Emotional Intimacy with Nature and Life & Intellectual Interest in Life of Pre-service Biology Teachers for Environmental Education

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Abstract We investigated emotional intimacy with nature and life, and intellectual interest in life among South Korean pre-service teachers (N = 114) training in biology education, analysing the differences between these two constructs as well as their relationship to environmental behaviour and sensitivity. In addition, differences in the respondents’ experiences of nature, concerns about environmental problems, and willingness to perform environmental education were explored. Four groups of pre-service biology teachers, categorized by the two investigated personal variables, showed different responses for the environment-related characteristics and other variables. Our results suggest that biology teachers should have higher emotional and intellectual interest in nature and life, and a balance between emotional intimacy with nature and life, and intellectual interest in life is needed to prepare them.

Keywords: Emotional intimacy with nature and life; Intellectual interest in life; Pre-service biology teachers; Environmental education

Introduction

Today’s societies face many environmental problems, including the destruction of habitats, loss of biodiversity, air pollution, water pollution, and so forth. These problems compel individuals to face issues and make value judgments that require scientific knowledge about the environment. Environmental education emerged in the early 1960s out of a need to respond to these urgent environmental issues. In South Korea, environmental education has emerged as a discrete subject (“Environment” in middle schools and “Environment and Green Development” in high schools) within the National Curriculum since 1995, but the ratios of schools that actually adopt the subject into the curriculum are low with 7.8% of middle schools and 12.2% of high schools. In addition, the number of high schools that conduct environmental education as a discrete subject is gradually decreasing because of focus shifting to preparation for college entrance examination (KME 2015).

A sense of the importance of environmental consequences of scientific and technological developments led some in the Science, Technology, and Society (STS) movement in science education to advocate a greater focus on the environment, leading to a Science, Technology, Society, and Environment (STSE) movement that includes understanding of sustainable development to maintain a life-sustaining environment as one component (Pedretti 2003). Korean science textbooks contain science concepts related to environmental issues such as biodiversity loss and global warming. Regrettably, science education has distanced itself from environmental education by focusing primarily on teaching knowledge and skills (Wals et al. 2014).

However, because young people are concerned about the quality of the environment despite their declining interest in science, environmental education might be an appropriate emphasis for rekindling students’ interest in the relevance of science (Gough 2002). Thus, science education needs to develop a mature symbiotic relationship with environmental education (Wals et al. 2014). In addition, if current social and environmental problems are to be solved, we need a generation of scientifically and politically literate citizens who are not content with playing the role of armchair critic (Hodson 2003). Gough (2002) has argued that science education must encourage young people to think ecologically if we want to achieve sustainable development.

Science educators have a key role in empowering students to take action to reduce global warming (Skamp, Boyes, and Stanisstreet 2013). At school, science teachers might play an especially crucial role in the formation of students’ value and attitudes towards environmental issues. Further, teachers’ attitudes towards nature and the environment can determine to a large extent their teaching practices. Not surprisingly, the attitudes and values of those who introduce students to environmental knowledge have been found to be
critical components of the environmental attitudes that children eventually develop (Palmer et al. 1998a).

Scientific knowledge may influence public concern and attitudes about the environment (Kollmuss and Agyeman 2002; Shi, Visschers, and Siegrist 2015; Tobler, Visschers, and Siegrist 2012). When children have a prejudice against a set of living organisms, for example, spiders, environmental knowledge can improve their attitudes towards those creatures (Prokop et al. 2009). Moreover, research has shown that children learn to appreciate local animals and plants when teachers help them to become familiar with them (Lindemann-Matthies 2005). For these educational effects, teachers need to have a positive attitude to nature and life, especially biology teachers who educate students about life in the environment. Similarly, if pre-service teachers have a negative attitude to nature and life, they are likely to transfer their negative attitude to the children when they become teachers.

Pre-Service Biology Teachers and Environmental Education

We have recognized the need for change in science education (Bybee 2008; Hodson 2003; Liu 2016). School science should not only transmit scientific knowledge but also encourage students to apply knowledge to solve problems and actively participate as citizens in decision-making on scientific, technological, and environmental issues (Hodson 2003; NRC 2012). Zeidler et al. (2005) argued that incorporating socio-scientific issues in the science curriculum for students’ scientific literacy enables citizens to make informed decisions and participate in the formulation of public policy on societal issues. Many of these issues are related to natural resources and global environmental change (Liu 2016).

