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Facilitating the development of students' generic green skills in TVET: an ESD pedagogical model

Abstract

Technical and vocational education and training (TVET) plays a significant role in supporting green economic restructuring as well as tackling environmental problems through skills development. Generic green skills play an important role among required skills, as they are necessary for all occupations to ensure environmental friendly workplace practices, and as a consequence they should be addressed in the TVET curriculum. The pedagogy needed to facilitate the development of these green skills is an emerging research area worldwide.

This paper considers pedagogy for education for sustainable development (ESD) as a broad framework that can enhance the development of generic green skills. It examines current theories and a selection of practices related to ESD pedagogy and analyses pedagogical approaches commonly used in ESD curricula. It also reports on the results of a pilot study that revealed a significant gap between the pedagogical approaches put forward in the literature and ESD pedagogical practices within the context of TVET.

Based on ESD pedagogy analyses and the results of the pilot study, this paper puts forward a pedagogical model designed to support generic green skills development. It suggests a problem-oriented and project-based pedagogical framework that brings real-world learning opportunities into the classroom as a pedagogical approach, which has the potential to enhance the development of students' generic green skills.

Keywords: Green skills, Generic green skills, TVET, ESD pedagogy, real-world learning, locally relevant knowledge, problem-oriented learning, project-based learning; problem-oriented and project-based pedagogical framework

1 Introduction

During the UN Decade of Education for Sustainable Development (ESD), technical and vocational education and training (TVET) started re-orienting its curriculum towards ESD. The final report on this UN Decade (UNESCO 2014) revealed actions around the world related to ESD inclusion such as TVET teacher training (China), reforming and innovating TVET curriculum (Kenya, China, Mauritius, Canada, Poland, Greece), incorporating sustainable development into vocational qualifications (Finland), introducing policy to support green skills development (Australia, Republic of Korea, France) and developing a network to facilitate cooperation between TVET institutions (Peru). Adoption of Sustainable Development Goals (SDGs) in 2015 strengthened the emphasis on the role of skills in addressing SD challenges, and included support for green economic restructuring. In relation to skills that are required, generic green skills are widely accepted as core competencies for almost any occupation (ILO 2011; OECD 2013; Pavlova 2017; 2018) and have been identified as having a significant impact on facilitating the future workforce's understanding of issues related to green growth and as well as enhancing those skills required for more environmental friendly performance in the workplace.

In order to address the issue of generic green skills development, generic green modules/ environmental modules have been introduced into the TVET curriculum. For example, the Ministry of Education and Training (MOET) in Vietnam introduced a compulsory 30-hour subject on climate change for all TVET institutions under MOET supervision (Pavlova 2017). Many vocational training providers (VTPs) also viewed industrial safety units that contain content on environmental awareness, hygiene and safety as a means to address generic green skills (ibid). A number of generic green modules have been introduced in Hong Kong that include environmental knowledge and reflection on green practices that are needed for greening the economy and society as a whole. Although positive processes for greening the TVET curriculum have been observed worldwide, many aspects of its effective implementation are still under-researched (Pavlova 2017). In particular, the effectiveness of implementing these learning modules in order to equip students with generic green skills/competencies has not been thoroughly examined.

The reorientation of the TVET curriculum so it includes generic green skills requires innovative pedagogy to facilitate the effective implementation of "greened" curricula. Traditional methods of academic instruction, such as lecture-driven delivery, have inadequately equipped students with the required competencies to make the transition from the classroom to real world problem solving (Steinemann 2003; Seatter & Ceulemans 2017). Moreover, TVET pedagogy, which has uncritically responded to industry demands (e.g. fueling productivity and efficiency) but has ignored unintended environmental and social consequences, and has therefore been criticized for failing to equip students with green skills (Anderson 2009; Arenas & Londono 2013; Bedi & Germein 2016). Thus, a more innovative

pedagogy that provides interactive, experiential and transformative learning as well as real-world problem solving opportunities to facilitate students' generic green skills development should be applied. However, innovative pedagogies proposed in the literature for facilitating effective teaching and learning in TVET, such as work-based learning, authentic learning and campus-based learning have not been specifically designed to assist generic green skills development. There has hardly been any research that can provide empirical evidence regarding the nature of teaching and learning to help with generic green skills development in the context of TVET.

In addressing this issue, the paper suggests applying ESD pedagogy as a broad framework that can enhance the development of generic green skills through TVET programs. It outlines current theories and a selection of practices related to ESD pedagogy and reviews pedagogical approaches commonly used in ESD curricula to develop students' key sustainability competencies. It also reports on the results of a pilot study based on classroom observations and interviews with TVET staff involved in teaching a generic green module at one TVET institution in Hong Kong. This study revealed a significant gap between the pedagogical approaches put forward in the literature and ESD pedagogical practices in the context of TVET. Therefore, the importance of developing a model that can present a theoretical understanding of how to approach the development of generic green skills is of a particular significance.

Grounded on ESD pedagogy analysis and the results of the pilot study, this paper outlines a pedagogical model designed to support generic green skills development. It puts forward a *problem-oriented and project-based pedagogical framework* that includes real-world learning opportunities as a pedagogical approach and which has the potential to enhance the implementation of generic green modules to expedite the development of students' generic green skills.

2 Current Theories and Practices related to ESD Pedagogy

This section outlines the theory and practice related to ESD pedagogy. First, it conceptualizes the meaning of ESD pedagogy based on the understanding and characteristics of ESD. Following on from this, the section outlines the theory and part of the practice with regard to an ESD pedagogical approach and strategy.

2.1 **The conceptualization of ESD pedagogy**

Considering the diverse understanding of ESD and ESD pedagogy in literature, it is important to conceptualize the meaning of ESD pedagogy and outline some of its related practices.

