Contributions from Science Education Research 9

Olivia Levrini · Giulia Tasquier
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Contents

Chapter 16
Self-Efficacy of In-Service Secondary School Teachers in Relation to Education for Sustainable Development: Preliminary Findings

Athanasios Mogias, George Malandrakis, Penelope Papadopoulou, and Costas Gavrilakis

16.1 Introduction

The international community is now committed to Sustainable Development (SD), as a vision that incorporates responses to the most pressing modern economic, social, and environmental issues that humanity is facing (UN General Assembly, 2019). United Nations 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) are certainly the most ambitious and widely accepted political text and roadmap to guide efforts towards this vision (UN General Assembly, 2015). Education and especially Education for Sustainable Development (ESD) is among the most urgent challenges of the twenty-first century and if addressed contains the most promise (Wals, 2012), given that it is both a component of SDGs (target 4.7) and a critical tool to promote the Agenda as a whole. Within this context, educational resources have been developed to support

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curriculum developers and teachers in designing relevant strategies, curricula, and courses (Rieckmann, Mindt, Gardiner, Leicht & Heiss, 2017). However, several questions arise, such as whether teachers are prepared to implement ESD and to what extent they feel equipped to fulfill this task. Towards this direction, many teacher education institutions around the world have already integrated or plan to integrate ESD in their curricula, to prepare future teachers of primary and secondary education to address global challenges of sustainability. Various frameworks and guides (e.g., Sleurs, 2008; UNESCO, 2018) have been developed to support such integration – for example the notion of pre-service and in-service teachers' self-efficacy is a critical factor affecting their ability to implement ESD (Moseley, Huss & Utley, 2010).

16.1.1 Teachers' Self-Efficacy for ESD

Based on Bandura's social learning theory, self-efficacy belief indicates one's confidence in her/his ability to organize and execute a course of action, to solve a problem or accomplish a task (Bandura, 1977). Self-efficacy may suggest a belief in the ability to engage in a successful behavioural performance or to achieve a desirable outcome (Moseley & Taylor, 2011). Moreover, self-efficacy may focus either on the performance or on the learning (Ormrod, 2012). Therefore, self-efficacy of teachers, regardless of the subject matter, is closely connected with the teaching-learning process, since it is linked to behavioural patterns that teachers show in the classroom. These patterns can result in marked differences in the type of teaching and the strategies and methodologies used by teachers in their daily practices.

From the early '90s and until the last few years, only two self-efficacy scales had been developed to measure teachers' ability to implement Environmental Education (EE), the precursor of ESD, both deriving directly from different versions of the Science Teaching Efficacy Belief Instrument (STEBI) (Enochs & Riggs, 1990). The first was the Environmental Education Efficacy Belief Instrument (EEEBI) (Sia, 1992), and the second was the Environmental and General Science Teacher Efficacy Assessment (EGSTEA) (Moseley & Taylor, 2011). As science-based, these instruments can hardly cover the wider subject matter of EE/ESD and its holistic and systemic pedagogical approaches. However, despite the plethora of studies worldwide on teachers' self-efficacy (4,742 results in Scopus, January 2020), the main targeted population is that of pre-service teachers (388 studies), while none of the 96 studies focusing on in-service teachers deal with EE/ESD (Wilson & Tan, 2004). In addition, although the self-efficacy of secondary teachers has also been extensively studied (44 results), only nine of them involve in-service teachers, of which none is connected with EE/ESD. Therefore, the literature review that follows is constrained to studies with primary and secondary education teachers (both pre- and in-service) related to self-efficacy in EE/ESD.

