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A Project entitled

Evaluating environmental literacy and self-efficacy of Hong Kong General Studies pre-service teachers

Submitted by

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Declaration

I, *CHEN Renjuan* , declare that this research report represents my own work under the supervision of *Ms MAN Mei Sum*, and that it has not been submitted previously for examination to any tertiary institution.

Signed:

CHEN Renjuan

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1. Abstract

As the increasing environmental challenge worldwide, Environmental Education (EE) has been regarded as an effective way to reduce problems by improving environmental literacy of students. Particularly, teachers play a key role in undertaking the responsibility of nurturing Environmental Literacy (EL) of future generations to carry out EE. This study aims to examine environmental literacy of Hong Kong pre-service General Studies (GS) teachers and their self-efficacy toward EE teaching. 54 valid responses were eventually collected from students majoring in GS at the Education University of Hong Kong. The result of this study would contribute to the implementation of EE in Hong Kong and provide implications for pre-service teachers' training programmes in tertiary education institutes.

2. Introduction

As environmental crises are perceived to be the most pressing global risks, there has been a constant need to seek and improve solutions to environmental problems (World Economic Forum, 2022). Notably, education plays an imperative role in comprehensively transforming toward an environmentally healthy society by helping individuals understand the cause, consequences, and actions required to tackle environmental problems. Environmental education (EE) is regarded as an effective avenue to foster environmentally literate citizens who are inclined to be actively involved and address environmental challenges (Roth, 1992; UNESCO, 2016).

Environmental literacy (EL) has been regarded as the long-term goal of EE in most countries and regions all over the world, and so does in Hong Kong. There are various means to carry out

EE in Hong Kong, including schooling, government-supported schemes, and activities hosted by non-government organizations (Cheng & So, 2011b). In mainstream Hong Kong primary schools, General Studies (GS) is the core subject to bring about EE. As suggested in the GS Curriculum Guide, "People and Environment" is one of the most important learning strands that students are expected to learn in the cognition, affection, and behavior level related to the environment (Curriculum Development Council, 2017). In this regard, GS teachers play vital roles in nurturing students' EL and improving the quality of EE. However, EE has been marginalized in local primary schools and in-service teachers are found to possess low level of EL and self-efficacy toward EE teaching (Cheng & So, 2015; Lee, Williams, & Lam, 2009; Ko & Lee, 2003). Therefore, it is necessary to investigate whether pre-service GS teachers are well-prepared for their future EE teaching. This research could fulfil the existing research gap on the EL and self-efficacy toward EE of Hong Kong pre-service GS teachers in order to provide implications for pre-service GS teacher education programmes in tertiary institutions.

3. Literature review

3.1 Environmental Literacy (EL)

EL has been considered the key success of EE. Roth proposed a precise definition of EL and it has been broadly adopted in EL-related literature. Roth (1992) defines EL as "the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (p. 10). He claims that six main components affect EL, namely environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement. Another scholar proposed a similar interpretation of EL, namely ecological knowledge, socio-political knowledge, knowledge of environmental issues, affect, cognitive skills, and environmentally responsible behaviors (Simmons, 1995, as cited in Erdoğan, Kostova, & Marcinkowski, 2009). Due to the evolving understanding and various research of EL, a number of EL compositions were created with different elements, whereas they commonly encompass at least four broad categories, which are environmental knowledge, skills, affect, and behavior (McBeth, & Volk, 2009; McBridge, Brewer, & Borrie, 2013). Skills refer to one's necessary abilities for identifying environmental issues, critically thinking skills, and implementing pro-environmental strategies (Hollweg et al., 2011). Behavior can be embodied through one's active involvement in activities with the aim of solving environmental problems (Simmons, 1995, as cited in Erdoğan et al., 2009). As for the two categories of knowledge and affect, they appear to be listed with sub-components respectively, based on different research focus and perspectives of authors. For example, environmental knowledge comprises not only ecological knowledge and knowledge of environmental issues (Roth, 1992; Simmons, 1995, as cited in Erdoğan et al., 2009) but also the strategies to behave environmentally (Hollweg et al., 2011).

Similarly, the affective dimension is concerned with not only one's environmental attitudes (emotions) and values but also awareness and concern (Tuncer et al., 2009; UNESCO, 1977).

It has been acknowledged in the literature that one's level of EL is determined by several components that are interrelated with each other. In particular, environmental behavior is considered the best determining factor of the degree of EL as it can be directly observed and assessed (Roth, 1992). Previous studies investigate the relationship among the components of EL and believe that environmental knowledge, skills, and affects are vital predictors of environmental behaviors (Gheith, 2019). Research notes that affective components of EL appear to influence environmental behavior (Yavetz, Goldman, & Pe'er, 2009). However, high levels of environmental affects do not necessarily transfer to behaviors. This may be associated with insufficient support of environmental knowledge in responsible behaviors (Pe'er, Goldman, & Yavetz, 2007). That is to say, environmental affect alone is not the sole determinant. More importantly, increased environmental knowledge correlates with more pro-environmental behavior (Tuncer et al., 2009; Yavetz et al., 2009) and is perceived as the prerequisite to one's behaviors (Frick, Kaiser, & Wilson, 2004). To elucidate the relationship between environmental knowledge and behavior, a structure of knowledge is developed in the previous studies. Different forms of environmental knowledge inside the structure tend to interact with each other and holistically affect one's behaviors. According to Kaiser & Fuhrer (2003), the first form of knowledge is system (declarative) knowledge that contains the knowledge of how ecosystems work and interact with human society, such as knowledge of ecology; the second form of knowledge is action-related (procedural) knowledge that includes the possible strategies of how to act environmentally; the third form of knowledge is effectiveness knowledge that is concerned with the potential consequences of different environmental behaviors.

