Development and Validation Model of Peatland Conservation through Interdisciplinary Science Learning

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Abstract. The peatland conservation model is generally developed based on the community. A new education-based conservation model was developed through temporary activities through seminars, workshops or non-formal learning. The aim of this research is to develop and validation a peatland conservation model through interdisciplinary science learning that connects universities, schools and communities in peatland conservation activities. The development of a peatland conservation model went through third stages following interdisciplinary research patterns. Validation was determined by content and empirical validation. The peatland conservation model consisted of three interrelated dimensions in peatland conservation, namely universities, schools and communities. The model was equipped with implementation tools in the field in the form of science learning tools. The form of a peatland conservation model book, teaching practice materials, an environmental literacy questionnaire, and an interdisciplinary thinking performance rubric were developed in this study. The validated aspects included theory, assumptions, and conceptual model representations with the Aiken score was 0.88 as a valid category and the ICC value of 0.457 showed that the reliability was not good. Empirical validation showed that the dimensions of the university, school and community constructs had internal consistency reliability and validity. The relation between dimension that universities had an influence on schools and society, and schools have an influence on society. The peatland conservation model was equipped with practical teaching learning tools that directly connected universities and schools. However, this model was also suitable for non-educational natural sciences courses or pure natural sciences to form interdisciplinary thinking skills and environmental literacy.

Keywords: development and validation, peatland conservation model, interdisciplinary science learning.

INTRODUCTION

Indonesia is a country that has tropical peatlands with an area of 13% of the world's total peatlands, and spread across the islands of Sumatra, Papua and Kalimantan (Gumbricht et al., 2017). Only about 57% of the peatlands in Central Kalimantan remain which are classified as genuine peatlands, while the rest is degraded peatlands (Agus et al., 2020).

Degraded peatlands experience changes in their chemical, physical and biological properties, thereby reducing their function as an ecosystem. Indonesian peatlands (Sumatra and Kalimantan) produced an estimated 119.7 million tonnes of carbon emissions per year in 2015 (Miettinen et al., 2017) causes the greenhouse effect which triggers climate change. The climate change then affect other ecosystems as freshwater (Sunardi et al., 2017).

Damage to the function of peat ecosystems in Indonesia occurs as a result of erroneous land management, such as selecting activities in peat areas that are not in accordance with the characteristics of peatlands (Masganti et al., 2014). Fires and peatland subsidence significantly reduce carbon levels in peatlands which trigger greenhouse emissions including carbon (Sangok et al., 2017).

Peatland degradation causes environmental problems, so they must be resolved immediately. Environmental damage can be overcome if people develop environmental literacy (Mitarlis et al., 2017; Yang & Li, 2019). Environmental literacy is defined as the product of several components of disposition, knowledge, competence, and behavioral responses to the environment that influence each other (Liang et al., 2018; Liu et al., 2015). Environmental literacy is assumed to display behavior that is responsive to environmental protection (Shamuganathan & Karpudewan, 2015). Knowledge about the

peatland environment will change people's mindsets, attitudes and behavior so they care more about the environment.

Building generational environmental literacy is very important as a solution to environmental problems (Shamuganathan & Karpudewan, 2015). The formation of environmental literacy can be carried out from elementary school through effective education (Ozsoy et al., 2012). The school community that has great natural proficiency will donate a great impact on students' natural proficiency and knowledge (Putra et al., 2021).

The formation of environmental literacy must be carried out since childhood, an attitude of caring for the environment will become the attitude of generations and ultimately society. Environmental literacy must be grown from elementary, secondary, tertiary level schools, and finally becomes an environmentally literate society. An education-based conservation model is needed to form environmental literacy.

Colleges and universities can serve as ideal models of sustainability, as laboratories for society to learn and places for students to develop new habits (Veisi et al., 2019). Student teacher candidates have the potential to become agents of change in increasing environmental literacy of students and society. The development of environmental literacy for prospective teachers will make them confident and competent to provide environmental education for students in schools (Dada et al., 2017).

A conservation model to shape community literacy can be designed through universities and schools. The environmental literacy of student teacher candidates must be improved first during lectures before they become agents of change. The development of environmental literacy for prospective teachers will make them confident and competent to provide environmental education for students in schools (Dada et al., 2017) with contextual, participatory and inquiry learning strategies (Ridlo & Alimah, 2013). The execution of learning resources within the shape of local environmental problem based learning understudy worksheets strengthens students' environmental literacy (Suryawati et al., 2020). Environmental literacy can be the focus of peatland conservation through environmentally oriented learning. Environmentally literate student teacher candidates are the starting point for developing community environmental literacy.