Conservation of biodiversity is conceived as an integral element of the broader concept of sustainable use of natural resources (Kassas 2002). Biodiversity conservation has increasingly gained recognition in national and international agendas (Navarro-Perez and Tidball 2012). Thus, teaching biodiversity has been a challenging educational task at least since the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992 (Van Weelie and Wals 2002). Education has been acknowledged as an important tool to achieve biodiversity protection through the transformation of human attitudes towards nature (Ehrlich and Pringle 2008). In this sense, there are great opportunities for education to contribute by helping citizens to act in favour of biodiversity (Dreyfus, Wals and Van Weelie, 1999).

Concerns about biodiversity have been underpinned in environmental education (Kassas 2002; Saito 2013). Kassas (2002) argued that biodiversity education as part of the vista of environmental education is aimed at developing knowledge and skills and cultivating attitudes that would enable citizens to respond to this environmental issue. In South Korea, biodiversity has been mainly addressed in a biology subject. The biology teacher contributes to education for, in, and about the environment by providing a scientific perspective, but one that goes beyond providing factual information (Slingsby and Barker 2003). With the decrease in adoption of environmental education as a discrete subject, the importance of biology teachers as educators for biodiversity loss may increase in South Korea.

However, recent studies from various countries have shown that pre-service teacher education programmes do not sufficiently emphasize environmental education (Kyburz-Grabert and Robottom 1999; Plevyak et al. 2001; Powers 2004; Van Petegem et al. 2005). Furthermore, in recent decades, academic and school biology has become increasingly dominated by physiology, molecular biology, and genetics (Hershey 1996; Greene 2004). Pre-service and in-service biology teachers seem to have a preference for microbiology and genetics (Finley, Stewart, and Yarroch 1982; Fisher 2001; Lock 1997); many teachers today have very little experience with fieldwork, ecology, whole organism biology, and biodiversity (Lindemann-Matthies and Kadji-Beltran 2006). Consequently, ecology and sustainability issues are often neglected (Lock 1997; Tamir 1992) and the teachers might not be able or even willing to teach biodiversity (Lindemann-Matthies and Bose 2008).

Nevertheless, schools are crucial for the creation of positive attitudes toward global biodiversity (Ballouard, Brischoux, and Bonnet 2011). Effective biodiversity education strongly depends on the teachers and their motivation and the quality of their training (Kassas 2002). Knowledgeable and skilled student teachers are a key component for the successful implementation of biodiversity education in schools (Fiebelkorn and Menzel 2013). University-based teacher education must be regarded as one of the best foundations for the propagation of biodiversity education within school systems because of its potential multiplier effect (Lindemann-Matthies et al. 2009, 2011; Powers 2004). Teachers who experienced environmental education in their pre-service preparation are more likely to have confidence in applying these newly learned skills in their classroom (Lane et al. 1995). Pre-service teacher education is critical, then, in preparing environmentally literate teachers (Beckford 2008; Lin 2002; Van Petegem et al. 2005).

Emotional Intimacy with Nature and Life, and Intellectual Interest in Life of Pre-Service Biology Teachers

Kassas (2002) proposed that “understanding ecology”, “intimacy with nature”, and “supportive
society” may be considered as the perspectives that help environmental education navigate the course of its steps for teaching biodiversity. Kassas (2002) also identified four aspects of learning in fields of environmental education to be applied on biodiversity concerns for defining goals: emotional, scientific-ecological, ethical aspects, and political. In addition, conservation practitioners, policymakers, and educators have recognized the need for both emotion and knowledge to inspire environmental awareness, caring, and even love to motivate pro-conservation behaviour (Iozzi 1989; Kals, Schumacher, and Montada. 1999; Hinds and Sparks 2008; Novacek 2008; Wilson 2008). Therefore, we assume that it is desirable that pre-service biology teachers be familiar with and inquisitive about nature and biological organisms.