Moreover, Frick et al. (2004) pinpoint that the importance of system knowledge is easily overlooked because of its mediated influence on behavior by affecting the other two forms of knowledge. For example, if someone lacks ecological concepts and related issues (system knowledge), he or she is unlikely to fully understand what actions should be taken (action-related knowledge) and even not to mention choosing the most practical final decision (effectiveness knowledge). In brief, environmental knowledge, affect, and behavior are interreacted components of EL. In particular, environmental system knowledge is considered the foundation of EL and should be studied as a priority when exploring EL of a new targeted research group.

3.2 Teachers' environmental literacy and teacher education

Teachers' EL have a profound impact on the development of EE. Except for undertaking the majority of responsibilities to develop children's EL, teachers are considered as the critical factor that affects students' EL, that is, the key to achieving the goal of EE. If teachers lack environmental knowledge, skills, and positive attitudes, it is doubtful that teachers are able to successfully teach EE and nurture students with higher level of EL (National Environmental Education Advocacy Council, 2005). Significantly, there is a compelling need to explore the EL of pre-service teachers who are expected to be environmentally literate and get well-prepared before graduation (Álvarez-García, Sureda-Negre, & Comas-Forgas, 2015). The assessment of pre-service teachers is conductive to predict the tendencies of future EE and evaluate the effectiveness of EE training in teacher education programmes (Yavetz, Goldman, & Pe'er, 2014).

There is a myriad of studies concerning pre-service teachers' EL in international research.

Nevertheless, the vast majority of studies highlight teachers' low to moderate level of environmental knowledge required as educators. Tuncer et al. (2009) investigated 684 pre-service teachers in Turkey. They found that participants lack environmental knowledge pertaining to the source of carbon monoxide, the solution to nuclear waste, and the local garbage storage. In Taiwan, researcher noticed that future teachers misunderstood some ecological concepts and environmental issues, such as biodiversity and global warming (Liu, Yeh, Liang, Fang & Tsai, 2015). In the meantime, a comprehensive global report shows that most student teachers have limited or no preparation related to EE in teacher education programmes (UNESCO, 2021). Yavetz et al. (2009) invited 214 student teachers and compared their EL before and after their college studies. Findings indicate that their level of EL by the end of the study is still insufficient, which draws emphasis on the effectiveness of incorporating EE in teacher education programmes.

Locally, studies related to teachers' EL is very limited in Hong Kong, while similar conclusion can be drawn as in other countries. Cheng & So (2011a) indicate that GS in-service teachers appear to lack content knowledge, which may impede the effectiveness of EE implementation in schools. However, there has been no investigation about pre-service teachers' EL in Hong Kong. The research population gap is intended to be bridged in this study.

3.3 *Ecological knowledge (EK)*

EK is composed of ecological concepts, such as ecosystem, materials cycling, adaption, etc. (Roth, 1992). As stated in section 3.1 above, environmental system knowledge is considered the entry point of developing EL, especially knowledge of ecology is the core conceptual basis of EL to build up environmental attitudes and responsible behavior (Hollweg et al., 2011;

Stevenson, Carrier, & Peterson, 2014). As for the EK level of pre-service teachers, it directly affects their EL and their teaching in EE. Research manifests that low level of pre-service teachers' environmental knowledge is very likely to depress their confidence and abilities in developing students' EL (Moseley, Reinke, & Bookout, 2003).

Nonetheless, investigation primarily focuses on assessing pre-service teachers' EK level is extremely limited. Puk & Stibbards (2010) reveal that pre-service teachers in Canada possess inadequate ecological knowledge that is indispensable for future EE teaching, including the core concepts of how ecosystems work and the social impact on ecosystems. Esa (2010) discloses that prospective teachers in Malaysia lack clear understanding of certain ecological concepts, such as carrying capacity and ecological footprint.

3.4 Self-efficacy (efficacy expectations)

Bandura (1997) proposes that self-efficacy refers to "beliefs of one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). According to the self-efficacy theory (Bandura, 1977), self-efficacy is not associated with an individual's actual abilities in execution but with one's convictions before the behavior of what he or she is capable of doing with those abilities, which is also called *efficacy expectations* (refer to Figure 1). Bandura (1997) states that one's beliefs and expectations of abilities are cognitive simulation processes, which are significant regulators of human decision-making and behaviors. It is proved that efficacy expectations determine the amount of effort and persistence of an individual when confronting adverse obstacles (Tschannen-Moran, Hoy, & Hoy, 1998). That is, individual with a high level of efficacy expectations anticipate success that will lead to positive outcomes, while those with inefficacious expectations envision failure that will hinder

performance.