The Indonesian peat restoration agency (BRG) has developed a community-based peatland conservation model with conservation programs within village communities and local governments. BRG builds relationships with universities and private institutions, seeks international support, cadres of peat-aware communities (Peat Restoration Agency, 2019). The use of peatland conservation funding can serve as a conservation model (Roucoux et al., 2017).

The peatland conservation model is generally developed based on the community through temporary activities with seminars, workshops or non-formal learning (Taylor et al., 2018). FAO and Weatland International developed guidelines on the conservation and restoration of peatlands with climate change mitigation (Greiser & Joosten, 2018).

The researchers of this study argued that the pattern of conservation in universities and high schools have been carried out with education and training, but it have not been accompanied by the development of learning programs to form students and student peatland conservation awareness that can be applied in learning. Based on the background above, this article describes the results of the development of a peatland conservation model and its implementation through natural science learning.

The aim of this research was to develop and validation a peatland conservation model through interdisciplinary science learning that connected universities, schools and communities in peatland conservation activities.

METHODS

The development of a peatland conservation model went through third stages following interdisciplinary research patterns (Wernli & Darbellay, 2016). The first stage was about developing a peatland conservation model with interdisciplinary research. This was about the establishment of a new discipline (establishing a peatland conservation discipline by the community and science learning at universities and schools). The second stage was about carrying out interdisciplinary scenario strategies so that new knowledge was generated in the form of peatland conservation models through natural science learning. The third stage was validation of model as shown in Figure 1.
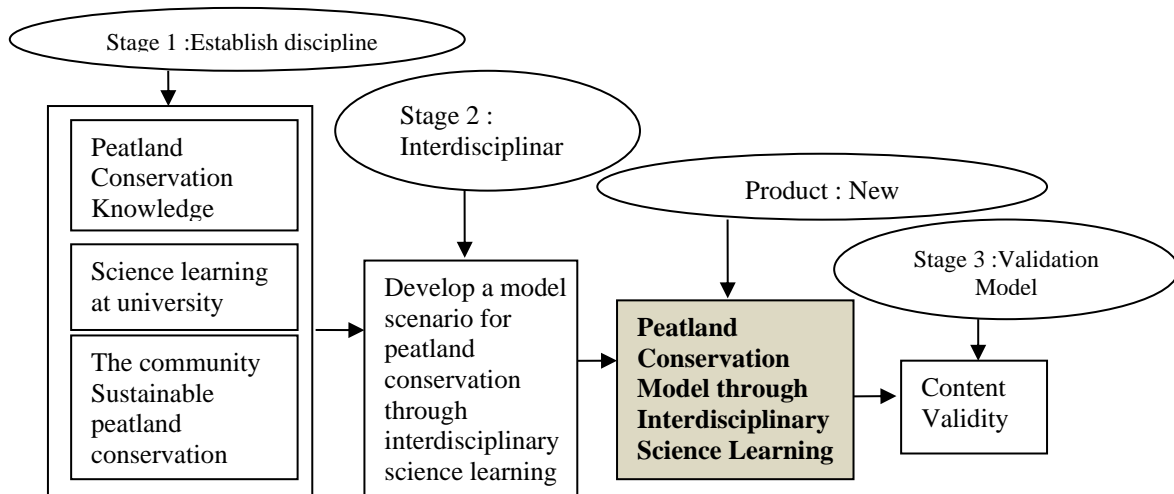
Figure 1. Stages of Developing a Peatland Conservation Model through Interdisciplinary Science Learning

Quality of peatland conservation model through interdisciplinary science learning was analyzed by determining the validity and reliability of the model. Validity was determined by content validation (Nieveen, 1999) and empirical validation. The validator's assessment was analyzed with the coefficient value of Aiken (1985). The reliability of content validation was determined from the intra-class correlation coefficient (ICC) (Brookhart & Chen, 2015) as a degree of correlation and agreement between measurements (Perinetti, 2018).

The empirical validity of the peatland conservation through interdisciplinary science learning model was seen from convergent and discriminant validity. Validity was analyzed with the smartpls 3 software. Convergent validity was seen from the loading factor value and discriminant validity from the AVE value. Loading factor values above 0.5 were categorized as valid and AVE values above 0.5 were categorized as valid (Larcker, 1981).

The design of the peatland conservation model through interdisciplinary science learning was validated empirically through the responses given by the people of Palangka Raya. The response questionnaire consists of 24 items for the dimensions of universities, schools and communities that were connected through interdisciplinary learning of science and peatland conservation. Response questionnaires were distributed via the Google form to lecturers, teachers, students, and the general public in Palangka Raya from 2-17 January 2023. A total of 127 responses were collected with complete answers. Responses were analyzed with smartpls 3.0.

