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THE ROLE OF INTEGRATED SCIENCE LEARNING MODULES IN TRAINING TEACHING SKILLS FOR PROSPECTIVE TEACHERS

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Abstract. Integrated science education requires prospective teachers to incorporate various educational elements into their teaching practices. Students in the Science Education Program at the Faculty of Teacher Training and Education, Universitas Lambung Mangkurat (FKIP ULM) encounter challenges when planning science lessons that blend different concepts, contexts, and skills into a cohesive learning experience. To tackle this challenge, the researchers created a teaching module that provides guidance on integrating science education using two of Robin Fogarty's curriculum integration models: the connected model and the nested model. This study seeks to examine the module's role in developing teaching skills. It employs a qualitative methodology with a case study approach, focusing on the experiences of sixth-semester science education students during their teaching. Data were gathered through semi-structured interviews, utilizing theoretical sampling until saturation was reached. The analysis was conducted using Charmaz's grounded theory approach and then discussed from the perspective of the Teaching Mastery Framework. 1) Aligning activities with the teaching materials, 2) Connecting teaching materials to real-life situations, 3) Bridging different concepts throughout the learning process, and 4) Creating a well-structured lesson plan for teaching practice . The findings indicate that the developed integrated science education module can support prospective teachers in planning of teaching practice, especially in teachers' pedagogical content knowledge (PCK) and developing lesson plan.

Keywords: integrated science education, prospective teachers, science education, teaching mastery framework, teaching skills

INTRODUCTION

Knowledge in school was realized through three massage systems according to Basil Bernstein: curriculum, pedagogy, and assessment (Bernstein, 1975; Kennedy & Henderson, 2024). Hence, it is imperative for teachers to have skills for all three. It has indeed become a challenge to teach in an effective way for pre-service teachers as professionals, especially graduates of the faculty of the Institute of Education in Indonesia (Maharani & Fithriani, 2023; Sujadi et al., 2019). The structure of pre-service teacher training was designed so that they would study the content knowledge and pedagogical knowledge in the fifth semester before they are able to put the theory into practice via an internship program in schools. Therefore, it is integral for higher education institutions to ensure the pre-service teachers are well-prepared to have confidence in facing the challenges.

The challenges that pre-service teachers face during their internships include classroom management, deciding appropriate teaching materials and resources, developing a lesson plan and executing it, and deciding how the materials are being taught (Maharani & Fithriani, 2023; Mudra, 2018; Sujadi et al., 2019). As lecturers in

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the teacher training faculty, we conducted initial interviews with prospective teachers who are experiencing teaching internships on the problems that they face as intern teachers. We found that several difficulties they experience are developing coherent lesson plans, deciding classroom activities, and explaining weird phenomena asked by students according to scientific knowledge that requires cross-discipline comprehension.

As lecturers who teach pre-service teachers in science education, we strive to provide quality teacher training by developing teaching modules that outline how to integrate science teaching. These modules were developed by adapting Robin Fogarty's two modes of integrated curriculum: the connected model and the nested model (Hafizah & Sauqina, 2023; Sauqina & Hafizah, 2024). The connected model is a way to integrate learning by connecting concepts from different disciplines to explain a phenomenon. Meanwhile, a nested model is a way to integrate concepts and skills by nesting them in one learning experience. These modules are different compared to other books on the same topic available on the market because they do not only explain the theories on how to teach with integrated knowledge. These modules were designed to focus on integrating science subjects. Besides that, it is also complemented with contextual examples of material exposition that can be used to create lesson plans according to the Emancipated Curriculum implemented in Indonesia. We provide this feature so that prospective teachers could use it as teaching references and learning resources.

This study is a continuation of previous development research of both modules. This study explores the role of the modules in assisting pre-service teachers' teaching practices. We discuss teacher competence based on the Teaching Mastery Framework, a framework used in school as a guideline for teachers' practice (Irwanto & Saifullah, 2022; Karlina et al., 2024). The Teaching Mastery Framework is aligned with Bernstein's formal education message systems: curriculum, pedagogy, and evaluation (Bernstein, 1975; Kennedy & Henderson, 2024). Further, the Teaching Mastery Framework breaks down the three systems into eight detailed aspects that will be explained further in the research method section and results and discussion. This research aims to evaluate the module that has been developed. The findings will serve as a baseline for making targeted revisions to improve the product further.