According to Kals and Maes (2002), environment-specific emotions, such as moral emotions, emotional affinity towards nature, and ecological fear can have a powerful and stable impact on and further explain individual differences among environment-sustaining behaviours. Connection or affinity to nature is thought to have an impact on our empathy for other species and our desire to help conservation efforts (Conn 1998; Kellert 2003). Many studies in the past decade have shown an affinity towards nature for pro-environmental behavior and activities (Dutcher et al. 2007; Hinds and Sparks 2008; Kals, Schumacher, and Montada 1999; Mayer and Frantz 2004; Schultz 2000). Environmental knowledge also has been shown to predict behaviour, although knowledge must be regarded as a necessary but not sufficient condition for salutary decision-making (Gifford and Nilsson 2014). Furthermore, in teaching students to care about biodiversity, knowledge of the common organisms around them is considered essential (Balmford et al. 2002 Barker, Slingsby, and Tilling 2002; Bebbington 2005). Moreover, Kals, Schumacher, and Montada (1999) showed that an “emotional affinity toward nature” as well as “interest in nature” are variables with a strong empirical link to nature-protective behaviour. They suggested that affinity toward nature can best be described as an emotion that develops through experiences with nature during childhood. Affect-specific property can be independent of cognitive operation (Zajonc 2000), and emotions can be intrinsically/implicitly based on one’s decision and behaviour (Taylor 2001).

Although interest is assumed to be a phenomenon that emerges from an individual’s interaction with his or her environment (Krapp, Hidi, and Renninger 1992), interest in something suggests a preference to engage in those activities and topics rather than others. According to Hidi, Renninger, and Krapp (2004), interest is object-specific and involves cognitive and affective functioning, indicating that an individual will have a positive affect toward, as well as relatively greater knowledge about, particular content in which he or she is interested. In discussing self-determination theory, Deci (1992) argued that interest is a powerful motivator for children, and that even adults can become enthusiastic for an activity without a payoff if it interests them. Therefore, we need to consider the behavioural consequences of different interest in nature and life in that interest can be the core affect distinguishing intrinsically and extrinsically motivated activities. In addition, interest is usually associated with positive emotion, and “emotional interest” needs to be distinguished from “cognitive interest” because of its direct emotional impact (Kintsch 1980). Eagly and Chaiken (1993) showed that emotional affinity to nature is more closely related to environmentally relevant commitment and behaviour than mere cognitive interest in nature.

One might be emotionally interested and playing with them without scientific interest in animals while another might be interested in scientific knowledge about animals without positive emotion. Therefore, we considered two kinds of emotional and intellectual interest: ‘emotional intimacy with nature and life’ and ‘intellectual interest in life’. We viewed intimacy with nature and life as emotional interest and it can be considered a construct that embraces both a familiarity with nature and life and sentimental enjoyment of nature. Further, we assumed that pre-service biology teachers who have greater emotional intimacy with nature and life would be more likely to have pro-environmental characteristics, which would be revealed during their teaching practice.

Kals, Schumacher, and Montada (1999) argued that “interest in nature” is also related to an individual’s nature-protective behaviour. Similar to their construct, intellectual interest in life in this study is considered to be on a cognitive level. Thus, as cognitive interest, it can be under the control of a system partially independent from the affective domain (Zajonc 1980). For our research purposes, then, we assumed that intellectual interest in life can be related to certain pro-environmental characteristics of pre-service biology teachers. Because intellectual interest in life in can be rooted in various motivations, as a variable in this study it is considered a construct that includes scientific curiosity and intellectual aspirations to understand objects. For example, increased knowledge of wildlife species not only enables the public to better understand wildlife but may also encourage pro-environmental behaviours such as protecting and conserving wildlife (Wilson and Tisdell 2005).

Purpose of the Study

This study focused on two variables, emotional intimacy with nature and life, and intellectual interest in life, among pre-service biology teachers. Its goal was to examine the relationship between these two
constructs and environment-related characteristics, such as environmental behaviour and sensitivity. In addition, we investigated differences in respondents’ experiences of nature, general concern about environmental problems, and willingness to perform environmental education.

