

Development of Research Based Book on Mendel Genetics In Biology Major Universitas Negeri Medan

Naimatussyifa Daulay (a*), Tumiur Gultom (b), Martina Restuati (c)

Department of Biology Education
 Postgraduate Program of Universitas Negeri Medan
 Deli Serdang, Indonesia*
 syifalovato@gmail.com*

Abstract - The aim of the study was to produce a product in the form of a textbook based on research about Mendel genetics on *Drosophila melanogaster* that are suitable for use in Genetic course. The development model used in this study is the Thiagarajan (4D). The test subjects were genetics material expert, language, learning, and layouts. The results of product validation by material experts amounted to 95,4%, the language expert was 84,37% , the learning design expert was 94,4%, and expert layout was 85%. It can be concluded that the product can be used as an additional textbook in learning activities in the Genetic course and there is no revision.

Key words – *Textbook; 4D Development Model; Mendel Genetics; Drosophila melanogaster*

I. INTRODUCTION

Textbooks are print learning media that contains knowledge of the results of the analysis curriculum in written form. Preparation of textbook is to provide textbooks that are in accordance with the demands of the curriculum by considering aspects of student needs, the characteristics and environment of students, helping students obtain alternative textbooks other than textbooks, and facilitate an educator in the learning process (Habibi, 2016). Genetic material is considered abstract so it is difficult to understand (Corebima, 2009). Genetics is one of the most difficult topics in science education (Tsui, 2010). Jalmo (2018) that Genetics is difficult to be learned by students, one of which is heredity, so we need a good technique in learning it. Based on information from the Genetics Lecturer on the Mendelian Genetics topic is difficult to understand also abstract for biology students.

Based on a questionnaire given to undergraduate students of the Biology Major Universitas Negeri Medan that the book they have in learning genetics is a book written by lecturer to supporting a course. There are also borrowing books from libraries that have limited stock. The scope of the chapter discussing Mendelian Genetics is not very supportive for students. The books are still in the form of contextual material that is not accompanied by research results. In the process of learning Genetics includes presentations and discussions of the results of student studies from journals as well as additional explanations from supporting lecturers. Assignments are also emphasized in the making of papers, although there are

assignments on mini research but not accompanied by guidelines.

Through the distribution of student needs analysis questionnaire as many as 27 students that 85% stated that the textbooks used to study Mendelian Genetics exist but are not so profound, other than that the material is only in the form of content material. 67% said it was difficult to understand Mendel's Genetic material. Through interviews conducted on 10 random students that they are abstract in understanding Mendelian Genetics and need a clear guidebook in learning it. 74% stated that it is very important teaching materials about Mendel Genetics based on research and 78% of them also said teaching materials accompanied by mini research would be very helpful for them.

One of the effort that can be done is by developing research based Mendel Genetics textbooks. This was also strengthened by Permenristekdikti Number 44 of 2015 that mandatory forms of learning must be added in the form of research, design, or development that is integrating the results of research into learning, and supported by the Indonesian National Qualification Framework Curriculum (KKNI), namely mini research activities. Research results that are integrated in teaching materials are effectively used in learning because they are more applicable and meet the present elements (Parmin, 2012). Research-based learning aims to create a learning process that leads to analysis, synthesis, and evaluation activities and to improve the ability of students and lecturers in the assimilation and application of knowledge (Widyawati, Tridiah et al, 2010).

The purpose of this study was to determine the feasibility of the material, language, presentation, and layout of the Development of Mendel Genetics Textbook Based on Research in the Biology Major Universitas Negeri Medan.

II. RESEARCH METHODS

A. Location and Time of Reseach

Research location is in the Biology Major Universitas Negeri Medan. Development of Textbooks Mendelian genetics was carried out in January until June 2019.

B. Research Subjects

Material and language expert by genetics lecturer, learning design expert by biology education lecturer, graphic expert by

educational technology lecturer, and biology or biology education students.

C. Procedures for Developing Textbooks

This stage aims to establish basic problems, analyze the curriculum, analyze student characteristics, and analyze the essential concepts of the material as the content of textbooks. An analysis of student needs was carried out in the form of administering questionnaires to 27 students. The result is that they need teaching material that contains research on the topic of Mendelian genetics, namely the crossing of *Drosophila melanogaster*, while teaching materials accompanied by research results are not yet available in the Biology Major. In addition, interviews with 10 Biology students have made it difficult for them to understand Mendel's Genetic material it also that Genetics Lecturer said that mendels theory was abstract for students. Curriculum analyze is by checking of semester learning plan of genetics was carried out to see the basic competencies and indicators in the Genetics Course.