In particular, some studies have already used EEEBI to assess teachers' self-efficacy (see Evans, Tomas & Woods, 2016). For instance, Moseley, Reinke and

Bookout (2002) evaluated the effect of a 3-day outdoor EE program on pre-service elementary teachers' self-efficacy. They found that although the program did not change the already high self-efficacy beliefs of the participants, some days after the completion of the program their self-efficacy dropped significantly, probably due to the re-evaluation of their ability to teach, as they learned more about teaching methodologies. Similarly, Moseley et al. (2010) examined the influence on EE teaching self-efficacy of K-12 teachers (both primary and secondary education) after their participation in a two-week intensive summer course about earth systems science, using the GLOBE curriculum. They revealed significant gains in both self-efficacy dimensions of EEEBI - i.e. personal environmental teaching efficacy (PETE) and environmental teaching outcome expectancy (ETOE) - immediately following the workshop. Using the same instrument, Gardner (2009) investigated the self-efficacy of elementary education pre-service teachers in the USA and found that not only do they feel a lack of sufficient knowledge and skills in EE, but also realized that there is an interesting relationship between teachers personal experiences with nature as young children and their current self-efficacy beliefs. Richardson et al. (2014) also used the EEEBI to examine the change of pre-service teachers' EE self-efficacy due to their engagement in a two-year intervention grounded on inquiry-based instruction.

Boon (2011) developed a scale to investigate Australian pre-service (early childhood and primary) teachers' beliefs and their knowledge about ESD. An adjusted version of this questionnaire was also used by Effeney and Davis (2013) to explore relationships between knowledge and efficacy for teaching sustainability in a group of pre-service primary and early childhood education teachers in the same country. They revealed that the participants were confident in their abilities to teach ESD and their self-efficacy was strengthening with increased levels of perceived knowledge. However, perceived knowledge had no relationship with actual knowledge (Effeney & Davis, 2013). It should be mentioned that there has been much discussion in the literature about the relationship between perceived/actual knowledge and self-efficacy (see Mintz et al., 2020). Several studies have revealed correlations between high levels of perceived knowledge and self-efficacy, which, according to Mintz et al. (2020), reminds us that the definition of self-efficacy is one's belief in his/her ability to carry out a task, independently of measures of actual ability (Bandura, 1997). Thus, without disregarding actual knowledge, these findings encourage the use of perceived knowledge as a potential dimension and a handy determinant of teachers' self-efficacy.

Moreover, Dahl's (2019) recent study with pre-service teachers in seven different teacher education programs in Europe, based on an instrument focused on teacher professional competencies, including an item regarding teaching for SD, showed that they do not feel well prepared to educate for sustainability. Another recent study (Tomas et al., 2017), also used only a few items of a wider Likert-style survey to explore pre-service teachers' (early childhood and primary) attitudes toward ESD, and to assess their ESD self-efficacy before and after completing an ESD unit in an Australian university.

Attention should also be paid to a new questionnaire created by Gan and Gal (2018) aiming to evaluate general education pre-service (early childhood and primary) teachers' ability to promote ESD, emphasizing pro-environmental behaviour both inside and outside the classroom (private and public sphere, respectively). The same purpose and the emergent calls for initial teacher-education institutions to integrate ESD competencies into their programs (Sleurs, 2008; Rieckmann, et al., 2017), motivated Malandrakis, Papadopoulou, Gavrilakis, and Mogias (2019) to develop another new teachers' self-efficacy assessment instrument, called Teachers' Self-Efficacy Scale for Education for Sustainable Development (TSESESD). It describes ESD self-efficacy as a belief linked with four domains of competencies, namely (a) values and ethics, (b) systems thinking, (c) emotions and feelings, and (d) actions. This instrument has been inspired by Sleurs' (2008) model which consists of five competence domains: (a) knowledge, that is conceptual, factual and action related, is related to time as well as to space and that is inter-, trans, pluri- or cross-disciplinarily constructed; (b) systems-thinking, meaning the different kinds of systems that are addressed, including interrelationships in time and space; it implies the awareness of being part of the living system, "Earth" in space and time; (c) emotions, since thinking, reflecting, valuing, making decisions, and acting are inseparably tied with emotions; empathy and compassion thereby play a key role; (d) values and ethics, where the main guiding principle of ESD is equity (social, intergenerational, between genders, between communities, between human beings and nature, etc.); and finally (e) action, the process where all the competencies of the other four domains merge to meaningful creations, participation, and networking in SD in all four levels: individual, classroom/school, regional, and global. In TSESESD, knowledge is not included as a domain, since according to the founding description of social cognitive theory (Bandura, 1989), it interacts with environmental and behavioural factors (e.g., self-efficacy) to influence human behaviour. Thus, in Malandrakis et al.'s (2019) study, knowledge was examined as a factor influencing self-efficacy. Specifically, the perceived knowledge was examined as it is more relevant to the self-efficacy founding theory (Bandura, 1997), as it tends to reflect teachers' confidence in what they know and are able to do. In parallel, TSESESD instrument attempts to integrate critical methodological elements of ESD, such as the holistic and interdisciplinary approach of knowledge, critical and systems thinking, emphasis on values clarification and so on, which are needed to deal with socio-economic and political dimensions of environmental and other sustainability issues (Malandrakis, Papadopoulou, Gavrilakis & Mogias, 2016; Malandrakis et al., 2019). TSESESD has already been used with pre-service primary school teachers and checked for face and content validity (Malandrakis et al., 2016), while its construct validity and factor structure has also been examined, revealing good psychometric properties (Malandrakis et al., 2019).

