



Development of a popular scientific book on water hyacinth liquid organic fertilizer on cowpea growth

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Abstract

Water hyacinth is an invasive aquatic weed that is very detrimental. Its growth is so fast that it can be detrimental in terms of the water sector, fisheries and accelerate siltation of waters. Water hyacinth contains nutrients such as nitrogen, phosphorus, and potassium that are important for plant growth. Popular scientific books on making organic liquid fertilizer from water hyacinth are very limited so there is a need to develop this book. This research aims to make a popular scientific book with the title "Benefits of Water Hyacinth Liquid Organic Fertilizer on Long Bean Growth" that is valid and can be used by all groups. This research uses Educational Design Research (EDR) with a quantitative approach. EDR includes a preliminary research phase, a product prototype design phase (prototyping phase), and a product assessment phase by experts (assessment phase) but in this study only up to the product prototype design phase (prototyping phase). This research uses Tessmer's formative evaluation which includes self-evaluation and expert review. The validation data were analyzed using Akbar's categories. The validation of the developed PSB showed a validity level of 87.65% (very valid), so that this book is suitable for use as a reference in learning and as a source of information for the general public who are interested in the use of water hyacinth as fertilizer or fertilizer.

Keyword: development; popular scientific book; liquid organic fertilizer; water hyacinth; cowpea growth

Abstrak. Eceng gondok merupakan tanaman gulma air invasif yang sangat merugikan. Pertumbuhannya yang sangat cepat sehingga dapat merugikan dari segi bidang perairan, perikanan dan mempercepat pendangkalan perairan. Eceng gondok mengandung unsur hara seperti nitrogen, fosfor, dan kalium yang penting bagi pertumbuhan tanaman. Buku ilmiah populer mengenai pembuatan pupuk cair organik dari eceng gondok sangat terbatas sehingga perlu adanya pengembangan buku ini. Penelitian ini bertujuan untuk membuat buku ilmiah populer dengan judul "Manfaat Pupuk Organik Cair Eceng Gondok Terhadap Pertumbuhan Kacang Panjang" yang valid dan dapat dimanfaatkan oleh semua kalangan. Penelitian ini menggunakan jenis penelitian Educational Design Research (EDR) dengan pendekatan kuantitatif. EDR meliputi tahap pendahuluan (preliminary research), fase perancangan prototipe produk (prototyping phase), serta fase penilaian produk oleh ahli (assessment phase) namun pada penelitian ini hanya sampai tahap perancangan prototipe produk (prototyping phase). Penelitian ini menggunakan evaluasi formatif Tessmer yang meliputi evaluasi diri (self-evaluation) dan uji pakar (expert review). Data hasil validasi dianalisis menggunakan kategori Akbar. Validasi BIP yang dikembangkan menunjukkan tingkat kevalidan sebesar 87,65% (Very valid), sehingga buku ini layak digunakan sebagai referensi dalam pembelajaran maupun sebagai sumber informasi bagi masyarakat umum yang tertarik dalam pemanfaatan eceng gondok sebagai pupuk organik.

INTRODUCTION

Fertilizers can be classified into two types based on their content: organic and inorganic fertilizers (Kalasari & Astut, 2020). Organic fertilizers come from natural materials produced by living organisms or the remains of dead organisms, such as animal manure, vegetable waste, and similar materials. These organic materials undergo decomposition and transformation. Based on their physical form, organic fertilizers are divided into two categories: liquid and solid organic fertilizers. Solid organic fertilizers have a solid texture, while liquid organic fertilizers (LOF) are in liquid form, which allows nutrients and chemical compounds to be more easily absorbed by plants (Juliani et al., 2020). One plant that can be used as the main ingredient in the production of liquid organic fertilizer is water hyacinth (*Eichhornia crassipes*).

Water hyacinth (*Eichhornia crassipes*) is an aquatic plant often considered harmful and invasive because of its presence in water bodies. This plant floats on the water surface and can grow in both shallow and deep water (Sekarini et al., 2024). It reproduces rapidly through both vegetative and generative means (Amin et al., 2019). Under optimal conditions, it can double its population in 7–10 days. A single stalk of water hyacinth can cover an area of 1 square meter in approximately 52 days (Poernama et al., 2023). Water hyacinth is known as a harmful weed in aquatic environments due to its rapid growth, which often leads to problems by covering the water surface and disrupting aquatic life (Jayati & Susanti, 2020). Therefore, using water hyacinth as a raw material for making liquid organic fertilizer is an innovative step to help control its excessive population.