RESEARCH METHOD

This study used qualitative research methodology with a case study approach (Bryman, 2012). The data is collected using semi-structured interviews, guided by lists of questions regarding preparation, implementation, and evaluation, aligned with the Teaching Mastery Framework. The main questions for the interview can be found in appendix 1.

The sample was decided based on theoretical sampling, which means the researchers stop taking more samples after data saturation (no more new data were found) is reached (Strauss & Corbin, 1990). In this study, the data saturation was met after nine respondents. The respondents are pre-service teachers from the science education program, faculty of teacher training and education of Universitas Lambung Mangkurat, who are in the *Asistensi Mengajar* (teaching assistance) program, which allows them to teach junior high school students as teacher interns for the first time after three years of studying about science and science education.

The interviews were recorded and then transcribed and analyzed. This study used Charmaz's grounded theory analysis approach (Charmaz, 2014). This approach started with initial coding for line-by-line analysis to create labels based on code. And then followed by selective coding, where the labels were examined and then refined

to develop themes. To ensure data trustworthiness and reduce threat to validity, the coding was conducted by two researchers who also apply the constant comparison technique to decide the labels and themes (Bryman, 2012).

The themes found in the data were discussed from the Teaching Mastery Framework perspective. The Teaching Mastery Framework is a teaching framework based on best practice in Global Islamic Boarding School and has become the school standard for teachers. This framework was chosen because it was developed based on the school's community of learning reflection while also being grounded in education theories (HAFECS, 2024). The Teaching Mastery Framework is divided into three parts that are aligned with Bernstein's three systems of transmission of education, namely planning, execution, and evaluation. However, the Teaching Mastery Framework also breaks down the three parts into 8 aspects, which are used as the theme for this qualitative study. The 8 aspects of the Teaching Mastery Framework are 1) Pedagogical Content Knowledge (PCK), 2) Higher Order Thinking Skills (HOTS), 3) Lesson Plan, 4) Teaching Tactics, 5) Classroom Management, 6) Soft skills, 7) Teaching Scenario, and 8) Teaching Grading.

RESULTS AND DISCUSSION

We found four themes that emerged from the interviews with the respondent. Those four themes are

1. Aligning activities with the teaching materials

Pre-service teachers expressed that the modules were able to help them to decide on classroom activities that are aligned with what has been taught. In the following quote, Lila explained that the module supported her to come up with students' activities that could explain the relationship between physical activities and heartbeat and pulses.

"…because, to be able to compare that, for example, if staying still, in one minute it's only 30. Then, like, if after walking, which means being active, like walking, after 1 minute it increases, right? The pulse becomes faster. (I learned) from this module… if it's from this module, it's a bit there, because it connects, like, the activities being done with the material being taught, activities, and teaching materials… if the activities being done relate to the circulatory system in the body, it's more like how daily activities affect, what, the circulatory system, like the pulse becoming faster." Lila.

In teaching science, connecting empirical observation by students with the concepts is one of the recommended ways to teach science, because science was based on previous scientists' investigations about world phenomena (Norris, 1985). In the Teaching Mastery Framework, the decision to deliver teaching is part of teachers' pedagogical content knowledge, or PCK. PCK in action could be seen in the form of a decision on what is the suitable way to teach a certain concept (Shulman, 1986, 1987). In the Teaching Mastery Framework, PCK is part of the planning phase of teaching.

2. Connecting teaching materials to real-life situations

The respondent also expressed that the modules were able to help them to connect teaching materials to real-life situations. In the following quote, Oka explained that the module inspires her to bring real-life situations into her introduction of the concept that she brought to the classroom.

"...especially in the Integrated Science course, ... (the module) also relates the material to everyday life; for example, the topic of interactions between components of an ecosystem is linked to everyday life, such as food chains or food webs. So, I used examples of animals that are found in South Kalimantan," Oka.

In teaching science, using appropriate context to students' lives is recommended; it makes scientific concepts relevant to students' diverse cultural and socioeconomic backgrounds, fostering greater engagement and understanding (Sánchez Tapia, 2020). In the Teaching Mastery Framework, the decision to use context is also part of teachers' pedagogical content knowledge, or PCK. According to Morine-Dershimer and Kent (1999), PCK is the culmination of seven knowledge types, one of them being the contextual knowledge, that is, knowledge about context that is relevant to the learning activities. In the Teaching Mastery Framework, PCK is part of the planning phase of teaching.

