Environmental Education Research
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ceer20

Use of self-determination theory to support basic psychological needs of preservice science teachers in an environmental science course

Güliz Karaarslan [a c], Hamide Ertepınar [b] & Semra Sungur [c]

[a] Department of Elementary Education, Ağrı İbrahim Çeçen University, Ağrı, Turkey

[b] Department of Elementary Education, İstanbul Aydın University, İstanbul, Turkey

[c] Department of Elementary Education, Middle East Technical University, Ankara, Turkey

Published online: 11 Oct 2012.

To cite this article: Güliz Karaarslan, Hamide Ertepınar & Semra Sungur (2013) Use of self-determination theory to support basic psychological needs of preservice science teachers in an environmental science course, Environmental Education Research, 19:3, 342-369, DOI: 10.1080/13504622.2012.695013

To link to this article: http://dx.doi.org/10.1080/13504622.2012.695013

Environmental Education Research, 2013
Vol. 19, No. 3, 342–369, http://dx.doi.org/10.1080/13504622.2012.695013

Use of self-determination theory to support basic psychological needs of preservice science teachers in an environmental science course

Güliz Karaarslan[a,c]*, Hamide Ertepınar[b] and Semra Sungur[c]

[a]*Department of Elementary Education, Ağrı İbrahim Çeçen University, Ağrı, Turkey;*
[b]*Department of Elementary Education, İstanbul Aydın University, İstanbul, Turkey;*
[c]*Department of Elementary Education, Middle East Technical University, Ankara, Turkey*

(*Received 21 September 2011; final version received 14 May 2012*)

In this paper, we examine how the basic psychological needs of preservice science teachers (PSTs) were supported in a series of environmental science course activities informed by self-determination theory (SDT). We collected qualitative data about the PSTs' sense of competence, autonomy, and relatedness through interviews, group discussions, assignments, and reflection papers. Data were analyzed in relation to the instructional design features of the course; namely, collective construction of ideas, student guided discussions, real life connection, and consistent group dynamics. Findings illustrate primary support for cognitive features, including, how course activities supported a sense of confidence in action, sense of self-initiation, awareness of personal role in the system, and awareness of environmental actions. Overall, results suggest that SDT can be effectively utilized as a framework for environmental education in courses designed to foster environmental self-determination and long-lasting pro-environmental behaviors.

Keywords: self-determination theory; basic psychological needs; preservice science teachers; environmental science course; environmental education

Introduction

Since the recommendations of the Tbilisi conference in 1977, various attempts have been made to instill environmental education (EE) with a particular range of objectives, content and pedagogical features. From the 1980s, sustainability has been treated as a cross-cutting theme and imperative, most notably at the first Tbilisi+ event at Moscow held by UNESCO and UNEP in 1987, then at Rio's Earth Summit in 1992, and onwards into the Thessaloniki declaration on Education for Sustainability in 1997 (Knapp 1997), the World Summit on Sustainable Development in 2002, and the UN's Decade of Education for Sustainable Development (Sato 2006). As Darner (2007) argues, despite important differences in emphasis, much that goes by the name of EE and more recently, education for sustainability, shares a common goal: to motivate individuals - via education - toward developing pro-environmental behaviors (Mckeown and Hopkins 2005).

*Corresponding author. Email: kguliz@metu.edu.tr

Marcinkowski's (2010) survey of the field recounts how a consistent goal of environmental educators has been to educate people's awareness of the environment and environmental problems and how to develop relevant knowledge, attitudes, motivations, skills, and commitment to protect the environment (UNESCO–UNEP 1976). However, since the inception of EE, research has often challenged the notion that environmental knowledge predicts environmental behavior (Seguin, Pelletier, and Hunsley 1999). Hungerford and Volk (1990), for example, had queried assumptions about how teachers efforts to increase environmental knowledge produces positive attitudes toward the environment and action, while more recent studies of EE have illustrated that even if young people have pro-environmental attitudes, they do not necessarily take action (De Young 2000; Finger 1994; Pelletier et al. 1998; Stets and Biga 2003).

Fundamental issues raised by Oskamp (1995) include questioning assumptions of a linear relationship between knowledge and action, as these are not sufficient for educational attempts to foster responsible environmental behavior (REB) even as we must also recognize there is not just one factor affecting REB. For instance, Hines, Hungerford, and Tomera (1986–1987) modeled a range of variables involved in pro-environmental behaviors, highlighting the significance of attitude, locus of control, personal responsibility, action skills, knowledge of issues, knowledge of action strategies, and intention to act. We note too that in a recent study by Tabernero and Hernandez (2011), the level of satisfaction when performing a pro-environmental behavior was reported to be important in the choice of action, behavioral intentions, and future motivation. In fact, intention to act is identified as one of the better predictors of environmentally responsible behaviors (Hsu and Roth 1999) and has even become a focus for pedagogical development in EE classrooms (Darner 2007).

The literatures on EE and REB however, do not necessarily examine the promoters or inhibitors of an intention to protect the environment (Darner 2007). In fact, Darner (2009) charges, while there are many effective EE programs, there is little explanation about why they are effective in terms of developing intention to act. A key issue here is that two people may have the same intention to take action but their reasons for acting may differ. Equally, people may have external or internal reasons to demonstrate the same pro-environmental behaviors. To address this, Darner recommends self-determination theory (SDT) as an alternative theoretical frame in EE, while Darner's (2007) experimental studies conducted to explore its effectiveness have revealed that SDT guided instruction supports students' basic psychological needs, including that it offers an effective way to foster motivation toward responsible environmental behaviors.

Drawing on the same arguments posed by Darner (2007) then, this inquiry explores how SDT guided instruction can be framed to support basic psychological needs and improve self-determination towards environmental ends. However, while this study may be considered a replication of Darner's (2007) work, a key difference is the present work focuses on the application of SDT in EE classrooms with preservice science teachers (PSTs) in Turkey rather than US college students.

In Turkey, the science curriculum for elementary schools was revised in the 2004-2005 academic year and dimensions of environment and technology were added to the science component (Erdogan, Kostova, and Marcinkowski 2009). The revised curriculum aimed to develop students' environmental awareness and consciousness (Erdogan 2007) and their science process skills (Ozgelen and Yilmaz-Tuzun 2007). Today, there is a compulsory course titled 'environmental

science' for PSTs in faculties of education, and there are also several elective courses related to environment and sustainability. Nevertheless, environmental and sustainability education in Turkey is still at the early stages, and some PSTs consider EE an educational extra (Tuncer et al. 2009).

According to Schmidt (1996), the purpose of an effective preservice teacher education about the environment is that teachers should be knowledgeable about the environment and how (and when) to address environmental problems during education. Indeed, with an increase in the rate of industrialization and increasing environmental problems in Turkey, it is widely agreed that Turkey should revise university curricula to develop teachers' capacities in EE (Tuncer et al. 2009).

In this study then, we focus on how PSTs' basic psychological needs related to fostering self-determination are supported in an environmental science course. In SDT, basic psychological needs are defined as the need for competence, relatedness, and autonomy (Deci and Ryan 1990, 2000). The need for competence refers to a sense of confidence and efficacy in actions (Deci and Ryan 2004); the need for relatedness involves feelings connected to a community and a sense of security in the community; and the need for autonomy concerns individuals' needs to be self-initiating and self-regulating of their behaviors (Deci et al. 1991). The current study explores how environmental educators and teachers might prepare for, and construct, EE classrooms supporting these three basic psychological needs.

SDT and basic psychological needs

As proposed by Deci and Ryan (1985), SDT is a theory of human motivation that focuses on the process of internalizing goals and values (Deci and Ryan 2000). SDT suggests that a person may manifest a particular environmentally responsible behavior for external reasons, such as to receive a cash refund, or for internal reasons, like feeling s/he has protected the environment (Pelletier 2004 and Darner 2007). As with many human behaviors, pro-environmental behaviors are not necessarily intrinsically motivated (Osbaldiston and Sheldon 2003). Also, the notion of internal to external motivations for behaviors suggests a range of possibilities (Deci and Ryan 1985; Ryan and Deci 2000b), notwithstanding precluding the notion of amotivation (Pelletier et al. 1998, see below).

In brief, intrinsic motivation refers to an innate tendency to engage in a particular behavior (Deci and Ryan 1990), such that intrinsically motivated people act according to their personal choice and interests (Pelletier et al. 1998). In contrast, extrinsically motivated behaviors are stimulated by external or internal forces (Ryan and Deci 2000b), of which four main types are identified: integrated regulation, identified regulation, introjected regulation, and external regulation.

Integrated regulation refers to a behavior motivated from beyond the self that becomes an integral part of a person's self-concept (Pelletier et al. 1998). The person does not necessarily feel pleasure while performing such a behavior, but is happy to behave in that way (Ryan 1995). Some pro-environmental behaviors illustrate such integrated regulation (Osbaldiston and Sheldon 2003); for instance, recycling is not necessarily seen as an enjoyable environmental activity but many people recycle because it comes to illustrate their value system in practice (Darner 2009).

Identified regulation refers to behaviors regulated by an 'identification with' some- thing, one or other (Deci and Ryan 2004), in that it occurs when a person attributes value to the behavior and accepts it as personally important (Deci et al.