Efficacy expectations are distinct from outcome expectations which refer to an individual's estimation of outcomes after his or her specific behaviors (Bandura, 1977). Efficacy expectations precede and help shape outcome expectations because outcome expectations have a minor effect on predicting behaviors, making them unessential to measure (Bandura, 1997). Therefore, this study will concentrate on assessing the efficacy expectations of pre-service GS teachers instead of their outcome expectations.

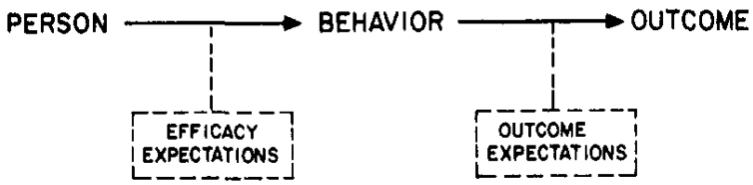

Figure 1. Self-efficacy theory (Bandura, 1977)

3.5 Personal teaching efficacy

When applying Bandura's self-efficacy theory to educators, it has been suggested that the sense of personal teaching efficacy should correspond to efficacy expectations proposed by Bandura (Ashton, 1986, as cited in Lee, 2000). Personal teaching efficacy is "a teacher's judgements of his or her teaching competence" (Lee, 2000, p. 19), which plays a powerful role in teaching. It affects how much effort the teacher will devote to instruction and how long the teacher will persevere when facing difficulties in the classroom. A few research indicates that teachers with high level of personal teaching efficacy may provide more types of feedback and innovative instructional approaches to make a difference in students' learning than teachers who have relatively low level of expectations (Bandura, 1997; Behar-Horenstein, Pajares, & George, 1996). As a result, students who are influenced by teachers with high level of self-efficacy are

found to have greater academic performance, learning motivation, and self-confidence (Lin & Gorrell, 2001).

Bandura also stresses the multidimensionality of self-efficacy. It emphasizes that an individual's high level of efficacy expectation in one area may not necessarily be the same as in other areas (Bandura, 1997). For instance, a person with a high level of efficacy expectation in science learning may not possess the same level of efficacy in solving statistical problems in mathematics. In short, the sense of self-efficacy is context-specific and depends on the specified abilities related to the given situation of a certain domain (Tschannen-Moran et al., 1998). Therefore, when linking this characteristic to educators, it is believed that teachers' personal teaching efficacy will vary in terms of different areas of teaching and should be identified from subject to subject (Ashton, 1986, as cited in Lee, 2000).

3.6 Personal teaching efficacy in EE

In light of context-specific feature of teaching efficacy, previous research illustrates the level of specificity. For example, to explore teaching efficacy of chemistry teachers, scholars distinguish chemistry teaching efficacy for assessment instead of science teaching efficacy as the former is more relevant to laboratory and teaching experience in chemistry (Rubeck & Enochs, 1991). Similarly, when the context specificity is applied to the study of EE, it is suggested that teaching efficacy in EE should be regarded as an independent context for research (Nesmith et al., 2016). As stated in the previous section, teachers who hold high level of teaching efficacy are intended to work hard and be more persistent. If teachers' teaching efficacy in EE is reinforced, their performance in teaching EE will correspondingly enhance (Moseley et al., 2003).

In order to improve EE, there should be more research focuses on in-service and pre-service teachers' teaching efficacy in EE (Saribas, Kucuk, & Ertepinar, 2017), while several studies reveal that educators possess low level of teaching efficacy in EE (Saribas, Teksoz, & Ertepinar, 2014). Sia (1992) notices that pre-service teachers perceive themselves as possessing inadequate level of EL and training required to teach EE effectively. Moseley, Reinke, & Bookout (2002) found that pre-service elementary teachers lack confidence in their abilities to use effective pedagogies to teach EE.

Locally, in the research conducted by Ko & Lee (2003) in Hong Kong, 215 secondary in-service science teachers' teaching efficacy level in EE are found to be moderate, whereas teachers lack confidence in their skills of teaching EE. However, study related to pre-service teachers' teaching efficacy in EE is deficient in Hong Kong. This study will contribute to the existing literature on this aspect.

4. Research objectives and questions

This study aims to evaluate the level of environmental literacy and self-efficacy of General Studies pre-service teachers in Hong Kong, particularly their ecological knowledge level and sense of personal teaching efficacy in environmental education. Prior international research has investigated ecological knowledge and teaching efficacy in EE respectively, yet few study has explored the correlation between these two factors. More importantly, no previous studies have examined the preparation for EE of pre-service GS teachers in Hong Kong. This study may provide implications for GS teacher education programmes in the university.

The following research questions will guide the study:

(1) What is the ecological knowledge (EK) level of pre-service General Studies teachers in Hong Kong?