Commonly, ESD is regarded as a particular way of linking education and sustainable development, although it is described and conceptualized in different ways according to the various interpretations of sustainable development and educational ideologies (Corney & Reid 2007). From a teaching and learning perspective, ESD has been understood as an

emerging paradigm that enables holistic, systemic, connective and ecological ways of thinking and learning (Sterling 2002). Although there is no widely accepted definition of ESD pedagogy, many approaches are in accord about its specific characteristics. The ESD Sourcebook (Learning and Training Tools NO.4 2012) reveals that ESD pedagogies are

*"often **place-based or problem/issue-based**. ESD pedagogies **encourage critical thinking, social critique, and analyses of local contexts**. They **involve discussion, analysis and application of values**. ESD pedagogies often **draw upon the arts** using drama, play, music, design, and drawing to **stimulate creativity and imagine alternative futures**".* (UNESCO 2012, 15)

Although the majority of literature on ESD pedagogy has been focused on higher education (e.g. Brundiers, Wiek & Redman 2010; Blake, Sterling & Goodson 2013; Remington-Doucette et al. 2013), the results of studies in the literature can help conceptualize approaches relevant to TVET that can then be empirically tested. These identified studies revealed that ESD pedagogy promotes **cooperation and collaboration**, **issues investigation**, **multiple perspectives and real-world problem solving** (Laurie et al. 2016). For instance, the Burns Model of Sustainability Pedagogy (Burns 2009; 2013) takes an integrated approach to examining complex sustainability issues through problem-based learning and collaborative group work that focus on inquiry, experience and reflection and which have a central focus on ecological design. Although many of the proposed ESD pedagogies, such as inquiry-based learning and case studies, have been in practice in different disciplinary traditions for years, they are now implemented in **interdisciplinary contexts** and applied to **address sustainability issues**, which do more on developing the acquisition of **skills, perspective and values required for sustainable societies** instead of facilitating learning of knowledge (Laurie et al. 2016).

Therefore, ESD pedagogy could be understood as diverse teaching and learning methods that can facilitate participation and collaboration, develop critical problem-solving abilities and stimulate innovation through a holistic and interdisciplinary approach, which is also value-driven and locally relevant. It could also make a contribution to developing students' generic green skills, which could assist the future workforce to understand green growth issues and increase their environmental awareness.

2.2 ESD Pedagogical Approaches

An increasing number of pedagogical approaches proposed in recent literature are related to traditional approaches, such as work-based learning (e.g. Finn 2017; Wall et al 2017); campus-based project learning (e.g. Lindstrom & Middlecamp 2017) or emerging high-tech-based approaches such as game-based learning (e.g. Madani, Pierce & Mirchi 2017). All these approaches advocate teaching and learning through solving actual, real-world sustainability problems as an effective way of developing sustainability competencies (Rowe 2007; Brundiers, Wiek & Redman 2010; Remington-Doucette et al. 2013). Most of the ESD pedagogical frameworks that incorporate real-world problem solving opportunities use

problem-based learning (PBL), project-based learning (PjBL) or the integration of PBL and PjBL (e.g. Brundiers, Wiek & Redman 2010). Therefore, the following review is focused on elaborating the theory and practice related to PBL, PjBL and the integrated models of PBL and PjBL. The intention is to formulate a theoretical framework for developing an ESD pedagogical model to facilitate the effective implementation of a generic green module to equip students with generic green skills.

2.2.1 Problem-based learning

Problem-based learning (PBL) is widely identified as an effective approach for ESD as it focuses on complex interdisciplinary problems, and provides students with the opportunity to gain experience in addressing complex problems they may face in their future careers (Steinemann 2003). It encourages students to work in a team and integrate theory with practice to figure out solutions to problems, which is assumed to be the aim of the PBL approach to professional education (Savery 2006).

The foundations of problem-based learning are firmly based on the work of researchers such as Dewey, Piaget, Bruner and Gagne. It incorporates the objectives of developing **problem solving and self-directed learning abilities and supports motivation for learning (**Barrows 1986).

2.2.2 *Project-based learning*

Project-based learning (PjBL) is a form of situated learning, based on constructivism theory. This theory suggests that students gain a deeper understanding of the learning material when they actively construct their understanding by working with, and using, ideas in real-world contexts. (Krajcik & Shin 2014). PjBL, which interweaves knowledge application and project practice, can help students consolidate and broaden their understanding (Tempelman & Pilot 2011), and provide opportunities for students to develop the communication, problem-solving and team-working skills which will be needed in their future careers (Elshorbagy & Schönwetter 2002). Furthermore, when students perceive they are developing the professional skills required for their future careers, their **learning motivation will be enhanced** (Fang 2012). This kind of motivation can be sustained through meaningful, real-world problem solving and projects (Bell 2010).

A pan-European study, which compared sustainability subjects in technology universities, found that the most effective pedagogy for students to learn about sustainable development was a community-based project that involved collaboration between multiple learners as well as the use of a constructive-learning pedagogy (Jollands & Parthasarathy 2013). Another recent study also demonstrated that PjBL can effectively improve students' generic green skills specifically in relation to project management, collaboration and communication proficiency (Ana, Sunarsih & Roheani 2015).

2.2.3 *The Integrative models of PBL and PjBL*

ESD has increasingly focused on integrating problem- and project-based approaches to create more real-world learning opportunities for students to better understand and address sustainability challenges (Brundiers & Wiek 2013; Wiek et at. 2014; Kricsfalusy, Reed & George 2016).