Based on the above and the obvious lack of studies focusing on in-service teachers of secondary education, the goal of the present study is to examine the self-efficacy beliefs of in-service secondary school teachers for ESD teaching, as well as their perceived knowledge of environmental issues.

16.2 Methodology

16.2.1 Research Instrument

The newly launched instrument entitled "Teachers' Self-Efficacy Scale for Education for Sustainable Development" (TSESESD) (Malandrakis et al., 2019) was used in the present study. The conceptual framework for the development of the instrument was based on the relevant literature from the fields of Science Education and Environmental Education / Education for Sustainable Development (EE/ESD) (e.g., Nolet, 2009; Sia, 1992; Sleurs, 2008). The instrument encompasses the above mentioned four domains of competencies, the magnitude of which portray teachers' belief in their ability to implement them in ESD. Moreover, following OECD's (2002) recommendations for a broader framework in terms of competencies, incorporating not only social and behavioural components, but also knowledge, cognitive, and practical skills, this study also investigated secondary school teachers' perceived Content Knowledge (CK) about specific ESD concepts, like the greenhouse effect, climate change, ozone layer depletion, ecological footprint, and biodiversity loss, among others. Moreover, their perceived Pedagogical Content Knowledge (PCK) was also studied taking into consideration the relevant literature (e.g., Sleurs, 2008), with the addition of three more dimensions, those of interdisciplinarity, ESD curricula, and assessment.

As a result, the whole instrument was composed of 24 items in the self-efficacy scale, not equally distributed among the four domains, and 14 and 17 item subscales focusing on CK and PCK, respectively (Tables 16.1 and 16.2). Furthermore, participants' characteristics regarding gender, scientific specialization, residency, years of service, age, high school level of teaching, previous experience in ESD, and

Table 16.1 In-service secondary teachers' self-efficacy scale for ESD (TSESESD), perceived knowledge scale, and their sub-domains indices

Domain	Items	Range	Mean	SD	Cronbach α	Skewness	Kurtosis
Values and ethics	6	1–7	4.77	1.49	0.944	−0.508	−0.246
Systems thinking	5	1–7	4.15	1.54	0.936	−0.159	−0.614
Emotions and feelings	3	1–7	4.61	1.33	0.885	−0.417	−0.023
Actions	10	1–7	4.31	1.47	0.962	−0.314	−0.319
Total	**24**	**1–7**	**4.43**	**1.47**	**0.975**	**−0.343**	**−0.325**

Table 16.2 In-service teachers' knowledge scale and its sub-domain indices

Domain	Items	Range	Mean	SD	Cronbach α	Skewness	Kurtosis
Perceived knowledge							
Content knowledge	14	1–7	4.33	1.73	0.949	−0.156	−0.088
Pedagogical content knowledge	17	1–7	3.84	1.65	0.966	−0.749	−0.720
Total	**31**	**1–7**	**4.06**	**1.68**	**0.971**	**−0.022**	**−0.733**

the frequency of information sources used about general environmental and/or sustainable development issues were also included.