(2) What is the level of personal teaching efficacy of pre-service General Studies teachers in Hong Kong toward environmental education (EE)?

(3) Does the level of personal teaching efficacy of Hong Kong pre-service General Studies teachers in environmental education (EE) show a significant correlation with their ecological knowledge level?

5. Methodology

5.1 Participants

The research objects only eligible for this study are students majoring in Bachelor of Education (Primary) – General Studies at the Education University of Hong Kong (EdUHK). A portion of year one to year five students were invited as the participants of this study through convenience sampling. Convenience sampling is a form of nonprobability sampling method, which is commonly used when the researcher has limited resources and time (Stratton, 2021). However, participants are recruited depending on their motivations which may cause bias in the study. As there was a small group of targeted research objects in this research, it was considered as a limitation that the research results could only be confined to the participants in this study rather than generalization of population outside the participant group (Stratton, 2021). In considering the resources and sample population of this study, convenience sampling was the most feasible method for the principal investigator to conduct this study within EdUHK. Participants were invited via two methods. Invitations were sent to a portion of year one to year four GS students

through email. Additionally, year five GS students were invited through the social network of the principal investigator. All participants were expected to complete a questionnaire including demographic information (2 items), ecological knowledge (7 items), and personal teaching efficacy in EE (11 items).

5.2 Design of the study

To assess participants' level of ecological knowledge and personal teaching efficacy in EE, this study adopted quantitative research approach like the previous literature related to EE. Two scales were used to assess two factors respectively. The first instrument includes seven questions (refer to Appendix 1) selected from *The Trends in International Mathematics and Science Study (TIMSS)* to evaluate participants' level of EK that is necessary for teaching EE in GS. The first scale comprises 7 items that include both types of multiple-choice and short questions. Each correct response counts for 1 mark, while each incorrect answer receives 0 mark. Participants' answers should be thoroughly correct to receive one mark if there are two questions/blanks or more in an item. Possible scores received from the first scale range from 0 (no correct answer) to 7 (answers are all correct).

The process of selecting valid items from TIMSS went through two procedures. The first step was to align ecological concepts embedded in the literature (Munson, 1994; Simmons, 1995, as cited in Erdoğan et al., 2009; Zak & Munson, 2008) with those are suggested in the GS Curriculum Guide (Curriculum Development Council, 2017). Eight ecological concepts were elected to be the essential knowledge of environmentally literate pre-service GS teachers in teaching EE, namely ecosystem, biotic and abiotic factors, adaption, biodiversity, materials cycling, predator-prey, food chain, and human activity impact. The second step was to sort out

the valid items in TIMSS by lining the science framework (TIMSS, 2011) and content area of each item with the above eight concepts. It tuned out that each item was selected to correspond to an ecological concept except for a special case. It is worth mentioning that there is an item (item 3 in Appendix 1) in TIMSS that covers two concepts, namely biodiversity and biotic and abiotic factors. As Hancock (n.d.) proposed, biodiversity refers to all kinds of life that can be found within a specific area. Accordingly, item 3 requires to list out the biotic and abiotic factors in a given area, which is able to demonstrate the definition of biodiversity. Thus, item 3 in the instrument is considered valid to measure participants' understanding of the above two concepts. TIMSS is a worldwide assessment aiming to improve learning and teaching in mathematics and science in the fourth and eighth grades. It is regarded as a reliable test to assess students' understanding of physics, earth science, and life science as over fifty countries or regions took part in 2011 (Martin & Mullis, 2013). Thus, participants of this study were expected to answer the selected items from TIMSS 2011 all correctly to show their mastery of the basic concepts to teach EE as educators.

The second instrument intends to evaluate participants' personal teaching efficacy in EE. 11 items were partially extracted from the Environmental Education Efficacy Belief Instrument (EEEBI) developed by Sia (1992) and was used for this study (refer to Appendix 2) to quantitatively ascertain the personal teaching efficacy (efficacy expectation) of pre-service GS teachers toward EE. EEEBI is a valid and reliable measurement that has also been adopted in other EE-related studies (Gardner, 2009; Ko & Lee, 2003). It is a 5-point Likert-type scale: 1 for "strongly disagree", 2 for "disagree", 3 for "uncertain", 4 for "agree", and 5 for "strongly agree". Participants were allowed to indicate the degree to which they agree or disagree with the statements.

5.3 Analysis method

In this study, the Statistical Package for the Social Sciences (SPSS) version 26 was used to analyze the collected data. At the first stage of analysis, Cronbach-Alpha (Coefficient Alpha) was estimated for the items in two instruments in the questionnaire to ensure their reliability. According to Oluwatayo (2012), measuring reliability aims to see whether each item in the scale is consistent with each other and to assure internal consistency in quantitative research. It allows a certain range of random errors in the same research and sample population. Whiston (2005) asserts that Cronbach-Alpha can be applicable for computing reliability index when the test item is not presented in dichotomous format (e.g., true/false question). Consequently, Cronbach-Alpha seems to be the appropriate method for measuring the reliability index in this study.