3. Bridging different concepts throughout the learning process

The connected model was the basis of the development of the module. It is focused on ensuring that the learning experience brings out the subtleties of interconnection across disciplines by explicitly addressing it in the learning. The respondent expressed that the modules were able to assist them in doing so.

"The integrated science modules play a significant role in (my) lesson planning. Because this module, um... teaches an approach that connects various science concepts into a single unit. Um... this knowledge and module help me in linking the concept of concave mirrors with other science topics, such as light and waves, making the learning process more comprehensive and meaningful for the students." Yati

To be able to plan the connection between scientific concepts requires a comprehensive understanding about the concepts being taught and being able to recognize whether the concepts are usually taught separately or altogether within the state-approved curricula. Such knowledge is recognized as content knowledge in PCK (Morine-Dershimer & Kent, 1999; Shulman, 1987). From the Teaching Mastery Framework perspective, it is part of the planning phase.

4. Creating a well-structured lesson plan for teaching practice

The module is designed to support pre-service teachers in lesson planning by incorporating concept connections and cues for topic segmentation when lessons need to span multiple sessions (Hafizah & Sauqina, 2023; Sauqina & Hafizah, 2024). Additionally, it offers activities that can be implemented to seize opportunities for developing students' science skills during the exploration of scientific concepts.

This theme used the phrase "well-structured." It is meant to refer to a lesson plan that was designed with consideration of students' learning experience. From the interview, we found that the design of the modules helps respondents to structure their lesson plan.

"*Especially the integrated science course (module), because in developing lesson plans or modules, it can be structured and also relate the material to everyday life." Oka.*

"...it (the module) helps connect the previous learning. Like, for example, the previous lesson was about the rotation and revolution of the Earth, and then it's

connected to the next lesson plan about the rotation of the moon and so on. This is useful, this connected model (from the module). The connected model also includes connections, like how they imagine it with real life and so on…"Nada.

Making lesson plans is a crucial aspect of teaching in schools since lesson plans contain learning goals that teachers want to achieve, the teaching materials needed to support learning, and assessment instruments to, at least, assess whether the goals have been achieved by the end of learning (Farhang et al., 2023; Nesari & Heidari, 2014). Teachers' skill to plan lessons could be seen in the teachers' lesson plan, which is also an aspect of the Teaching Mastery Framework. The lesson is part of the planning phase.

The themes as discussed above show that most of the assistance by the integrated science learning modules is in training pre-service teachers' skills in the planning phase of the Teaching Mastery Framework. The planning phase consisted of three aspects, namely 1) Pedagogical Content Knowledge (PCK), 2) Higher Order Thinking Skills (HOTS), and 3) Lesson Plan. PCK in the Teaching Mastery Framework refers to Morine-Dershimer and Kent's conception of PCK that comprises seven aspects: pedagogical knowledge, content knowledge, curriculum knowledge, knowledge of learner and learning, assessment and goals (specifically assessment procedure, evaluation outcomes unseparated from educational ends, goals, purposes, and values), and knowledge of specific context affects teachers' PCK directly, and knowledge of general educational context (Irwanto & Saifullah, 2022; Morine-Dershimer & Kent, 1999). This encompasses all the knowledge necessary to plan appropriate learning for students, expanded from Shulman's conception of PCK (Shulman, 1987). Higher Order Thinking Skills (HOTS) in the Teaching Mastery Framework refers to teachers' skill in laying down a step-by-step cognitive learning path for students starting from the lower order thinking skills (e.g., remembering, understanding) to higher order thinking skills (e.g., evaluating, creating). Meanwhile, a lesson plan refers to the document that outlines objectives, content, activities, and methods that teachers use to teach a specific lesson. However, the Teaching Mastery Framework's concept of lesson plan also includes teachers' alternative plans to anticipate if the initial plan encounters challenges or does not achieve the desired outcomes (HAFECS, 2024). This allows teachers to adapt their teaching strategies in real-time, ensuring that they can effectively address students' needs and maintain the flow of the lesson.