The university dimension was distributed using a response questionnaire with eight items. The measurement used a Likert scale with 4 scales (strongly agree, agree, disagree, strongly disagree). University dimension points related to the university's role in peatland conservation, science learning, science curriculum, interdisciplinary possibilities for science and peatland learning, formation of environmental literacy, and the formation of students' interdisciplinary thinking skills.

The school dimension was distributed using a response questionnaire with six items. The school dimension items were related to the school's role in peatland conservation, science learning, science curricula and science learning tools. The community dimension was distributed by means of a response questionnaire with ten items. The community dimension points were related to the community's role in peatland conservation, social and environmental.

RESULTS AND DISCUSSION

Development Model of Peatland Conservation through Interdisciplinary Science Learning

The first stage of interdisciplinary research was carried out using qualitative research and meta-analysis. Qualitative research with interviews, observations, and documentation on peatland conservation and science learning in Palangka Raya could also be seen in Table 1. This stage resulted in peatland conditions, science learning, and conservation activities by the university and school community.

Table 1. Observation and Documentation of Peatland Conservation in Sebangau National Park (TNS)

No	Observation	Documentation
1	Ecotourism of Kereng Bangkirai Sebangau port, Central Borneo	
2	Sebangau National Park (TNS) Central Borneo	
3	Chili farmers in Kereng Bangkirai Sebangau, Central Borneo	
4	Interview with Peatland Researcher (LG) BPTP Central Borneo and with Peatland Researcher CIMTROP, Central Kalimantan	
5	Ulin wooden sticks, the house of the Kereng Bangkirai Sebangau community, Central Borneo on peat swamp water	

The second stage of interdisciplinary research with a scenario strategy resulted in a hypothetical peatland conservation model through interdisciplinary science learning. The meta-analysis resulted the relationship between universities, schools and communities in conservation activities. At this stage a peatland conservation model was produced through interdisciplinary science learning as shown in Figure 2.

The learning program connected universities, schools and communities in peatland conservation activities through the formation of environmental literacy. The model of peatland conservation through interdisciplinary science learning was applied in three main dimensions, namely universities, schools and communities as shown in Figures 2.
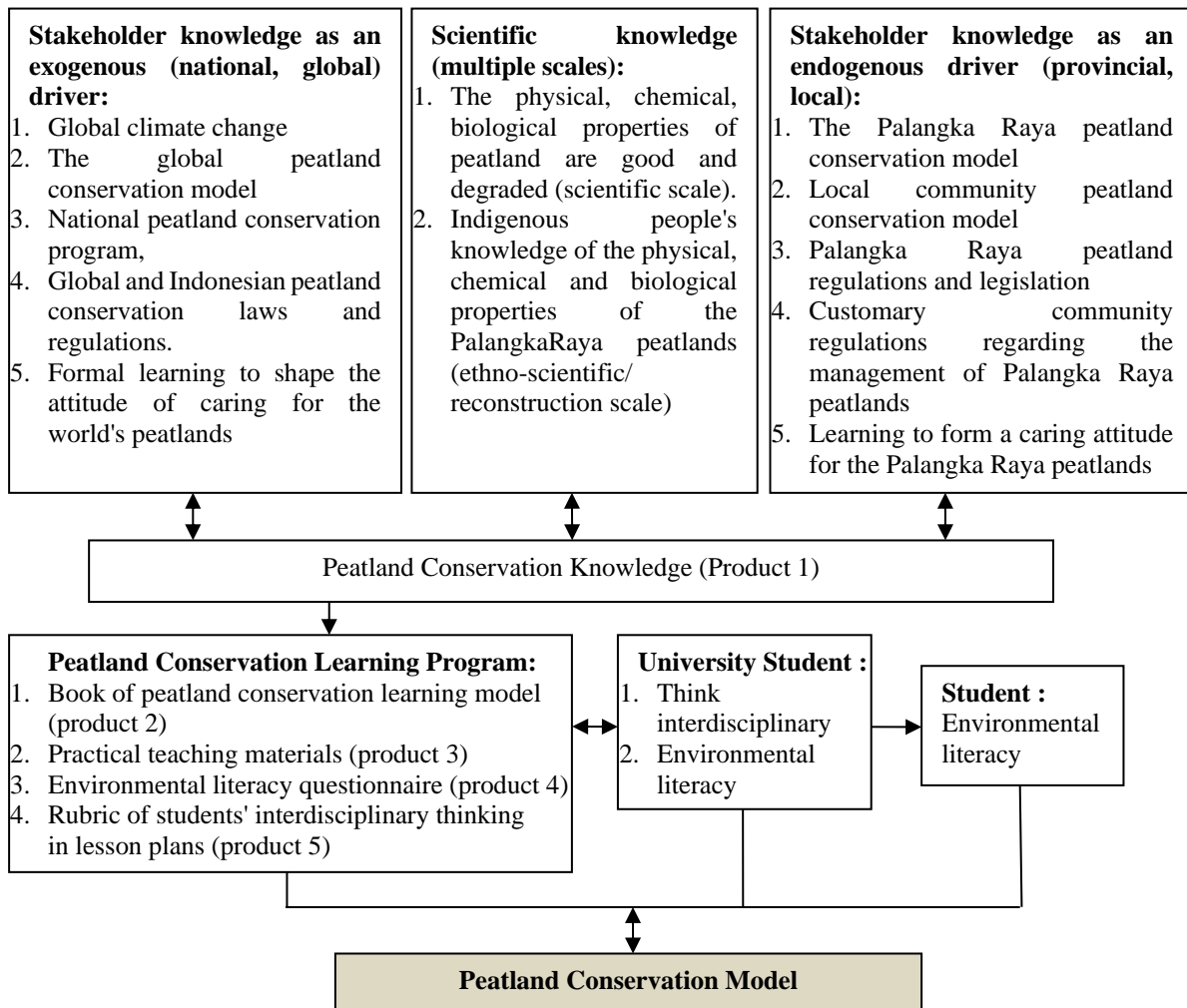
Stakeholder knowledge as an exogenous (national, global) driver:	**Scientific knowledge (multiple scales):**	**Stakeholder knowledge as an endogenous driver (provincial, local):**
1. Global climate change 2. The global peatland conservation model 3. National peatland conservation program, 4. Global and Indonesian peatland conservation laws and regulations. 5. Formal learning to shape the attitude of caring for the world's peatlands	1. The physical, chemical, biological properties of peatland are good and degraded (scientific scale). 2. Indigenous people's knowledge of the physical, chemical and biological properties of the PalangkaRaya peatlands (ethno-scientific/ reconstruction scale)	1. The Palangka Raya peatland conservation model 2. Local community peatland conservation model 3. Palangka Raya peatland regulations and legislation 4. Customary community regulations regarding the management of Palangka Raya peatlands 5. Learning to form a caring attitude for the Palangka Raya peatlands

