

Teachers' preparedness to teach environmental science in Bhutan

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Abstract

Environmental science (ES) was introduced in Bhutan as an optional school subject for classes IX-XII to equip young people with the knowledge, values, and skills to protect the environment and promote sustainable and equitable use of natural resources in the pursuit of gross national happiness. Teachers are believed to play a crucial role in the effective implementation of ES, and this paper analyses Bhutanese teachers' views on how well they have been prepared to implement ES. The interview data from 14 teachers and six principals showed that limited qualifications and professional development in teaching ES have resulted in lack of confidence in teaching ES, lack of pedagogical content knowledge, and lack of clarity about the ES objectives. These results suggest integrating more knowledge about education for sustainable development (ESD) into teacher education program to adequately prepare teachers to teach ES if required and integrate ESD principles into other subjects.

Keywords: Bhutan, environmental science, education for sustainable development, professional development, teacher training, gross national happiness

INTRODUCTION

Education for sustainable development (ESD) is relevant to developing countries such as Bhutan (UNESCO, 2018), especially as Bhutan has high aspirations for sustainable development. Moreover, many of the elements of ESD are reflected in the Bhutanese concept of gross national happiness (GNH). The four ESD sustainable development dimensions, ecological, economic, social, and political, are reflected in the four pillars of GNH: environmental conservation, sustainable and equitable socioeconomic development, preservation and promotion of culture, and good governance (Schuelka & Maxwell, 2016).

Importantly, Bhutan 2020: A vision for peace, prosperity, and happiness (Royal Government of Bhutan [RGoB], 1999) guides the actions required to achieve socioeconomic, political, cultural, and ecological sustainability. Bhutan's government aims to continue implementing the UN's sustainable development goals and track the progress of the implementation in the 12th five-year plan for Bhutan (Gross National Happiness Commission [GNHC], 2019).

The UN expects all member nations, including Bhutan, to have mainstreamed ESD into teacher training programs by 2020 (UNESCO, 2016, p. 287). Elements of ESD are also evident in other education policy documents. The national education framework (Ministry of Education [MoE], 2009) aims to prepare students to be creative, skilled, and competent to address environmental sustainability.

To address aims and visions of the government, a new environmental science (ES) elective course was introduced into Bhutanese schools for classes IX-XII with the goal of building "a cadre of young people equipped with knowledge, skills and values to engage them in...promoting sustainable and equitable use of natural resources, preventing all forms of environmental degradation in the pursuit of GNH" (DCRD & RSPN, 2013, p. 17). In ES, students study the UN millennium development goals (MoE, 2013), the concepts, principles, and practices as well as their correlation to the GNH pillars. ESD teaching requires implementing transformative approaches to teaching, such as action-oriented, self-directed, participatory, collaborative, problem-oriented and interdisciplinary or transdisciplinary pedagogies (UNESCO, 2017). This is

Contribution to the literature

- This study explores the importance of teacher training in effective teaching of environmental science in schools to prepare students' competencies towards sustainable environmental conservation.
- The study investigates Bhutanese teachers' preparedness and perceived good practice in teaching environmental science.
- The findings from the study identify the challenges faced by the teachers and the need for professional development in effective implementation of environmental science.

because ESD prepares every individual with the knowledge, skills, values, attitudes, and other key competencies that are essential for understanding and addressing sustainability (UNESCO, 2017).

LITERATURE REVIEW

Pre-Service and In-Service Teacher Training in ESD

Teacher training is important to effective teaching of ESD in schools because "the success of the educational enterprise is...believed to hinge on the quality of teaching that goes on in the classrooms" (Powdyel, 2005, p. 53). UNESCO (2005) emphasised the importance of training teachers with a pedagogical content knowledge and competence to successfully integrate sustainability issues into all disciplines and impart high quality ESD. Although most countries have included ESD as one of the general goals of education in their school curricula, but teachers lack training to teach ESD effectively (Evans et al., 2016) from a paucity of ESD in teacher education programs (Ferreira et al., 2007) and teacher educators' lack of knowledges, skills, and dispositions for incorporating ESD into the teacher training (United Nations Economic Commission for Europe [UNECE], 2016). Ultimately, lack of teacher training is believed to impede ESD teaching in schools (Miles et al., 2006) because effective ESD implementation depends on the quality of a teacher (Musset, 2010).