The magnitude of Cronbach-Alpha ranges from 0 to 1 (Connelly, 2011). If the Cronbach-Alpha approach to 0, it means all items in the scale are independent of each other and are not correlated. In contrast, if Cronbach-Alpha is close to 1, it implies that all items in the scale measure the same concept. Scholars also suggested that Cronbach-Alpha between 0.6 to 0.7 is acceptable and 0.8 to 0.95 is an ideal interval (Ursachi, Horodnic, & Zait, 2015). In this study, Cronbach-Alpha was measured for two instruments in the questionnaire, namely 0.601 and 0.943 respectively, which fulfil the requirement as the suggested index interval by scholars (0.6 to 0.95). It can be stated that the test items of this study are reliable.

The second stage of data analysis included the demographic information, ecological level, and teaching efficacy of participants. By using the function of descriptive statistics in SPSS, the central tendency (i.e., mean, median, and mode), minimum, maximum, and standard deviation

were generated and clearly shown in tables or diagrams. Furthermore, the Pearson correlation coefficient was computed to investigate the relationship between ecological knowledge and personal teaching efficacy in EE. It is worth mentioning that Pearson's correlation only examines the relationship between two variables but could not tell their cause-effect relationship (DeCoster & Claypool, 2004).

6. Findings

6.1 Demographic information of respondents

There were 67 respondents to the questionnaire and 54 valid responses were collected. The socio-demographic information of respondents was summarized by descriptive statistics. All 54 respondents were EdUHK students majoring in BEd-Primary (General Studies) and are pre-service General Studies teachers. 44.4% of participants were male and 55.6% were female. The most participation in this study was year 5 students (33.3%), followed by year four students (25.9%) and year one students (20.3%), then the year three students (16.7%), and the smallest number of participants was year two students, accounting for only 3.7%.

6.2 Ecological knowledge (EK) level

Descriptive statistics was run to unfold the EK level of respondents (refer to Table 1). The highest score of EK test was 7 (full marks), while the minimum score was 1. The mean score of EK test was 5.629. The overall result shows that pre-service GS teachers possess moderate level of EK.

	Mean	Minimum	Maximum	Median	Mode	SD	N
Ecological knowledge	5.629	1.00	7.00	6.00	7.00	1.457	54

Table 1. Overview of results of ecological knowledge (EK) test

Furthermore, a deeper statistical analysis of each item (refer to Table 2) in the EK test reflects the specifics of pre-service GS teachers' EK level. The results show that item 1, 2, 3b, and 5 (i.e., ecosystem, adaption, biodiversity, predator-prey) got relatively high accuracy, which is above 70% correctness. It is interpreted that pre-service GS teachers have relatively high-level understanding of these four concepts. On the contrary, item 3a, 4, 6, and 7 (i.e., biotic and abiotic factors, materials cycling, food chain, and human activity impact) were obtained with comparatively low accuracy. Notably, 31.5% of participants presumed plants as non-living things (abiotic factors) when answering item 3a. 31.5% and 27.8% of respondents declared that they were unsure about the answer to item 4 and item 6. Meanwhile, 33.3% of respondents did not fully understand the impact of human activity on the environment in item 7. Although most of them were able to identify the ways to reduce air pollution, they failed to correctly explain the reasons behind. For example, respondents could recognize that bicycle as a more environmentally-friend way of travelling than motorbike, while they could not point out that was because of no fumes emission of bicycle as motorbike does. Hence, pre-service GS teachers seem to have inadequate understanding of the above four concepts.

Test items (ecological concepts)	Accuracy	SD	Std. Error Mean	Remarks
Item 1 (Ecosystem)	79.6%	0.407	0.055	Option "I am not sure" (11.0%)
Item 2 (Adaption)	98.1%	0.136	0.019	-
Item 3a (Biotic and abiotic factors)	68.5%	0.469	0.064	Answer: plants are non-living things (31.5%)
Item 3b (Biodiversity)	100%	-	-	-
Item 4 (Materials cycling)	68.5%	0.469	0.064	Option "I am not sure" (31.5%)
Item 5 (Predator-prey)	87.0%	0.339	0.046	-
Item 6 (Food chain)	72.2%	0.452	0.062	Option "I am not sure" (27.8%)
Item 7 (Human activity impact)	57.4%	0.293	0.040	Incomplete explanations (33.3%)

Table 2. The statistics of each item in the EK test

6.3 Personal teaching efficacy in EE

Descriptive statistics was also run to explore respondents' level of personal teaching efficacy in EE. The results reveal that participants had positive teaching efficacy in five items (refer to Table 3a). 74% of respondents reported that students' questions related to EE were welcomed (item 10). 59.2% of respondents indicated that they were capable of answering EE questions raised by students (item 7) and would find better ways to teach EE (item 1). 55.6% of respondents asserted that they were able to help students understand EE concepts (item 9).

