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CONTENTS

DESIGNING AND TESTING AN EDUCATION FOR SUSTAINABLE DEVELOPMENT SELF-EFFICACY SCALE FOR PRE-SERVICE TEACHERS: PRELIMINARY FINDINGS

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Abstract: Education for Sustainable Development (ESD), as a significant tool to address the increasing challenges posed by environmental and other sustainability issues, has been integrated into teachers' education curricula across the world. Although several frameworks of knowledge, skills and competencies that teachers should possess have been developed, there is limited research on pre-service teachers' self-efficacy on ESD. Self-efficacy, however, is among the most influential factors affecting teachers' ability for effective teaching in this field. In order to meet this need, a comprehensive instrument has been developed, based on international literature regarding competencies for ESD teachers. The instrument, under the heading 'Teachers Self-Efficacy Scale for ESD' (TSESESD), includes four domains of competencies; values and ethics, systems thinking, emotions and feelings, and action. The present study aims to study the basic psychometric properties of the particular instrument, along with its validity and reliability characteristics. An additional goal is to examine TSESESD association with knowledge, a well-known factor affecting self-efficacy. Three hundred five primary education future students from three different Greek universities participated in this pilot study. Preliminary findings demonstrated that TSESESD has good psychometric properties, accompanied by strong validity and reliability scores. The internal consistency of the scale is considered as adequate (Cronbach α=0.98), whereas the mean inter-correlation of items within domains is also satisfactory (M=0.7). Moreover, Greek pre-service teachers were found to possess rather moderate knowledge, while they displayed slightly higher self-efficacy values, considering themselves to be better prepared to teach about emotions and feelings, values and ethics, and in a lesser extent about systems thinking and actions.

Keywords: Education for Sustainable Development, Pre-service teachers' education, Self-efficacy scale

INTRODUCTION

Given that environmental and other sustainability issues, such as climate change, ecosystems degradation, food insecurity and inequalities, worsen during the last decades, Education for Sustainable Development (ESD) has become one of the most promising and emerging priorities of our days (Wals, 2012). Major international meetings for sustainable development, such as the recent UN Conference on Sustainable Development (2012: Rio+20, The future we want), as well as those focusing on ESD, such as the UNESCO World Conference on ESD held in Aichi-Nagoya, Japan in 2014, recognise the potential of ESD to empower people to transform themselves and the society they live in by developing knowledge, skills, attitudes, competencies towards a sustainable future (UN, 2012; UNESCO, 2014). UN had already declared the Decade of ESD (2005-2014) in order to put ESD higher on national and international agendas, advance policy and improve the conceptual understanding of ESD (UNESCO, 2005a). In this context, the role of educators is crucial as they have to provide their students with the appropriate sustainability concepts and competencies (UNESCO,

2005a). A number of international organizations have already developed frameworks of knowledge, skills and competencies that educators should possess in order to sufficiently address these challenges (NAAEE, 2004). Furthermore, several teacher preparation programs have been organized aiming to develop in-service and pre-service teachers' competencies in order to meet ESD needs (Van Petegem, Blieck, Imbrecht, and Van Hout, 2005; UNESCO, 2005b; UNESCO, 2010; Ferreira, Ryan, and Tilbury, 2006). Such initiatives either focus on teachers and student teachers who have already an interest in sustainability or attempt a whole inclusion of ESD within pre-service teacher education.

In this context, self-efficacy is among the most influential factors affecting teachers' ability to implement ESD (Moseley, Reinke, and Bookout, 2002; Moseley, Huss, and Utley, 2010). Due to its significance in teachers' professional development, several scales assessing either general self-efficacy (Tschannen-Moran and Woolfolk Hoy, 2001; Woolfolk Hoy and Davis, 2006) or specialized aspects of the construct, such as the science teaching efficacy beliefs - STEBI-B - (Enochs and Riggs, 1990), the chemistry-teaching efficacy beliefs - STEBI-CHEM - (Rubeck and Enochs, 1991) and the mathematics teaching efficacy beliefs instrument - MTEBI - (Enochs, Smith and Huinker, 2000) have been developed, all stemming from the initial instrument (STEBI). These instruments are based on Bandura's (1977) social learning theory and his cognitive model suggesting self-efficacy as '*beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments*' (van Dinther et al., 2013). Self-efficacy encompasses two components, i.e., the beliefs in one's ability to successfully perform the behaviour (efficacy expectation), and that the performance of the behaviour will have a desirable outcome (response–outcome expectancy) (Moseley and Taylor, 2011).