Given the recognition by UNESCO that teachers are uniquely placed to be 'change agents' for addressing sustainability, there is emphasis on integration of ESD into pre-service teacher education programs (UNESCO, 2018). Teachers need adequate ESD knowledge, values, skills and an understanding of appropriate pedagogical content knowledge and assessment practices (UNESCO, 2018) to develop students' knowledge, skills, behaviours, and dispositions (UNESCO, 2017).

Effective ESD training for pre-service teachers can be undertaken using integrated or cross-curricular approaches (Raath & Hay, 2019) that may also facilitate shifts from the traditional teacher-centred approach to teacher-facilitated, student-centred approaches (UNESCO, 2014). Effective training in ESD could also empower teachers to foster students' critical thinking skills, understanding of complex systems, envisioning of

sustainable futures, and community participation (UNESCO, 2002, 2012).

In-service professional development (PD) programs are another approach to training teachers in implementing ESD in their schools. Ongoing PD programs could develop knowledge, skills, and competencies required to implement ESD in schools that teachers may not have learned during their pre-service programs (UNESCO, 2017).

There are several effective professional learning strategies: allocating sufficient collegial support, resources, and time for teachers to reflect on and challenge their thinking on teaching (Timperley et al., 2008), and adding team teaching and new teaching practices in the subject (Rytivaara et al., 2019). Further, teachers could critically self-reflect on improving their teaching and promoting student subject learning (Geijsel et al., 2009) and conducting research to improve the effectiveness of their teaching (Timperley et al., 2008). Also, principals could mentor and encourage teachers to implement new knowledge and practices, with follow-up to ensure that students effectively learn the subject (Langelotz, 2017). Thus, effective teacher training in ESD is important for ensuring teachers' ESD knowledge, skills, and confidence, which is evident in the literature and this study.

Teachers ESD Knowledge, Skills and Confidence

Teachers require the key sustainability competencies of knowledge, skills, attitudes, values, motivations, and commitment in teaching ESD (UNESCO, 2017, 2018). Teachers' overall knowledge, skills, and confidence in ESD teaching depends on the relevance of ESD in their pre-service training (Arnold & Mundy, 2020; Tomas et al., 2017). Teachers with appropriate knowledge, skills, and positive attitudes towards ESD can positively influence student learning (Barnes, 2015), while teachers with negative attitudes are believed to negatively impact on students' ESD learning (Spiropoulou et al., 2007).

Further, teachers with appropriate training could innovate appropriate teaching pedagogies, such as action-oriented and transformative pedagogies, that can encourage students to be enlightened, active, and responsible citizens (UNESCO, 2017). Teachers with increased knowledge and understanding about sustainability concepts and skills are believed to have enhanced confidence in teaching ESD (Evans et al., 2016),

Table 1. Frequency of interview responses from principals and teachers about preparedness to teach ES

Sub-theme	Coded response	[P, I]	[T, I]
Allocation of teachers to teach ES	Preferred science teachers	6	-
	Allocated non-science teachers	3	-
Pre-service training in ES	Lack of pre-service training in teaching ES	4	12
PD workshops in ES	Teachers have not attended PD workshops	1	7
	Teachers have attended PD workshops	3	8
	PD attended was inadequate	-	6
Teachers' confidence in teaching ES	Lack of confidence in teaching ES	0	13
Subject/teaching-related barriers	Teachers' lack of interdisciplinary knowledge in ES	2	7
Teachers' knowledge about ES teaching objectives	Educating students to preserve and protect the environment	-	6
	Addressing climate change	-	3
	Teaching students to respect nature	-	1
	Taking care of waste	-	1
Good practice in teaching ES	Organising field trips	-	8
	Solving real world environmental problems outside the class	-	3
Indicator of good practice in teaching ES	Students implementing knowledge and values learnt into practice in real-life situations	-	7

Note. [P, I]: Principal interviews (n=6); [T, I]: Teacher interviews (n=14); & Dashes indicate absence of data as questions were inapplicable or not posed in the interview

while the low levels of teacher confidence may relate to inadequate professional preparation in teaching ESD (Effeney & Davis, 2013). Thus, teachers' knowledge, skills and confidence are keys to a successful implementation of ESD in schools.