The initial step taken is to realize the definition stage into the design stage. To design a prototype of a textbook product, research in the laboratory is needed as initial research for the development of textbooks. After the research is carried out, the textbook product is developed based on the research results as the main reference. Research in the Laboratory, by

III. RESULTS AND DISCUSSION

The average rating of the two experts was 95.4% and classified as very good. The results of this assessment showed

TABLE 1. PERCENTAGE OF RATINGS FROM THE MATERIAL EXPERT TEAM ON THE SUITABILITY OF THE MATERIAL/CONTENT

No	Assessment component	Average (%)	Criteria
1	Presentation of content (availability in books)	92,6	Very good
2	Feasibility of content (conformity with curriculum / competency achievement)	98,9	
3	Learning strategies in books (conformity with research-based learning)	94,7	
Average		95,4	Very good

The average assessment of the suitability of the book against Genetic learning based on the assessment component is 94.4% and is classified as very good. The results of this

looking at the crossing of *Drosophila melanogaster* according to the Mendelian Genetic principle that is *monohybrid*, *dihybrid*, *back cross*, and *test cross*. Research objectives are (1) students are able to find out the sterilization of tools in *Drosophila melanogaster* crossing research, (2) students are able to know the making of *Drosophila melanogaster* food, (3) students are able to use Stereo Microscopes in *Drosophila melanogaster* observations, (4) students are able to know the procedures for Monohybrid Cross, (5) students are able to know the procedure for Dihybrid Cross, (6) students are able to know the procedures for *Back Cross*, (7) students are able to know the procedures for *Test Cross*, (8) students are skilled in doing Mendelian Genetic research.

At this stage the design of the textbook is carried out to produce a prototype of the textbook as an initial draft. Some things are done in media selection, additional Mendelian Genetic theory teaching materials in various book and journal sources, format selection, then initial design.

At the development stage it is only limited to product evaluation using a questionnaire. The phase that went through namely the assessment of expert teams. The product is validated and revised by material experts, linguists, instructional design experts, and layout design experts. Then the product is corrected by the researcher and validated again to show good feasibility.

that in terms of material, the expert team considered the book to be good and could be used in the actual field as a textbook in learning activities and there were no revisions.

assessment indicate that in terms of learning design experts assess the book that this book is feasible and can be utilized in the actual field of learning activities.

TABLE 2. PERCENTAGE OF RATINGS FROM LEARNING DESIGN EXPERTS

No	Assessment component	Average (%)	Criteria
1	Presentation Eligibility (availability in the book)	100	Very good
2	Feasibility of content (conformity with curriculum / competency achievement)	91,6	
3	Learning strategies in books (conformity with research-based learning)	91,6	
Average		94,4	Very good

The average language assessment in the textbooks developed based on the assessment component is 84.37% and is classified as very good. The results of this assessment

indicate that in terms of language experts assess the book that this book is feasible and can be utilized in the actual field of learning activities.

TABLE 3. PERCENTAGE OF THE ASSESSMENT OF LINGUISTS ON THE BOOKS DEVELOPED

No	Assessment component	Average (%)	Criteria
1	Communicative	81,25	Very good
2	Straightforward	93,75	
3	Dialogical and Interactive	87,5	Very good
4	Use of terms and symbols	75	Good
Average		84,37%	Very good

The average layout assessment of Mendel Genetic Teaching Book is 82.5% and is classified as very good. The results of this assessment indicate that in terms of layout,

experts assess the book that this book is feasible and can be utilized in the actual field as a textbook in learning activities and there is no revision.

TABLE 4. PERCENTAGE ASSESSMENT OF THE LAYOUT DESIGN TEAM OF EXPERTS DEVELOPED BOOKS

No	Assessment component	Average (%)	Criteria
1	Leather Design	80	Very good
2	Skin typography	84.3	Very good
3	Content design	81.8	Very good
4	Illustration of contents	85	Very good
Average		82.5	Very good

The product that has been developed in this research is a Mendel Genetic Textbook based on research on *Drosophila melanogaster*. Imana (2015) which states that research-based books can be selected as a means of developing research results because they are flexible and books that are compiled can be useful for students to support the learning process.