1991; Deci and Ryan 2004). The motivation behind the behavior is still categorized as extrinsic since the behavior is undertaken because of its perceived usefulness and importance (Deci et al. 1991). Integrated regulated behaviors are assumed to be more autonomous or self-determined because the activity is performed for personal reasons rather than external pressures (Deci et al. 1991). In contrast, introjected regulation occurs when the behavior is performed to avoid feelings of guilt, anxiety, or shame (Deci and Ryan 1990; Ryan and Deci 2000a). In essence, individuals perform the behavior because of a sense of internal coercion.

Finally, external regulation refers to the behaviors initiated by external outcomes such as rewards or punishment. External regulation is the least self-determined form of extrinsic motivation (Deci and Ryan 1990), and is often bracketed with the lowest level of self-determined motivation, amotivation; namely, the lack of intention to act (Deci and Ryan 2000; Pelletier et al. 1998). In essence, amotivated individuals deem an activity or behavior of little worth to their personhood and do not want to be active participants (Ryan 1995, Vallerand and Ratelle 2004). They may also feel not competent to take part in the activity (Pelletier et al. 1999).

To summarize, integrated regulation and intrinsic motivation are often grouped and termed self-determined motivation, while external, introjected, identified regulation, and amotivation constitute nonself-determined motivation (Deci and Ryan 1990). (However, in some studies, identified regulation, integrated regulation, and intrinsic motivation are accepted as forms of self-determined motivation, Ryan and Deci 2000a.)

According to Pelletier's (2004) studies of environmental activism, people exhibiting self-determined motivations towards addressing environmental issues act more voluntarily and maintain their behaviors into the longer term. These outcomes rely on the continued support given to meeting three basic psychological needs: namely, the need for autonomy, competence, and relatedness (Deci and Ryan 1990, 2000; Ryan and Deci 2000a). To clarify, the need for autonomy is related to the human need to feel one's actions are derived from self, not from an external force (Gagne and Deci 2005). The need for competence leads individuals to believe that they have the capacity to act and attain the goals of a particular behavior (Pelletier et al. 1999). (When the need for competence is not satisfied, individuals feel amotivated because of negative capacity beliefs and they may become helpless, see Pelletier et al. 1999). Finally, the need for relatedness represents the feeling of belonging to a group. Significantly, for the purposes of this study, relatedness refers to a tendency to feel connected to others (and can include the other-than-human), and a sense of security in one's community (Deci and Ryan 2004; Sheldon and Elliot 1999).

Again, according to Pelletier (2004), when these three needs are fulfilled, environmental self-determination might be fostered. While as Darner (2009) states, in EE classrooms, these three basic psychological needs may be supported in specific contexts to foster self-determined motivation toward pro-environmental behaviors. Nevertheless, Darner (2009) argues that it is not always obvious how this context can be created in EE classrooms, nor how other factors outside the classroom can affect self-determined motivation - be they those which obtain before, during, or after the EE course in question, or in other aspects of education in general.

SDT and pro-environmental behaviors

To be able to produce satisfactory solutions to environmental problems, it typically remains that motivation for participation in action is required. A key issue in the

field of EE is that knowledge of specific actions for the environment is expected to satisfy an individual's need for competence. That is to say, people should be aware of environmental behaviors and feel competent to activate pro-environmental behaviors (White 1959, Pelletier 2004). In some research, incentives do seem to be an effective method to encourage pro-environmental behaviors (Pelletier 2004). However, incentives often have only short-term effects and do not necessarily lead to long-term changes (Katzev and Johnson 1984). Some researchers, such as DeYoung (1986) and Srivastava, Locke, and Bartol (2001), have observed that when incentives (or reinforcements) are removed, people may quickly discontinue a pro-environmental behavior, while other studies suggest that individuals only maintain the behavior when they are self-determined to continue to behave pro-environmentally (Pelletier 2004). Therefore, in order to sustain pro-environmental behaviors into the longer term, students' environmental self-determination should be explored and supported (Darner 2007). Moreover, as Green-Demers, Pelletier, and Menard (1997) have found, the correlation between self-determined motives (intrinsic motivation, integrated regulation, and identified regulation) and the frequency of pro-environmental behaviors can be high, and that the more self-determined people are, the more frequently they demonstrate pro-environmental behaviors, and the less important the difficulty of the behavior is for them.

Stepping back, as noted above, it is important to recognize how self-identifying, social and contextual factors also affect self-determination and one's competence in relation to actions. Organizational features such as an institution's or community's approach to recycling, and the behaviors of others (e.g. teacher in a classroom, being part of an activist group) can influence satisfaction of basic psychological needs (Pelletier 2004). Equally, engaging others' concern about the environment supports people's need for relatedness (Pelletier 2004), while knowing and sharing which behaviors are pro-environmental and why they should be performed can assist people in feeling more competent and active for the environment (De Young 2000). Finally, Darner (2007) also points out that to foster motivation toward the environment, students should feel that they are cared for and connected to others; only in this way can they trust others in/while solving environmental problems.

Satisfaction of basic psychological needs in EE classrooms

Based on the above and related literature, we can identify key socio-contextual factors supporting basic psychological needs and leading to self-determined behaviors (Deci and Ryan 1990, 2000; Ryan and Deci 2000b; Sheldon and Elliot 1999). Such studies illustrate that satisfaction of one basic psychological need alone is not sufficient to foster self-determined motivation; rather, the three needs (competence, autonomy, and relatedness) should be supported (Deci and Ryan 2004). For instance, to satisfy need for autonomy, ideally individuals should be presented with choices and self-initiate the behavior (Deci and Ryan 2000; Deci et al. 1994). Environmental problem-solving activities and preparing environmental action plans may be effective since students can make their own decisions concerning what actions they should take for the environment instead of being told about what they should do (Darner 2007). Also, some instructional features can fulfill students' need for relatedness: for example, integrating group work, introducing environmental organizations, and working with model environmentalists, who share similar backgrounds with students and support the need for relatedness in the classroom (Darner

2007). Accordingly, determining which instructional features might foster self-determined motivation are a key focus of this paper.

Significance and purpose of the study

The purpose of this study then was to explore how PSTs' basic psychological needs are supported during an environmental science course based on SDT as a guide for the course activities. We tried to determine those features that contribute to satisfaction of the three basic psychological needs: competence, relatedness, and autonomy. Darner (2009) argues that these basic psychological needs should be satisfied in specific contexts which develop self-determined motivation toward pro-environmental behaviors since it is not possible to claim that general need satisfaction will motivate pro-environmental behaviors. This is because in some approaches to EE, behaviorist perspectives and positivist approaches are emphasized as sufficient for behavioral change-related pedagogies (cf. critique offered by Robottom and Hart 1995). However, according to Pelletier (2004), SDT identifies an important mediator between individuals' satisfaction, importance, perceived competence, and pro-environmental behaviors. Namely, if the goal is fostering actions for a more sustainable world, it is important to integrate environmentally responsible behaviors into considerations of people's lifestyles. SDT then, might reveal which social factors lead to such lifestyles (Pelletier 2004), while we might also analyze the instructional features of EE which support students' basic psychological needs to become self-determined toward pro-environmental behaviors (Darner 2007). Equally, teachers must understand which kinds of classroom environment lead students to become active players in their lifestyles and develop their own understandings about pro-environmental behaviors; and consequently, preservice and inservice professional development on these aspects might help play a critical role in educating environmentally concerned youth and adults (Disinger 2001).

Studies of efforts to improve teacher education to integrate EE into the K12 curricula are many and varied. They include Plevyak et al. (2001), who investigated the effectiveness of EE programs in teacher education, finding (perhaps unsurprisingly) that PSTs who engage in EE programs teach environmental issues more confidently than PSTs who do not participate in such courses. Furthermore, in the context of science education, EE can be used to incorporate a broad range of disciplines into lessons and make science more accessible, relevant, and meaningful to a wider group of students (Moseley, Huss, and Utley 2010). While if improving the quality and impact of EE is the goal, Pelletier (2004) recommends an experiential pedagogy with pro-environmental motivation as a focus, so that teachers might motivate others toward fostering pro-environmental behaviors.

General design

To investigate how PSTs' basic psychological needs might be satisfied during an environmental science course, multiple case studies were developed. Research was conducted in an environmental science course offered to PSTs in their fourth (senior) year of study, at a large public university in Ankara. We examined six weeks of a 13 week course, where each of the 6 course weeks was considered a case. In each case, PSTs discussed an environmental problem provided by the

authors of this study, and PSTs completed assignments for each week. From the 33 students (22 females and 11 males) who enrolled on the course, a focus group of five PSTs was formed (one volunteer from each group), to allow the researchers to investigate further how PSTs' basic psychological needs were supported. During the six weeks, data were collected from the focus group participants (all female) via multiple sources (interviews, group discussions, assignments, and reflections). Assignments were collected from the whole class but only the focus group members' assignments were examined in detail. Finally, at the end of the semester, the 33 PSTs prepared a capstone project in which they proposed their personal solutions to an environmental problem and wrote their reflections about their studies. Again, only the reflections of the focus group members were analyzed in detail. In addition to the interviews, audio recordings of group discussions, the assignments, reflections, and other quantitative measurements were also utilized to triangulate findings. As such, method triangulation was used to validate the data and analysis, on the understanding that using different measurements encourages the researcher to pursue 'repeat verification' (Miles and Huberman 1994).

