Engaging Student Teachers in Designing Ecopedagogy Learning Modules for Bali's Subak Cultural Landscape

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Abstract

We assessed learning modules designed by student teachers for a contextual biology learning course to address three principles of ecopedagogy: ecological, cultural and technological literacy. An active-learning course was planned, implemented and evaluated using Bali's subak heritage as an example of place-based education. Students were encouraged to apply the principles of ecopedagogy to the design of the learning modules. We describe how teaching modules created by teams of students were proposed, developed, critiqued and gradually improved. The final version of the modules were assessed with a four scale rubric: 4 (exceptional), 3 (admirable), 2 (acceptable) and 1 (amateur). Statistical analysis showed significant improvement (P=0.001) in students' module design ability, mainly evidenced by the higher distribution of exceptional, admirable and acceptable scores in the final module compared with those in the drafts. This study provides an example of how student engagement in designing learning materials can serve two purposes: improving their understanding of the subject matter (cultural heritage) and also their pedagogical skills through interactive learning.

Introduction

Engaging student teachers in designing learning modules based on ecopedagogy can be an effective way to prepare them for understanding the core value of future education: sustainability. Several authorities (Arbuthnott, 2009; Kuhlman and Farrington, 2010; Siteinei and Morrish, 2014) noted that sustainability is concerned with the well-being of future generations and preservation of the foods, agriculture, natural resources and environment. Thus, "*sustainability is not a goal but an endless process of constant implementation, assessment and readjustment*" (Klahr, 2012, p.20).

Ecopedagogy refers to the branch of pedagogy in which education is practiced based on sustainability (Gadotti, 2010). It "*facilitates understanding of sustainable living by teaching the basic principles of ecology and a profound respect for living nature, through experiential, participatory and multidisciplinary approaches*" (Capra, 2005, p.xiv). Richard Kahn (2010) describes four priorities in the ecopedagogy movement, namely the deepening of understanding of new possibilities for convivial life, the building of praxis between scholars and the public, critical dialogue and self-reflective solidarity across a multitude of groups and considerations of traditional ecological knowledge as a science.

Future teachers need to be inspired to develop their capacity for designing and evaluating ecopedagogy materials. For one group of student teachers, inspiration came from Bali's subak cultural landscape. The subak is a traditional, community-level religious institution for managing irrigation water. It is well adapted to and embedded in, the characteristics of the Balinese landscape (Roth, 2011). It is also a meeting ground between cultural ecology, scientific exploration, political dialogue, community stewardship and the study of nature (Lansing and Miller, 2003; Sobel, 2004). Subaks thus present a remarkable case study for modeling a specific learning context, particular attributes of place, multidisciplinary approaches, self-community connection and spurring the students towards out-of-the box thinking (Cramer, 2008; Martin, 2006).

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Using subaks to introduce students to the design and evaluation of ecopedagogy modules will put them at the center of the learning process, enhance their motivation to learn, integrate various teaching strategies, improve their knowledge and skills and provide a rewarding experience (Cohen et al., 2004). Through this, students have the opportunity to develop their potential to initiate and achieve higher-order thinking required for decision-making and problem solving. As an authentic assessment exercise, designing learning activities that combine ecopedagogy and an inquiry-based model enhances student learning and prepares researchers for their future roles, whether as scientists or informed citizens (Hui-Min Chung and Behan, 2010). Such assessment can also foster the integration of theory, actions, assessment, group learning and educational outcomes (Fitch et al., 2008). Last, it offers a perfect opportunity to meet conservation goals while reconnecting with the land and providing citizens with the skills necessary to continue protecting the cultural landscape in the future (Cramer, 2008).

Materials and Methods

This study was conducted from August 2013 to February 2014 during a semester-long Contextual Biology Learning (CBL) course at the Mahasaraswati Denpasar University Indonesia, with an enrollment of 34 undergraduate student teachers. The course was designed to cover three principles of ecopedagogy: ecological, cultural and technological literacy. Ecological literacy was defined as the ability of students to insert ecological concepts, such as ecosystems, biogeochemical cycles and biodiversity, into the design of learning modules; while cultural literacy referred to their ability to provide an example of contextually relevant culture (e.g., rice culture) in their modules. Finally, technological literacy was taken as students' competency to use modern technology – for example mobile phones – as a set of learning tools. The objective of the CBL was for student teachers to apply ecopedagogy principles in the design and evaluation of subak-based learning modules. In addition to disseminating environmental information, CBLs also encourage future teachers to produce new knowledge and seek out new education paradigms. In ecopedagogy, CBL "takes into account people, cultures, lifestyles and the respect towards identity and diversity" (Gadotti, 2008, p.18).