Items	Description	Positive (%)
Item 1	I will find better ways to teach environmental education	59.2%
Item 7	I am able to answer students' environmental education questions.	59.2%
Item 9	I have the ability to help students understand environmental education concepts better.	55.6%
Item 10	I welcome students' questions about environmental education.	74%
Item 11	I know how to turn students on to EE.	53.7%

Table 3a. Items that respondents show positive teaching efficacy in EE (N = 54)

Meanwhile, a large proportion of participants expressed negative (Neg) or uncertainty (Unc) of teaching efficacy in the remaining items (refer to Table 3b). Some respondents (62.9%) indicated that they did not know or were unsure about the steps to teach EE concepts (item 2). At least 61.1% of respondents specified that they did not understand EE well enough (item 5). A total of 59.2% of respondents mentioned that it was difficult for them to explain the rationales of the scientific experiments related to EE (item 6). More than half of the respondents claimed that they lacked necessary skills to teach EE (item 8) and were unconfident in teaching EE effectively (item 4).

Items	Description	Neg (%)	Unc (%)
Item 2	I know the steps necessary to teach environmental education concepts effectively.	33.3%	29.6%
Item 3	I will be very effective in monitoring classroom activities.	33.3%	29.6%

Items	Description	Neg (%)	Unc (%)
Item 4	I will generally teach environmental education effectively.	33.3%	18.5%
Item 5	I understand EE well enough to teach it.	35.2%	25.9%
Item 6	I will not find it difficult to explain to students why science experiments related to environmental topics work.	37%	22.2%
Item 8	I have the necessary skills to teach environmental education effectively.	31.5%	22.2%

Table 3b. Items that respondents show negative teaching efficacy in EE (N = 54)

Overall, respondents perceived themselves as inefficacious in understanding of EE, content knowledge, and pedagogical knowledge of EE teaching. Notwithstanding, they considered that they understand the basic concepts required to teach EE and were capable of answering students' EE-related questions. They also expressed their willingness of finding better ways to teach EE effectively.

6.4 Correlation between ecological knowledge level and personal teaching efficacy in EE

Pearson correlation coefficient (Pearson's r) was computed to find out the relationship between EK level and personal teaching efficacy in EE (refer to Table 4). Holistically, it was analyzed that there was a statistically significant correlation at 0.05 level but a weak positive relationship (p-value = .028, Pearson's r = .298) between these two factors. In a more specific analysis, EK level and teaching efficacy related to EE content knowledge (item 7, 9) were found to have a significant correlation at 0.01 level and a relatively moderate positive relationship (p-value = .007, Pearson's r = .361).

		Ecological knowledge	Teaching efficacy in EE	Teaching efficacy in EE content knowledge (item 7 & 9)
Ecological knowledge	Pearson's r	1	.298*	.361**
	Sig. (2-tailed)	-	.028	.007

Note: **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4. Pearson correlation coefficient between EK and personal teaching efficacy in EE

7. Discussion

7.1 Ecological knowledge (EK) level

The average score of EK test indicates that the EK level of pre-service GS teachers was moderate. It shows that respondents had enough understanding of ecosystem, adaption, biodiversity, and predator-prey (item 1, 2, 3b, and 5). After specific analysis of the items, however, it is found that they still need to strengthen their understanding of several core ecological concepts. Approximately 30% of respondents expressed uncertainty about the concepts of materials cycling and food chain, whereas the two concepts are the imperative components to build up the understanding of "the interdependence and interaction between living things and the environment" as incorporated in the GS Curriculum Guide (Curriculum Development Council, 2017). Hence, it is true that a portion of respondents lacked realization of the interacted nature of ecosystem. They were incapable of applying basic ecological

concepts to scenarios in the test items, demonstrating their incomplete comprehension of these concepts.

Apart from these, item 3a (biotic and abiotic factors) and item 7 (human activity impact) were observed to obtain the lowest accuracy in the first scale. In the result of item 3a, as plants are considered as abiotic factors, it shows that respondents might have common misconceptions about the characteristics of living and non-living things. As elucidated in the GS Curriculum Guide (Curriculum Development Council, 2017), "recognizing the characteristics of living things" is attributed to one of the key learning objectives in key stage 1 (Primary 1 to Primary 3). Thus, it could be noticeable as false that pre-service GS teachers mastered the basic ecological concepts. The possible reason for this result may be associated with the persisting misconceptions of participants. Even though they have been educated with EK from primary school to university, they have overlaid complex concepts onto a fragile foundation of EK without rectifying misconceptions (Butler, Mooney Simmie, & O'Grady, 2015). Besides, as respondents were found to have difficulties in clearly explaining the impact of travelling methods on the environment in item 7, it is recognizable that pre-service GS teachers lacked clear understanding of how human activities affect natural systems. This finding also echoes the previous study (Puk & Stibbards, 2010).

The above presence of misconceptions and weak EK foundation in pre-service GS teachers is evident, which suggests the transformation over the courses in the teacher education programmes. Except for instructing complex factual knowledge in the university, there should be opportunities to help pre-service GS teachers diagnose and repair their misconceptions before their graduation. If pre-service teachers enter the local schools by holding misconceptions of EK, it is very likely that they deliver misconceptions to students, and students'

level of EK and EL will be negatively influenced (Butler et al., 2015).