Setting and case descriptions

The study was conducted in an environmental science course during the Fall semester of 2009–2010. Throughout the semester PSTs worked in small groups which had been formed at the beginning of the semester. The groups engaged with SDT-guided activities during the first six weeks, while the course as a whole lasted 13 weeks. Through the 6 weeks, the discussion part was mostly carried out by the first author, the course instructor, guided by the students. The topics covered in each week and the associated theme or title of the environmental problems are presented in Table 1.

Throughout the cases, most of the problems discussed by PSTs during the course were related to their local environment and their daily life situations. Using real life examples can motivate students more to take local actions (Unal 2008). According to Yin (2009, 18), research case studies that embrace important contextual conditions allow readers to understand real life phenomena deeply. Darner (2007) also argues that involving an out-of-school component that includes social groups interested in solving environmental problems can support students' needs for relatedness, when connections are made between environmental problems, everyday situations, and real life.

Throughout the cases, while discussing the problems, PSTs mostly tried to relate problems and solutions to their daily life and tried to give examples from their local environment. Each problem included questions asking about the reasons for the problem and possible solutions. There was a consistently positive group dynamic in the course as PSTs studied with the same group of friends and ideas were usually shared without hesitation. The purpose of fostering these particularly instructional features was to support PSTs' need for relatedness. Moreover, the instructor guided them rather than leading them during the discussions, and PSTs were given the chance to make their own decisions while completing their assignments and the final project. In this way, the activities were designed to satisfy PSTs' need for autonomy.

Six course weeks

Case 1

In the first week of the course, PSTs engaged with two problems: 'Easter Island' (Keller and Botkin 2008) and 'Environment vs. Economy' (Mckinney, Schoch, and Yonavjak 2007). The Easter Island problem introduced PSTs to an environmental disaster that occurred in the past and was chosen to help investigate the relationship between past and present. The problem encouraged the PSTs to consider how lessons might be learnt from past actions and behaviors, with the expectation that the same mistakes won't be made again. PSTs also discussed consumption of resources and their individualized roles in present-day consumption. The second problem built on and broadened out the latter consideration by confronting them with the economic and environmental concerns of today. At the end of the case, PSTs discussed how people can live in harmony without destroying nature and how sustainable living may be achieved. Their assignment for the week involved choosing an environmental problem causing environmental degradation and examining the problem critically. They were expected to feel a part of the problem and its possible solution, and thus explore how they would feel more competent to take action.

Case 2

In the second week, PSTs were presented with a pervsasive modern-day environmental problem, namely choices related to 'Paper vs. Plastic' (Mckinney et al. 2007). Students were invited to consider routine situations and think about whether, and to what degree, their everyday decisions are 'environmentally sound'. For example, they discussed consumption scenarios and considered which is more environmentally friendly, paper or plastic, through questions related to the problem (e.g. "You are at the grocery store and you are offered a choice of either a plastic or paper bag. Which one do you choose? Justify your answer"). A guest speaker from a local non-governmental organization then made a presentation to the group about how to prepare environmental action plans and worked through samples. PSTs prepared a group assignment about how they could encourage people to change their attitudes and behaviors toward paper and plastic choices and use. Again, they were expected to locate themselves and their role in this, and the effect of their daily decisions on the environment. Addressing their need for relatedness was also factored in by focusing on connectedness to their community via the guest speaker's presentation. Group discussions and assignment tasks were also heavily scaffolded to address autonomy and relatedness.

Case 3

In the third week, the PSTs discussed 'Why worry about extinction?' (National Geographic July 2009), to learn about endangered and extinct species in Turkey. Discussion focused on causes and what they could do to protect species. Discussions also addressed the values, and value, of environmental programs and organizations. Again, structuring the discussion of the problem this way was designed to help PSTs' understand how humans cause environmental problems but can also be involved in resolving them. The week's assignment required each student to investigate a case about biodiversity loss and examine the reasons and consequences of

the problem. Again it was assumed that developing this understanding and the earlier discussions would satisfy their need for competence.

Case 4

During the fourth week the PSTs examined examples of successful attempts to reduce ozone depletion (Keller and Botkin 2008). Success stories can be used to generate wider environmental interest and may make people feel more connected to positive actions. In this instance, the problem was designed to introduce a success story in which PSTs learnt about the harmful effects of ozone depletion and how these may be reduced via an agreement protocol, in this case, also amongst PSTs. As ozone depletion remains a problem, PSTs mostly discussed what they themselves could do to reduce ozone depletion in Turkey. (PSTs were not given an assignment this week.)

Case 5

The problem of the fifth week focused on the Ilısu dam project-Hasankeyf, in Batman, southeast Turkey. The case was prepared in light of documents provided by a non-governmental organization dealing with the conservation of nature in Turkey (Nature Society 2004–2012). PSTs discussed the value and effects of dams, exploring why they can be controversial. In particular, they discussed ecological, social, and economic consequences of dams, the pros and cons of their friends' ideas, and alternatives to dams. For their assignment, PSTs were invited to choose a question related to a water problem and investigate it (e.g. Appendix-B, Week 5). The tasks invited them to question what would be better for the environment with this problem, particularly in relation to energy consumption; and as with previous weeks, it was expected that group discussions and assignments addressed relatedness and competence needs.

Case 6

In the last of the 6 weeks, the PSTs were presented with the problem of the Mamak Garbage Dump, a large landfill site in Ankara, Turkey. Materials were derived from Internet sources, newspapers and magazines. PSTs discussed the effects of landfills on the environment and what they could do to reduce the amount of waste they produced each day. For their assignment, PSTs investigated solid waste management in their hometown and its environs. Their assignment was designed to increase awareness of waste problems in their community, and would also service their need for relatedness, including supporting them in feeling competent to take action.

Each case then represented a core process of discussing environmental problems and completing assignments. The framework for each problem started with questions concerning the reasons for the problem and possible solutions. During the six weeks, group discussions typically lasted about 20 minutes. After each discussion, each group shared their suggestions, ideas, and solutions with the other groups (via whole class discussion). The first author guided discussions only, rather than leading them. Assignments after a session also involved preparation for the next week's problem and discussion. At the end of the semester, each group prepared a final project in which they discussed their personal views on solutions to the

environmental problems which they identified as relevant to their community. The focus group members' project addressed food consumption at the campus. Finally, each student in the group wrote a reflection paper about their final project.

Data collection and analysis

The participants in this study were from the same department as the researchers, and thus this represents a convenience sample, with corresponding strengths and weaknesses. The bulk of the qualitative data were derived from participants' responses to seven interview questions previously prepared by Darner (2007) translated into Turkish by the authors. As different environmental problems were discussed each week, new questions related to the problems were asked and hence, the interview discussions and focus developed iteratively. To illustrate, PSTs were first asked questions about what they mostly discussed during each week, what helped them while solving the problem, or what they liked most during the discussions. (The interview protocol can be seen in Appendix A.) The environmental problems including questions, assignments, and reflection tasks were prepared by the first author of this study. Background material for the environmental problems was selected from a range of environmental science texts and Internet sources (e.g. Nature Society 2004–2012; Keller and Botkin 2008; Mckinney et al. 2007) and were regulated in accordance with the course catalog and syllabus. Before use, all activities were reviewed by three experts in science education.

We utilized open coding and constant comparative methods as initially suggested by Glaser and Strauss's (1967) work on Grounded Theory, to analyze the qualitative data. Open coding starts with dividing data into small units and assigning codes to emergent themes (Creswell 2007). With regard to constant comparative procedures, each incident in the data was compared with other incidents to identify similarities and differences (Glaser and Strauss 1967). Strauss and Corbin (1998) recommend that literature be used as another source for codes and concepts, so in this case, we drew on examples related to SDT and relevant literature (Benabou and Tirole 2003; Darner 2007; Deci and Ryan 2004; Hohwy 2007; Pelletier 2004). All the data including interviews and group discussions were transcribed verbatim and analyzed each week, alongside assignments. Interview themes were crosschecked with the assignments and group discussions in order to validate the main data, primarily to investigate whether or not the same codes and categories emerged in these different data sources. Intercoder agreement was also checked, with two science educators examining the interview transcripts, producing 87% intercoder agreement.

Quantitative data were also collected from the PSTs via a daily need satisfaction scale (DNSS) developed by La Guardia et al. (2000) and modified for the classroom community by Darner (2007). The DNSS is a 7-point Likert scale ranging from 1 (not at all true) to 7 (very true). The scale consists of nine items in three dimensions namely; autonomy, competence, and relatedness subscales. It was administered three times during the study (after case 4, case 5, and case 6) to support the qualitative data. The reliability of the scale after these three administrations (DNSS1, DNSS 2, and DNSS 3) were found to be .65, .66, and .78, respectively.

Results

Quantitative results

The descriptive statistics for the DNSS scores are presented in Table 2. On a 7-point Likert scale, PSTs reported reasonable levels of autonomy, competence, and relatedness (i.e. basic psychological needs) after implementation of the last three cases. Throughout the three weeks, there were not sharp changes in their scores.

In order to investigate the relationship between the three basic psychological needs during the last three weeks, Pearson Moment Correlation was carried out. Preliminary analysis was performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity.

For the Ozone depletion week (case 4), there was a strong positive correlation between competence and relatedness, $r = .69$, $n = 27$, $p < .005$ and there was also medium positive relationship between autonomy and competence, $r = .39$, $n = 27$, $p < .005$.