**Methods**

**Participants**

The participants in this study were 114 pre-service biology teachers training in the department of biology education at Seoul National University, South Korea. The participants were between 20 and 25 years of ages. Eighty-six of the respondents were female (75%), and 28 (25%) male. This gender ratio reflects the demographic profile for South Korean biology teachers. The majority of the respondents (104) reported that they had grown up in urban or suburban areas (91%).

**Measures**

A questionnaire was developed to measure interest in nature and life (emotional intimacy and intellectual interest), environmental behaviour, environmental sensitivity, experience with nature and life, willingness to perform environmental education, and concern for environmental problems (see online Appendix 1). All items were designed using a 5-point Likert scale. The values of the items in each category were averaged to obtain a measure of the construct. One Ph.D. researcher and two experienced in-service biology teachers checked all the items in the questionnaire. The reviewers were asked whether the items were relevant to the study’s and if the items were understandable for pre-service teachers. The items were revised based on their comments and suggestions.

**Emotional intimacy with nature and life, and intellectual interest in life.** Seven items measuring interest in nature and life were developed by reference to Kals, Schumacher, and Montada (1999). The four items representing emotional intimacy with nature and life were constructed to reflect one’s familiarity and enjoyment of nature. The three items representing intellectual interest in life were constructed to reflect intellectual curiosity about the diversity and ecology of plants and animals. The respondents were asked to indicate the extent to which each item corresponded to their attitudes and experiences by marking the appropriate scale ranging from not at all to very much. The items were subjected to confirmatory factor analysis followed by Varimax rotation, and the empirical factors confirmed the a priori dimensions of the items. That is, for emotional intimacy with nature and life, and intellectual interest in life, the corresponding items were loaded on each factor. Cronbach alphas for these items were 0.71 and 0.79, respectively.

**Environmental behaviour.** The 12 items measuring environmental behaviour were based on the research of Smith-Sebasto and D’Acosta (1995). The respondents were asked to indicate to what extent they demonstrated the environmental behaviour presented in each item. Cronbach alpha for these items was 0.76.

**Environmental sensitivity.** The eight items measuring environmental sensitivity were selected and constructed based on the research of Leeming and Dwyer (1995). The respondents were asked to report their perceptions by rating these items according to their assessment of their environmental empathy. Cronbach alpha for the items was 0.75.

**Experience of nature.** The category measuring experience of nature consisted of 11 items, divided into two categories: direct experiences (six items) that the respondents have experienced for themselves among nature-related episodes, and indirect experiences (five items) that they have experienced through non-self things or people, such as books and teachers, in a roundabout way. Respondents made ratings according to their perceptions of their experience of nature. Responses ranged from not at all (assigned a value of 1) to very much (assigned a value of 4). Cronbach alphas for these items were 0.81 and 0.67, respectively.

**Willingness to perform environmental education.** The willingness to perform environmental education was measured by their self-assessment for the corresponding two items. Responses ranged from strongly disagree to strongly agree. Cronbach alpha for these items was 0.75.

**General concern for environmental problems.** The degree of respondents’ general concern for environmental problems was measured by rating their self-assessment, ranging from not at all to very much, for the following single item: “I am currently concerned about environmental problems.”

**Statistical Procedures and Analysis**

Data analyses were performed using SPSS Version 15.0. Statistical analysis included factor analysis, cluster analysis, and ANOVA, followed by a post-hoc multiple comparison Scheffe test. As stated above, factor analysis was conducted to evaluate the stability of two constructs: emotional intimacy with nature and life, and intellectual interest in life. Cluster analysis was used to determine whether the pre-service biology teachers could be classified according to the differences in these two main constructs. One-way ANOVAs followed by a post hoc multiple comparison Scheffe test were performed to compare the response patterns among the groups for the investigated variables.
Results

Differences in Emotional Intimacy with Nature and Life, and Intellectual Interest in Life

A cluster analysis with the variables of emotional intimacy with nature and life, and intellectual interest in life, enabled us to categorize the respondents into four groups (Table 1). These groups showed a clear distinction between the mean values associated with emotional intimacy with nature and life, and intellectual interest in life (Tables 2 and 3). Both Groups 2 and 3 had higher mean values in the intimacy variable than the other two groups. For the interest in life variable, group 1 and 2 had higher mean values. The pre-service biology teachers in Group 2 had relatively high mean values in both intimacy and interest, while those teachers in Group 4 revealed otherwise. The pre-service biology teachers in Group 1 and 3 had reciprocal traits for both of these variables.