METHOD

Context of the Study

14 ES teachers and six principals or vice-principals from six secondary schools in Samtse, Bhutan participated in this study.

Data Collection

This study employed interviews to investigate: How effectively do Bhutanese teachers feel they have been prepared to implement environmental science in schools in Bhutan?

Interviews

Semi-structured interviews were conducted with the participants to elicit rich data (Bryman, 2016) and in-depth understandings of the perceptions the participants (Brinkmann & Kvale, 2018; Punch, 2013).

According to Cassell and Symon (2004), interviewing is readily accepted by research participants, and offers flexibility and the opportunity to repeat questions, clarify responses, and press for extra information when a response appears inadequate or irrelevant (Ary et al., 2009).

Data obtained through interviews are often more valid because participants can express views and opinions in their own words (Minichiello et al., 2008). However, interviews can be time-consuming (Bryman, 2016; Cohen et al., 2018), which is a significant issue in schools because teachers and principals are time-poor.

To gain deeper insight into the research questions, two sets of interview protocols were designed, one for the teachers and one for the principals. As it was important to respect timetabling constraints, the interviews were about 35 minutes each. Interviews were digitally recorded, then the audios were transcribed using InqScribe™ version 2.2.4.

Data Analysis

CAQDAS NVivo12 was used to analyse the interview transcripts. Data was coded using both deductive and inductive approaches (Elo & Kyngäs, 2008) through a constant comparison method (Leech & Onwuegbuzie, 2011) maintaining coding memos within NVivo12, as suggested by Corbin and Strauss (2014) and Polit and Beck (2006). After all the interview data had been coded, NVivo12 was used to run a matrix coding query to determine the frequency of each code and category for each group of participants.

RESULTS AND DISCUSSION

The results (Table 1) and discussion are presented under themes and supported by illustrative excerpts from the data sources, marked by principal interview [P, I] and teacher interview [T, I].

Allocation of Teachers to Teach ES

All principals preferred science teachers to teach ES, which complies with the education policy that expects science teachers to be capable of teaching ES: "The policy behind is, every science teacher should be in a position to teach ES" [P, I]. Also, the principals explained that ES is related to other science disciplines. "ES is more of like biology. We allocate ES to science teacher who have biology background and those teachers who teach chemistry" [P, I].

Despite this preference to allocate ES to science teachers, three principals reported that they allocate non-science teachers to teach ES. "We normally give it to the science teacher or the geography teacher because it is quite related to their subject. At present, I have given to geography teacher, and he is trained" [P, I]. Also, one of the principals reported that in the event of a lack of teachers with the relevant subject background, they allocate teachers based on their interest in teaching ES:

We also look for teachers if they are interested even if they do not have subject background. It also depends on school's situation. If we do not have teacher with the science background, then we look for those teachers who are interested we at least meet [P, I].

The rationale provided by the principals for preferential allocation of science teachers to teach ES appeared logical and understandable, and the link between science education and environmental education is well established in the literature. For example, Littledyke (1997) suggests that environmental education "draws on science to support knowledge of the causes of environmental problems, as well as the complexity of ecological systems. Such knowledge is complex, interrelated and impinges on a number of disciplines" (p. 642). However, the goal and content of ES includes more than science as outlined in the Environmental Science Curriculum Framework (ESCF) (DCRD & RSPN, 2013, p. 17). In addition, ES content should be drawn from other disciplines, including geography, maths, history, and economics (DCRD & RSPN, 2013). The underpinning ESD focus, and interdisciplinary nature of ES content means that it can be problematic to allocate the ES teaching to teachers with a single subject specialisation, including science. I argue that principals could consider a teacher's capacity to teach and engage with the multidisciplinary nature of ES in their teacher allocation decisions.