For the Ilısu Dam Project (Hasankeyf) week (case 5), there was a strong positive relationship between competence and relatedness, $r = .75$, $n = 25$, $p < .005$.

For the Mamak garbage dump week (case 6), there was a strong positive relationship between competence and relatedness, $r = .73$, $n = 31$, $p < .005$.

Overall, the Pearson Moment Correlation results indicated that there was a positive correlation between competence and relatedness needs in all three course weeks.

Qualitative results

Eight codes and two categories emerged from the qualitative analysis. The codes and categories refer to evidence that seemed to support the meeting of PSTs' basic psychological needs. In other words, we tried to identify material in respondents' comments regarding whether their basic psychological needs were supported or not through the six cases. Four of the codes (collective construction of ideas, student guided discussion, real life connection, and consistent group dynamic) were named in light of Darner's (2007) study since there were representative interpretations in students' discussions and interviews for these four codes. The remaining four codes (sense of confidence in action, sense of self-initiation, awareness of personal role in the system, and awareness of environmental actions) were newly emergent during the analysis and they were named based on the relevant literature (Benabou and Tirole 2003; Deci and Ryan 2004; Hohwy 2007; Pelletier 2004). The codes and categories are summarized in Table 3 and the descriptions of codes are presented in Table 4.

Cognitive features

Four of the codes - sense of confidence in action, sense of self-initiation, awareness of personal role in the system, and awareness of environmental actions - were assigned to an overarching category of cognitive features because all these codes address cognitive structures. It was assumed that when these features were activated during the discussions, students' basic psychological needs could be satisfied. Table 5 presents sample excerpts from interview data for each code under each category.

Sense of confidence in action. This code title reflects the self-confidence explanations of Benabou and Tirole (2003) and Deci and Ryan's (2004) descriptions, namely, that 'need for competence refers to a sense of confidence and effectance in action rather than an attained skill or capacity.' In effect, if students feel confident about engaging in a task, they may choose to participate in a related behavior and their sense of competence is satisfied. For example, one of the questions in the third week's problem was 'What would you do to save species?' PST1 explained in the interview:

> Actually, I do not believe I would act on my own. I think many people do not take action because they do not believe it worthwhile, but after taking this course, I became more sensitive to the environment. I believe that I can do something so when I am confronted with a problem like that, I can take the next step and try to do something.

In the fourth case, on ozone, participants stated that they could change their habits and they could contribute to behaviors that sought to reduce emissions or effects of chlorofluorocarbons. They felt more confident since they were introduced to a success story, and they believed that they could take action for the environment. Thus, with this feeling of more confidence, their need for competence was also addressed.

Sense of self-initiation. Sense of self-initiation is not an externally initiated movement, rather it is traced to the self (Hohwy 2007). Feeling a sense of initiative supports individuals' need for autonomy since their behavior does not come from an external force (Deci and Ryan 2004). During the interviews and group discussions, participants stated that they wanted to initiate some actions. For instance, in the first case, when asked what was their most favorite part of the case, PST2 said: 'It was nice to recognize something from my life in this case. Actually I was aware and I could warn people in my community.' In the third week, when asked what they could do to protect the species, PST1 commented:

> I would start to organize my closest friends and we would take action. You could not do so many things as an individual and it is difficult to overcome companies. But we should do something to make people aware. We can initiate an organization.

In the sixth case, during the group discussions, one of the respondents mentioned her response would be to write some statements about waste and hang them on her apartment wall as a prompt for action. Cumulatively, we note that by this point, PSTs were showing they felt themselves to be more willing to take initiative and they showed greater levels of willingness to act for the environment. Thus, we conclude their need for autonomy was being addressed because they were making their own decisions about how to act for the environment, rather than rely on an authority figure telling them what they should do.

Awareness of personal role in the system. This code title reflects Darner's (2007) account of when individuals identify their own role in contributing to an environmental problem, coupled with their feelings of competency to solve the problem. We assumed that when PSTs realized or were aware of their own role in the system, rather than feel amotivated they might feel more competent to solve the problem. Therefore, this code refers to examples of increases in individuals' awareness of their role in the outcomes and the solutions of the problem. For instance, in

the fifth case, PST2 mentioned that her awareness started to increase during the discussions. She said:

> We started to be conscious after the course. Yeah, our awareness of environment increased. After that, I am thinking when I hear these issues, I try to make my own inferences, such as would it be better if it is not like that?

In the group discussion for the fifth case, the focus group members broached what could be done to protect the environment and history of Hasankeyf. They mentioned: 'the area should be declared as a naturally protected area and media should be utilized to increase public awareness. If we conserve historical places, then species living there will be conserved too, because this place is their environment.' In the second week, PST5 stated that her awareness increased, saying: 'After this issue, I became more conscious. Whenever I consume something, I am telling myself whether I can use it more than one time or if I can reuse them. I think my awareness has increased even in one week.' Group discussions also tackled their personal roles. For example, PSTs said that they should reduce usage of too much plastic and they could use more reusable bags at the markets, expressing the view that if people changed their habits, then this problem could be solved. Assignments also revealed that PSTs were aware of their role in the system because they knew that the most important reason for the problems was human choices. For instance, PST4 explained in her third assignment:

> We, as the inhabitants of this planet, should be very careful. We should know what we can do to stop giving harm to the species and we should protect them before they are gone. Firstly, we should be aware of the importance of biodiversity which shows that every species in the nature has a value.

In terms of data for this code, it can be inferred that their need for competence was satisfied as they learnt their role in this complex system, and when they began to explore solutions for the environmental problems.

Awareness of environmental actions. When individuals get more information about issues regarding the environment and are more aware of the problems, they feel less satisfied with the environmental conditions. Hence, they indicate more pro-environ- mental behaviors and have lower level of self-determined motivation (Pelletier 2004). During the six weeks, some environmental organizations and activities were introduced to PSTs in the course of finding solutions to the problems. Respondents in their interviews and group discussions stated that their awareness of some environmental actions had increased. In the second week, PST1 explained this situation well in her interview:

> We were greatly influenced by the presentation (guest speaker's presentation). When we learnt about action planning as the guest speaker explained, we wanted to make such a plan. We had some plans and I hope they will become real. I think we will do something.

Increase in their awareness of action plans initiated them to act for the environment. While, in the fourth case, PSTs pointed out that they were influenced by the story, in that the success story encouraged them to change their habits for the environment, and thus, their need for relatedness was more likely to be satisfied.

Instructional features

Four codes - collective construction of ideas, student guided discussions, real life connection, and consistent group dynamics - were related to the instructional design of the course and are termed, instructional features. Whether the material gathered here also supports PSTs' basic psychological needs is also explored.

Collective construction of ideas

This code refers to mixing ideas together and deriving one single idea; in other words, students examine a range of solutions and propose a shared solution to the problem (Darner 2007). This feature speaks to students' need for relatedness, and material from almost each week could be coded here. In general, PSTs explained that they listened to all of the ideas in their group and made their decision together, emphasizing that group work was very effective for developing their learning. For instance, in the first case, PST2 said: 'Studying with friends is very effective. One of our friends may clarify the thing which I did not know and thus, we complete each other.' As they mostly learnt from each other, need for autonomy may also be satisfied. In the second case, when asked what helped them while solving the problems, PST5 offered:

> We are learning by supporting each others' ideas. I mean when one of us makes a comment, other ideas come to our mind. We combined all of these ideas. Of course, each of us contributed to the solution of the problem. One's ideas encouraged others' ideas and led to thinking different opinions. This process continued in every question.

Thus, PSTs pointed out that they collectively constructed ideas and produced a shared solution to the problem they discussed. Focus group discussions also revealed that they shared their ideas together and made their final decisions.

Real life connection

One of the social elements highlighted in Darner's (2007) study is 'real life connection' in socioscientific investigations, to highlight the significance of environmental problems mostly encountered outside the classroom context. In this study, the problems presented in the classroom were selected to connect to PSTs' real life and encourage 'real world' learning. PSTs quickly realized the connections between the problems and everyday situations, and during the interviews, emphasized that while most of the problems were connected to the real world, they now felt more capable of finding solutions. For instance, when asked what they liked during the discussions, PST4 commented like that: 'I like the kinds of cases which are from real life. I support case studies in the course. They lead people to brainstorming solutions.' Moreover, in the fourth case, during the group discussions, they connected the ozone problem to their lives and they discussed basic solutions to reducing ozone depletion. In the assignments, they also gave examples from their everyday lives, as PST1 explained in her fourth assignment (about water pollution):

> There are some kinds of rags which don't require detergent for cleaning. It requires more physical effort but it works efficiently as a detergent. We have this kind of rag in our home. Carbonates can be used as bleacher. Still, sometimes I use it for my

> teeth. They can be used in other cleaning processes. Moreover, we can choose cleaners which include less phosphate and trichlorasan because trichlorasan in detergent reacts with chlorine in water and forms chloroform, which is toxic, and these kind of detergents are sold in Turkey.

In sum, she was aware of her role and she presented solutions related to her life. In so doing, her need for relatedness was expressed and as she could suggest solutions, she could also feel more competent.

