user manual

This research led to development of a book, which will be the subject of this paper. This book offers supplementary educational material for biotechnology studies. According to Adalikwu & Iorkpilgh (2013), the instructional materials themselves serve as a facilitator between educators and students and foster student motivation during learning activities. The developed book can be utilized as a resource for lecturers to implement the learning process for their students.

The developed book's title is "DNA Isolation, Amplification, and Visualization". In accordance with the 2017 Guidelines for the Preparation of Learning Tools and Higher Education Teaching Materials, the Directorate General of Learning and Student Affairs stipulates that a book must include the following elements: (1) Preface, (2) Table of Contents, (3) Body divided into chapters or sections, (4) Bibliography, (5) Glossary, and (6) Index List. The opening section of the prepared book includes a book cover,

introduction, table of contents, list of photos, list of tables, list of abbreviations, and instructions for using the book, as well as the lecturer's role in learning. Six chapters comprise the torso or core. In addition, each chapter contains a synopsis, practice questions, and a list of references. The glossary and index are located at the end of the book and serve as a conclusion to the entire text. According to Sakraida & Draus (2005), books must be meticulously created so that they may be utilized effectively.

According to Primiani (2014), the creation of research books is one of the actions that can broaden and deepen more applicable content. In addition, students as book readers will have a better contextual understanding of research-related learning materials. This is essential for assisting students in the learning process by facilitating their comprehension of theoretical concepts and motivating them to conduct mini-research. This is consistent with Ibana's (2015) assertion that research-based books can be selected as a method for creating research results since they are adaptable and the books generated can be utilized by students to aid in the learning process. Therefore, the information from the research results will be compiled into a book based on research and supplemented with extra pertinent literature. In addition to being valuable for the development of biotechnology in the molecular field, the material offered in the book is also useful for the advancement of biotechnology in the molecular sector. The most effective strategy for improving learning outcomes is the creation of instructional resources that meet the needs of the community of learners (Hera et al., 2014).

According to the validation results of a team of subject matter experts, linguists, and design experts, this book is worth using. The outcomes of the construction of the textbook for this Biotechnology course have been amended based on the advice of validator specialists. Reviews by experts are crucial for determining the viewpoint of each expert on the book written from the perspective of their individual expertise (Lestari, 2013). Referring to the regulation of the Minister of National Education of the Republic of Indonesia Number 2 of 2008, it is stated that a book eligible for use as instructional material must meet the following quality (standard) criteria: (1) content/material feasibility, (2) presentation feasibility, (3) language feasibility, and (4) graphic feasibility. These requirements have been stated in the validation sheet components that are evaluated by the validator.

According to the findings of a data analysis conducted on the development of product books, this book is appropriate for use as a supplementary material in Biotechnology courses. The findings of this feasibility study are observable based on the 84 percent accuracy of the information supplied in the book produced by material specialists. This book based on research is meant to aid students in comprehending the principles of DNA Isolation, Amplification, and Visualization.

Additionally, it is envisaged that students would be able to relate theoretical studies to current situations. According to Oktaviana at al. (2015), research-based books have a significant influence on students' comprehension of abstract ideas in textbooks, resulting in a more realistic comprehension.

The viability of the book was also validated by linguists in order to assess the sequence of language, effectiveness, consistency, and appropriateness and correctness of sentence patterns in line with excellent and proper Indonesian language. This may facilitate student comprehension of the information for DNA isolation, amplification, and visualization. This book about biotechnology based on research will be simpler for pupils to comprehend with improved grammar. The book has a high level of readability, piques the reader's attention, and is visually appealing. 77 percent of this linguist's validation findings are within the acceptable range and may be used.

The validity of this book was also validated by design professionals. The goal of this design validation is to evaluate the physical characteristics of the book, including its size, appearance, picture illustrations, and layout. This element may help readers appreciate well-packaged books, so increasing their desire in reading them so that they can be utilized as supplementary materials in Biotechnology classes. The average validation score from design professionals is 85 percent, indicating that this book is deserving of placement in the very excellent category. The achieved score indicates that this book meets the requirements for a book.

Thus, it can be stated that this book is suitable for use in biotechnology lectures as a learning medium according to material experts, biotechnologists, linguists, and design experts.

CONCLUSION

The research based book on isolation, amplification, and visualization material product passed validation by materials experts, linguists experts, and design experts with scores of 84% (very good), 77% (very good), and 85%. (very good).

According to expert validation, this product book can help students study biotechnology, particularly DNA isolation and amplification. The developed book is very systematic, informative, and learning-supportive, so potential students will always be motivated to learn based on their own learning style.

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