As previously explained, the integrated science learning module was able to assist pre-service teacher training in planning teaching practice in 1) Aligning activities with the teaching materials, 2) Connecting teaching materials to real-life situations, 3) Bridging different concepts throughout the learning process, and 4) Creating a well-structured lesson plan for teaching practice. However, all the themes only cover two out of three aspects of the planning phase. This finding shows that the book could be improved further by incorporating other aspects of teaching planning, specifically on assisting pre-service teachers to make a well-thought cognitive learning path that could be implemented for school science lessons. Besides that, this study also found that the modules might need a significant redesign if they aim to assist pre-service teachers in all phases of teaching practice, since they are not yet able to cover the aspects from the execution and evaluation phase of the Teaching Mastery Framework. However, since the module was initially designed for the sake of providing pre-service teachers with information on how to integrate science learning across disciplines and multiple skills, including science skills, it is understandable that

the modules were not able to assist pre-service teachers in strengthening all aspects of the planning phase of the Teaching Mastery Framework.

In addition, another important aspect that emerges from this finding is the necessity of scaffolding pre-service teachers' ability to construct coherent learning progressions within science education. Learning progressions not only bridge lower- and higher-order thinking skills but also provide a systematic structure that aligns instructional activities with conceptual development over time. Without explicit guidance on how to design these progressions, pre-service teachers may rely heavily on fragmented activities that do not fully support students' deeper understanding of scientific concepts. Thus, integrating structured support for developing learning progressions into the modules could strengthen the planning phase and ensure that pre-service teachers are equipped to guide students toward more meaningful and sustained learning outcomes. To some extent, this need has already been partially addressed by the modules, as they provide guidance in linking activities, connecting materials to real-life contexts, and creating structured lesson plans. However, their current contribution remains limited, indicating that a more deliberate focus on supporting the construction of comprehensive learning progressions is required if the modules are to fully prepare pre-service teachers for the complexity of science teaching.

CONCLUSION

This study identified four themes from interviews with pre-service teachers regarding their experiences with the integrated science learning modules. The modules can support pre-service teachers in planning teaching practice by helping teachers align activities with teaching materials, connect concepts to real-life situations, bridge different scientific concepts, and create well-structured lesson plans. From the Teaching Mastery Framework perspective, these findings demonstrate the modules' potential to enhance pre-service teachers' planning skills. Specifically, it enhances in-service teachers' PCK and lesson planning. However, the current modules do not adequately address the Teaching Mastery Framework's execution and evaluation phase. A redesign is necessary if the module wants to also support pre-service teachers in all phases of teaching.

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APPENDIX 1
List of Questions

In this study, we would like to examine three aspects of teaching, namely **planning, implementation, and assessment**. After observing your teaching session, I have several questions. Let us begin with the **planning** stage.

Planning

(if possible, while reviewing your lesson plan)

1. Why did you choose to teach this topic?
   a. Where did you learn about it?
2. How did you determine the competencies to be taught in this lesson?
   a. Where did you learn about it?
3. What practical and/or theoretical skills did you intend to teach students in this lesson?
   a. Where did you learn about it?
4. How did you decide on the appropriate activities for this lesson?
   a. Where did you learn about it?
5. Since you have studied many subjects in the science education program, were there any courses or sessions (not yet mentioned) that helped you in completing this lesson plan/Modules?
6. We would like to know whether the Integrated Science Modules played a role in your lesson planning. Did any knowledge or experience from the Modules help you in planning this lesson?

Implementation

(if possible, while reviewing the teaching video)

1. During the *apperception* stage, you asked students about (insert context here). What was the purpose of asking this question?
   a. Where did you learn about it?
2. While teaching, you mentioned (insert context here, for example, if there was a cross-disciplinary concept, such as from physics to biology). What did you expect students to learn from this?
   a. Where did you learn about it?
3. What was your purpose in asking students to engage in (insert context here, for example, a practicum)?
   a. Where did you learn about it?
4. (If any interesting aspects appeared in the video related to developing thinking processes or kinesthetic skills) Did you plan this in advance? If yes, why? If not, why?
5. What was your purpose in doing this?
   a. Where did you learn about it?
6. We would like to know whether the Integrated Science Modules influenced your decision-making during teaching. Did any knowledge or experience from the Modules help you in implementing this lesson?

Assessment

(if possible, while reviewing the teaching video or lesson plan)

1. What skills did you intend to observe through the assessment you designed?
2. Where did you learn about it?
3. We would like to know whether the Integrated Science Modules contributed to your formulation of assessment.
4. Did any knowledge or experience from the Modules help you in designing this assessment