Student-guided discussion

This code was adapted from Darner's (2007) study in which she used the category of student-guided lecture. In student-guided discussion, most of the information is derived from the students not the instructor, therefore, their need for autonomy is supported (Darner 2007). PSTs mostly explained that they liked the discussion part of the course as it contributed to their learning and this feature was realized in almost all weeks. For instance, in the first week when asked what their favorite part was in this week, PST4 said in her interview: 'After the (group) discussions finished, each group presented their ideas and these ideas were integrated to other ideas. This was enjoyable.' Moreover, she added: 'We learn different opinions and there may be people who think differently. I mean that this kind of socialization in the class is more enjoyable and useful.' Her comments indicated that this kind of instruction style supported the PSTs' need for autonomy and relatedness. While in the third week, when asked what helped them while solving problems, PST5 commented:

> The instructor and your comments and also my group mates' comments helped me with solving the problem. One of my group mates explained that eucalyptus trees are threatening some species in their surroundings because they are using so much water. I learnt this from my friends. It was beneficial to me.

PSTs often expressed that they learnt from each other during the discussions and this helped them discuss problems in a more effective way. They felt also more satisfied in their discussions about the environment because they could make their own decisions and their decisions were not controlled by 'outsiders'. Moreover, most of the information was derived from the students not from the instructor (Darner 2007). Therefore, it can be inferred that their need for autonomy was more likely to be supported.

Consistent group dynamic

Consistent group dynamic was determined as the primary characteristic of the focus group in Darner's (2007) study. This feature refers to a sense of belonging to a group and therefore, it more likely supports students' need for relatedness (Darner 2007). This feature may also foster PSTs' need for competence because group friends allow each other to share ideas while solving the problems. If they felt a lack of relatedness, they would not share their ideas (Darner 2007). During the interviews, PSTs often explained that they shared their ideas easily in the group, as PST1 said in her interview: 'I do not hesitate about telling my ideas in the group

because we are in a group of friends. I know that people will not find my ideas as ridiculous.'

When asked whether there was anything they hesitated about contributing, they said they did not because they thought it was out of place. On this question, PST5 offered the following in her interview in the sixth week; 'No, nothing. If there is something like that, we just laugh together. We can tell everything in the group. After that, we continue discussing different things about the issue.' In sum, the respondents generally emphasized that they could express their ideas easily in the group. Therefore, it can be said that their need for relatedness and competence was satisfied.

All the assignments which participants completed in each week were related to their real life and they were likely to support PSTs' basic psychological needs. PSTs also expressed that their awareness of their role increased, thanks to their assignments, and they realized that they may be part of the solutions. Therefore, their need for relatedness and competence was more likely fostered in these course weeks.

In Table 6, the frequency numbers of codes and categories emerged during the analysis in each course week are shown. The codes found most frequently in the analysis were awareness of personal role, sense of self-initiation, awareness of environmental actions, collective construction of ideas, student guided discussion, and real life connection. These codes indicate evidence of the satisfaction of basic psycho- logical needs throughout the six weeks. In the first weeks of the course, PSTs did not believe themselves to be competent to act for the environment but, they began to feel more confident in the following weeks. They started to question the frequency and extent of their pro-environmental behaviors during the discussions, their awareness of their role increased, and they felt more self-determined toward the environment.

Furthermore, by the time of the final project, their reflections also demonstrated that their basic psychological needs were supported, with material coded to: awareness of personal role in the system, sense of confidence in action, consistent group dynamic, and collective construction of ideas. The focus group members. For example, studied nonorganic food consumption on campus. They investigated how campus residents might be encouraged to consume organic food. Afterwards, each group member evaluated their project through a whole group rubric and they wrote a reflection paper. PST5 wrote:

> In my opinion, our project may be useful to solve this problem because our actions can be shown to be very effective solutions to the problem. If all these actions are performed organic food consumption will increase in the campus.

In effect, the PSTs understood their role in the system. Moreover, as PST1 stated: 'We believe that we are aware of the importance of the issue. Because of this, we can make decisions easily, take actions and work together beneficially even we present different ideas.' They also stated that they liked studying with the same group in the project. They liked sharing their opinions with the group members and they learnt from each other. Thus, it can be inferred that their need for competence, autonomy, and relatedness was satisfied during the project work.

Discussion

This paper aimed to explore how PSTs' basic psychological needs fostering their self-determined motivation toward the environment were fulfilled during an environmental science course. Qualitative results revealed that supporting cognitive and instructional features during the course may satisfy PSTs' basic psychological needs. Eight codes and two categories emerged during the analysis and provide evidence as to whether or not PSTs' basic psychological needs were supported.

'Sense of confidence in action' did not emerge in the first two weeks of the course. Rather, PSTs maintained that they could not change the current situation. Deci and Ryan (2004) reported that a sense of competence represents feeling effective and confident in taking action. Feeling confident can take time; solving the problems presented in the course may support PSTs' need for competence but not from day 1. Equally, at the time, PST1 stated that she did not think that she could be effective on her own but, if she could increase other people's awareness in her community and if she could get support from them, then she could address the problem. It can be inferred that PST1 needs other peoples' support to act for the environment. That is, her sense of relatedness should be satisfied in order to feel a sense of competence.

Darner (2007) expressed that there is a positive relationship between sense of relatedness and competence. If a person's need for relatedness is not fulfilled, the person will not want to engage in activities (Deci and Ryan 2004). The quantitative findings of this study also supported this finding. It was found that there was a positive relationship between need for competence and relatedness. Throughout the process of working through how to solve environmental problems, PSTs believed that they could take action to protect the environment and they proposed their own solutions. They also expressed that their awareness was increased during the discussions. They realized that they could make an effort to solve the environmental problems and they comprehended that environmental actions and organizations may be effective in solving problems. For instance, PST2 said that through the Easter Island case, they realized that they were living in a comparable situation today and there was a connection between this case and the present.

Deci and Ryan (1990) reported that it is important that students perceive the problem or the situation as solvable and there must be a social situation supporting all their basic psychological needs. As the course progressed, PSTs increasingly realized that people can find solutions to environmental problems and felt more competent to act for the environment. To facilitate this, PSTs learnt about environmental actions and organizations in their community and their awareness of these organizations increased. When individuals perceive that people around them are concerned about the environmental issues and care about the problems, their amotivation toward the environment reduces and their environmental awareness and need for competence increases (Pelletier 2004; Pelletier et al. 1999). If individuals believe that some environmental actions are effective to solve environmental problems, their need for relatedness and competence may be supported. PSTs felt more competent when they learnt about environmental actions in their community.

Deci and Ryan (1990) also argued that only feeling competent is not sufficient to fostering self-determined motivation; individuals should also feel autonomous. Quantitative findings revealed that there was a positive relationship between PSTs' need for autonomy and competence, while satisfaction with their sense of self-initiation revealed that PSTs felt more autonomous.

It was argued earlier that when individuals' behavior is derived from self rather than outside factors, they feel more initiative (Deci and Ryan 2004) and their need for competence is more likely to be fostered. Some of the participants stated that they wanted to take action to protect the environment. For instance, in the third week, PST1 said that she would start to organize her close friends and they would take action. This illustration of 'sense of self-initiation' emerged in the first week and continued to appear in other weeks excluding the fourth week. Through the weeks, they also started to decide what is better for the environment. As Darner (2007) stated, the more students focus on what is better for the environment, the more self-determined they feel toward the environment, which again shows that their basic psychological needs are supported.

'Awareness of personal role in the system' emerged in almost all weeks of the course. PSTs expressed that their awareness increased while solving the problems. For instance, PST2 made an explanation in the fifth week interview:

> We started to be conscious after the course. Yeah, our environmental awareness increased. After that, I am thinking when I hear these issues. I try to make my own inferences so that would it be better what if it is not like that.

In group discussions for the fifth week, they also stated what they could do to protect the history and environment of Hasankeyf. They commented that the area should be declared as a naturally protected area and the media should make efforts to increase public awareness. Hence, they tried to produce solutions to the problem.

When individuals are aware of their internal conditions, feelings, values, and desire, they can make their own decisions and choices (Ryan and Deci 2008). After they realized their personal role in the problems, they began to consider what actions may be better to protect the environment. In this manner, their need for competence and autonomy was more likely to be supported.

Furthermore, this study revealed that some instructional features also satisfied PSTs' basic psychological needs. For instance, most of the participants stated that the environmental problems given in the course were related to their life and thus, helped their learning. When real life examples are given to students, they feel more motivated to take action for solving these problems (Unal 2008). Material coded to 'real life connection' emerged in all of the course weeks, while Darner (2007) reported that dealing with environmental problems which students may encounter outside the classroom can support students' need for relatedness and develop environmental self-determination.

'Collective construction of ideas' and 'student-guided discussion' which were other codes in the instructional features category occurred in almost each week and, consistent group dynamic was often apparent. During the discussions, they collectively constructed the ideas and suggested solutions to the problem. For example, PST2 said about the first week; 'Studying with friends is very effective. One of us explains something which we did not know and we complete each other in this way.' During the group discussions, group members often helped each other devise solutions to the problems collectively. This process helped the group devise solutions to the problems rather than just choosing the best idea.

Darner (2007) pointed out that collective construction of ideas satisfies individuals' basic psychological needs. More specifically, group work developed a connectedness between students and fulfilled their need for relatedness. Claxton (2002)

reported that individuals' need for relatedness is satisfied when they work in a group in which a learning community and collaboration are built through a group problem-solving activity, as cited in Darner (2007). Also, PSTs' need for autonomy was satisfied since they made their own decisions and choices and they learnt from each other. Participants also commented that all of the class discussions were both enjoyable and informative for them.