16.2.2 Participants

Two hundred sixty-seven Greek in-service secondary education teachers from eight mainland and island cities participated in the present study. Fifty-six percent of the participants were females, while the majority (62.5%) had less than 20 years of service, although almost half of the participants were over 50 years of age. The 48.3% came from science disciplines (mainly physics teachers), 64.3% were serving in junior high schools (grades 7–9) at the time of the study, and 35.7% in upper high schools (grades 10–12). Their previous experience with ESD, either by attending relevant training seminars or implementing ESD projects in their schools, was limited (39.2% and 25.4%, respectively). Finally, participants reported the internet as the main source of their environmental information with a mean value of 4.14 (±1.12) in a 5-point Likert scale, while TV documentaries, specialized journals, and books followed (3.13 ± 1.25, 2.35 ± 1.40, and 2.33 ± 1.34, respectively).

16.2.3 Data Analysis

Teachers' answers were assigned to numbers from 1 (*"not at all"/"not sure at all"*) to 7 (*"very good"/"absolutely sure"*), with lower scores indicating lower teachers' self-efficacy and perceived knowledge levels, and vice versa. Data analysis involved (a) descriptive statistics applied to portray mean values (± standard deviation) of the 24 self-efficacy and 31 perceived knowledge items (CK and PCK), (b) regression coefficients to determine probable perceived knowledge effects on self-efficacy scores, and (c) implementation of inferential statistics to further investigate the potential effect, in terms of significant differences, of background factors on teachers' self-efficacy and knowledge scores. For all statistical tests, the significance level was predetermined at a probability value of 0.05 or less.

16.3 Results

Greek in-service secondary school teachers were found to report rather moderate self-efficacy scores in the TSESESD domains (4.43 ± 1.47), while they presented slightly lower scores on the knowledge scale (4.06 ± 1.68), indicating also moderate perceived content and pedagogical content knowledge of certain environmental and/or sustainability issues (Tables 16.1 and 16.2). More specifically, for the Self-efficacy scale, "Values and Ethics" presented the highest mean score among the

domains (4.77 ± 1.49), while "Systems thinking" the lowest (4.15 ± 1.54) (Table 16.1). Regarding the perceived knowledge scale, CK presented the highest mean score (4.33 ± 1.73), while PCK exhibited an evident low score (3.84 ± 1.65) (Table 16.2). Moreover, all domains showed excellent internal consistency values, revealing an overall Cronbach α value of 0.975 for Self-efficacy, and 0.971 for perceived knowledge, respectively (Tables 16.1 and 16.2). Inter-correlations both within scale domains and between self-efficacy and perceived knowledge scales were also calculated (Table 16.3).

In particular, inter-correlations of domains in the self-efficacy scale ranged between 0.678 and 0.789, in the perceived knowledge was 0.706, while a strong correlation was also revealed between the two scales (0.775). All correlations were statistically significant at the 0.01 level (Table 16.3). Additionally, regression analysis was performed to determine the effect of perceived knowledge in self-efficacy scores. The analysis revealed that 60% of the observed variance ($R^2 = 0.600$) in teachers' self-efficacy scores can be explained through perceived knowledge, portraying a good association between the two variables.

Independent *t*-tests and One-Way Analysis of Variance were further performed to investigate probable significant differences in terms of the participants' gender, specialization, seminar training, previous experience in ESD, and years of service. Although male teachers appeared to be slightly more knowledgeable, their female counterparts showed rather higher self-efficacy values, but in both cases, the differences were not statistically significant (Fig. 16.1a). Science teachers, although exhibited significantly higher scores in perceived knowledge, they were slightly surpassed by their colleagues from humanities studies in self-efficacy domains (Fig. 16.1b). Seminar training and previous experience in ESD appeared to positively influence both teachers' perceived knowledge and self-efficacy ($p \leq 0.001$) (Fig. 16.1c and d). Finally, an interesting finding, which acquires a more in-depth investigation, is that secondary education teachers with limited teaching experience (less than 6 years of service) as well as those with more than 30 years of class experience, were found to report higher mean values than their peers in both perceived knowledge and self-efficacy (Fig. 16.1e).