7.2 Personal teaching efficacy in EE

Respondents were found to have low level of personal teaching efficacy in EE in six out of eleven items in the second instrument. They believed that they welcomed and were capable of answering students' questions related to EE, while they acknowledged that they were incompetent in explaining the rationale of scientific experiments on EE. This contradiction could be further explained as pre-service GS teachers may perceive themselves possess basic level of EK but inadequate in-depth understanding. Meanwhile, pre-service GS teachers acknowledged their deficiency of understanding of EE and skills of teaching EE, which may explain their less efficacy in teaching EE effectively and shy away from EE at the current stage. However, they revealed that they would keep finding better ways of teaching EE afterwards. This result is also reflected in the previous literature (Sia, 1992) and it highlights pre-service GS teachers' readiness and positive attitudes towards EE training. It implies and suggests that teacher education programme should not only provide content knowledge (i.e., ecological knowledge) necessary to teach EE in GS but also be encouraged to organize courses that systematically instruct pedagogical knowledge and approaches of EE teaching to pre-service GS teachers. These interventions in teacher education are likely to enhance pre-service teachers' teaching efficacy in EE and therefore reinforce their efforts and persistence when facing difficulties in the classrooms (Stevenson et al., 2014). Therefore, it is suggested that subject matter knowledge and pedagogical knowledge of EE teaching are considered the priorities in pre-service GS teacher education programmes (Kennelly, Taylor, & Serow, 2012; Summers, Corney, & Childs, 2003).

7.3 Relationship between EK level and personal teaching efficacy in EE

The Pearson correlation coefficient indicates a slightly moderate but highly significant relationship between pre-service teachers' EK level and their efficacy in teaching EE concepts. This finding is reasonable as the deeper understanding of ecological concepts in pre-service teachers, the stronger their teaching efficacy that they can help students to construct these concepts and answer their questions. In short, the perceived level of EK in pre-service GS teachers is fairly near their actual level of EK, which is different from the findings in the previous study (Stevenson et al., 2014). Besides, another Pearson's r indicates the weak but significant relationship between pre-service teachers' EK level and their overall teaching efficacy in EE. Although the correlation is not strong, it implies that the higher EK level of pre-service GS teachers, the stronger their beliefs of teaching EE better. Therefore, courses related to ecology hosted in the teacher education programmes are necessary as the foundation for teachers to teach EE concepts, while it is insufficient for them to teach EE in a holistic manner. It has been proved in the previous literature that pedagogical knowledge is posed to be the challenge of developing EE (Ko & Lee, 2003). Therefore, it can be further suggested that pedagogical content knowledge should be provided in teacher education programmes for pre-service GS teachers.

8. Conclusion

8.1 Theoretical and practical implications

This study is able to fill the existing research and population gap by providing an initial picture

of pre-service GS teachers' EL level (especially EK) and personal teaching efficacy toward EE in Hong Kong. The findings of this study may also contribute to future research on evaluating the EE training in teacher education programmes in Hong Kong.

Except for the theoretical implications, the suggestions stated in the previous sections are valuable to the pre-service GS teacher education programmes and trainings in the tertiary education institution. In view of the GS Curriculum Guide, teachers undertake the tasks of helping students develop EL in cognition, affect, and behavior level. Consequently, teacher education programmes must equip pre-service GS teachers with the necessary subject knowledge, pedagogical knowledge, and teaching efficacy in EE to be well-prepared before stepping into classrooms.

8.2 Limitations and future research

There are two limitations perceived in this study. Limited sample size (N=54) is the primary limitation as the results may not represent the EK level and teaching efficacy of all pre-service GS teachers in Hong Kong. According to Sedgwick (2012), the small sample size may affect the Pearson correlation coefficient to a certain extent. Another limitation focuses on the lack of follow-up interviews with participants. Due to limited resources and time, this study merely investigates the overview of EL and self-efficacy of pre-service GS teachers through quantitative method, while it may not deeply substantiate their opinions on EE teaching and existing EE training programmes through qualitative method. Therefore, future research may consider studying the effectiveness of pre-service teacher education programmes in building prospective GS teachers' teaching efficacy in EE, thereby improving the quality of EE in Hong Kong.

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Appendix 1

Part 1 of the questionnaire: Environmental Literacy (ecological knowledge)