Other codes which represent whether individuals' basic psychological needs were supported are 'student-guided discussion' and 'consistent group dynamic' again. According to Darner (2007), student guided lecture supports students' need for autonomy since the information is mostly derived from students not from the instructor. In the present study, PSTs' need for autonomy and competence was more likely to be fulfilled because they stated that group discussions helped them share their ideas and make effective contributions for the solutions to the problems. Quantitative data revealed that there was a positive relationship between competence and relatedness. This finding was also supported with qualitative data. As they collectively constructed ideas, they learnt much from each other and they considered that they made effective contributions. This finding was more certain in the reflection papers. For example, PST4 said in her reflection paper written after the final project: 'As a group, we made effective contributions. Every group member had a different way of thinking and this helps us get more ideas about the project.' PST2 also said similar things: 'Having different perspectives in our group helped us produce solutions more and more. I know that these perspectives enable us to recognize interdependence in the systems.' Group discussions helped them learn from each other and produce effective solutions. Thus, their need for relatedness and competence was more likely satisfied.

The consistent group dynamic also satisfied their need for relatedness. For example, PST1 described this situation in a good way: 'There wasn't any time when my suggestions were not considered. It is a really warm environment. We all say everything without hesitation.' Darner (2007) claimed that working in the same group throughout the whole course can support students' need for relatedness. It can be inferred that participants of this study did not hesitate to share their ideas in the group and they expressed that group discussions are effective to develop their learning. Hence, it is more likely that their need for relatedness was satisfied.

Working on assignments and the final project also supported PSTs' basic psychological needs. These kinds of activities allow students to decide what is better for the environment and produce effective solutions and thus satisfy their need for autonomy (Darner 2007). With regard to the final project, they proposed their own solutions and actions for an environmental problem which they chose. In one of the reflection papers, PST3 made some interpretations about their final project. As noted above, they believed that they could produce effective solutions for the environmental problems and became a part of the solution. Hence, their need for autonomy and competence was more likely to be supported.

Conclusion and implications

This study illustrates how environmental science course activities can support PSTs' basic psychological needs. If cognitive features and instructional features are developed during a course, it is possible to satisfy PSTs' basic psychological needs and thus, to develop environmental self-determination. In this regard, SDT proposes a

crucial framework in the development of pro-environmental behaviors (Pelletier 2004).

The findings of this study have implications for EE researchers, teachers, and curriculum developers. What shapes pro-environmental behaviors is considered a complex process; also, it is difficult to explain pro-environmental behaviors with one framework (Kollmuss and Agyeman 2002). In this paper, we have examined how environmental self-determination, which is an internal factor affecting environmentally responsible behaviors, may be fostered in the classroom. Various features which foster basic psychological needs leading to self-determined motivation were explored in relation to 6 weeks of an environmental science course. These cognitive and instructional features may be integrated into EE classrooms in order to motivate self-determined pro-environmental behaviors (Darner 2009). In EE classrooms, problem-solving activities may be used more frequently and a warm classroom community may be encouraged in which students support each other and work in collaboration. Some environmental actions may be introduced to students so that they can learn about the environmental activist groups and environmental organizations in their community. While sources of influence on their motivation toward the environment and the fostering of self-determination to take action for the environment (Pelletier 2004) can also be explored.

Our ultimate purpose as environmental educators is to develop long-lasting pro-environmental behaviors. This means that individuals' environmental self-determination should be developed. For instance, a person may occasionally participate in carpooling in her or his lifestyle. However, it will be better when this person uses carpooling regularly in her or his life because of intrinsically motivated factors (Osbaldiston and Sheldon 2003). Moreover, in terms of teachers' professional development, PSTs can be taught how to support autonomy amongst their learners. In an environmental education context, teachers play a critical role in educating children to be more motivated toward the environment and exhibit pro-environmental behaviors. Creating a SDT-guided classroom environment allows students time for independent work and constructing student-guided discussions may be a positive example for PSTs (Reeve 2004). Hence, empirical investigations in terms of SDT framework in EE should be increased in order to further explore how individuals' basic psychological needs are supported so that environmental self-determination can be fostered.

Concluding comments: limitations and future studies

There are some limitations of this study that should be recognized. First, the data of the study were limited to the comments of the participants, discussions, assignments, reflections, and environmental problems given in the course. In order to understand better whether students' basic psychological needs were supported or not, different environmental courses including various environmental problems and assignments should be investigated. Second, the results of this study were limited to the contexts and design of the study; therefore, generalizing to different contexts and other cases should be treated with caution. Lastly, in this study, some environmental problems related to course topics were discussed. In further studies, other environmental concerns such as deforestation and alternative energy could be utilized in the environmental classrooms. PSTs might also be followed into their careers, to investigate whether or not they participated in environmental actions beyond the course.

SDT has been studied for 30 years in many different areas (Vansteenkiste and Sheldon 2006). However, the EE context is under-researched in terms of SDT. Longitudinal and further studies are recommended to see the wider effects of self-determined motivation on pro-environmental behaviors, including the effects of classroom instructional designs, and the role of other factors, including lifestyle. Also, noting that in this study the participants were PSTs, students could be encouraged to choose environmental problems that interest them from global to local environmental contexts to further support their need for autonomy.

The study largely examined basic psychological needs of PSTs qualitatively. In future studies, PSTs' environmental self-determination and its influence on actual pro-environmental behaviors could be investigated both quantitatively and qualitatively, with a diversity of methods. As a follow-up study, PSTs who participated might also be observed in their teaching so that it can be understood if their feelings of self-determination (or not) translate or match those they use as strategies to motivate their students.

Finally, the codes and categories that emerged in the study can be treated as observation-based hypotheses to be tested with a larger number of students (who are not from the current focus group or cohort, or context). Such an approach to the presentation of the findings could help educators better understand why the phenomena observed here may or may not be observed in comparable contexts.

Notes on contributors

Güliz Karaarslan is a PhD student and research assistant at the elementary education department of Middle East Technical University, Turkey. Her main research interest is environmental education.

Hamide Ertepınar is a professor at the elementary education department of Istanbul Aydin University, Turkey. She received her PhD (1985) in chemistry from Middle East Technical University. Her main research interests are students' conceptions of science, misconceptions in chemistry and science education, and conceptual change and environmental education.

Semra Sungur is an associate professor at the elementary education department of Middle East Technical University, Turkey. She received her PhD (2004) and MS (2000) in secondary science and mathematics education from Middle East Technical University. Her main research interests are problem-based learning, self-regulation, and constructivism.

References

Benabou, R., and J. Tirole. 2003. Intrinsic motivation and extrinsic motivation. *Review of Economic Studies* 70: 489–520.

Claxton, Guy. 2002. Education for the learning age: A socio-cultural approach to learning to learn. In *Learning for life in the 21st century*, ed. G. Wells and G. Claxton, 19–33. Malden, MA: Blackwell.

Creswell, John W. 2007. *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Darner, R. 2007. The use of self-determination theory to foster environmental motivation in an environmental biology course. PhD diss., University of California.

Darner, R. 2009. Self-determination theory as a guide to fostering environmental motivation. *The Journal of Environmental Education* 40, no. 2: 39–49.

De Young, R. 2000. Expanding and evaluating motives for environmentally responsible behaviors. *Journal of Social Issues* 56, no. 3: 509–26.

Deci, E.L., H. Eghrari, B.C. Patrick, and D.R. Leone. 1994. Facilitating internalization: The self-determination theory perspective. *Journal of Personality* 62: 119–42.