Table 1. Number of students in four groups classified by cluster analysis

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>12</td>
</tr>
<tr>
<td>Group 2</td>
<td>20</td>
</tr>
<tr>
<td>Group 3</td>
<td>31</td>
</tr>
<tr>
<td>Group 4</td>
<td>51</td>
</tr>
</tbody>
</table>

Table 2. Means and ANOVA results for the groups’ intimacy with nature

<table>
<thead>
<tr>
<th>Group</th>
<th>df (Between groups, Within groups, Total)</th>
<th>F</th>
<th>post-hoc multiple comparison Scheffe test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3.04</td>
<td>b</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>4.33</td>
<td>63.68</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>4.24</td>
<td>(3, 110, 113)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>3.12</td>
<td></td>
</tr>
</tbody>
</table>

Significance level p < .05

Table 3. Means and ANOVA results for the groups’ interest in life

<table>
<thead>
<tr>
<th>Group</th>
<th>df (Between groups, Within groups, Total)</th>
<th>F</th>
<th>post-hoc multiple comparison Scheffe test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>4.06</td>
<td>a</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>4.27</td>
<td>59.59</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.95</td>
<td>(3, 110, 113)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2.69</td>
<td></td>
</tr>
</tbody>
</table>

Significance level p < .05

Differences in Environment-related Characteristics

The four groups classified according to the intimacy and the interest variables showed different responses to the environment-related characteristics. The results are presented in online Appendix 2. As for the environmental behavior and environmental sensitivity variables, Group 2, which showed higher mean values in both intimacy and interest, was distinguished from the other groups. That is, pre-service biology teachers with both high emotional intimacy with nature and life, and intellectual interest in life scored higher on both the environmental behaviour and sensitivity variables.

The group with both high intimacy and interest also showed the highest degree of general concern for environmental problems. The general concerns of the other groups were not statistically different. Based on post-hoc Scheffe multiple analysis, the willingness to perform environmental education seemed not to be statistically different among groups. However, supplemental Tukey multiple analysis with greater statistical power revealed that there was a difference among the groups, indicating that the pre-service biology teachers with less intimacy with nature and life, and interest in life were more likely to have less willingness to perform environmental education.

The pre-service teachers in Group 2 reported the most direct and indirect experiences of nature. In other words, pre-service biology teachers with higher emotional intimacy with nature and life, and intellectual interest in life had experienced more of nature, both in direct ways, such as spending time in mountains and rivers, and in indirect ways, such as reading books about nature. Group 4, with both low intimacy and interest, had the lowest rate of direct experience, while all other groups except Group 2 were on a similar level in the indirect experience of nature.

Discussion

The Importance of Emotional Intimacy with Nature and life, and Intellectual Interest in Life

In this study, South Korean pre-service biology teachers’ interest in nature and life, as two variables associated with effective environmental education, were captured by the two dimensions of emotional intimacy with nature and life, and intellectual interest in life. Through cluster analysis, these dimensions resulted in four groups with two complementary groups of the pre-service teachers (cf. Group 1 and 3). The pre-service biology teachers with high emotional intimacy with nature and life did not always show high interest in life, and vice versa. This result suggests that while the two dispositions may at first seem parallel, they may not always be manifested in one person. One can have an interest in life without feeling any emotional intimacy. Conversely, one can feel emotional intimacy without having any intellectual interest in life. The results of this research do not explain how these two dispositions influence or interact with each other. However, we can infer the importance of two dispositions based on
the differences in the environment-related characteristics of the groups.

It is worth pointing out that the group of pre-service biology teachers who revealed a concurrent high emotional intimacy with nature and life, and intellectual interest in life were in sharp contrast to other groups in terms of environmental behavior and sensitivity. Thus, it seems likely that the pre-service biology teachers with both high emotional intimacy with nature and life, and intellectual interest in life are apt to act more environmentally and be more environmentally sensitive. In addition, the pre-service biology teachers with simultaneously higher emotional intimacy and intellectual interest are more likely to worry about the present status of our environment and to become more environmentally responsible in-service teachers who are willing to offer opportunities for environment-related learning to their students. In terms of environmental education, then, the findings strongly suggest that emotional intimacy with nature and life, and intellectual interest in life are important characteristics for biology teachers.