In terms of ESD, Environmental Education Efficacy Belief Instrument (EEEBI) is the only instrument created in this context (Sia, 1992). EEEBI has also been developed by modifying the STEBI–B and has been used in various studies (e.g. Moseley, Reinke and Bookout, 2002; Moseley, Huss, and Utley, 2010; Gardner, 2009). It uses 23 questions (Likert-type), 13 positively written and 10 negatively written, and measures both the Personal Environmental Teaching Efficacy (PETE) and the Environmental Teaching Outcome Expectancy (ETOE). Moreover, Moseley and Taylor (2011) modified the EEEBI, the STEBI and two factors from the OSTES (Ohio State Teacher Efficacy Scale (Tschannen-Moran and Hoy 2001) to create the EGSTEA (Environmental and General Science Teacher Efficacy Assessment) in order to examine both environmental and general science efficacy. Previous studies, based mainly on the above instruments, suggest that teachers do not feel capable to implement Environmental Education (EE), due to the lack of appropriate preparation and training (Moseley, Huss, and Utley, 2010). However, there are some exceptions indicating that teachers do have high environmental education teaching self-efficacy, at least prior to an environmental education teaching experience (Moseley, Reinke, and Bookout 2002), which resulted to re-evaluate their teaching ability (as they learned more about teaching methodologies). The complex environmental and sustainability concepts and issues being involved, the interdisciplinary nature of this field, as well as the need to engage alternative teaching processes that differ from the traditional teaching approaches, explain partially the difficulty for teacher education institutions making pre-service teachers to feel well-prepared to implement EE and ESD.

Nowadays the progress of EE and the emergence of ESD necessitate the development of a new instrument focusing on pre-service teachers. Actually, Sia's (1992) EEEBI scale resulted from a direct transformation of STEBI-B, were the term 'EE' just replaced the term 'science', since it is considered that environmental education is mostly based on science education (Moseley, Huss and Utley, 2010). In this case, the pedagogically innovative characteristics of EE are hardly included in EEEBI, as this scale covers general aspects of teaching process without paying attention on critical methodological elements of EE, such as the holistic and interdisciplinary approach, critical and systems thinking, dealing with values, fostering of

action competence etc. Furthermore, the emphasis given from ESD (as the contemporary aspect of EE) on socio-economic and political dimensions of environmental and other sustainability issues and the need to invest on relevant methodological approaches in order to deal with these dimensions are far away from the rational of EEEBI.

In the present study an effort is made to develop an instrument that produces valid and reliable data regarding pre-service teachers' self-efficacy for ESD (TSESESD). This scale is based on the rational that ESD teachers need to possess a set of competencies in order to successfully fulfil their educational role (i.e., planning of teaching, reflecting on the educational work, visioning the profile and reflecting the educational work, visioning the profile and performance of school, looking for partners outside the school) (Sleurs, 2008). Although the notion of competence is very complex, the CSCT project (Curriculum, Sustainable development, Competences, Teacher training) developed a coherent set of competences that can inspire teachers' training institutes aiming to integrate ESD into their curricula (Sleurs, 2008).

METHODOLOGY

The instrument development framework

According to CSCT project that inspired us to develop this instrument (Sleurs, 2008), ESD competencies are classified into five domains; values and ethics, systems thinking, emotions, ethics and values, action, and knowledge (Sleurs, 2008). In particular, knowledge includes content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK). As it is well established from the international literature that knowledge it is not an integral part of the self-efficacy concept, but an independent variable that possibly affects it, in the particular study only the first four domains were included in the scale development process.

It also should be mentioned that in terms of CK we decided to investigate whether teachers feel they possess sufficient knowledge relevant to particular ESD concepts and issues (e.g. the greenhouse effect, sustainable development, energy footprint etc.) rather than their feel of competence to teach these concepts/issues. In this context, the dimension of CK has been examined and tested as a potential determinant of teachers' ESD self-efficacy. According to Bleicher and Lindgren (2005) who examined the relationships between conceptual understanding, self-efficacy and outcome expectancy beliefs of pre-service teachers in science education, the increase of the quantity of content knowledge increased their self-efficacy beliefs but it may not be sufficient to overcome their reluctance to teach science if some of their learning does not take place in a constructivist environment. Palmer (2006) also recorded in his study that an increase in participant's self-efficacy is associated to their understanding of science content and/or of how to teach science.