Deci, E.L., and R.M. Ryan. 1985. *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum Pres.
Deci, Edward L., and Richard M. Ryan. 1990. A motivational approach to self: Integration in personality. In *Nebraska Symposium on motivation: Vol. 38. Perspectives on motivation*, ed. R. Dienstbier, 237–88. Lincoln, IN: University of Nebraska Press.
Deci, E.L., and R.M. Ryan. 2000. The 'What' and 'Why' of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry* 11, no. 4: 227–68.
Deci, E.L., and R.M. Ryan. 2004. Overview of self-determination theory: An organismic dialectical perspective. In *Handbook of self-determination research*, ed. M.R. Ryan and E.L. Deci, 3–33. Rochester, NY: University of Rochester Press.
Deci, E.L., R.J. Vallerand, L.G. Pelletier, and R.M. Ryan. 1991. Motivation and education: The self-determination perspective. *Educational Psychologist* 26, no. 3&4: 325–46.
DeYoung, R. 1986. Encouraging environmentally appropriate behavior: The role of intrinsic motivation. *Journal of Environmental Systems* 15: 281–92.
Disinger, J.F. 2001. K-12 education and the environment: Perspectives, explanation and practice. *The Journal of Environmental Education* 33, no. 1: 4–11.
Erdogan, Mehmet. 2007. An analysis of newly developed fourth and fifth grade science and technology curriculum; A qualitative study. *Journal of Turkish Educational Sciences* 5, no. 1: 221–59.
Erdogan, M., Z. Kostova, and T. Marcinkowski. 2009. Components of environmental literacy in elementary science education curriculum in Bulgaria and Turkey. *Eurasia Journal of Mathematics, Science & Technology Education* 5, no. 1: 15–26.
Finger, M. 1994. From knowledge to action? Exploring the relationships between environmental experiences, learning and behavior. *Journal of Social Issues* 50: 141–60.
Gagne, M., and E.L. Deci. 2005. Self-determination theory and work motivation. *Journal of Organizational Behavior* 26: 331–62.
Glaser, G.B., and A.L. Strauss. 1967. *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine.
Green-Demers, I., L. Pelletier, and S. Menard. 1997. The impact of behavioral difficulty on saliency of the association between self-determined motivation and environmental behaviors. *Canadian Journal of Behavioral Sciences* 29, no. 3: 157–66.
Hines, J.M., H.R. Hungerford, and A.N. Tomera. 1986–1987. Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education* 18, no. 2: 1–8.
Hohwy, J. 2007. The sense of self in the phenomenology of agency and perception. http://www.theassc.org/files/assc/2668.pdf (accessed May 23, 2010).
Hsu, S.J., and R.E. Roth. 1999. Predicting Taiwanese secondary teachers' responsible environmental behavior through environmental literacy variables. *The Journal of Environmental Education* 30, no. 4: 11–8.
Hungerford, H.R., and T.L. Volk. 1990. Changing learner behavior through environmental education. In *Essential readings in environmental education*, ed. H.R. Hungerford, W.J. Bluhm, T.L. Volk, and J.M. Ramsey, 289–304. Champaign, IL: STIPES.
Katzev, R.D., and T. Johnson. 1984. Comparing the effects of monetary incentives and foot in the door strategies in promoting residential electricity conservation. *Journal of Applied Psychology* 14: 22–7.
Keller, E.A., and D.B. Botkin. 2008. *Essential environmental science*. Hoboken, NJ: John Wiley.
Knapp, D. 1997. Twenty years after Tbilisi: UNESCO interregional workshop on reorienting environmental education for sustainable development. *NAI's Environmental Education Newsletter* 1, no. 1: 6.
Kollmus, A., and J. Agyeman. 2002. Mind the gap: Why do people act environmentally and what are barriers to pro-environmental behavior? *Environmental Education Research* 8, no. 3: 239–60.
La Guardia, J.G., R.M. Ryan, C.E. Couchman, and E.L. Deci. 2000. Within person variation in security of attachment: A self-determination theory perspective on attachment, need fulfillment, and well-being. *Journal of Personality and Social Psychology* 79: 367–84.

Marcinkowski, T.J. 2010. Contemporary challenges and opportunities in environmental education: Where are we headed and what deserves our attention. *The Journal of Environmental Education* 41, no. 1: 34–54.
McKeown, R., and C. Hopkins. 2005. EE and ESD: Two paradigms, one crucial goal. *Applied Environmental Education and Communication* 4: 221–4.
Mckinney, L.M., R.M. Schoch, and L. Yonavjak. 2007. *Environmental science systems and solutions*. 4th ed. Sudbury: Jones and Bartlett.
Miles, M.B., and A.M. Huberman. 1994. *Qualitative data analysis: An expanded source book*. Thousand Oaks, CA: Sage.
Moseley, C., J. Huss, and J. Utley. 2010. Assessing K–12 teachers' personal environmental education teaching efficacy and outcome expectancy. *Applied Environmental Education and Communication* 9: 5–17.
Nature Society. 2004–2012: Hasankeyf yok olmasin. http://www.dogadernegi.org/index.php.
Osbaldiston, R., and K.M. Sheldon. 2003. Promoting internalized motivation for environmentally responsible: A prospective study of environmental goals. *Journal of Environmental Psychology* 23: 349–57.
Oskamp, S. 1995. Resource conservation and recycling: Behavior and policy. *Journal of Social Issues* 51, no. 4: 157–77.
Ozgelen, Sinan, and Ozgul Yilmaz-Tuzun. 2007. Preservice science teachers' perceptions about science process skills and their practices. Paper presented at the 84th Annual American Educational Research Association, April 15–18, in Chicago, IL.
Pelletier, L.G. 2004. A motivational analysis of self-determination for pro-environmental behaviors. In *Handbook of self-determination research*, ed. R.M. Ryan and E.L. Deci, 205–32. Rochester, NY: University of Rochester Press.
Pelletier, L.G., S. Dion, K. Tuson, and I. Green-Demers. 1999. Why do people fail to adopt environmental protective behaviors? Toward a taxonomy of environmental amotivation. *Journal of Applied Social Psychology* 29, no. 12: 2481–504.
Pelletier, L.G., K.M. Tuson, I. Green-Demers, K. Noels, and A.M. Beaton. 1998. Why are you doing things for the environment? The motivation toward the environment scale (MTES). *Journal of Applied Psychology* 28, no. 5: 437–68.
Plevyak, L.H., M. Bendixen-Noe, J. Henderson, R.E. Roth, and R. Wilke. 2001. Level of teacher preparation and implementation of EE: Mandated and non-mandated EE teacher preparation states. *Journal of Environmental Education* 32: 28–36.
Reeve, J. 2004. Self-determination theory applied to educational settings. In *Handbook of self-determination research*, ed. R.M. Ryan and E.L. Deci, 205–32. Rochester, NY: University of Rochester Press.
Robottom, I., and P. Hart. 1995. Behaviorist EE research: Environmentalism as individualism. *Journal of Environmental Education* 26, no. 2: 5–10.
Ryan, R.M. 1995. Psychological needs and facilitation of integrative processes. *Journal of Personality* 63, no. 3: 397–427.
Ryan, R.M., and E.L. Deci. 2000a. Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. *American Psychologist* 55, no. 1: 68–78.
Ryan, R.M., and E.L. Deci. 2000b. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology* 25: 54–67.
Ryan, R.M., and E.L. Deci. 2008. Self-determination theory and the role of basic psychological needs in personality and the organization of behavior. In *Handbook of personality*, ed. O.P. John, R.W. Robbins, and L.A. Pervin, 205–32. New York, NY: The Guilford Press.
Sato, Masahisa. 2006. Evolving environmental education and its relation to EPD and ESD. Paper presented at the UNESCO Expert Meeting on Education for Sustainable Development (ESD): Reorienting Education to Address Sustainability, May 1–3, in Kanchanaburi, Thailand.
Schmidt, K.F. 1996. Green education under fire. *Science* 274: 1828–30.
Seguin, C., L.G. Pelletier, and J. Hunsley. 1999. Predicting environmental behaviors: The influence of self-determined motivation and information about perceived environmental health risks. *Journal of Applied Social Psychology* 29: 1582–604.
Sheldon, K.M., and A.J. Elliot. 1999. Goal striving, need satisfaction, and longitudinal well-being: The self-concordance model. *Journal of Personality and Social Psychology* 76: 482–97.

Srivastava, A., E.A. Locke, and K.M. Bartol. 2001. Money and subjective wellbeing: It's not the money, it's the motive. *Journal of Personality and Social Psychology* 80: 959–71.
Stets, J.E., and C.F. Biga. 2003. Bringing identity theory into environmental sociology. *Sociological Theory* 21, no. 4: 398–423.
Strauss, A.L., and J.M. Corbin. 1998. *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage.
Tabernero, C., and B. Hernandez. 2011. Self-efficacy and intrinsic motivation guiding environmental behavior. *Environment and Behavior* 43, no. 5: 658–75.
Tbilisi Declaration. 1977. http://www.gdrc.org/uem/ee/tbilisi.html (accessed October 15, 2010).
Tuncer, G., C. Tekkaya, S. Sungur, H. Ertepınar, and M. Kaplowitz. 2009. Assessing pre-service teachers' environmental literacy in Turkey as a mean to develop teachers education programs. *International Journal of Educational Development* 29: 426–36.
Unal, N. 2008. Pre-service teachers' perceptions toward global versus local environmental issues. PhD diss., Middle East Technical University.
United Nations. 1992. *Chapter 36: Promoting education, public awareness and training. In Earth Summit: Agenda 21, The United Nations Programme of Action from Rio*. New York, NY: United Nations.
United Nations Educational, Scientific and Cultural Organization (UNESCO–UNEP) 1976. Environmental education newsletter. *Belgrade Charter* 3, no. 1: 1–10.
United Nations Educational, Scientific and Cultural Organization. 1987. *International congress on environmental education and training*. Moscow: UNESCO.
Vallerand, R.J., and C.F. Ratelle. 2004. Intrinsic and extrinsic motivation. A Hierarchical model. In *Handbook of self-determination research*, ed. R. Ryan and E. Deci, 37–63. Rochester, NY: University of Rochester Press.
Vansteenkiste, M., and K.M. Sheldon. 2006. There's nothing more practical than a good theory: Integrating motivational interviewing and self-determination theory. *The British Psychological Society* 45: 63–82.
White, R.W. 1959. Motivation reconsidered: The concept of competence. *Psychological Review* 66, no. 5: 297–333.
Yin, Robert K. 2009. *Case study research design and methods*. 4th ed. Los Angeles, CA: Sage.

Table 1. Course topics and environmental problems in each week.

Course weeks	Topics	Environmental problems
Week 1	Environmentalism and history of environmental science	Easter Island Environment vs. Economy
Week 2	Changing attitudes to the natural world	Paper vs. Plastic
Week 3	Conservation values and ethics; the value of biodiversity	Why worry about extinction?
Week 4	Air pollution	Reducing ozone depletion
Week 5	Water pollution	Ilısu Dam Project – Hasankeyf
Week 6	Soil pollution	Mamak Garbage Dump

Table 2. Descriptive statistics related to daily needs satisfaction scale (DNSS).

