学 位 論 文 の 要 旨

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1　論　文　題　目

Sustainability-Oriented Biology Education:

Development of Science Teacher Training Modules

2　論　文　の　要　旨

2.1 Introduction

This dissertation focuses on the incorporation of Sustainability-Oriented Biology Education (SOBE) into the training of Indonesian prospective science teachers, aiming to intersect biology, sustainability, and teacher education. The central research question of this dissertation is: "*How to effectively conceptualize and implement SOBE into the training of prospective science teachers in Indonesia*?". To address this, the following objectives were proposed:

(1) To develop an initial SOBE framework, drawing on existing science curricula and blending traditional biology education with sustainable development principles.
(2) To investigate the current status of biology and sustainability education in selected science teacher training programs in Indonesia, using interviews and surveys.
(3) To design and test a SOBE teacher training module, aiming to influence prospective science teachers' understanding and attitudes towards botany and sustainability positively.

The goal of this research is to make a significant contribution to nurture a next generation of science teachers that both comprehends and values biodiversity, while advocating for sustainability.

2.2 Methodology

A pragmatic perspective with a mixed-methods framework is employed to guide the research. The methodological approach involves the utilization of the ADDIE Model, which includes the following stages:

(1) Analysis: This stage involves an in-depth study of existing curricula, and interviews and surveys of teachers to identify potential areas for integrating SOBE.
(2) Design: Based on the insights gained from the analysis stage, the SOBE module is designed, customized to fit the Indonesian prospective science teacher training context.
(3) Development: This stage involves the collaborative development of the SOBE module, integrating expert feedback from relevant fields.
(4) Implementation: At this phase, the SOBE module is implemented at an Indonesian teacher training institution to understand its real-world effectiveness.
(5) Evaluation: This final phase employs a comprehensive mixed-methods approach for evaluation. Quantitative data are gathered through questionnaires, while qualitative data are derived from reflective journals and focus group discussions.

The methodology ensures a systematic and comprehensive approach for the development and evaluation of the SOBE module, thereby providing a deeper understanding of its impact in the context of science teacher training.

2.3 Findings

Based on the research question and the purpose of this dissertation, the findings, derived from a mixed-method approach in conjunction with the ADDIE model, can be summarized as follows:

(1) Development of SOBE Framework: Upon analyzing the current Indonesian K-13 curriculum, it was found that sustainability concepts were included but scattered and fragmented across various subject areas. Therefore, an initial framework for SOBE Module was developed to provide a more integrated and systemic approach to teaching sustainability. This framework, drawing inspiration from Mezirow's transformative learning theory, emphasizes critical reflection and rational discourse to challenge existing knowledge frameworks and worldviews, thus fostering a comprehensive understanding of sustainability.

(2) Current State of Biology and Sustainability Education: An examination of the present state of botany and sustainability education identified a diverse range of awareness and confidence among in-service science teachers concerning sustainability topics. This finding underlines the necessity to enhance both in-service and pre-service science teachers (PST)' skills and confidence in navigating the complexities of sustainability education. Furthermore, the survey with prospective science teachers revealed a solid understanding of endemic plants but a lack of knowledge about invasive species, suggesting an instance of "Plant Awareness Disparity" (PAD). This insight led to the recognition of the need for experiential learning opportunities to enhance the appreciation of plant diversity.

(3) Intervention Study: Three SOBE-focused teacher training modules was designed and evaluated. The first module, targeting Plant Awareness Disparity (PAD), significantly improves attitudes and understanding concerning plant biology and ecosystems, reflecting an enhanced appreciation for plant life. The second module addresses Species Awareness Disparity (SAD) and successfully fosters better mastery of concepts related to species biodiversity, indicating progress in recognizing the importance of various taxa. The third module extends sustainability principles to non-scientific audiences, effectively increasing understanding of sustainability practices while also noting the challenges inherent in interdisciplinary educational approaches. Each module collectively contributes to a more informed and conscious perception of sustainability issues among participating teacher trainees.

2.4 Discussion

The implications of the Sustainability-Oriented Biology Education (SOBE) modules are profound and wide-reaching, suggesting a shift towards a more integrated and holistic approach to biology education. By successfully incorporating sustainability concepts, these modules have demonstrated the potential to enhance the curriculum's relevance, engaging students more effectively in environmental issues and fostering a deeper understanding of and commitment to sustainability. This is especially pertinent in the Indonesian context, where local environmental challenges and cultural values can be directly addressed through education. Such an approach not only benefits the PSTs' understanding and appreciation of sustainability but also serves as a vital insight for curriculum developers and educational policymakers globally. However, the study's focus on the Indonesian educational context may not encompass the full diversity and complexity of global education systems, and its confined participant selection and geographical reach could limit the broader applicability and understanding of the modules' effectiveness. Methodologically, while the mixed-methods approach provided a balanced view, there is a need for more comprehensive approaches, including longer-term studies and deeper qualitative research, to understand the sustained impact and nuances of individual and contextual experiences with the SOBE modules. Therefore, future research should aim to broaden the geographical and demographic reach, ensuring a diverse and representative sample that can provide a more holistic understanding of the modules' impact across various educational contexts. Additionally, there is a need for more comprehensive methodological approaches, including longitudinal studies and in-depth case studies, to track long-term effects and provide deeper insights into the personal, cultural, and contextual factors influencing sustainability education. By addressing these limitations and considering these recommendations, the SOBE modules can be refined and adapted, contributing to a more nuanced, effective, and globally relevant approach to integrating sustainability into biology education.

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