Water hyacinth contains various elements important for plant growth, such as Nitrogen (N), Calcium (Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Chloride (Cl), Copper (Cu), Iron (Fe), and Manganese (Mn) (Jayati & Susanti, 2020). Fresh water hyacinth is also rich in organic matter beneficial to plants, containing 78.47% organic matter, 21.23% organic carbon, 0.28% total nitrogen, 0.0011% total phosphorus, and 0.016% total potassium (Yuliatin, Sari, & Hendra, 2020). These nutrients are essential for plant growth.

The results of research on the use of water hyacinth-based liquid organic fertilizer for the growth of yard-long beans will be developed into a popular science book. This is due to the limited availability of literature on the use of water hyacinth as a material for liquid organic fertilizer, especially literature that is written in simple language and presented in an engaging format to make it easier to understand. This popular science book is structured based on the principles of the scientific method and presented with attractive design and simple language to be easily understood, particularly by the general public who may find it difficult to comprehend scientific works. Thus, this product, in the form of a popular science book, is intended to be accessible to the general public from various backgrounds, with clear, simple, and engaging presentation.

With the above background, the researcher is motivated to conduct a study entitled "Development of a Popular Science Book on the Effect of Water Hyacinth Liquid Organic Fertilizer on the Growth of Yard-Long Beans." The result of this study is a popular science book that is expected to benefit the community, especially yard-long bean farmers. Moreover, for individuals who wish to grow yard-long beans at home, this book can serve as a valuable source of information on how to utilize water hyacinth to make liquid organic fertilizer. It can also serve as a reference in the field of education, particularly in plant physiology courses.

RESEARCH METHODS

This study utilizes a development model introduced by Tjeerd Plomp within the framework of Educational Design Research (EDR). Plomp's model consists of three main stages: preliminary research, the prototyping phase, and the assessment phase (Akker et al., 2013). However, this study is limited to the prototyping phase. According to Zaini (2018), the development stage should focus on the preliminary stage and formative evaluation. The formative evaluation used in this study is Tessmer's formative evaluation, which focuses on self-evaluation and expert review to produce a scientifically valid book for use.

Self-evaluation is conducted by the research team itself in the process of developing the popular science book (PSB). Meanwhile, expert review is carried out after the first book prototype is completed. During the expert review stage, the research team will engage three experts in media, content, and

language to validate the book. The team will then revise the book based on feedback until the final prototype is completed.

The book validation data is obtained from the assessments of the three experts (in media, content, and language), using a questionnaire instrument based on a Likert scale adapted from Sarpani et al. (2020). This data is then processed and analyzed using Akbar's (2022) calculation method. The validation analysis uses Formula 1, and the validity criteria of the popular science book are categorized according to Table 1 from Akbar (2022).

$$\text{Validity (V)} = \frac{\text{Validity score total (3 validator)}}{\text{Score total}} \times 100\% \dots \dots \dots \text{Formula 1}$$

Table 1 Validity Criteria of Popular Scientific Books

No	Validity Range	Validity Level
1	85,01% - 100,00%	Very valid, can be used without revision.
2	70,01% - 85,00%	Moderately valid, can be used but needs minor revisions.
3	50,01% - 70,00%	Less valid, recommended not to use, needs major revision.
4	01,00% - 50,00%	Invalid, should not be used.

(Source: Akbar, 2022)

RESULTS AND DISCUSSION

The Educational Design Research (EDR) development study that has been conducted includes the preliminary research stage and the prototyping phase. The following are the results of the development:

A. Preliminary Research

This stage includes observation, needs and problem analysis, solution development, and data collection. It also involves a contextual study, development of a conceptual or theoretical framework, and a literature review (Akker et al., 2013). The observations revealed that water hyacinth is an invasive weed in aquatic environments, particularly in South Kalimantan, which largely consists of wetlands such as swamps, rice fields, rivers, lakes, and others. Based on observations in Pindahan Baru Village, Beruntung Baru District, Banjar Regency, it was found that most of the water surface is covered by water hyacinth, and yard-long beans are a commonly cultivated vegetable in the area. The yard-long beans are used as food and also sold as a source of income.