Peatland Conservation Knowledge (Product 1)

Peatland Conservation Learning Program:
1. Book of peatland conservation learning model (product 2)
2. Practical teaching materials (product 3)
3. Environmental literacy questionnaire (product 4)
4. Rubric of students' interdisciplinary thinking in lesson plans (product 5)

University Student :
1. Think interdisciplinary
2. Environmental literacy

Student : Environmental literacy

Peatland Conservation Model

Figure 2. Model of peatland conservation through interdisciplinary science learning

Peatland conservation knowledge (product 1) from the scenario model with content global climate scientific scale and etno-scientific, Palangka Raya peatland conservation model, was the result of interdisciplinary process. The interdisciplinary scenario of the peatland conservation model is a tool for integrating knowledge in interdisciplinary studies of social sciences and science (Bohensky et al., 2011; Wesche & Armitage, 2014).

Product 1 was then developed into an interdisciplinary learning program with four products as a model implementation tool in the field. Five products complete the peatland conservation model based on interdisciplinary learning with natural science material (McKim et al., 2018), problem-based (Brabler, 2016), project-based (Braßler & Block, 2017; Stentoft, 2017), cooperative (Harvie, 2012), as well as adopting sustainable development goals (Jegstad et al., 2018). The peatland conservation model also uses teaching practice teaching materials with natural science learning. The use of modules or teaching materials can facilitate the management of science classes (Cowden & Santiago, 2016).

Validation of Peatlands Conservation through Interdisciplinary Science Learning

The design of a peatland conservation model through interdisciplinary science learning with three dimensions (university, school and community) was validated by five experts and practitioners (5 raters) in the field of peatland conservation and science education. The validated aspects included theory, assumptions, and conceptual model representations (Law, 2013). The Aiken score for the design of peatland conservation models through interdisciplinary science learning was 0.88, a valid category with a probability of 0.021. The ICC value of 0.457 meant that the reliability was not good.