Based on the above, two pools of items were developed by two of the authors. The first one (TSESESD) was developed following the literature established methodologies in psychological and educational sciences aiming to maximize the reliability, validity and generalizability of the scale. TSESESD was thus comprised of 24 items in total, six for Values and Ethics, five for Systems thinking, three for Emotions and Feelings, and ten for Actions domains. Knowledge scale, with 31 items, consisted of two domains: 'Content Knowledge (CK)' with 14 items, regarding current environmental issues, and 'Pedagogical Content Knowledge (PCK)' with 17 items. Within PCK, beyond the literature suggested topics (Sleurs, 2008), additional items were embedded aiming to emphasize on three more dimensions, those of interdisciplinarity, ESD curricula, and evaluation. In this way, an instrument being more content-specific and relevant with the national context was developed.

In the next phase, the other two authors (also academic experts on ESD) examined the theoretical construct of the two scales and assessed each item for face and content validity, specifically in terms of content, language, difficulty, and relevance to the main construct. The validity of the first scale was further tested by comparing students mean scores in TSESESD with those to an already existed and valid scale assessing their general teaching efficacy (Tschannen-Moran and Woolfolk Hoy, 2001).

It should be mentioned that during the development of the scales, only items related to the teacher as an individual were included, whereas dimensions considering the teacher as a member of the educational institution or as a member of the society were excluded (Sleurs, 2008) due to the very large number of items needed for that purpose.

Sample

For the items pilot study, a convenient sample of 305 pre-service primary education students, from three different universities in Northern Greece were engaged. None of these student-teachers (STs) had attended any ESD university course before completing the scales. The demographics of the sample are summarized in Table 1 with the ratio of male/female students to reflect the average gender distribution of pre-service primary teacher population in Greece (Mogias et al., 2015).

Table 1. Sample characteristics

Variable	Frequency	%
University		
University of Western Macedonia	122	*40.0*
University of Ioannina	35	*11.5*
Democritus University of Thrace	148	*48.5*
Department		
Department of Primary Education	266	*87.2*
Department of Pre-primary Education	39	*12.8*
Year of study		
First & Second	55	*18.0*
Third	17	*5.6*
Fourth or above	233	*76.4*
Gender		
Females	275	*90.2*
Males	30	*9.8*
Total :	**305**	*100*

Data Analysis

All students' answers were assigned to numbers from 1 ('Not at all' / 'No sure at all') to 7 ('Very good' / 'Absolutely sure') and entered to SPSS for further analysis. Based on item responses, summative scores for each domain and for the total scales (TSESESD, General Teaching Efficacy, and Knowledge) were also calculated. By doing this, lower scale scores indicate lower students' self-efficacy and knowledge confidence, and vice versa. In addition to descriptive, the internal consistency of the instrument was assessed using the Cronbach alpha reliability index.

Moreover, Pearson inter-correlations were calculated within the four domains of the main scale (TSESESD), and among TSESESD, General Teaching Efficacy and Knowledge scales. Finally, distributions were checked for normality by applying skewness and kurtosis indices, along with diagrammatic plots (e.g. Q-Q plots).

RESULTS

Greek pre-service teachers were found to possess moderate efficacy scores (M=4.25, SD=1.36), slightly above the balance point (3.5, see Table 2). More specifically, the

Table 2. Teachers Self Efficacy Scale for ESD (TSESESD) and its subdomains' indices