The researcher became interested in utilizing the abundant water hyacinth in the region as the main ingredient in the production of liquid organic fertilizer (LOF), considering that water hyacinth is readily available and could benefit the growth of yard-long beans, which are widely planted in the area. The observations indicated a need to address the rapid growth of invasive weeds and convert them into a product useful for local yard-long bean farmers—namely, processing them into liquid organic fertilizer (LOF). Based on the literature review, it was found that there are very few popular science books (PSBs) discussing the processing of water hyacinth into LOF and its effects on yard-long bean growth, highlighting the necessity of developing this PSB. The next steps involved processing the water hyacinth into LOF and collecting data on its effects on the growth of yard-long beans.

B. Prototyping Phase

This stage involves processing the data into a popular science book (PSB). At this stage, Tessmer's formative evaluation is used to ensure the PSB is valid before it is utilized. The formative evaluation stages taken from Tessmer include self-evaluation and expert review. The initial step involves processing observational data on the effects of water hyacinth liquid organic fertilizer (LOF) on the growth of yard-long beans into the first draft of the book. The next step is conducting a self-evaluation by the research team to revise the initial book draft into PSB Prototype 1.

Following this, the initial PSB prototype is validated by three lecturers who are experts in media, content, and language using a questionnaire instrument adapted from Sarpani et al. (2020), and the data is then analyzed using Akbar's (2022) validation criteria. The validation results are presented in Table 2. Suggestions and comments from the validators are summarized in Table 3. The PSB, having undergone expert review by three experts, is then revised again through self-evaluation until the experts declare it

complete and valid. The validated PSB becomes the final prototype version. The final PSB prototype results are shown in Figure 1.

Table 2 Average Percentage of PSB Validity Test Results

No	Component	Percentage	Validity Level
1	Coherency aspect	85,42%	Very valid
2	Readability	75,00%	Moderately valid
3	Vocabulary: expressions, verbs, choices, exaggerations	75,00%	Moderately valid
4	Active and passive sentences	83,33%	Moderately valid
5	Format	100%	Very valid
6	Writing Method	91,67%	Very valid
7	Applications and Implications	91,67%	Very valid
8	Definitions and Explanations	91,67%	Very valid
9	Other style devices: narrative, humor, and analogy	87,50%	Very valid
Mean		86,81%	Very valid

Table 3 Validator Comments and Suggestions

No	Suggestions	Follow-up
1	Changed the word "Foreword" to "Preface".	Has been replaced as suggested.
2	Correct the writing of image sources according to writing rules.	Has been corrected according to the rules of scientific writing.
3	Tidy up the writing of the table of contents.	The writing of the table of contents has been tidied up.
4	Cover made more minimalist and and reduced some elements that seem excessive.	The cover has been made more minimalist and designs that are considered excessive have been corrected.
5	In the discussion of morphology should be made segments based on the parts of plant morphology for easy understanding.	The discussion of morphology has been improved by dividing it into discussions of root, stem, leaf, flower and fruit morphology.
6	Add translation to Surah Al-Imran verse 191 contained in the book.	Translation has been added.
7	Correct typos and title writing.	Typing errors and title writing have been corrected.
8	The origin of water hyacinth is placed at the beginning of the discussion of water hyacinth morphology.	The origin of water hyacinth has been moved to the beginning of the discussion of water hyacinth morphology.
9	Adjust the placement of "Did you know?" as one of the characteristics of PSB.	The placement of "Did you know?" has been corrected and adjusted.



Figure 1
Final front cover of PSB prototype

According to Latifah et al. (2020), validation is carried out to ensure that the developed Popular Science Book (PSB) meets the required standards of validity and is suitable for use. According to Zaini (2018), expert review serves as a reference for evaluating the developed product and determining whether the design of the educational product is valid or not. In terms of coherence, a score of 85.42% was obtained, categorized as highly valid. According to Fitriyani et al. (2022), coherence includes paragraph structure, main ideas, logical sequencing of ideas, the use of transition words between sentences, and guiding sentences for comprehension. This indicates that the PSB has a clear flow and main ideas, with good connections between sentences. This is in line with Rahmi et al. (2022), who state that a product should use straightforward, interactive, and communicative language aligned with the cognitive development of the reader.