The estimation of the model peatland conservation through interdisciplinary science learning with a loading factor value above 0.6 - 0.7 was obtained so that it could be accepted as an appropriate indicator for further evaluation. The latest model estimate, like Figure 3, illustrates that universities have an influence on schools of 0.868. Universities had an influence on society by 0.320 and schools had an influence on society by 0.600.
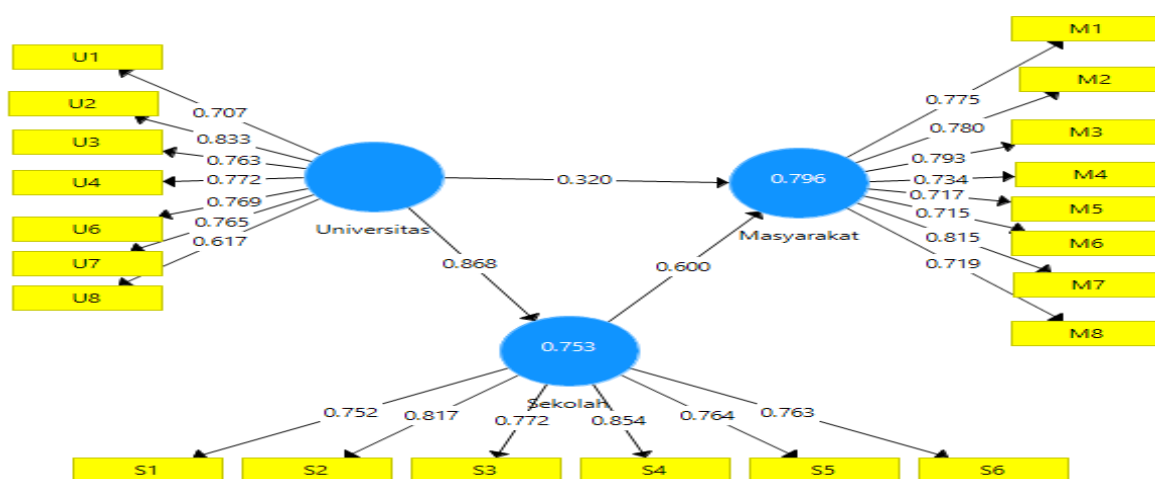

Figure 3. Output path-coeficient Smartpls 3 for peatland conservation through interdisciplinary science learning

The output of the Fornell-Larcker Criterion SmartPLS 3 for peatland conservation through interdisciplinary science learning as in Table 1 shows that the value of composite reliability and Croncbach's alpha was above 0.7 for each construct. The dimensions of the university, school and community constructs had internal consistency reliability.

Tabel 1. Output Fornell-Larcker Criterion SmartPLS 3 for Peatland Conservation through Interdisciplinary Science Learning

Dimension	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Community/Society	0.894	0.900	0.915	0.573
School	0.877	0.879	0.907	0.621
University	0.869	0.878	0.899	0.561

The research results showed that there were three potentials that could be used as part of conservation. The potential of universities with science lessons, schools with science lessons, and peatland user communities were three potentials as part of peatland conservation. A peatland conservation model that was suitable for field conditions by utilizing the potential and conditions that existed in the community such as universities, schools and communities through science learning. Teacher education programs can be used as conservation programs for an area (Boubonari et al., 2013). Many studies have shown that environmental literacy including conservation attitudes can be developed in schools and universities (Hartadiyanti et al., 2020; Ozsoy et al., 2012; Saribas et al., 2014; Sudarmin et al., 2018)

The peatland conservation model was compiled based on preliminary research findings, i.e., literature studies with interdisciplinary science research and model scenarios consisting of three dimensions, namely universities, schools and communities. University contributed in

science learning aspects, teaching practices, and science learning with environmental literacy outcomes. Schools contributed in science learning aspects, learning resources for the surrounding environment, learning objectives for the formation of environmental literacy. Communities with university and school education system components. The connecting aspect is science learning and environmental literacy. Sustainable development competencies can be included in the development of academic programs (Karaarslan & Teksöz, 2016; Wiek et al., 2011). An example of implementing the dimensions of sustainable development at the Selamat Kendal Islamic boarding school (Ngabekti et al., 2012). Sustainable development competencies should be included in university or school academic programs so that learning contributes to the formation of environmental literacy as an effort to conserve the environment.

CONCLUSION

The peatland conservation model consists of three interrelated dimensions in peatland conservation, namely universities, schools and communities. The model was equipped with implementation tools in the field in the form of science learning tools, i.e., the form of a peatland conservation model book, teaching practice materials, an environmental literacy questionnaire, and an interdisciplinary thinking performance rubric. The quality of the model valid and reliable.

The peatland conservation model should be implemented as a continuous learning program so that it has a greater impact on the environment. This model can be an alternative in filling out local content programs in schools with students as learning facilitators.

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