Table 1 shown, most of the course relied on active learning strategies in two phases of class presentations and discussion to produce a draft module (Phase 1) and final module (Phase 2). During these phases students worked in turn as reporters, moderators, note takers, evaluators and participants. Reporters described the progress of their draft module; moderators facilitated class discussion; note takers recorded the key points; evaluators assessed class performance; and participants provided feedback in the form of questions, suggestions and assessments. In addition to classroom activities, we also held a 3-day field trip for students to visit two sites in the Balinese Subak Cultural Landscape. During the journey, students observed and learned about the landscape of subaks, held discussions and interviewed farmers and local leaders. This provided an opportunity for experiential learning by connecting students to the community and focused on specific ecological locations and cultural and technological characteristics. We assessed learning module twice, using a scoring rubric at the end of both Phase 1 and Phase 2. The rubric was adapted from several sources, but was drawn mainly from Parks (2012). It consisted of four grades: exceptional (4), admirable (3), acceptable (2) and amateur (1). The rubric also contained nine criteria describing the performance conditions for a successful module:

1. Organization of the module materials using headings or subheadings to group-related material
2. Appropriateness level of the topic
3. Interest of the module to the reader
4. Suitable use of learning strategies
5. Originality of instructional materials
6. Compliance with the school curriculum
7. Appropriateness level of learning objectives to students' behavior and understanding
8. Achievement of learning competencies
9. Citations of library resources

To score modules, we followed the method of Powell and Wells (2002), in which scores were determined by the author and an additional assessor scoring each module independently, comparing module scores and discussing discrepancies and inconsistencies. Quantitative data were analyzed both descriptively and statistically. A Wilcoxon-paired test was used to detect significant differences in rubric scores between draft and final modules, which were determined according to $P<0.05$ unless otherwise noted.

Results and Discussion

A total number of 34 students designed modules. All modules were based on ecopedagogy, which appeared

Table 1. Classroom Activities in the Contextual Biology Learning Course

Meeting	Content	Activities
1st	Introduction	The instructor described the scope and objective of the course, inquiry learning, ecopedagogy, the *subak* landscape, and place-based learning.
2nd	Module development	The instructor outlined the definition, benefits, and procedure for preparing and assessing a module; question and answer session.
3rd –7th	Phase 1 class presentations & discussion	Using PowerPoint, 4–5 students presented their ideas (10 min); question and answer session (10 min); note-taking and evaluator reports (5 min); instructor comments (5 min).
8th	Draft module assessment	Students conducted self and peer-review of module drafts using the assessment rubric.
9th	General review	The instructor led a general evaluation, focusing on points in need of correction in the module drafts & how to use the assessment rubric for review.
10–15th	Phase 2 class presentations & discussion	Similar to Phase 1.
16th	Final module assessment	Similar to the draft module assessment.

Table 2. Assessment Comparison between Draft and Final Modules of Student Teachers: Presentations According to the Rubric Criteria

Rubric criteria	Draft module (% of students scoring in each grading category; n=34)				Final module (% of students scoring in each grading category; n=34)				Sig.
	Exc. (4)	Adm. (3)	Acc. (2)	Amt. (1)	Exc. (4)	Adm. (3)	Acc. (2)	Amt. (1)	
1. Organization of module materials.	5.9	44.1	38.2	11.8	23.5	59.2	23.5	0.0	***
2. Appropriate level of the topic.	5.9	32.4	47.1	14.7	25.3	35.4	41.2	0.0	***
3. Interest to the reader.	2.9	29.4	47.1	20.6	14.7	44.1	41.2	0.0	***
4. Suitable use of learning strategies.	0.0	17.6	32.4	50.0	5.9	35.3	35.3	23.5	**
5. Originality of instructional materials.	2.9	35.3	41.2	20.6	14.7	35.3	50.0	0.0	***
6. Compliance with the school curriculum.	0.0	14.7	38.2	47.1	0.0	41.2	52.9	5.9	***
7. Appropriate level of learning objectives.	0.0	29.4	35.3	35.3	0.0	55.9	38.2	5.9	***
8. Achievement of learning competencies.	0.0	26.5	32.4	41.2	0.0	38.2	55.9	5.9	***
9. Citations of library resources.	0.0	5.9	20.6	73.5	0.0	8.8	47.1	44.1	*