Domain	Items	Range	Mean	SD	Cronbach α	Skewness	Kurtosis
Values and ethics	**6**	1 – 7*	**4.49**	**1.38**	**0.948**	**-0.364**	**-0.063**
Values	1	1 – 7	4.33	1.40		-0.250	-0.233
Ethics	1	1 – 7	4.46	1.42		-0.423	-0.135
Norms	1	1 – 7	4.98	1.32		-0.648	0.435
Beliefs	1	1 – 7	4.54	1.41		-0.332	-0.257
Attitudes	1	1 – 7	4.45	1.37		-0.362	-0.089
Assumptions	1	1 – 7	4.17	1.33		-0.169	-0.098
Systems thinking	**5**	1 – 7	**4.05**	**1.37**	**0.927**	**-0.021**	**-0.284**
General Systems thinking	1	1 – 7	3.77	1.42		0.008	-0.580
Rational thinking	1	1 – 7	4.29	1.34		-0.050	-0.234
Dynamic thinking	1	1 – 7	4.26	1.37		-0.160	-0.235
Thinking in models	1	1 – 7	3.85	1.38		0.054	-0.300
Goals	1	1 – 7	4.08	1.36		0.046	-0.073
Emotions and feelings	**3**	1 – 7	**4.64**	**1.33**	**0.946**	**-0.187**	**-0.090**
Emotions	1	1 – 7	4.75	1.29		-0.324	0.317
Empathy	1	1 – 7	4.66	1.35		-0.190	-0.201
Usefulness of emotions	1	1 – 7	4.51	1.35		-0.046	-0.387
Actions	**10**	1 – 7	**4.10**	**1.35**	**0.953**	**-0.013**	**-0.173**
General actions	3	1 – 7	4.03	1.42		0.039	-0.253
Individual	1	1 – 7	4.18	1.34		-0.085	-0.258
Group	1	1 – 7	4.29	1.39		-0.146	-0.176
Level of action-Local	1	1 – 7	4.24	1.28		-0.014	-0.044
Level of action-Global	1	1 – 7	3.46	1.33		0.394	0.015
Evaluation of actions	3	1 – 7	4.23	1.32		-0.044	-0.169
Total	**24**	**1 – 7**	**4.25**	**1.36**	**0.980**	**-0.113**	**-0.158**

* 1 = "Not sure at all" to 7 = Absolutely sure"

'Emotions and feelings' domain had the higher mean score (M=4.64, SD=1.33) while 'Systems thinking' the lower (M=4.05, SD=1.37). Within the first domain of TSESESD, that of 'Values and Ethics' with mean score of 4.49 (SD=1.38), the 'Norm' subcategory displayed the highest mean score (M=4.98, SD=1.32), while 'Assumptions' the lowest (M=4.17, SD=1.33). In terms of 'Systems thinking', (M=4.05, SD=1.37), the 'Rational thinking' subcategory had the highest

Table 3. General Self Efficacy and Knowledge scales' indices

Domain		Range	Mean	SD	Cronbach α	Skewness	Kurtosis
General Self Efficacy Scale	**12**	**1 – 7***	**6.20**	**1.35**	**0.955**	**-0.438**	**0.443**
Knowledge	**31**	**1 – 7**	**3.95**	**1.42**	**0.958**	**0.002**	**-0.343**
Content Knowledge	14	1 – 7	3.82	1.41	0.895	0.059	-0.283
Pedagogical Content Knowledge	17	1 – 7	4.05	1.43	0.966	-0.044	-0.391

* 1 = "Not at all" to 7 = Very good"

score, immediately followed by 'Dynamic thinking' (4.29 and 4.26, respectively), while 'General systems thinking' displayed the lowest scores (M=3.77, SD=1.42). All the items of the category 'Emotions and Feelings' varied between 4.51 and 4.75, with the highest scores to

Table 4. Pearson inter-item correlations within each TSESESD subdomain

Domains	**Correlations within domains**									
Values and Ethics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.Values		.912**	.708**	.707**	.798**	.730**	.910**			
2. Ethics			.757**	.718**	.801**	.758**	.929**			
3. Norms				.719**	.691**	.608**	.844**			
4. Beliefs					.749**	.786**	.882**			
5. Attitudes						.796**	.907**			
6. Assumptions							.874**			
7. Values and Ethics										
System Thinking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.General systems thinking		.686**	.714**	.715**	.671**	.865**				
2. Rational thinking			.871**	.661**	.675**	.889**				
3. Dynamic thinking				.692**	.697**	.906**				
4. Thinking in models					.733**	.875**				
5. Goals						.865**				
6. System Thinking										
Emotions and feelings	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Emotions		.879**	.841**	.953**						
2. Empathy			.843**	.955**						
3. Usefulness of emotions				.943**						
4. Emotions and feelings										
Actions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.General actions		.844**	.699**	.650**	.621**	.558**	.485**	.610**	.616**	.593**
2.General actions			.729**	.598**	.603**	.520**	.480**	.614**	.588**	.595**
3.General actions				.742**	.768**	.669**	.544**	.693**	.676**	.689**
4.Individual					.876**	.704**	.613**	.716**	.682**	.663**
5.Group						.764**	.611**	.719**	.689**	.690**
6.Level of action-Local							.745**	.722**	.715**	.701**
7.Level of action-Global								.704**	.663**	.627**
8. Changes in actions									.791**	.778**
9.Reflection upon actions										.869**
10.Evaluate actions										

**. Correlation is significant at the 0.01 level

be recorded in the domain of emotions (M=4.75, SD=1.29). Finally, 'Actions' presented a rather high fluctuation between 'global level of action' (3.46) and 'group action' (4.29), revealing a mean score of 4.10.