	M	SD	Min	Max
DNSS1	4.84	.70	3.89	6.33
DNSS2	4.78	.72	3.44	6.33
DNSS3	4.83	.89	2.11	6.00

Table 3. The codes and categories emerged from qualitative data.

Cognitive features	Instructional features
Sense of confidence in action	Collective construction of ideas
Sense of self-initiation	Student guided discussion
Awareness of personal role in the system	Real life connection
Awareness of environmental actions	Consistent group dynamic

Table 4. Descriptions of eight codes under two categories.

Cognitive features	Instructional features
Sense of confidence in action Sense of confidence in action fosters individual's motivation to act and it provides a complete interest to perform a task (Benabou & Tirole 2003)	*Collective construction of ideas* This code refers that the group examine all of the ideas together and devise a solution to the problem. By working together, students can collectively construct ideas that draw upon each student's perspective and they can learn different aspects of the problem from each other's comments (Darner 2007)
Sense of self-initiation Sense of self-initiation is coming from self, not an external force (Hohwy 2007) and feeling initiative supports need for autonomy (Deci & Ryan 2004, 7)	*Real life connection* When they think about what would be better for the environment in their daily life, they can feel self-determined toward pro-environmental behaviors and their basic psychological needs are supported (Darner 2007)
Awareness of personal role in the system When individuals are aware of their role in the system both as a problem creator and the solver, they could feel more competent to solve the problems (Darner 2007)	*Student guided discussion* Student guided discussion refers to whole class discussion in which students learn from each other and the instructor only guides them during the discussions. This feature mostly supports students' need for autonomy since the information mostly comes from students rather than instructor or an authority (Darner 2007)
Awareness of environmental actions When individuals are aware of some environmental organizations, programs, and the behaviors of other people in their community, their sense of relatedness may be supported (Pelletier 2004)	*Consistent group dynamic* When students study with the same group of friends, or a consistent group, their basic psychological needs are supported. This feature supports their need for relatedness because they feel a sense of belonging to the group of friends (Darner 2007)

Table 5. Sample excerpts from PSTs' interview transcripts.

Cognitive features Code label and sample excerpts	Instructional features Code label and sample excerpts
Sense of confidence in action (Case-3) PST1: Actually, I would not believe to act on my own. I think many people do not take action because they do not believe but, after taking this course, I became more sensitive to the environment. I believed that I can do something so, when I confronted with a problem like that, I can take step and I can try to do something	*Collective construction of ideas (Case-6)* PST3: We all have our own ideas and we evaluate our ideas. When someone says something, another relevant thing comes to other person's mind (in group discussions)

(*Continued*)

Table 5. (*Continued*).

Cognitive features Code label and sample excerpts	Instructional features Code label and sample excerpts
Sense of self-initiation (Case-2) PST2: When I listened about how to make an action plan from guest speaker, I thought that we could make this kind of plan, a campaign. Some people may be responsible for this work and using cloth bag may be widespread everywhere. We dreamed it. This dream may be real	*Student guided discussion (Case-5)* PST2: For me, the discussion was very exciting. (whole class discussion).We talked very much. One of the groups brought a different view. There was a really nice class atmosphere
Awareness of the personal role in the system (Case-2) PST5: After this issue, I became more conscious. When I consume something, I am saying that I can use this one more time and leaving it for reusing. I think my awareness increased even in one week	*Real life connection (Case-3)* PST4: I like these kinds of cases. I support case studies in the course. Especially, these cases are from real life and therefore, they are nice because they led people to make brainstorming. Therefore, I like this course
Awareness of environmental actions (Case-2) PST1: We were so much influenced by the guest speaker's presentation. When we learnt about action plans that he explained, we wanted to make a plan. We had some plans and I hope they will become real. I think we will do something	*Consistent group dynamic (Case-1)* PST 1: I do not hesitate in saying my ideas in the group because we are in a group of friends. I know that people will not mock me

Table 6. The frequency numbers of codes and categories for each week.

	Cognitive features					Instructional features		
Weeks	SCA	SSI	APR	AEA	CCI	SGD	RLC	CGD
Week 1	0	3	7	4	8	4	2	0
Week 2	0	4	5	0	4	2	3	1
Week 3	2	5	8	3	6	3	2	0
Week 4	1	0	1	1	0	4	3	0
Week 5	0	4	3	3	3	3	2	1
Week 6	1	2	9	4	5	4	4	1
Total	4	18	33	15	26	20	16	3

Notes: SCA = sense of confidence in action, SSI = sense of self-initiation, APR = awareness of personal role, AEA = awareness of environmental actions, CCI = collective construction of ideas, SGD = student guided discussion, RLC = real life connection, and CGD = consistent group dynamic.

Appendix 1

Interview protocol

(1) I have here a section of the videotape that we are going to watch together. As we watch it, tell me what you were trying to do with your group.
(2) Did you feel like solving this problem was important? If you were not asked to solve this problem in class, would it still be important for you? Why or why not?
(3) As you were trying to work through this problem, is there anything (e.g. knowledge, group members' comments, teacher's comments, etc.) that helped you or that you found useful in solving the problem? Please explain.

(4) Did you feel like you could effectively contribute to solving this problem? Why or why not? (They should explain why they could or could not contribute effectively.)
(5) Did you feel like your suggestions were taken seriously by your group mates? Why or why not?
(6) Is there anything you thought of contributing but you did not because you thought it was out of place for some reasons? If so, what was that?
(7) Tell me what your favorite part was in this week's activities (discussions, assignments …).

Appendix 2

Sample environmental problems

Week 2

Problem 3-Paper vs. Plastic. Which is less damaging to the environment, paper or plastic? Which one should you use for your order? Many people answer that paper is more biodegradable which is better for the environment. Plastic is usually not biodegradable and it is not usually recycled. However, there are some pros and cons of using both paper and plastic. Numerous trees are cut down to be turned into paper. Even if paper is recyclable, trees are still cut to make the paper. When paper is recycled, its quality is lowered; recycled paper cannot be run through high-speed presses without being torn. You can use plastic over and over again but it cannot be recycled as easily as paper can be. Biodegradable plastics exist but currently petroleum-based nonbiodegradable plastics dominate the markets (Mckinney, Schoch, and Yonavjak 2007).

(1) So, you are in the grocery and you are offered a choice of either plastic or paper bag. Which one do you choose? Justify your answer.
(2) Do you think paper or plastic should be used more, or should the current balance be maintained? Some communities and countries have banned plastic bags entirely. Do you think using plastic should be banned in your country?
(3) There are many people who say, 'I am aware of environmental problems and we should protect the environment,' but do not change their lifestyle to be more environmentally friendly. Why do they not behave in a more environmentally friendly way by changing their habits, despite their positive attitude toward the environment? What do you think about this issue? Explain your answer.

Assignment 2. How can people change their attitudes and behaviors to the environment? I would like you to be prepared to encourage people to change their attitudes and behaviors to the environment. You can choose any environmental issue like usage of energy, water, producing wastes, air pollution, etc. Firstly, you will talk about the habits of individuals about these environmental issues that you chose and what happen when people do not behave environmentally friendly. Then, you will talk about what can be done to change people's attitudes and behaviors. You will prepare a 10–15 min persuasive video or any presentation with your group.

Week 5

Problem 6 -Ilısu Dam Project (Hasankeyf). The Ilısu Dam Project that is planned to be built on Dicle River is a highly controversial issue. Ilısu is a part of the Gap Project that covers a 75,000 km^2 area; it is one of the biggest watering and producing electricity projects. Ilısu will begin production at times when there is a high water level and electricity demand by collecting water flood in springs. However, this dam project will harm Hasankeyf which holds thousands of years of history and has cultural, religious, archeological, and also ecological importance. The history of thousands of years will be destroyed because of the dam project that has most 50 years lifetime. When the dam is built, Hasankeyf will be inundated with water.

(1) How do you think the Ilısu Dam project affects culture, history, and the natural environment? Think about Hasankeyf.
(2) If you took part in a Hasankeyf conservation project, what would you do to protect Hasankeyf?
(3) Which one do you think is more valuable: production of energy in Hasankeyf or history/people who live there?
(4) Although many dams provide a useful service like flood control, water supply, and electricity generation, all dams harm environment in some way. Do you think dams should be removed? Could you offer alternative solutions to dams (think both ecologically and economically)?

Assignment 4. You have four options. Please select one and start to investigate. Explain in your own words and reflect your ideas. Do not forget adding your references.

(1) Please investigate how excessive detergent usage affects the environment and explain your solutions to decrease detergent consumption. What can you do to make people aware of harmful effects of detergent consumption? What can you offer instead of detergent usage?
(2) Do a research about a body of water (lake, river, etc.). Investigate the biodiversity of this body of water and explore the threats of this body of water. Investigate if there is water pollution and investigate the reasons of water pollution in this body of water. Lastly, offer your solutions to protect this body of water.
(3) Investigate water consumption and water trouble of some developed and developing countries. You can compare several countries in terms of water consumption and suggest solutions to how we can use our water in a more sustainable way.
(4) From your community/city, investigate: where does the water comes from and how is it treated? Do you think water supplies are adequate in your community? What actions should we take to meet future needs?