Brundiers and Wiek (2013) explained the aims for combining PjBL and PBL: first the combination of PBL and PjBL can avoid both the risk of "***getting caught in the knowledge-first trap by endlessly analyzing problems***" and of "***jumping prematurely to solutions without sufficient problem framing and analysis***" (p. 1728). Second, it can expand the engagement structure of PBL by involving stakeholders in a collaborative learning and critical reflection process instead of simply involving stakeholders who act as consultants (Brundiers & Wiek 2013). There are at least three approaches that have integrated PBL and PjBL that have been identified in the literature.

Problem- and Project-Based Learning (PPBL) approach

The problem- and project-based learning (PPBL) approach is based on constructivist and experiential learning, which specifically incorporates the approaches of PBL and PjBL (Wiek et al. 2014). It adopts the learning process of **problem inquiry as in PBL** to formulate solutions for problem solving through **group projects**. In these settings, learning shifts from passive to active, whereby students investigate a real-world problem and work on solutions/options by engaging in small-group work (Brundiers & Wiek 2013).

Since 2007, Arizona State University (ASU)'s School of Sustainability (hereafter SOS) as the first school in USA with credible undergraduate and graduate programs in sustainability, and has incorporated PPBL opportunities into learning and teaching practice (Brundiers, Wiek & Redman 2010; Redman & Wiek 2012; Brundiers & Wiek 2013). These PPBL activities provide students with unique settings that facilitate their professional capacity building by collaboratively identifying, analyzing and developing solutions/options to sustainability problems at local and international scales (Steinemann 2003; Thomas 2009; Wiek, Withycombe & Redman 2011; Yasin & Rahman 2011, Wiek et al. 2014). In 2010, a PPBL model (the ASU-SOS "functional and progressive" model) was proposed for building sustainability competence by effectively and structurally integrating real-world learning opportunities into the curriculum (Brundiers, Wiek & Redman 2010).

Problem Oriented Project-Based Learning approach

A similar approach proposed to address ESD has been problem oriented project-based learning (POPBL). Yasin and Rahman (2011) indicates

*"POPBL has to start with **the analysis of a research problem** followed by **the design of the project** to solve the problem through **the implementation of the activity planned** in order to solve the problem under study"* (p. 3).

It has been argued that project-based learning in **subject-oriented curriculum** and **problem-oriented project work** is crucially different (Kolmos, Fink & Krogh 2004; Olsen & Pedersen 2005; Yasin & Rahman 2011). In a normal subject-oriented project-based curriculum, students' work with the questions and themes that are decided by teachers, and teachers play the role of an expert to demonstrate "how students in a constructive way can relate curriculum and theories to praxis" (Nielsen & Danielsen 2012, 258). In this way, students are given, or chose, the topic to "learn", rather than taking the responsibility of identifying the real-world problem they will work with. This kind of "PBL" ignores the notion that **formulating a problem is the large part of the learning process in PBL** (Yasin & Rahman 2011; Nielsen &. Danielsen 2012). The basic principles of POPBL can be summarized as:

Student-centered and able to motivate and gain commitment among students

Problem-oriented and not subject-oriented

Focus is more on the learning process and finding solutions rather than knowledge recall

Project-based which involves goals and actions for change

Exemplarity instead of generality

Promotes group/team work, social and communication skills

Pavlova (2015) suggests that POPBL helps students to incorporate ethics in the decision-making process and enables reflection on the issues and proposed solutions, and from this perspective it should play a central role in developing pedagogical approaches to ESD. POPBL starts from the *identification of an issue/problem* and the development of specifications or criteria that the solution should address, and leads on to a formulation of several ideas; selection of the best solution and its further development; experimentation and evaluation; obtaining feedback from different stakeholders and subsequent improvements to the suggested solution. This process is not linear and requires reflection at each stage throughout the life of the project; it might take students back to the previous stages.

The POPBL approach, for example, has been used in an ESD program – "Life Sciences in Education", which is the first ESD course for teacher education at the National University of Malaysia. The positive aspects of adopting POPBL in this program are by the students enjoying and learning a lot through community involvement and real life situations; they learn and apply the **generic skills such as team and interpersonal communication in group project work,** which further suggests that the POPBL approach is effective in developing students' generic green skills (Yasin & Rahman 2011). The technology teacher training program at Griffith University (Pavlova 2009) used this approach for the final year students' projects. They needed to pull together all the knowledge and understanding they had developed through the program to identify an issue, formulate a problem (brief) for the project and find a solution within the context of sustainable development.

Problem-Based and Project-Organized model

The problem-based and project-organized (Aalborg Model) (Kjarsdam & Enemark 1994) is another integrative approach targeted at problem solving through project work. It is a combination of problem-based (meta-concept) and project-organized approaches, and involves problem-orientation, project work, **interdisciplinary**, participant directed-learning, exemplary principle and teamwork (Kolmos, Fink & Krogh 2004). All the learning activities in different learning processes within this model are fundamentally centered on problem solving. The Aalborg Model has been used at the Aalborg University **across all educational programs**, including sustainability programs, such as Engineering Science and Sustainability (Holgaard et al. 2016).

In summary, the combination of PBL and PjBL provides students with more opportunities to solve real world problems in order to foster developments of students' sustainability competencies. The *project work* offers an opportunity for students to address a real-world problem and create changes in some way, while the *problem-oriented/based learning* process facilitates learning through problem formulation and exploration. All integrative approaches/models emphasize the importance of interdisciplinary learning, self-directed learning, community involvement and real-world problem solving.

However, they have a slightly different emphasizes: the PPBL approach accentuates outside classroom settings; POPBL approach place more emphasis on problem formulation as an essential part of the learning process; and the Aalborg Model highlights the principle of interdisciplinarity so all learning activities are centered on problem solving and cross different programs. Although these models were developed and used mainly in higher education (Bachelor and Master Level) and were not specifically applied to the TVET context, they provide an important theoretical foundation for the development of an ESD pedagogical model for TVET.