In addition, the balance of emotional intimacy with nature and life, and intellectual interest in life seems to be related to pro-environmental characteristics in pre-service biology teachers. Respondents who showed only high intellectual interest in life without emotional intimacy can be said to have simple intellectual curiosity. On the other hand, those who showed high emotional intimacy with nature and life without intellectual interest in life seem to have a simple sentimental yearning for nature. Importantly, our results suggest that pre-service biology teachers with both emotional and intellectual interest in nature and life are likely to bring these characteristics into the classroom and become pro-environmental biology teachers. We think it is within bounds to say that both emotional intimacy with nature and life, and intellectual interest in life may be prerequisites for a strong sense of environmental responsibility in pre-service biology teachers. We think it is within bounds to say that both emotional intimacy with nature and life, and intellectual interest in life may be prerequisites for a strong sense of environmental responsibility in pre-service biology teachers. We think it is within bounds to say that both emotional intimacy with nature and life, and intellectual interest in life may be prerequisites for a strong sense of environmental responsibility in pre-service biology teachers.

Accordingly, we assert the need for a strategic approach to helping pre-service biology teachers develop a substantial emotional intimacy with nature and life, and intellectual interest in life. The result is in accordance with the view that cognitive and affective integration is needed in a science education that informs environmental education, as a sense of relationship is essential for environmental care and responsibility leading to informed action (Littledyke 2008). Wilson (2008) also argued that a balance between affect-based emotion and cognition is critical in complex decisions for conservation efforts.

**The Promotion of Emotional Intimacy with Nature and Life, and Intellectual Interest in Life for Biology Teachers**

Many studies on significant life experiences (SLE) have described the influence of nature experiences in childhood and adolescence on adult environmental commitment (Chawla 1999; Palmer et al. 1998b; Tanner 1980; Wells and Lekies 2006). With regard to the SLE, environmentally committed people were distinguished from those who are apathetic to environmental concerns (Hsu 2009). In this study, the pre-service biology teachers who scored highest in both intimacy with nature and life, and interest in life also scored significantly higher on a number of pro-environmental characteristics, including environmental behaviors, environmental sensitivity, concern for environmental problems, and willingness for environmental education. Significantly, this group also reported more experiences of nature than the other groups. In particular, pre-service teachers with both lower intimacy and interest reported the lowest direct experiences of nature. These results imply that emotional and intellectual dispositions toward nature and life can be affected by prior experiences of nature.

In this study, experiences of nature referred to positive experiences like spending time at such places as mountains and rivers, and good impressions of nature from reading books about nature or observing the pro-environmental behaviour of parents and teachers. Palmer et al. (1998a) have suggested that teaching that addresses negative issues such as pollution and environmental degradation might compel individuals to think seriously about those problems. Similarly, Hsu (2009) has asserted that negative experiences, such as the loss of beloved natural places, can be influential as significant life experiences disposing one to individual action (Hsu 2009). Therefore, it is probable that negative experiences also provide motivation for practical environmental concern. Most likely, it is a combination of positive and negative experience that influences the environmental thinking of individuals (Palmer and Suggate 1996). By introducing activities that promote awe and wonder of the living world and sensitivity to care for organisms and their habitats, a personal association with nature can be developed (Barker and Slingsby 1998; Barker, Slingsby, and Tilling 2002; Kassas 2002).

**Conclusions and Implications**

This study examined the differences between emotional intimacy with nature and life, and intellectual interest in life, in South Korean pre-service biology teachers as well as the relationships between these two constructs and environment-related characteristics like environmental behavior and sensitivity, and the respondents’ experiences of nature, general concern about environmental problems, and willingness to perform environmental education.