Table 16.3 Correlation indices among the domains under study

	1	1a	1b	1c	1d	2	2a	2b
1. TSESESD		0.887**	0.896**	0.840**	0.946**	0.775**	0.574**	0.833**
1a. Values & Ethics			0.771**	0.686**	0.736**	0.732**	0.561**	0.772**
1b. Systems thinking				0.678**	0.777**	0.758**	0.577**	0.803**
1c. Emotions & Feelings					0.789**	0.559**	0.391**	0.620**
1d. Actions						0.697**	0.503**	0.761**
2. Perceived knowledge							0.909**	0.937**
2a. Content knowledge								0.706**
2b. Pedagogical content knowledge								

** Correlation is significant at the 0.01 level

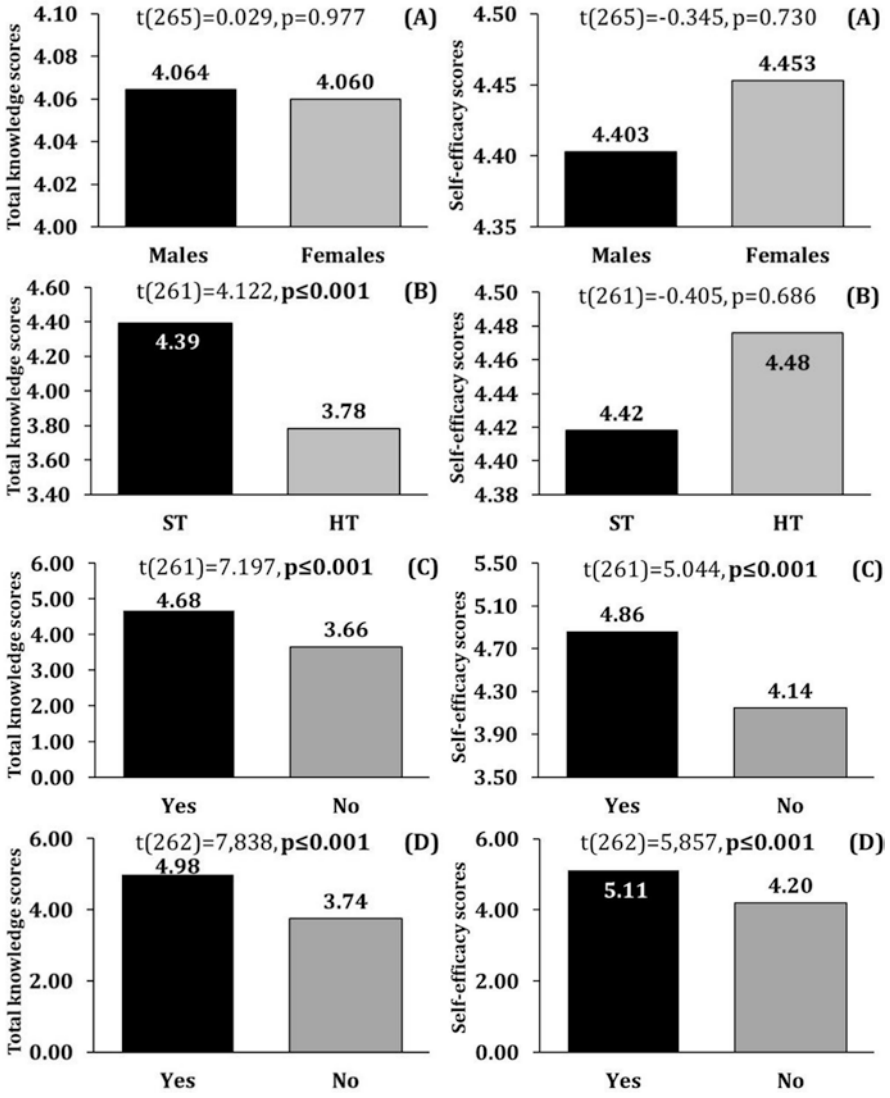

Fig. 16.1 Mean values of Knowledge and Self-efficacy scores concerning participants' gender (**a**), general specialization field (ST: Science Teachers; HT: Humanities Teachers) (**b**), in-service seminar training (**c**), previous experience in ESD (**d**), and years of service (**e**)