Learning will take place effectively if it is equipped with teaching materials, one of the teaching materials is books (Permana, 2015). Research results that are integrated in teaching materials are effectively used in learning because they are more applicable and meet the present elements (Parmin, 2012). Learning using books can facilitate the learning process so as to help achieve the competency completeness of students (Anggela, 2013). Teaching books are books that contain knowledge derived from basic competencies set out in the curriculum and arranged systematically and used by students to study (Prastowo, 2012). So that the development of Mendel's Genetic Textbook based on research is very appropriate to see the condition of UNIMED Biology Major students.

According to Millah (2012) that teaching books are a set of subject matter materials that are arranged systematically displaying the integrity of competencies that will be mastered by students in learning activities. Research-based textbooks that are developed can help students in the learning process, especially in theoretical concepts and are educated in conducting research. Many research findings suggest that research-based learning is learning that is able to develop students' research abilities. Waris (2009) explains that research-based learning developed at the Bandung Institute of Technology can foster independence of learning, critical abilities, creative abilities, and good communication. Research-based learning has been proven to have the carrying capacity of research skills based on learning in higher education.

The process of developing books is adjusted to the instructional objectives of the course, then gathering various information from various library sources, such as textbooks, scientific articles, journals, then packaged according to student needs and written as teaching materials using a systematic

framework (Husamah, 2015). The purpose of the preparation of this textbook is to provide textbooks in accordance with the demands of the curriculum by considering aspects of student needs, among others in accordance with the characteristics and environment of students, helping students obtain alternative textbooks other than textbooks, and facilitate an educator in the learning process (Habibi, 2016). The ability that needs to be achieved in the use of this textbook based is to recognize *Drosophila melanogaster* as a genetic research model, understand Mendel's genetic concepts, and be able to carry out research or mini research independently or in groups. In making this Mendel Genetic textbook, the authors refer to the development of the 4D model , where the steps of writing research development in accordance with predetermined limitations so that it is expected to be good if applied to the scope of lectures.

Based on the National Education Standards Agency (2006) that the feasibility of teaching materials is seen from the ability of teaching materials to meet the standards of eligibility assessment which consists of the feasibility of content, language, presentation, and graphics. The textbooks that have been developed have been adjusted to the standards of the book eligibility category in the assessment which includes the content, presentation, and language contained in the validation sheet which was previously reviewed by the validator expert. According to Prasetyo (2017) the material developed should be related to the achievement of competencies that must be mastered by students because the material contained in books helps students to master various competencies that have been determined. In making it easier for students to know what competencies must be mastered, the authors include the goals or learning outcomes in each chapter in the developed book.

Development of teaching materials needs to be done systematically based on interrelated steps to produce quality teaching materials. The development of teaching materials itself is an effort in the preparation of teaching materials which are certainly adjusted to the academic needs of students (Fauziah, 2015). This is in line with the background of the problems of the authors related to the development of textbooks prepared by supporting the involvement of students

in research-based learning in accordance with the KKNi and also the statement of Permenristekdikti No. 44 of 2015 that must be added to the form of learning in the form of research, design, or development.

Research-based learning is one of the student-centered learning (SCL) methods that integrates research into the learning process (UGM, 2010). This research-based teaching book is expected to help students understand the concept of Mendel Genetics as well as *Drosophila melanogaster* and relate it to life. Research-based provides opportunities for students to search for information, formulate hypotheses, collect data, analyze data, and make conclusions on data that has been arranged. The approach of using research-based learning can change the focus of education from memorizing concepts and facts to in learning, then students try to answer to understand or solve a problem.

In the feasibility of presenting the content by a team of material expert validators namely availability in books related to systematic content, motivational sentences, attractiveness, material relevance, presentation of material gets a value of 92.6%. Furthermore, on the appropriateness of the contents of the suitability of the book with the curriculum or the achievement of competencies scored 98.9%, and learning strategies in books related to research-based learning scored 94.7%. The linguists got an average score of 84.37% with a very good category. According to (Pangastuti, 2016), books must be presented coherently, straightforwardly, materials develop knowledge, foster motivation to think further, presentation of material develops physical activity, is good enough in motivating students to create, innovate, and apply based on materials, tools, the stages of work, and the content of the presentation.