2.3 **The Identified ESD Pedagogical Strategies**

This section reviews ESD pedagogical strategies, which are commonly used or suggested in the literature on ESD education. Analyses of ESD pedagogical strategies revealed the more common ones utilized in higher education. These include: Role plays and Simulations (to gain an in-depth understanding of another person's perspective); Stimulus activities (e.g. watching a video or looking at photos, poems or newspaper extracts to initiate reflection or discussion); Debates (to encourage the development of arguments and counter-arguments on a topic); Critical incidents (to consider students' personal perspectives and actions in relation to a moral or ethical stance – what they would do, could do and should do); Case studies (to develop a holistic view on an issue relevant to their context and to devise a solution); Reflexive accounts (to understand the effect of individual action on issues/solutions); Critical reading and writing (to understand possible motivations of the author and how the author might envisage alternative futures as a consequence); Problem-based learning (to identify

solutions based on investigation, developing a vision and plan of action); Fieldwork and outdoor learning (to link theory and real-world examples, promote active learning and develop an understanding of the complexity of sustainability); Modeling good practice (to demonstrate action-taking behavior such as reducing paper use, turning off lights at the end of the class) (Cotton & Winter 2010; Tilbury 2011).

In an attempt to further classify pedagogical strategies for ESD in higher education Lozano et al. (2017) selected twelve strategies either from well-cited ESD literature or ones that have been broadly adopted. These pedagogical strategies are non-exclusive, with some overlap in techniques and a clear potential to use two or more of the educational strategies synergistically:

Universal: broadly applicable pedagogies that have been used in many disciplines and contexts (including case studies, interdisciplinary team teaching, lecturing, mind and concept maps, and project and/or problem-based learning);

Community and social justice: pedagogies developed specifically for use in addressing social justice and community building (including community service learning, jigsaw/interlinked teams, participatory action research); and

Environmental education: pedagogies emerging from environmental sciences and education practices (including eco-justice and community, place-based environmental education, supply chain/Life Cycle Analysis, and traditional ecological knowledge) (Lozano et al. 2017, 6-7)

In addition, Lozano et al. (2017) map the extent to which specific sustainability competencies can be developed by different ESD pedagogical strategies. Although this mapping is hypothetical, it provides a suitable approach for identifying strategies that contribute towards the most effective development of generic green skills.

In summary, the pedagogy approaches identified above could be used in different ESD learning contexts and could be applied depending on students' characteristics, their previous learning experience about sustainability, the learning objectives for specific lessons, as well as the learning resources and space available for ESD education.

3 Results of the Pilot Study

This section introduces the aims and setting of the pilot study; it reveals the problems and challenges identified in the study and clarifies its implications in terms of developing the ESD pedagogical model put forward in this article.

3.1 **Introduction of the Pilot Study**

This small-scale study was conducted in one TVET institution in Hong Kong. It was designed to understand how students and teachers respond to a generic green enrichment module, and analyses included teachers' pedagogical practice, students' participation and the challenges

encountered by both teachers and students in teaching and learning this module. In addition, the study sought to identify the learning and teaching settings for this module, such as teaching and learning resources, course content, teaching staff' and students' learning background. This generic green enrichment module addresses topics such as environmental concepts, sustainable development, environmental laws and regulations, pollution at the workplace, green office/workplace, climate change and carbon footprints.

Research methods for the pilot study included in-class observations and on-site conversations. Four in-class observations in two different classes were conducted. They covered three different topics from the module:

Green office/workplace

Climate change and carbon footprint

Sustainable development and corporate social responsibility

Four on-site conversations focused on teaching reflections with two teachers after every in-class observation, and one formal conversation with the team leader to better understand the module settings and to discuss the observations and teachers' reflections. Attendance at the module team meeting also formed part of the data collection, in order to understand the module review plan and discuss identified issues with attendees. Observation notes and records of all conversations were taken during the two-month data collection process and these were subsequently analyzed. Recurring themes, patterns and issues were identified. The main two focuses of the analysis for this pilot study were the challenges and issues related to classroom practices during module implementation, as well as the level of students' engagement.

3.2 **Identified problems and challenges in teaching this green module**

The challenges and problems related to teaching and learning this module identified in this study are discussed below.

First, the lecture-based and content-centered pedagogical approach, which organized the lessons into one-way knowledge delivery and ignored students' prior experience and learning needs, did not stimulate students' participation and learning motivation. Most of the time, students played the role of passive information receivers as the teaching strategies did not provide them with opportunities to explore the real-world issues or exchange ideas and learning experiences. In addition, the content is based on a fixed teaching and learning package, which has little local relevance and is barely related to students' different learning or working experiences. From this perspective this module does not address diverse learning needs and neither does it support students to make connections between knowledge acquisition and application.

Second, most of the teachers who delivered this module are primarily responsible for teaching other subjects, such as surveying. They did not specialize or were not familiar with generic

green knowledge and practice as well as sustainability issues, which are complex and need to be considered in an interdisciplinary context. In addition, most of the students did not have any training or learning experiences related to sustainability issues. These factors posed a serious challenge for the teachers who were trying to facilitate a learning process whereby students could develop an understanding of sustainability issues and go on to generate solutions from different perspectives.

Third, although the assessment scheme included both continuous assessment and end-of-module assessment, some of the formats such as knowledge-based exams that require rote memorization may not be effective in evaluating students' sustainability competencies or for measuring intended learning outcomes. These assessment formats barely encouraged students' learning initiatives or explorations of real-world sustainability problems. The mini-project, as the end-of-module assessment, does not provide students with the opportunities to explore any real-world sustainability problems. In addition, the supervision and learning resources provided to students are not sufficient.