The readability aspect relates to the appropriateness for the user's age and education level. Readability scored 75%, categorized as fairly valid. This suggests that the PSB manages to capture attention and stimulate interest in the material, as well as encourage reading motivation. According to Rahmi et al. (2022),

readability is tied to the practicality of the language, including sentence construction, paragraphs, vocabulary, and discourse in the text. The vocabulary aspect assesses the appropriateness of word use, expressions, verbs, and word choices in the PSB to avoid ambiguity. The validation results showed a vocabulary score of 75%, which is also considered fairly valid. Fitriyani et al. (2022) emphasize that to facilitate comprehension, vocabulary should be simple, concise, and easy to understand.

The aspect of active and passive voice scored 83.33%, falling into the fairly valid category. Fitriyani et al. (2022) explain that the use of both active and passive sentences in the PSB plays a vital role in forming clear and persuasive sentence structures. In scientific writing, it is important to include verbs and active sentences that guide readers to take specific actions. Rahmi et al. (2022) also state that accuracy in using basic sentence structures and choosing the right words helps readers understand the intended message more easily.

The format and writing method aspects received scores of 100% and 91.67%, respectively, indicating that both are considered highly valid. The PSB format is designed to be visually appealing, with systematically organized data and supporting illustrations that facilitate the learning process. The writing method follows established standards, making the content easier to understand. Other aspects assessed include application and implication, definition and explanation, and stylistic elements such as narrative, humor, and analogy. These aspects scored 91.67%, 91.67%, and 87.50%, respectively—all categorized as highly valid. These high scores indicate that the PSB effectively conveys clear ideas and narratives that enhance user understanding. According to Jamaludin et al. (2024), presenting information through narratives helps clarify complex processes. Fitriyani et al. (2022) also stress the importance of concept relevance, as it motivates users by connecting new material to their existing knowledge.

Overall, the expert validation showed an average score of 86.81%. According to the PSB validity criteria adapted from Akbar (2022), this score confirms that the PSB “The Benefits of Water Hyacinth Liquid Organic Fertilizer for the Growth of Yard-Long Beans” is highly valid and ready for use without further revision. Nevertheless, the researchers still considered expert feedback to enhance the PSB's quality.

The advantages of this final PSB prototype include its development through the Educational Design Research (EDR) process, encompassing field needs analysis and expert validation. This validation followed a systematic and meticulous process, including self-evaluation and expert review. The experts ensured that the PSB met content, language, and media standards, confirming that the final prototype is valid for printing and distribution. This process also ensures that the final PSB prototype can provide accurate and valid data while enhancing knowledge and having a positive scientific impact in the future (Renaningtias & Apriliani, 2021).

Another strength of this final PSB prototype is its appealing design, clear and relevant images, bright and engaging colors, humorous elements, and clearly presented content. With these features, the developed PSB can attract readers of all ages—adults, teenagers, and children. Furthermore, the material it contains can improve community productivity, especially for yard-long bean farmers, by teaching them how to make LOF from readily available and easy-to-process materials that significantly enhance plant growth. This aligns with Regina (2023), who stated that one of the main strengths of popular science books—both digital and print—is their engaging writing style, which attracts a wide readership. This final PSB prototype is ready to be printed and distributed to the public and is expected not only to help reduce the impact of invasive water hyacinth but also to boost farmers' economies by improving crop growth.

CONCLUSION

The validation of the popular science book (PSB) titled “The Benefits of Water Hyacinth Liquid Organic Fertilizer on the Growth of Yard-Long Beans”, conducted by three validators, showed a highly valid result with an average validity percentage score of 86.81%. This assessment covered various aspects including readability, coherence, vocabulary, formatting, the use of active and passive voice, writing methods, as well as other elements such as definitions, explanations, applications, implications, humor, analogies, and narratives. Therefore, the PSB is considered suitable for use without requiring further revisions. However, the researchers still took expert suggestions and comments into account to enhance the quality of the PSB. It is recommended that future researchers continue the Educational Design Research (EDR) development process of this PSB through to the summative evaluation stage.

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