Validator's suggestion that glossary retrieval should be based on a trusted biology dictionary source, because if wrong meaning can damage the actual concept, language validator that made a strong statement on the conclusion that the packaging of the book discussion is contained. Sentences are presented simply with a maximum of 30 words per sentence to facilitate the reader in understanding the sentence (Warwork, 2013). Language standards include: using good and correct Indonesian, terminology adheres to enhanced spelling, clarity of language used, language suitability, and ease of language (Prastowo, 2012).

Validation by the layout design team assessed components including skin design, skin typography, content design, and content illustration. The purpose of this assessment is to assess the quality of the developed book graphics. The average validation result from the layout design team was 82.5% with a very good category. This shows that this book includes the criteria that must be owned by a book.

Limitations in the research development of the Mendelian Genetic Textbook based on research on *Drosophila melanogaster* include; ; (2) books are still supported by limited sources or references; (3) books have not been designed by adequate graphic art and have not yet been given an ISBN; (4) limited only to see the feasibility of material and language content by the material expert team, the feasibility of

learning design by the learning design expert, and the feasibility of the layout by the layout expert team, as well as the students' responses as users of development products in the form of research-based books on crossing *Drosophila melanogaster*, so that the book has not been tested to see its effectiveness and efficiency. Textbooks developed have advantages and disadvantages. The advantages of books that have been developed include: (1) systematically arranged from general to specific by presenting information on introduction of *Drosophila melanogaster* in general then the results of variations of *Drosophila melanogaster* specifically from the results of research; (2) the book is compiled from the results of the author's research so that students get an overview of the research and its stages; (3) the book is equipped with learning achievements in each chapter; (4) systematically arranged according to the format of writing a book contained in the course description, background, material, research activities for students, questions and answers as an evaluation for students; (5) there are motivational sentences for students to be enthusiastic in conducting research; (6) the book has been validated by experts namely material experts, linguists, learning design experts, and layout experts. The weaknesses of this research-based textbook are; (1) the material described is little, in the sense of not being able to represent the Genetics course, (2) the picture presented is the result of a private collection may not be appropriate in lighting or image positioning, and (3) this book has not been tested to see its effectiveness due to the limitations of researchers.

IV. CONCLUSION

Based on the research objectives, results and discussion of the development of the Mendelian Genetic Textbook based on research on *Drosophila melanogaster* in the Genetics course in the Biology Major Universitas Negeri Medan previously written, the research conclusions are as follows: (1) Mendel's Genetic Textbook based on research on *Drosophila melanogaster* is considered feasible and can be used in learning based on the results of the validation of the material expert team with a percentage of values of 95.4% (very good), (2) Mendel's Genetic Textbook based on research on *Drosophila melanogaster* is declared feasible and can be used in learning based on the results of the validation of linguists is 84.37% with a very good category, (3) Mendel's Genetic Textbook based on research on *Drosophila melanogaster* is considered feasible and can be used in learning based on the results of the design expert team's validation with a percentage of values of 94.4% (very good) and 85% (very good).

ACKNOWLEDGMENTS

Thank you to beloved parents, Dr. Hj. Nurmawati, MA and Drs. H. Ahmad Riadi Daulay, M.Ag. Thank you to beloved husband, Zul Anwar Rambe, S.Sos. Thank you to the whole family, Rabiah Afifah Daulay, M.Pd, Dira Anisah Ulfah Daulay, S.Psi, Miskah Hanum, SH, Ade Satria Hasibuan, S.Pd, and Nazlah Khanzuna Hasibuan.