These specific challenges are not only experienced by this TVET institution in Hong Kong; they seem to be common issues in sustainability education. For instance, Remington-Doucette et al., (2013) identified the challenge for implementing a sustainability-related introductory course at a university as being related to

"students' lack of basic knowledge, skills, and understanding of sustainability concepts and methodologies and a dearth of instructor capacity for coordination, supervision, and facilitation of a large number of real-world projects each semester." (411)

This situation resonates with the pilot study observations: lack of students' knowledge related to sustainability and limited capacity of instructors for supporting students' learning throughout sustainability projects.

3.3 **The Implications of developing the ESD pedagogical model**

As a result of the pilot study, three essential aspects were identified that need to be incorporated in the ESD pedagogical model: teaching content, pedagogy and assessment.

3.3.1 *Teaching Content*

First, there is a need to make full use of the *campus resources* to develop a curriculum so the campus can act as a living laboratory for sustainability education. For example, "how to deal with the waste management in the campus canteen" could be used as a practical question/case study for students to explore when they are learning the sustainability issues related to waste management. Moreover, the *workplaces on campus* that are used for practical training could be considered *as real-world learning resources* as well. For example, when exploring issues related to energy, students could visit the solar energy center on campus, and consider its advantages and disadvantages as well as how such systems work in different industries.

Second, it is essential to include *students' prior experience* into the learning content as well as the learning processes. This has the potential to turn the perceived disadvantage of "students' background are varied" to an advantage so different backgrounds become a stimulus for cross-disciplinary learning and initiate discussions from different perspectives. As *generic green skills* are the core competencies needed in almost any occupation, the content for the generic module should relate to students' different learning fields and industrial practice as much as possible.

Third, the learning content should be reoriented to be *more locally relevant* in order to provide more real-world learning opportunities for students and to encourage them to address the sustainability issues existing in their local community. Thus, more local case studies and learning activities should be included in the learning content to stimulate student discussion.

3.3.2 *Pedagogy*

In terms of pedagogy, the following four features should be explicitly applied.

1) Constructing learning environments based on a learner-centered approach, and employing pedagogical strategies, which encourage student participation and stimulate their engagement with learning, such as

Participatory/collaborative learning

Problem-based learning

E-learning technologies

2) Making connections between this generic module and students' major subject areas through individualized learning or inquiry-based learning in small groups. For example, encouraging students to use specific cases related to their subjects to develop their understanding of a new concept or to illustrate how they would utilize an identified strategy to solve the environmental problems within their professional contexts.

3) Integrating characteristics of ESD into pedagogical practice. A *value-driven* principle could provide an example of this. Plastic bottle recycling is a very significant problem in Hong Kong, but it also has a serious impact on the environment of some developing countries such as the Philippines, as garbage from Hong Kong is directly dumped there. This is a value-driven ethical issue, which could be presented to students as a case study to help them understand why waste classification and recycling is important and to explore better ways of tackling this issue in the workplace.

4) Creating more learning resources for students by collaborating with experts from different industries and inviting them to share their experiences and understanding of sustainability, such as how they deal with environmental issues to support green economic restructuring.

3.3.3 *Assessment*

The following points are important to address when designing the assessment for the module.

1) Employing formative assessment to encourage greater class participation. Part of the assessment could be allocated to students' presentations on a specific topic and group discussions on different aspects of sustainability.

2) A learning portfolio could be used for reporting on the project's progress at least once a week, so teachers can provide more guidance based on students' reflections. This would also mean the quality of the project learning could be maintained.

3) Evaluation of students' learning outcomes should be based on a more systematic competency framework, which clearly specifies those generic green skills students are expected to have. In return, this may help teachers to design lessons and learning activities based on more clear learning objectives which are framed on a clear generic green skills framework.

In summary, this pilot study helped formulate an approach towards building a pedagogical model that would increase the effectiveness of generic green skills learning as it identified problems and challenges that exist in relation to the teaching and learning of this module. Analysis of the literature data collected through the study helped suggest solutions that are applicable to specific educational settings within TVET in Hong Kong.

4 ESD pedagogical model: Problem-Oriented and Project-Based Learning Plus (POPBL^{+})

This section builds upon the POPBL model in order to facilitate the effective implementation of the generic green module to enhance students' generic green skills development by bringing real-world learning opportunities into classrooms (+).

4.1 **Problem-Oriented and Project-Based Learning^{+} (POPBL^{+}) Model**

The ESD pedagogical model – POPBL^{+} (see **Figure 1**) was developed based on the findings and reflections from the pilot study and the literature review.

The literature review has highlighted the significant importance of learning through real-world problem solving and generating solution options in order to increase students' sustainability competencies. The identified ESD pedagogical models have a common focus on examining ways in which real-world learning opportunities can be included within a sustainability context and implementing ESD through real-world problem solving. However, the pilot study conducted in a TVET institution in Hong Kong indicated that *it would be unrealistic to provide students with real-world learning opportunities* in this particular green generic module.

Thus, the suggested POPBL^{+} model was developed to create real-world learning opportunities by bringing the real-world sustainability issues into classroom/campus and helping students to connect these problems with their previous and current everyday life and work experiences. The model places more *focus on learning through real-world problem solving instead of learning in a real-world setting*. In this way, classroom learning acts as a bridge between real-world sustainability problems and students' real-world learning and work experiences, and the process of knowledge acquisition shifts towards knowledge application by conducting projects in the context of real-world issues.