Exc. (Exceptional), Adm. (Admirable), Acc. (Acceptable), Amt. (Amateur); *, **, *** Significant at P=0.05, 0.01 and 0.001, respectively using A Wilcoxon-paired test.

in module topics, content and learning strategies. The most common topic was the ecosystem (24%), followed by biodiversity (21%), waste recycling (18%), pollution (15%), human population (15%) and the biogeochemistry cycle (3%). Ecosystem materials included interaction between living and nonliving components, population and community. Several students tried to explain the relationship between the ecosystem and traditional subak ceremonies, e.g., tumpek uduh (the day Balinese make offerings in reverence of plants, in particular large trees, in the hope that they continue to bear fruit for human consumption), tumpek kandang (the day of ceremony dedicated to animals, especially livestock, in which it is emphasized that people should take care of their animals for the preservation and benefit of life), nangluk merana (a ceremony aiming to protect plants from pests and which provides blessings of fertility) and biukukung (when farmers offer rice paddies in the milk stage as petitions to the Goddess for a good harvest). Some modules described genetic diversity in the subaks, such as various local paddies (e.g., white, red and black paddies), species diversity (both plants and animals) and local ecosystems (e.g., watersheds, mixed farms and gardens). Interestingly, three modules focused on a species of bird, namely the Java Sparrow (Padda oryzivora). Its population has undergone a significant decline and it has become a rare species throughout its natural range as a consequence of intense trapping activity for trade and pesticide/herbicide use (BirdLife International, 2001; Siswowartono, 1996). Another module focused on biodiversity at Batur Global Geopark located around an active volcano in northeast Bali. Global Geoparks are intended to promote awareness of key issues facing society and provide information on the sustainable use of and need for, natural resources (UNESCO, 2014).

The topic of pollution encompassed the causes of soil, water and air pollution. Several modules detailed the pollution that occurs in rice paddy fields (e.g., the effects of plastic waste on irrigation water; death of eels, fish and other aquatic animals due to chemical contamination of irrigation water). Burning straw as a cause of air pollution and the proliferation of weeds due to the excessive use of chemical fertilizers were also mentioned in several modules. Students addressed waste recycling in terms of reducing chemical pesticides, replacing inorganic chemicals with organic ones, reusing agricultural waste for handicrafts and recycling cattle waste as compost. The topic of the biochemistry cycle was addressed through the food chain, food web, ecology pyramids and water and gas cycles. Finally, the topic of human population involved the impact of population density on rice field land conservation, food shortages and environmental pollution.

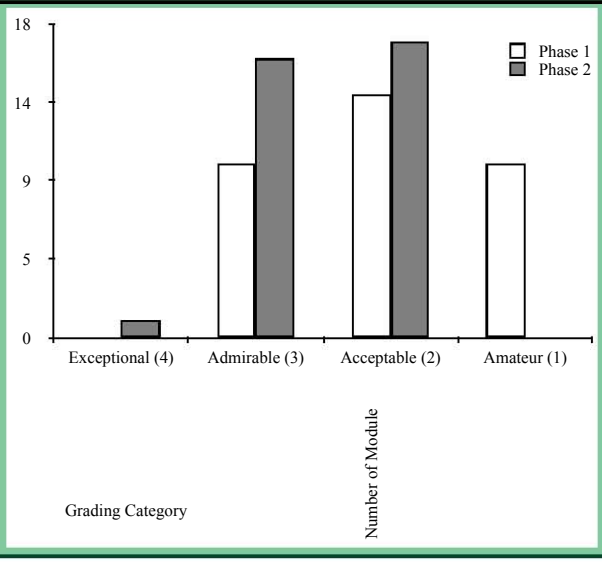
Class Presentations and Discussion

During Phase 1, students were critiqued on the compatibility of their module titles with the proposed content. Some modules only presented learning materials without learning strategies and several mentioned learning approaches but did not describe teacher or student behavior. Time allocated to modules also exceeded the time available in the curriculum. There were also issues related to originality and plagiarism: the content of some modules was similar to one another, while most module drafts cited text or illustrations without references. Evaluation was an important part of the module and included a lively discussion, particularly on how to design test and assessment rubrics. During the general review, the instructor engaged students as problem solvers for their respective modules, encouraging them to search for more references, write concisely and use more examples from the subak landscape. During Phase 2, most of the modules had improved, mainly in terms of organization, learning strategies, time allocation, interest and originality (Table 1). However, several students still encountered obstacles in terms of the consistency of their bibliography with APA Style (6th edition, www.apastyle.org/index.aspx).