Teachers Pre-Service Training in ES

Table 1 shows strong evidence of lack of pre-service training in ES. Teachers who are engaged in teaching ES have been trained to teach other subjects, as there is no teacher qualification specifically to teach ES. The teachers interviewed had mostly been trained in subjects such as geography ("I am supposed to teach geography. I did my PGDE and degree in geography" [T, I]), history ("I did my PG in history. History is my specialisation" [T, I]), or science ("I came here to teach biology" [T, I]). Therefore, with this limited training, it is not surprising that principals identified that teachers lack relevant pedagogical content knowledge (PCK) of ES. Example comments are "It may not be true to say that they are fully equipped or fully capable enough to teach ES

effectively" [P, I] and "In terms of pedagogy, they need to get trained in ES" [P, I].

Teachers' lack of preparation during their pre-service training to teach ES also exemplifies a broader international issue. The objectives of ES strongly reflect ESD principles, and as pointed out by Evans et al. (2016), Ferreira et al. (2016), and UNESCO (2014), although most countries have included environmental education (EE) or ESD as one of the general goals of education in their school curricula, they are often absent in teacher education programs. In Bhutan, EE may be taken as one optional module within a teaching degree, which likely limits knowledge about the content and appropriate teaching methods that teachers might employ to achieve the intended ES objectives and learning outcomes.

Professional Development for Teachers Teaching ES

The data from the teacher interviews indicate that PD workshops appear to be inadequate for preparing the teachers for ES teaching and identifying some unmet desire of teachers for PD. For example, "I got two times orientation workshops. It lasted almost one week, but I should say I am still not trained" [T, I]. Others mentioned, "Yes, in the beginning we had a workshop, but that workshop is not content related" [T, I]. The other half of the teachers claimed they had not attended ES PD workshops, for instance, "As of now, I have not attended any training or workshop related to ES subject" [T, I]. Further, one of the principals stated that none of the ES teachers had attended PD workshops and identified it as one of the challenges in teaching ES. "Orientation is not given to many teachers. So, this is the challenging part for teachers in this subject" [P, I]. Thus, the extent to which teachers have experienced ES PD appeared quite variable.

The reported lack of PD has created a challenge for ES teaching for half of the teachers. Also, many teachers perceived that the ES-related PD workshops offered were ineffective to enhance their ES content knowledge and teaching strategies. This apparently unmet need for effective PD that was expressed by many ES teachers underscores the desirability for ongoing professional learning through formal PD or other professional learning approaches. PD must be purposefully aimed at enhancing teachers' content knowledge and pedagogical skills and practices (Guskey, 2003). Further, Guskey (2003) refers to the importance of "collegiality and collaborative exchange" in the school workplace to informally facilitate learning across disciplines as part of the daily professional learning of teachers.

Teachers Confidence in Teaching ES

13 teachers admitted during interviews that they lacked confidence in teaching ES. For example, "I am not that much confident in teaching ES. As I said, I am specialised in history. So, I feel much more confident

teaching history than teaching ES" [T, I]. Some teachers suggested that their lack of confidence resulted from limited relevant experience and training in ES. One teacher stated that "Maybe we do not have much experience or exposure and orientation is not enough, that is why we are not confident about how to teach and what to teach" [T, I], and another stated, "In terms of strategy and other pedagogy, I am still in dilemma how to go about teaching ES. I am not that competent enough" [T, I].

The role of accrued experience in developing confidence in ES teaching was expressed by some teachers and is supported by a considerable body of literature (for example Wan, 2016). All but one teacher identified that their lack of confidence in teaching ES related to their lack of training and PD. This finding is consistent with previous research, for example Effeney and Davis (2013) and Tomas et al. (2017). A strong theme that emerged from this study was that teachers require more and better PD that is specific to teaching ES.