The POPBL^{+} model incorporates real-world learning opportunities into students' learning through **four progressive processes** (adapted from Brundiers, Wiek & Redman 2010), but these processes are not necessarily linear. The processes of "bringing the world in" and "stimulating the world" mainly prepare students with the necessary knowledge and skills to further explore real-world problems, while the processes of "visiting the world " and "engaging with the world" mainly encourage students to apply their knowledge in their learning and work areas. Between the learning process of knowledge acquisition and knowledge application, students' attitudes towards sustainability and their generic green skills will be developed. Learning processes for "knowledge acquisition" and "knowledge application" can be related to all four real-world opportunities. Thus, for example, visiting and engaging with the world can also facilitate knowledge acquisition by helping students identify knowledge and skills that help them to further engage in real-world problem solving. More specific learning objectives and learning activities for each learning phase are suggested in Table 1 below.

When applying and implementing this model it is important to design pedagogical strategies, learning contents and learning activities so they can facilitate students' understanding of local issues within a global context and recognize that solutions to local problems can have global consequences, and vice versa. In addition, it should also encourage students to connect their individual life and industrial experiences to the identified issues in order to simulate their engagement with real-life contexts and to generate solutions.

The significance of this model relates to its holistic approach in developing generic green skills through knowledge acquisition and application in the context of real-world sustainable development problems brought into classroom that allow students to engage with the world.

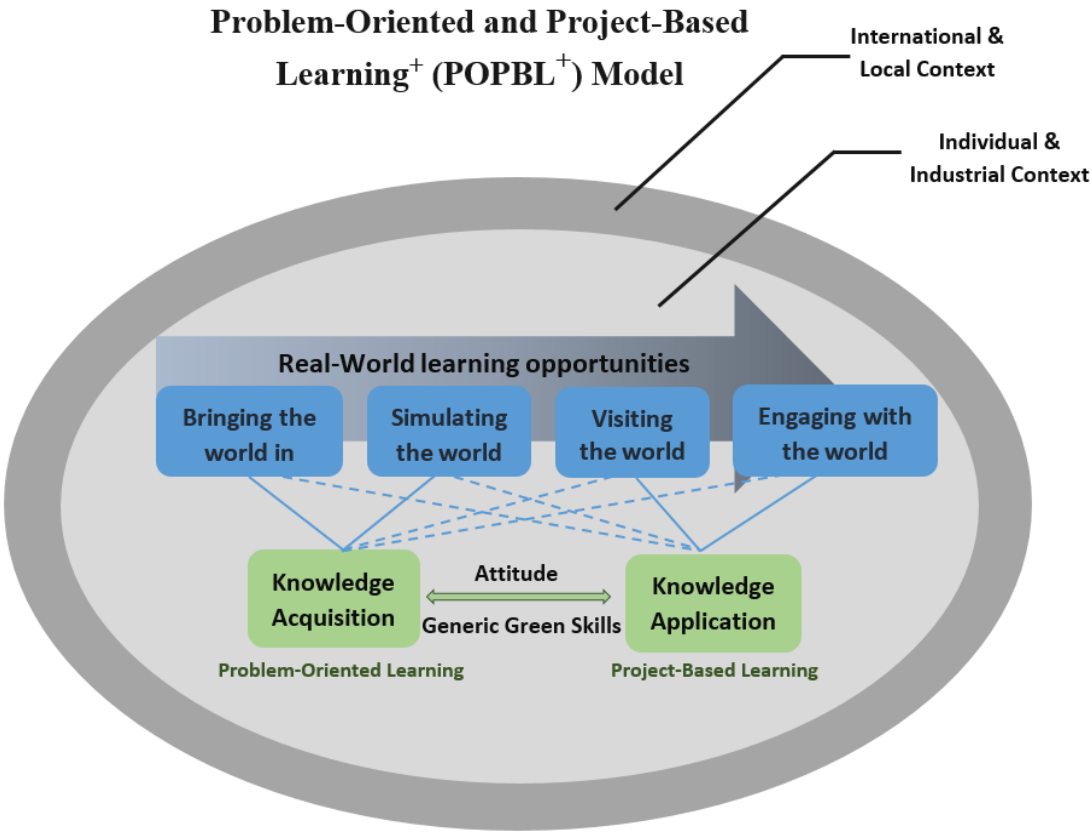

Figure 1: Problem-Oriented and Project- Based Learning+ (POPBL+) Model; Source: Authors

4.2 Design of Pedagogical Framework for Classroom Practice and Assessment

The application of the suggested model to planning classroom activities is outlined in Table 1. Pedagogical strategies and activities in **Table 1** are based on the review on ESD pedagogical strategies and a consideration of the learning settings within the pilot study TVET institution. Each pedagogical strategy suggested in the framework is based on specific learning objectives and their corresponding generic green skills within different learning phases. Both pedagogical strategies and learning activities can include additional forms of learning that can provide ESD learning opportunities for students and encourage them to engage to address the identified sustainability issues.

Table 1: **Pedagogical design framework developed based on POPBL+. Source: Authors**

Learning Phases	Learning Objectives	Generic Green skills[1]	Pedagogical Strategies (e.g.)	Learning Activities (e.g.)
Bringing the world	• Identify and formulate real-	Cognitive competencies	• Lecturing • Case studies	Draw a concept map; Analyze

[1] See Pavlova 2018 for description

in	world sustainability problems that can be solved via adjustments to industry practices; • Understand the key concepts and current situation related to the identified issues.		(problem-oriented)	critical incidents within international and local context (e.g. compare different solutions).
Simulating the world	• Experience the dynamics of communication through the process of identifying solutions; • Learn how to deal with various perspectives and conflict resolution.	Cognitive & interpersonal skills	• Stimulus activities/ discussion • Debates • Peer-review activities	Reflection on related videos, photos and documents
Visiting the world	• Connect students' learning and working experience to the identified issues.	Intrapersonal & interpersonal competencies	• Group discussions • Case studies (Industrial context)	Poster presentation (present a real-world sustainability problem explored in a group project);
Engaging with the world	• Propose potential solutions and strategies for dealing with identified issues,	Cognitive, technological & interpersonal skills	• Group projects	Interviews Questionnaires Field observations

Other learning methods as customer meetings, analysis of functions, construction, planning a production process or an assembly, diagnosis, maintenance, putting in to service and others that refer to technical aspects of solutions can also be included in the above learning phases to address generic technological skills.