The methodology of the present study was
responsible biology teachers. Further research supported by qualitative research methods like interviews and observations may shed additional light on the relationship between pre-service biology teachers’ interest in nature and life and their environmental commitment. Further, the generalizability of the findings may be limited to South Korea as the study was only carried out in this country. We need to consider the fact that people’s concern about environmental issues can be affected by their cultural worldview (Kahan et al. 2012). Further, the subjects in the study were limited to pre-service biology teachers enrolled in the university where the study was conducted. Therefore, more diverse samples are needed. In spite of these limitations, however, the results of this study point to a clear connection between an emotional/intellectual interest in nature and life, and pro-environmental attitudes and behaviours in biology teachers in training. It is noteworthy that the results in this study did not reveal how the two constructs of emotional intimacy with nature and life, and intellectual interest in life are related to each other, opening doors to further research.

This study revealed that emotional intimacy with nature and life, and intellectual interest in life may not always occur simultaneously in pre-service biology teachers. At the same time, both emotional and intellectual interest in nature and life are needed to promote pro-environmental behaviour in pre-service biology teachers. Environmentally responsible biology teachers can act as models for students, and pre-service teachers demonstrating pro-environmental behaviour and sensitivity are more likely to become such models. We conclude, then, that the promotion of emotional intimacy with nature and life, and intellectual interest in life is needed to fully prepare pre-service biology teachers to help in creating an environmentally literate citizenry.

Through the different phases in our lives, we have many opportunities to become environmentally responsible citizens (Hsu 2009). Pre-service teachers’ environmental awareness can be fostered by an outdoor program (Zachariou and Valanides 2006). Experiences in nature can have a great significance for adults as well as children. Therefore, pro-environment experiences can be a significant factor in promoting the emotional intimacy with nature and life, and the intellectual interest in life for pre-service biology teachers. During their years of pre-service training, they should have exposure to educational experiences that maximize the impact of the natural environment and take into account their existing positive or negative predispositions towards nature. More studies are needed to reveal the relationship between these two constructs and create programs to foster the development of environmentally responsible biology teachers.

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Supporting Information
Additional Supporting Information can be found in the online version of this article:
Online Appendix 1: Items for pre-service biology teachers in questionnaire
Online Appendix 2: Results for environment-related characteristics
Table A1: Means and ANOVA results for the groups’ environmental behavior
Table A2: Means and ANOVA results for the groups’ environmental sensitivity
Table A3: Means and ANOVA results for the groups’ general concern for environmental problems
Table A4: Means and ANOVA results for the groups’ willingness to perform environmental education
Table A5: Means and ANOVA results for the groups’ direct experience of nature
Table A6: Means and ANOVA results for the groups’ indirect experience of nature

Online Appendix 1: Items for pre-service biology teachers in questionnaire
<Emotional Intimacy with Nature>
In my childhood, I loved to spend time in nature, such as in the mountains, by the riverside or at the seashore.
I loved to play with or observe plants in my childhood.
I loved to pet animals like dogs and cats in my childhood.
As an adult, I want to enjoy the beauty of nature more frequently.

< Intellectual Interest in Life>
I want to know much more about different types of plants and their various life patterns
I want to know much more about different types of animals.
I want to know much more about different types of insects.

<Environmental Behaviours>
I listen carefully to an environment-related lecture during class.
I read or listen with concern to environment-related information in magazines, on TV, or on the Internet.
I have checked out from the library or bought at least one environment-related book.
I am careful about correctly sorting trash in home and at school.
I try not to use disposable products.
I turn off electronics that are not in use to save energy.
I have voted for a candidate or party that supports environmentally-friendly policies.
I have actively participated in nature conservation hosted by a local community or school.
I have been actively involved in a signature-collecting campaign held in a public place for environment conservation.
I usually advise my family to recycle goods.
I have been active in environment-related discussions with my friends and family, or during classes.
I make suggestions to people about leading an environmentally friendly life.

<Environmental Sensitivity>
It frightens me to think how much energy is wasted.
It makes me happy when I see that people protect nature.
It makes me happy when people recycle used bottles, cans, and paper.
I am worried about future generations when I see accidents of environmental pollution.
I am worried about the extinction of animals and plants.
It upsets me when I see habitats of animals and plants being destroyed by development.
It makes me feel at ease to think of nature, like forests, rivers, and seas.
I am frightened about the effects of pollution on me.