Subject/Teaching-Related Barriers

Teachers' lack of interdisciplinary knowledge in ES emerged as a barrier to teaching the subject from the interview responses of two principals and half of the teachers. In this regard, non-science teachers shared the difficulties they faced in teaching scientific knowledge, stating that "In case of me, I did not take science... I have to prepare myself and consult another subject teacher" [T, I], while science teachers teaching ES experienced challenges teaching knowledge from non-science disciplines:

ES is interdisciplinary subject. It involved many other subjects like economics, geography, sociology... where I am not specialised in. I need some more interdisciplinary knowledge... There are certain chapters that I am not competent enough to teach. For example, teaching about sustainable development...but other knowledge related to biology... I am able to teach them [T, I].

The concern expressed by the teachers about their lack of multidisciplinary knowledge is consistent with the challenges related to teaching interdisciplinary subjects that integrate sciences and humanities (Rives-East & Lima, 2013). Because ES is multidisciplinary, anyone teaching it needs to be operating to some extent out-of-field; that is, they are teaching a subject area for which they are not, or do not feel, specifically trained (Hobbs et al., 2019). For instance, a science teacher may have trouble teaching or linking to the history component of ES. These teachers are likely to face difficulties "both practically in the classroom and personally" (Hobbs et al., 2019, p. 87). Further, teachers with a specific subject specialisation may face disciplinary-based language barriers and limitations

when attempting to view sustainability issues from different perspectives. This finding highlights some potential value when implementing ES in interdisciplinary co-teaching among teachers with different subject specialisations and/or wider online collaboration with remote ES experts.

Teachers Knowledge About ES Teaching Objectives

The most reported teaching objective was educating students to preserve and protect the environment, as it was mentioned by six teachers, while three teachers claimed that addressing climate change is one of the ES teaching objectives:

It is about addressing climate change. Students should know about what climate change is...can be one objective of teaching ES because climate change is one global issue right now [T, I].

Overall, the findings revealed that teachers' limited knowledge and understanding of the ES teaching objectives as described in the ESCF (DCRD & RSPN, 2013) may be either due to the lack of PD to orient them to ES teaching or a lapse in time since they had engaged in relevant PD. However, in ES (unlike in other subjects), the objectives are listed in the textbooks and, therefore, are easily available to teachers. Perhaps the significance of the objectives was not made aware to teachers or were focusing on the more detailed textbook content and learning outcomes, especially as these were explicitly assessed.

Regardless of the reason, I argue it is crucial that teachers know the ES teaching objectives to best facilitate student achievement of those objectives. As outlined in the ESCF, ES has the following two objectives for preparing youth:

1. "To motivate them to take actions towards environmental conservation and uphold the principles of GNH" and
2. "To empower them to make right choices for sustainable future with global perspectives and transforming them to be responsible and productive citizens in the 21st century world" (DCRD & RSPN, 2013, p. 18).

Thus, teachers' knowledge of the teaching objectives is important for promoting selection and implementation of appropriate teaching approaches, such as action orientation, critical thinking, and community participation, and the design of suitable activities to support student learning, such as hands-on learning experiences, outdoor learning, problem solving, and so on. This finding indicates that greater knowledge of the ES objectives is required, which could be affected if the school principals establish a school teaching culture and practice to orient teachers about the ES objectives and promote the adoption of activities and strategies for effective implementation of ES.

Teachers Knowledge About Good Practice in ES Teaching

When teachers were asked more specifically about what constituted good practice for facilitating students' learning, the main message from the teachers was the importance of field trips. "Good practice is taking children on a field trip to different ecosystems, make children realise the beauty of nature, the aesthetic value of the plants and biodiversity" [T, I]. Another teacher stated that "to teach ES effectively, first we have to develop students' attachment towards environment. We can do it through field trip" [T, I]. This view aligns with the ESCF, which states that field trips are an essential components of ES teaching and learning (DCRD & RSPN, 2013). In this study, the teachers valued field trips because they believed they are effective in developing knowledge and attachment to the natural environment and fostering pro-environmental values and attitudes. In this, their views are consistent with UNESCO's (2017) claim that field trips provide opportunities for students to witness first-hand and understand sustainability through such things as agricultural practices and water quality monitoring infrastructure in their communities. Outdoor learning has merits in terms of bonding students with nature, fostering their respect for nature, and promoting in-depth understandings of local biodiversity and ecological systems (Sobel, 1996). Further, field trips in the outdoors may also connect students with their communities to develop student pro-environmental attitudes and empower them to take action (Sobel, 1996).