This general approach to planning presented in Table 1 can be used for generic green module development or as a curriculum development framework to plan specific projects. The key

principle is to design a program or curriculum (including learning content and activities) based on the four progressive learning processes to include real-world learning opportunities into students' learning, and formulate an assessment scheme based on the generic green skills framework (Pavlova 2018).

5 Conclusion

This paper conceptualized an ESD pedagogical model relevant for the TVET context based on the pilot study and literature review. The study identified the gap between pedagogical approaches used in TVET to teach SD issues and approaches suggested in the literature (although they are proposed for universities and other education institutions). The Problem-Oriented and Project-Based Learning Plus model (POPBL^{+}) is proposed here to facilitate the effective delivery of the generic green module to enhance students' generic green skills. Bringing the world into the classroom is an important component of this model, as the current reality of the TVET institution involved in this study would not allow students to go outside campus during the module.

This paper suggests how four components of the model can be translated into learning objectives, pedagogical strategies and learning activities and which specific generic green skills can be addressed through the different components.

Thus the model presented in this paper has the potential to contribute to both the theoretical and practical developments related to the use of ESD pedagogy for developing generic green skills in TVET. As a result, this model enriches the understanding of ESD pedagogy in TVET. The significance of this model is in its capacity to guide effective implementation of generic green modules through designing learning activities that facilitate the development of students' generic green skills. Research to confirm the effectiveness of this model, in particular the use of active methods of learning that can increase students' motivation and interest, is continuing and will be reported in subsequent publications.

References

Anderson, D. (2009). Productivism and ecologism: Changing discourses in VET. In J.Fien, R. Maclean, & M. Park (eds.): Work, learning and sustainable development: Opportunities and challenges. Dordrecht, Netherlands: Springer, 35-57.

Arenas, A., & Londono, F. (2013). Connecting vocational and technical education with sustainability. In Stevenson, R., Brody, M., Dillon, J. & Wals, A. (eds.): International Handbook of Research on Environmental Education. New York: routlege, 163-170.

Barrows, H. (1986). A taxonomy of problem-based learning methods. Medical Education, 20(6), 481-486.

Bedi, G., & Germein, S. (2016). Simply good teaching: Supporting transformation and change through education for sustainability. Australian Journal of Environmental Education, 32(1), 124-133.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83(2), 39-43.

Blake, J., Sterling, S., & Goodson, I. (2013). Transformative Learning for a Sustainable Future: An Exploration of Pedagogies for Change at an Alternative College. Sustainability, 5(12), 5347-5372.

Brundiers, K., Wiek, A., & Redman, C. L. (2010). Real-world learning opportunities in sustainability: From classroom into the real world. Int J of Sus in Higher Ed, 11(4), 308-324. Education, Vol. 11 Issue: 4, pp.308-324, https://doi.org/10.1108/14676371011077540

Brundiers, K., & Wiek, A. (2013). Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability. Sustainability, 5(4), 1725-1746.

Burns, H. (2009). Education as sustainability: An action research study of the burns model of sustainability pedagogy. ProQuest Dissertations Publishing.

Burns, H. (2013). Meaningful sustainability learning: A study of sustainability pedagogy in two university courses. International Journal of Teaching and Learning in Higher Education, 25(2), 166-175.

Corney, G., & Reid, A. (2007). Student teachers' learning about subject matter and pedagogy in education for sustainable development. In: Environmental Education Research, 13(1), 33-54.

Cotton, D.R.E. & Winter, J. (2010). It's not just Bits of Paper and Light Bulbs: A review of Sustainability Pedagogies and their Potential for use in Higher Education. In Jones, P., Selby, D. and Sterling, S. (eds.). Sustainability Bibliography 113 Education: Perspectives and Practice Across Higher Education, London: Earthscan.

Elshorbagy, A. & Schönwetter, D. (2002). Engineer morphing: bridging the gap between classroom teaching and the engineering profession. In: International Journal of Engineering Education 18 (3), 295–300.

Fang, N. (2012). Improving engineering students' technical and professional skills through project-based active and collaborative learning. In: International Journal of Engineering Education 28 (1), 26–36.

Finn, F. (2017). Work-based Learning Influences, Outcomes and Sustainability in Postgraduate Nurse Education: A Case Study, PQDT - UK & Ireland.

Holgaard, J. E., Hadgraft, R., Kolmos, A., & Guerra, A. (2016). Strategies for education for sustainable development–Danish and Australian perspectives. In: Journal of cleaner production, 112.

ILO. (2011). Skills for green job, a global view: Synthesis report based on 21 country studies. Online: http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_159585.pdf (retrieved 21.01.2019).

Jollands, M. & Parthasarathy, R. (2013). Developing Engineering Students' Understanding of Sustainability Using Project Based Learning. In: Sustainability, 5(12), 5052-5066.

Kjærsdam, F., & Enemark, S. (1994). The Aalborg Experiment. Aalborg. Aalborg University Press.

Kolmos, A., & Fink, F. K. (2004). The Aalborg PBL model: progress, diversity and challenges. L. Krogh (eds.). Aalborg: Aalborg University Press.

Krajcik, J. S., & Shin, N. (2014). Project-based learning. In: The Cambridge Handbook of the Learning Sciences, Second Edition. Cambridge: Cambridge University Press, 275-297.

Kricsfalusy, V. G., Reed, M., & George, C. (2016). Integrating problem- and project-based learning opportunities: Assessing outcomes of a field course in environment and sustainability. In: Environmental Education Research, 1-18.