All domains showed excellent internal consistency values (Cronbach α), ranging from 0.927 (Systems thinking) to 0.953 (Actions), revealing an overall value of 0.980. Normality tests suggested normal distribution of the sample (Table 2). In relevance of the General Teaching Efficacy (Table 3), pre-service teachers exhibited extremely high scores (M=6.20, SD=1.35), approaching the upper limits of the scale, while the internal consistence of the particular scale is also considered as more than adequate (Cronbach α=0.955). Regarding the two Knowledge subscales, Greek pre-service teachers were found to possess moderate content knowledge of specific environmental issues (M=3.82, SD=1.41), while in the pedagogical content knowledge they presented values slightly above the balance point (M=4.05, Table 3). Both knowledge domains revealed very good to excellent internal consistency values (0.895 and 0.966 for CK and PCK, respectively), while normality tests also suggested normal distribution of the sample (Table 3).

All inter-correlations within each domain of TSESESD (Table 4) are considered as adequate in magnitude and statistically significant ($p \leq 0.01$), indicating strong relationships between the items constituting each of these domains. For instance, the mean inter-correlation for all domains was 0.733, were ranging from 0.480 in the domain of Actions, to 0.955 in the domain of Emotions.

In addition to this, satisfactory levels of inter-correlations were also recorded among TSESESD, General Teaching Efficacy and Knowledge (mean correlation: 0.7, see Table 5), as well as within their sub-domains. In particular, pre-service teachers scores in TSESESD had a medium to large correlation with General Teaching Efficacy (0.613) indicating an increased validity of the scale. Moreover, high correlation scores were observed between TSESESD and Knowledge (0.792), and its subdomains scores (0.524, 0.868).

Table 5. Correlation indices between TSESESD and its subdomains, General Teaching Efficacy scale, and Knowledge and its subdomains

	1	**1a**	**1b**	**1c**	**1d**	**2**	**3**	**3a**	**3b**
1. TSESESD		.907**	.933**	.900**	.917**	.613**	.792**	.524**	.868**
1a. TSESESD Values & Ethics			.799**	.723**	.794**	.532**	.768**	.513**	.837**
1b. TSESESD Systems thinking				.798**	.816**	.569**	.752**	.525**	.802**
1c. TSESESD Emotions& Feelings					.758**	.555**	.630**	.390**	.712**
1d. TSESESD Actions						.587**	.751**	.492**	.826**
2. General Teaching Efficacy							.512**	.352**	.550**
3. Knowledge								.877**	.923**
3a. Content Knowledge									.625**
3b. Pedagogical Content Knowledge									

** Correlation is significant at the 0.01 level

DISCUSSION AND CONCLUSIONS

Analysis indicates that TSESESD has good psychometric properties, accompanied by strong validity and reliability scores. High correlation within scale domains indicates the relevance of the studied issues, while the strong correlation between TSESESD and the already existed general teaching efficacy scale strengthens its validity. However, further analysis is required for a better examination of the scale's properties, including factor analysis, contrasted groups' test and test/re-test procedures.

A finding of this research is that student teachers have strong self-efficacy beliefs about their ability to teach ESD issues. This belief seems to be based mainly in their felling that the pedagogy they possessed is enough to deal with these issues. Given that none of the teacher students has prior experience with ESD issues, this finding seems to be in line with Moseley, Reinke, and Bookout (2002) findings, that teachers have high environmental education teaching self-efficacy at least prior to an environmental education teaching experience and before they re-evaluate their teaching ability as a consequence of this experience. The former claim is strengthened by another finding, that students declare that their content knowledge in ESD issues is inadequate. That means that student are not aware enough about the inherent complexity of sustainability issues per se, consequently they are not informed about the variety of teaching methods and techniques needed and used in ESD education. The other findings of this research are more or less expected, e.g. general system thinking low score, given the difficulty of the issue and students lack of experience in ESD.

Teachers' education on ESD has already made a significant progress at international level. Many universities have integrated innovative curricula, anticipating the comprehensive preparation of ESD teachers. TSESESD, based on a comprehensive competencies' framework (Sleurs, 2008), can be a useful tool for improving ESD teachers education.

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