REFERENCES

- [1] Anggela, M. Pengembangan Buku Ajar Bermuatan Nilai-nilai Karakter Pada Materi Usaha dan Momentum untuk Pembelajaran Fisika Siswa Kelas XI SMA. *Pillar of Physics Education*. 1: 63-70, 2013
- [2] Chattopadhyay, A. Understanding of Genetic Information in Higher Secondary Students in Northeast India and the Implications for Genetics Education. *Cell Biol Educ*. 2005; 4(1): 97–104, 2005.
- [3] Corebima, A.D, *Pengalaman Berupaya menjadi Guru Profesional*. Pidato Pengukuhan Guru Besar dalam Bidang Genetika pada Fakultas MIPA Universitas Negeri Malang, 30 Juli 2009.
- [4] Fauziyah, Desain Penelitian Pengembangan Bahan Ajar Ipa Terpadu Tema Cahaya dan Warna untuk Pembelajaran IPA SMP, *Prosiding Symposium Nasional Inovasi dan Pembelajaran Sains (SNIPS)*: 978-602-19655-8-0, 2015.
- [5] Habibi, Endang., Mohammad. Pengembangan Buku Ajar Mata kuliah Mikrobiologi Dasar. *Jurnal Pendidikan: Teori, Penelitian, Pengembangan*, 5(1): 2502- 471X, 2016.
- [6] Husamah, R., F & Utomo, H, Development Of Enrichment Book Of Animal Ecology Based On Collembolan Community Structure Research Throught out Watershed Brantas Upstream Of Batu City. *Prosiding Seminar Nasional Pendidikan Biologi 2015* Universitas Muhammadiyah Malang, Malang Jawa Timur, 2015.
- [7] Ibana, L. *Mikroalga sebagai Ioinikator Pencemaran Perairan di Waduk Selorejo untuk Pengembangan Buku Referensi Biologi*. Malang: UM Press, 2015.
- [8] Jalmo dan Tri. Biology Education Students' Mental Models on Genetic Concept, *Journal of Baltic Science Education*, 17(3): 2538-7138, 2018.
- [9] Kemenristekdiksi, Pedoman Penyusunan Perangkat Pembelajaran Dan Bahan Ajar, 2017.
- [10] Millah, E. Pengembangan Buku Ajar Materi Bioteknologi di Kelas XII SMA IPIEMS Surabaya Berorientasi Sains, Teknologi, Lingkungan, dan Masyarakat (SETS). *E-journal Bio Edu*. Vol 1, 2012.
- [11] Pangastuti, A., Amin, M., dan Indriwati, E.S, Pengembangan Buku Ajar Biologi Sel Dengan Pendekatan Bioinformatika. *Jurnal Pendidikan*, 1(2). 116-121, 2016.
- [12] Parmin, Peniati, E, Pengembangan Modul Mata Kuliah Strategi Belajar Mengajar IPA Berbasis Hasil Penelitian Pembelajaran. *Jurnal Pendidikan IPA Indonesia*, 1(1):8-15, 2012.
- [13] Permana, H.F, Pengembangan Buku Ajar Biologi Berbasis *Blended Learning* Sebagai Bekal Hidup di Abad 21 Untuk Mahasiswa Kimia FMIPA UM. *Prosiding Seminar Nasional Pendidikan Biologi*. Universitas Negeri Malang, 2015.
- [14] Prasetyo N., dan P. Perwiraningtyas, Pengembangan Buku Ajar Berbasis Lingkungan Hidup Pada Matakuliah Biologi Di Universitas Tribhuwana Tungga dewi, *Jurnal Pendidikan Biologi Indonesia*. 3(1): 19-27, 2017.
- [15] Prastowo, A, *Panduan Kreatif Membuat Bahan Ajar Inovatif: Menciptakan Metode Pembelajaran yang Menarik dan Menyenangkan*. Jogjakarta: Diva Press, 2012.
- [16] Tsui, C. Y., and David, F. T, *Teaching and Learning Reasoning in Genetics with Multiple External Representations*. Paper presented at the Australian Association of Research in Education. AARE 2001 Conference. Fremantle, Western Australia. 3-6 December 2001. Curtin University of Technology, 2001.
- [17] Tsui, C., & Treagust, D, Evaluating Secondary Students' Scientific Reasoning In Genetics Using A Two-Tier Diagnostic Instrument. *International Journal of Science Education*, 32(8), 1073-1098, 2010.
- [18] Universitas Gadjah Mada, *Pedoman Umum Pembelajaran Berbasis Riset*, Yogyakarta, 2010.
- [19] Venville & Treagust, Teaching about the gene in the Genetic Information Age. *Australian Science Teachers Journal*. Juni 2002.
- [20] Waris, A, *Model Pembelajaran Berbasis Riset di Prodi Fisika ITB*. Berita Pembelajaran, 6 (2), hlm.1-3. Bandung, 2009.
- [21] Widyawati, Tri Diah, Pedoman Umum Pembelajaran Berbasis Riset (PUPBR). Kerjasama Antara Pusat Pengembangan Pendidikan, Kantor Jaminan Mutu, dan Lembaga Penelitian dan Pengabdian Kepada Masyarakat UGM Universitas Gadjah Mada, 2010.