Rubric Assessment

The majority of students increased their competency in designing learning modules (Figure1). At the end of Phase 1, half of the module drafts were categorized at the level of “acceptable” and the remainder split equally between “admirable” and “amateur.” However, at the end of Phase 2, none were graded as ‘amateur’ and the number of final modules in the “exceptional,” “admirable” and “acceptable” grades was higher than for the draft versions. Statistical analysis indicated

Fig. 1. Ecopedagogy Module Performance: Comparison of Phase 1 (draft) versus Phase 2 (final) Presentations of Student Teachers.



significant improvement (P=0.001) in the performance of final modules over draft modules.

Nearly all criteria in the assessment rubric, the final modules scored higher than the drafts (Table 2). For example, the percentage of modules scored as "exceptional" in terms of organization, interest, understanding and material was five to six times higher than the drafts. Similarly, the number of final modules scored as "admirable" in terms of originality, curriculum appropriateness, learning objectives and reference list was twice as high as for the draft modules. Unfortunately, the reference list and learning strategy criteria of about half and one-quarter of final modules, respectively, were graded as "amateur." This was because some students had difficulties writing a bibliography of primary sources, which are mainly taken from journals and conference proceedings.

Summary

This study aimed to answer the question: What drives student-teacher engagement in ecopedagogy approaches? The information gathered may help in creating more active learning environments. Our study supports the findings of previous research that engaging students in active learning can integrate alternative methods with traditional ones such as the lecture (Haskett, 2001), enhance student ability to solve novel problems (Cortright et al., 2005), improve course structure, address teaching deficiencies (Hiller and Tyre, 2009) and increase student engagement in learning (Taptamat, 2011).

A unique aspect of this study was to provide future educators with a methodology for designing and evaluating the effectiveness of a place-based education approach. The place in question was a meeting ground of cultural ecology, scientific exploration, political dialogue, community stewardship and the study of nature (Sobel, 2004). Stevenson (2011) adds that place can be a source of ideas and values that shape personal, cultural and professional identity.

The program described in this paper trained student teachers to teach lessons, meet curriculum objectives using the subak landscape as a classroom setting, prepare students to adapt to local conditions and respect and conserve these environmental resources. Our assessment found that applying active learning strategies to the cultural landscape positively influenced student learning, as evidenced by students' increased knowledge, understanding and ability in designing learning materials. This may in turn contribute to positive behavior in students toward subak conservation (Dimopoulos et al, 2008).

Further recommendations based on the findings of this study are (a) the effectiveness of ecopedagogy modules should be confirmed via feedback from students and teachers through active research into learning processes to produce more reliable conclusions. Future research should address to what extent these learning materials hold meaning for students, influence young peoples' learning in relation to critical and complex issues and for the health of the planet (Gadotti, 2010; Rivera and Dann, 2011); (b) educators of student teachers need to empower students to work as active partners and introduce a variety of socially meaningful activities in the learning process. Service learning projects are one of many forms of meaningful learning in which educators can strive to equip students with five transferable skills – communication, commitment, consideration, courage and competence – in leadership (Robinson and Torres, 2007). This will help students to take part in decision-making processes in their own communities and beyond (Savelava et al., 2010); (c) in case ecopedagogy modules were implemented systematically and over an extended period of time, they may eventually contribute to better environmental governance in terms of subak conservation by broadening stakeholder acceptance and involvement at the local level (Dimopoulos, 2008); (d) the education system should be changed into a resource center that initiates and supports students' inclusion in sustainable processes in their own communities. In this case, we should keep in mind that elements of Balinese culture like the subak have historically been important selling points in the Balinese tourist industry (Lorenzen and Lorenzen, 2011). If Bali wants to maintain its deep cultural landscape heritage, local schools should be "agents of change" in encouraging the future generation to work in rice cultivation.

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