<Experience of Nature>
Experience of spending time in nature, like mountains, fields, rivers, and seas in childhood years
Experience in a farming village
Experience of observing and growing plants
Experience of keeping and playing with pets and stock
Experience of observing and rearing animals, such as insects
Experience of having good impressions from nature
Experience of reading books about nature and life
Experience of watching films about nature in the mass media
Experience of observing parents raise plants or animals
Experience of hearing adults’ (like parents and teachers) sayings about nature and the environment
Experience of observing adults’ (like parents and teachers) behaviours to protect nature and the environment

<Willingness to Perform Environmental Education>
If I become a teacher, I will make students get hands-on educational experiences in nature.
If I become a teacher, I will make students get environmental education.

<General Concerns about Environmental Problems>
I am currently concerned about environmental problems.
# Online Appendix 2: Results for environment-related characteristics

## Table A1. Means and ANOVA results for the groups’ environmental behavior

<table>
<thead>
<tr>
<th>Group</th>
<th>Environmental behavior</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.97</td>
<td>6.48</td>
<td>b</td>
</tr>
<tr>
<td>2</td>
<td>3.34</td>
<td>(3, 110, 113)</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>3.09</td>
<td></td>
<td>ab</td>
</tr>
<tr>
<td>4</td>
<td>2.87</td>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

Significance level \(p < .05\) \(p < .05\)

## Table A2. Means and ANOVA results for the groups’ environmental sensitivity

<table>
<thead>
<tr>
<th>Group</th>
<th>Environmental sensitivity</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.86</td>
<td>5.53</td>
<td>b</td>
</tr>
<tr>
<td>2</td>
<td>4.23</td>
<td>(3, 110, 113)</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>3.85</td>
<td></td>
<td>b</td>
</tr>
<tr>
<td>4</td>
<td>3.80</td>
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<td>b</td>
</tr>
</tbody>
</table>

Significance level \(p < .05\) \(p < .05\)

## Table A3. Means and ANOVA results for the groups’ general concern for environmental problems

<table>
<thead>
<tr>
<th>Group</th>
<th>General concern for environmental problems</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.58</td>
<td>6.16</td>
<td>ab</td>
</tr>
<tr>
<td>2</td>
<td>3.85</td>
<td>(3, 110, 113)</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>3.06</td>
<td></td>
<td>b</td>
</tr>
<tr>
<td>4</td>
<td>3.10</td>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

Significance level \(p < .05\) \(p < .05\)

## Table A4. Means and ANOVA results for the groups’ willingness to perform environmental education

<table>
<thead>
<tr>
<th>Group</th>
<th>Willingness to perform environmental education</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.08</td>
<td>4.49</td>
<td>a</td>
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<tr>
<td>2</td>
<td>4.20</td>
<td>(3, 110, 113)</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>4.05</td>
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<td>ab</td>
</tr>
<tr>
<td>4</td>
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<td>b</td>
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</tbody>
</table>

Significance level \(p < .05\) 0.0669 \(p < .05\)

## Table A5. Means and ANOVA results for the groups’ direct experience of nature

<table>
<thead>
<tr>
<th>Group</th>
<th>Direct experience of nature</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>21.74</td>
<td>bc</td>
</tr>
<tr>
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<td>(3, 110, 113)</td>
<td>a</td>
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<td>ab</td>
</tr>
<tr>
<td>4</td>
<td>2.67</td>
<td></td>
<td>c</td>
</tr>
</tbody>
</table>

Significance level \(p < .05\) \(p < .05\)

## Table A6. Means and ANOVA results for the groups’ indirect experience of nature

<table>
<thead>
<tr>
<th>Group</th>
<th>Indirect Experience of nature</th>
<th>(F) (Between groups, Within groups, Total)</th>
<th>post-hoc multiple comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.27</td>
<td>12.39</td>
<td>b</td>
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<tr>
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<td>4.00</td>
<td>(3, 110, 113)</td>
<td>a</td>
</tr>
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<td>3.43</td>
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<td>b</td>
</tr>
<tr>
<td>4</td>
<td>3.20</td>
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<td>b</td>
</tr>
</tbody>
</table>

Significance level \(p < .05\) \(p < .05\)