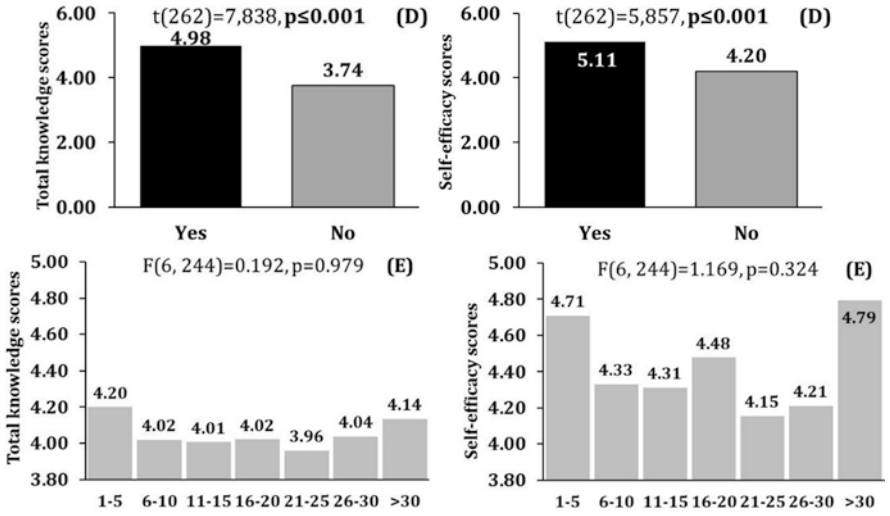

Fig. 16.1 (continued)

16.4 Discussion and Conclusions

Analysis indicates that TSESESD for secondary in-service teachers has good psychometric properties, having excellent internal consistency scores, along with strong and significant correlations among all domains.

The implementation of TSESESD with Greek secondary in-service teachers revealed that they exhibit moderate scores in both their self-efficacy beliefs to teach ESD issues and in their perceived content and pedagogical content knowledge of certain environmental and/or sustainability issues. Their self-efficacy scores are relatively lower than those reported for both Greek pre-service and in-service elementary teachers using the same scale (Malandrakis et al., 2019). For perceived knowledge the situation is mixed, as the secondary in-service educators of the present study gain about the same scores with their in-service colleagues of elementary schools, but higher than the scores of the pre-service elementary teachers (Malandrakis et al., 2019). However, the direct comparison of our findings with those in the literature is difficult, since the previous studies not only use tools other than TSESESD (mainly EEEBI) that are based on very different conceptual frameworks, but also due to the focus of these studies on pre-service teachers.

Another important finding is that, within secondary teachers, the science-oriented group seems to possess significantly higher perceived knowledge scores than their humanities colleagues, but the latter exhibit higher self-efficacy scores in teaching ESD. Also, the seminars and the previous experience in ESD, along with the years of teaching experience seem to have a critical role in teachers' self-efficacy and perceived knowledge, with those having either too few years of service or too much to exhibit the higher scores in both scales. However, despite the differences, these

secondary in-service teachers' scores are considered as moderate. This finding can partially be explained due to the lack of relevant training during their undergraduate studies and a respective shortage in their in-service support on these topics.

In light of the significant progress that has been occurring in ESD lately at the international level, many teacher training institutions have already integrated, or are in the process of integrating corresponding novel courses. These programs are often content-oriented (e.g., physics, biology, chemistry, history, language) to some extent, following traditional pedagogic approaches and, therefore, leave little or no space for learning and training about effective teaching methods and techniques within the framework of ESD. Therefore, the proposed instrument is expected to establish a baseline for providing detailed information to university programs and course designers in terms of incorporating all the necessary competencies teachers need to acquire in order to feel capable of planning and implementing ESD curricula and relevant projects or learning activities worldwide.

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