Laurie, R., Nonoyama-Tarumi, Y., Mckeown, R., & Hopkins, C. (2016). Contributions of education for sustainable development (ESD) to quality education: A synthesis of research. In: Journal of Education for Sustainable Development, 10(2), 226-242.

Lindstrom, T., & Middlecamp, C. (2017). Campus as a living laboratory for sustainability: The chemistry connection. In: Journal of Chemical Education, 94(8), 1036-1042.

Lozano, R., Merrill, M., Sammalisto, K., Ceulemans, K., & Lozano, F. (2017). Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal. In: Sustainability, 9(10).

Madani, K., Pierce, T. W., & Mirchi, A. (2017). Serious games on environmental management. In: Sustainable Cities and Society, 29, 1-11.

Nielsen, J.L., & Danielsen, O. (2012). Problem-Oriented Project studies: The Role of the Teacher as Supervisor for the Study Group in Its Learning Processes. In Dirckinck-Holmfeld, L., Hodgson, V. & McConnell, D. (eds.) Exploring the theory, pedagogy and practice of networked learning. New York: Springer, 258.

OECD. (2013). OECD skills outlook 2013: First results from the survey of adult skills. Online: https://www.oecd.org/skills/piaac/Skills%20volume%201%20(eng)--full%20v12--eBook%20(04%2011%202013).pdf (retrieved 21.01.2019).

Pavlova, M., (2009). Technology and vocational education for sustainable development empowering individuals for the future (UNESCO-UNEVOC book series; v. 10). Dordrecht: Springer Netherlands.

Pavlova, M. (2018). Fostering inclusive, sustainable economic growth and "green" skills development in learning cities through partnerships. In: International Review of Education: Journal of Lifelong learning64 (3), 339-354.

Pavlova, M. (2017). Green Skills as the Agenda for the Competence Movement in Vocational and Professional Education. In Mulder, M. (eds.): Competence-based Vocational and

Professional Education. Bridging the Worlds of Work and Education. Cham: Springer International Publishing Switzerland, 931-951.

Pavlova, M. (2015). Design and technology education for sustainable futures. In K. Stable, K. & Keirl, S. (eds.): Environment, Ethics and Cultures: Design and Technology Education's contribution to Sustainable Global Futures. Rotterdam: Sense, 87-100.

Redman, C., & Wiek, A. L. (2012). Sustainability as a transformation in education. In Johnston, L. (eds.): Higher Education for Sustainability: Cases, Challenges, and Opportunities from Across the Curriculum. London: Taylor and Francis, 214-222.

Remington-Doucette, S., Connell, K., Armstrong, C. M., & Musgrove, S. (2013). Assessing sustainability education in a transdisciplinary undergraduate course focused on real-world problem solving: A case for disciplinary grounding. In: International Journal of Sustainability in Higher Education, 14(4), 404-433.

Rowe, D. (2007). Education for a sustainable future. In: Science, 317(5836), 323-324.

Savery, John R. (2006). Overview of Problem-Based Learning: Definitions and Distinctions. In: Interdisciplinary Journal of Problem-based Learning, 1(1), 9-20.

Seatter, C. S., & Ceulemans, K. (2017). Teaching sustainability in higher education: Pedagogical styles that make a difference. In: Canadian Journal of Higher Education, 47(2), 47-70.

Steinemann, A. (2003). Implementing sustainable development through problem-based learning: Pedagogy and practice. In: Journal of Professional Issues in Engineering Education and Practice, 129(4), 216-224.

Sterling, S. (2002). Sustainable education: Re-visioning learning and change. Devon, UK: Green Books.

Sunarsih, A. & Rohaeni, N. (2015). PENGEMBANGAN TUGAS AKHIR MELALUI PROJECT BASED LEARNING MODEL UNTUK MENINGKATKAN GENERIC GREEN SKILLS SISWA. In: Jurnal Pendidikan Teknologi Dan Kejuruan, 21(3).

Tempelman, E., & Pilot, A. (2011). Strengthening the link between theory and practice in teaching design engineering: An empirical study on a new approach. In: International Journal of Technology and Design Education, 21(3), 261-275.

Thomas, G. (2009). How to do your research project: A guide for students in education and applied social sciences. London: Sage.

Tilbury, D. (2011). Assessing ESD Experiences during the DESD: An expert review on processes of learning for ESD, Paris: UNESCO.

UNESCO (2014). Shaping the Future We Want：UN Decade of Education for Sustainable Development (2005-2014) FINAL REPORT. Online: https://sustainabledevelopment.un.org/content/documents/1682Shaping%20the%20future%20we%20want.pdf (retrieved 21.01.2019).

UNESCO (2012). Education for Sustainable Development：Source book. Online: http://unesdoc.unesco.org/images/0021/002163/216383e.pdf (retrieved 21.01.2019).

Wall, T., Hindley, A., Hunt, T., Peach, J., Preston, M., Hartley, C., & Fairbank, A. (2017). Work-based learning as a catalyst for sustainability: A review and prospects. In: Higher Education, Skills and Work-Based Learning, 7(2), 211-224.

Wiek, A., Xiong, A., Brundiers, K., & van, D. L. (2014). Integrating problem- and project-based learning into sustainability programs – A case study on the school of sustainability at arizona state university. In: International Journal of Sustainability in Higher Education, 15(4).

Wiek, A., Withycombe, L., & Redman, C. (2011). Key competencies in sustainability: A reference framework for academic program development. In: Sustainability, 6(2), 203-218.

Yasin, & Rahman. (2011). Problem Oriented Project Based Learning (POPBL) in Promoting Education for Sustainable Development. In: Procedia - Social and Behavioral Sciences, 15(C), 289-293.

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