1. Plants use energy directly from the sun. What do they use the energy from the sun for?

A. To make food

B. To disperse seeds

C. To fertilize the soil

D. To prevent insect damage

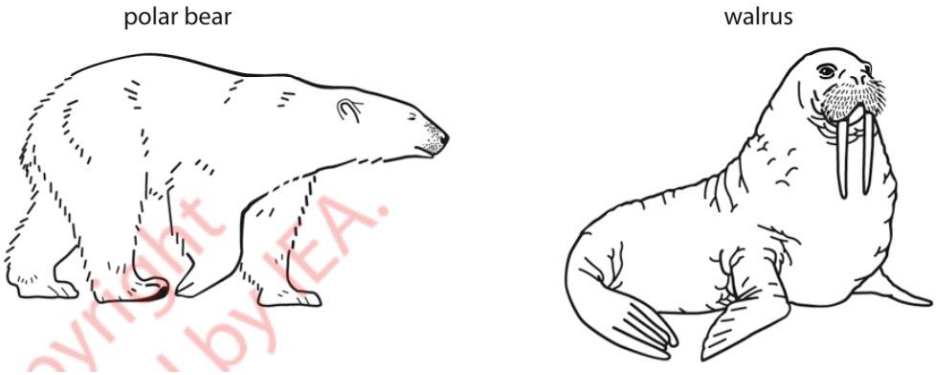
E. I am not sure

Key: A

2. Polar bears and walruses look very different, but both can survive in the extreme cold.

A polar bear has a thick coat of fur that helps keep it warm. The walrus has no fur.

What does the walrus have that helps it keep warm?



A. fat layers

B. tusks

C. whiskers

D. flippers

E. I am not sure

Key: A

3. **The picture below shows a pond. In the spaces provided below, list three living things and three non-living things shown in this picture.**

Living things:

1. _____ **2.** _____ **3.** _____

Non-living things:

1. _____ **2.** _____ **3.** _____

Living things:

Fish, frog, turtle, dragonfly (insect, butterfly, fly), water lily (plants, flowering plant, water plant), trees, grasses, molluscs (snails)

Non-living things:

Sun, clouds, water, rocks, pebbles (stones), sand, soil (dirt, earth), mud, air

4. Animals and plants contribute to the nutrient cycle in nature. Which following option is <u>INCORRECT</u>?

A. Substances from decomposition of animal carcasses or feces can be used by plants

B. Animals feed on plants and make up their own substance through digestion and absorption

C. Leaves buried in soil cannot be broken down

D. Fertilizers in the soil can serve as nutrients to plants

E. I am not sure

Key: C

5. A predator is an animal that feeds on other animals. Which of these is a predator?

A. deer

B. wolf

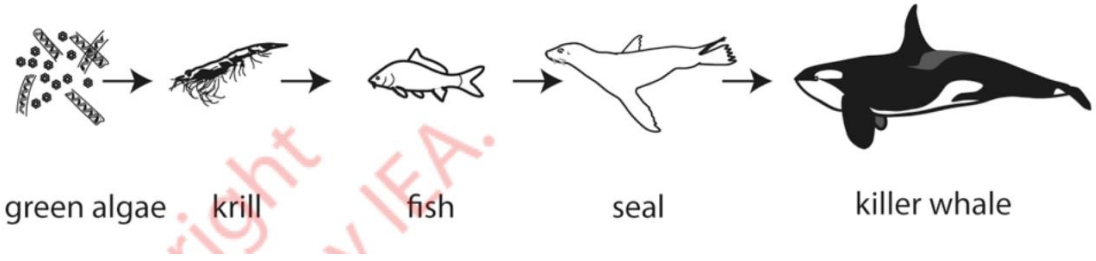
C. cow

D. goat

E. I am not sure

Key: B

6. The diagram below shows a food chain. Which predator-prey relationship is correct?



A. fish (predator) - seal (prey)

B. green algae (predator) - krill (prey)

C. fish (predator) - krill (prey)

D. seal (predator) - killer whale (prey)

E. I am not sure

Key: C

7. The pictures below show two ways of traveling around town.

Which way of traveling is better for the environment?

(Check one box)

Bicycle (✔) Motorbike ( ) I am not sure ( )

Please briefly explain your answer.

Correct response:

No pollution is given off by bicycle. / Bicycle is not noisy like a motorbike. / The motorbike gives out fumes which go up into the air and pollute it, whereas a bike does not.

Incorrect response:

My answer is bicycle because it does not use gas. / My answer is bicycle because motorbike uses limited resources.

Appendix 2

Part 2 of the questionnaire: Self-efficacy (personal teaching efficacy in environmental education)

1	2	3	4	5
Strongly disagree	disagree	Neither agree or disagree	agree	Strongly agree

Items	1	2	3	4	5
1. I will find better ways to teach environmental education.	☐	☐	☐	☐	☐
2. I know the steps necessary to teach environmental education concepts effectively.	☐	☐	☐	☐	☐
3. I will be very effective in monitoring classroom activities.	☐	☐	☐	☐	☐
4. I will generally teach environmental education effectively.	☐	☐	☐	☐	☐
5. I understand EE well enough to teach it.	☐	☐	☐	☐	☐
6. I will not find it difficult to explain to students why science experiments related to environmental topics work.	☐	☐	☐	☐	☐
7. I am able to answer students' environmental education questions.	☐	☐	☐	☐	☐

8. I have the necessary skills to teach environmental education effectively.	☐	☐	☐	☐	☐
9. I have the ability to help students understand environmental education concepts better.	☐	☐	☐	☐	☐
10. I welcome students' questions about environmental education.	☐	☐	☐	☐	☐
11. I know how to turn students on to EE.	☐	☐	☐	☐	☐