Indicators of Good Practice in ES Teaching

In response to the question about good practice, some teachers referred to the outcomes that might indicate good practice, instead of, or in addition to, describing what constitutes good practice. Half of the teachers believed that students implementing the knowledge and values learnt into practice in real-life situations outside of ES classes was an indicator of good practice: "Good practice in teaching ES means mainly implementing the knowledge learned in the class to real life situation" [T, I]. Another teacher reported changing behaviours as a good practice: "From my understanding, good practice in ES is, if students can learn properly and change their habits, pick up whatever values that we discuss in the class. If those can be put into practice for behavioural change" [T, I].

These teachers' views about good practice are not about actual teaching practice but are rather about the learning outcomes that students can apply to their real-world contexts. This finding aligns with the ESCF (DCRD & RSPN, 2013), which states the desirability of students connecting "the concepts and principles of various sciences to the real-life situations promoting practice" (p. 6). Given the above, it is important for ES

teachers to create opportunities for the learners to implement knowledge learnt in the class to address real-world environmental issues, potentially leading to more effective learning, and upholding of the GNH principles. Further, applying the knowledge and skills in their real worlds may foster key competencies, such as critical thinking, action competence, and community participation (UNESCO, 2017). As Ally (2004) asserted, engaging students in applying their learning in real world settings enables students to contextualise and develop personal meanings about what they have studied in class. Additionally, according to Rowe (2007), student success in solving environmental problems may facilitate their appreciation and realisation of their potential for creating positive impacts and sustainable societies. However, for students to interact with the world in a way that will support sustainability, they must develop key ESD competencies viz systems thinking competency, anticipatory competency, normative competency, strategic competency, collaboration competency, critical thinking competency, self-awareness competency, and problem-solving competency (UNESCO, 2017, p. 10). These could be achieved through teaching approaches such as constructivism (see Pass, 2004), critical theory (see Elliott & Davis, 2018, p. 16) interdisciplinary curriculum approaches (see UNESCO, 2005; UNESCO-UNEP, 1977), whole school curriculum approaches (see (Tilbury & Wortman, 2005), and action-orientation (see Jensen, 2004). The development of students' competencies through these approaches could potentially aid in achieving the aims and objectives of teaching ES.

CONCLUSION AND IMPLICATIONS

Teachers in this study had much to contribute around the question of preparedness to teach ES. Allocation decisions and justifications by principals indicated in several cases that the subject does not have the same status as other compulsory sciences and arts subjects. Allocation of teachers with spare teaching load portrays ES as a likely "second class" subject. Moreover, the optional nature of ES could perpetuate the notion that it has less status than compulsory subjects. Teaching arrangements, such as team or integrated teaching, may be potential alternatives that could address both of these issues. Teachers' lack of PCK, interdisciplinary knowledge, and clarity about the ESCF objectives, all of which may relate to limited ES teaching qualifications and PD, could be addressed through school initiatives to develop cultures that enhance ongoing professional learning in relation to ESD through collegial support (Timperley et al., 2008), team teaching (Rytivaara et al., 2019), and engaging in critically reflecting on their teaching practice. Further, improved ICT facilities could help teachers to access the PD they require through access to online journals, seminar reports, webinars and online coaching, virtual communities of practice

(McLoughlin et al., 2018), and free educational materials related to good practice. Furthermore, the two teacher education colleges could effectively embed ESD into the teacher education program to adequately prepare teachers to teach ESD.

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