Theoretical Formulation and Empirical Investigation of a Conceptual Model of Teachers' Competence in Environmental Education

Maria Daskolia & Evgenia Flogaitis, University of Athens, Greece

Abstract

This study primarily aimed to suggest a theoretically and empirically valid definition for the construct of teachers' competence in environmental education. The study was designed and developed in two phases. We first attempted to formulate a hypothetical model of teachers' competence in environmental education, based on a specification of the concept of "competence," an extensive literature review, and analysis of theoretical considerations and proposed frameworks concerning teachers' roles, general competencies and professional development in environmental education. This model was then empirically tested by surveying a nationwide sample of Greek secondary education teachers. The findings of the study indicate a high degree of consensus on the part of the Greek environmental education practitioners concerning the model's content. As far as the model's structure is concerned, we conclude that there should be some alterations in the initially proposed category scheme.

Résumé

Conçue et développée en deux phases, cette étude visait principalement à proposer une définition valide sur le plan tant théorique qu'empirique pour la construction de la compétence des enseignants du domaine de l'ERE. Nous avons tout d'abord tenté de formuler un modèle hypothétique de la compétence des enseignants en ERE en nous appuyant sur une spécification du concept de « compétence », un examen approfondi de la documentation et l'analyse des considérations théoriques et des cadres proposés quant aux rôles, aux compétences générales et au perfectionnement professionnel des enseignants évoluant dans le domaine de l'ERE. Ce modèle a par la suite subi une épreuve empirique à l'aide d'un sondage effectué, à l'échelle nationale, auprès d'un échantillon d'enseignants du système d'éducation secondaire en Grèce. Les conclusions de l'étude révèlent un consensus marqué, chez les éducateurs environnementaux grecs, pour le contenu du modèle. En ce qui a trait à la structure du modèle, nos conclusions reconnaissent la nécessité d'apporter certaines modifications aux catégories proposées au départ.

It is widely acknowledged that teacher education, both at the preservice and the inservice level, can and should play an important role in the development of teachers' competence in environmental education, and in this way, assist the

promotion and development of environmental education itself (Tilbury, 1993; UNESCO-UNEP, 1988; Wilke, Peyton, & Hungerford, 1987). To be efficient and successful, the whole venture has to be built on an agreed conception of teachers' competence in environmental education, based in both theory and practice.

However difficult this may sound, in order to claim a widely approved definition of any environmental education concept or construct (Sauvé, 1992, 1994), it is absolutely necessary for teacher education program design and implementation to be preceded by adopting, either explicitly or implicitly, a certain viewpoint of the "right" teacher for environmental education (Glasgow, 1996, p. 72). What is most often ascertained in practice is a mismatch of different viewpoints on proposed teacher education goals and content. Other criticisms include poor appreciation of teachers' training needs and expectations and the consequent failure to take these into account in program design (Chung, 1991; Lane, Wilke, Champeau, & Sivek, 1994), and the lack of any particular theoretical framework on teacher competency in environmental education to use as a practical guideline (Simmons, 1995).

This not only strengthens the view that the integration of teacher education and environmental education should remain among the top priorities of environmental education theory and research (Tilbury, 1993), but that the design and implementation of environmental education teacher education should be based on a negotiation process between theory and practice regarding the content and scope of teachers' competence in environmental education.

Rationale and Aim of the Study

Our interest in proposing a theoretically complete and empirically approved definition for the construct of teachers' competence in environmental education was part of a research project on the identification of Greek secondary education teachers' inservice training needs in environmental education (Daskolia, 2000). We wanted an appropriate model either to be identified in the literature or constructed, and then to serve as a basis for the methodological design and implementation process of assessing teachers' training needs.

After an extended literature review, we realized that although there was strong theoretical speculation on issues such as a teacher's role and her/his proper preparation in environmental education, it mainly consisted of unclassified views, or of interesting but difficult to compare theoretical propositions and models. Moreover, none of these views or models offered a definition of "competence" as a starting point for framing the construct's structure and content in environmental education teaching practice. What was also found to be missing in the related literature was any well-documented attempt to empirically verify whether there was a wider basis of approval for any of these theoretical views and suggestions, especially on the part of teachers. This verification could be used by decision-makers in the design of teachers' professional development in environmental education.

We concluded that it would be of particular theoretical and practical interest if we tried to analyze the existing views and propositions in the related literature with the purpose of identifying any recurrent thematic areas and determining their scope. This procedure would eventually provide us with the necessary "building materials" for framing a new conceptual formulation of the construct of teachers' competence in environmental education. This hypothetical model could then be submitted to the various groups involved in teacher education to get an indication of their degree of agreement with the proposed way of defining teachers' competence in environmental education.

Theoretical Formulation of the Model

According to Sauvé (1992), a model is the conceptual or concrete representation of a physical or social reality, actual or theoretical. A model's formulation gives a researcher the possibility to express, on the strength of her/his scientific knowledge and intuition, the way s/he conceives that reality. Since one of a model's validity standards is its well-informed theoretical base (Sauvé), a comprehensive review of the literature preceded our attempt to formulate the proposed model. Our first task was to define the concept of "competence," which would then be used as a basis for determining the model's structure.

Teachers' Competence: The Construct and Its Structure

After careful examination and comparison of alternative approaches, teachers' competence in environmental education as a construct was eventually defined within the cognitive competence tradition (Eraut, 1994).[1] This approach is most suitably conveyed by Messick's (1984) consideration of competence as what a person knows and can do under ideal circumstances. Within this tradition, competence refers to an integrated structure consisting of relevant (to a specific subject or task) knowledge ("understanding") and abilities ("the co-ordination of appropriate internal resources necessary for successful adaptation") (Wood & Power, 1987, p. 414).

A useful distinction regarding teachers' professional knowledge arose after reviewing the proposed theoretical frameworks for teacher knowledge domains (Ben-Peretz, 1995; Grossman, 1995; Tamir, 1990). Teacher knowledge was divided into the following fields:

- knowledge of content or subject-matter knowledge;
- knowledge of learners and learning;
- general pedagogical and subject-matter pedagogical knowledge;
- knowledge of curriculum;
- knowledge of context; and
- knowledge of self.

As for the concept of "ability," we first dissociated it from that of "skill" by postulating that ability refers to a much more complex structure (Eraut, 1994, p. 112). A person's ability to perform or accomplish a task was thus presumed to be based on a combination of appropriate forms of knowledge, the right skills, and any gained experience from executing that task. We also adopted Bennett's (1997) theoretical framework for the development of (generic) skills. This model identified four levels of managerial processes involved in the context of a person's professional function:

- management of task;
- management of others;
- management of self; and
- management of information.

Teachers' Roles, General Competencies, and Professional Development in Environmental Education

As for the content of our proposed model, it ensued from the analysis of the various theoretical considerations about teachers' roles, general competencies, and professional development in environmental education. More specifically, we reviewed and analyzed two categories of theoretical models. The first were models which attempted to specify in a normative way teachers' general competencies in environmental education. These were Peyton, Hungerford and Wilke (1980), Wilke, Peyton & Hungerford (1987), the Wisconsin Department of Public Instruction (Engleson, 1987), and Simmons (1995). The second were models which attempted to define the important goals and/or content areas on which teachers' preservice education and inservice training in environmental education should focus. These were Stapp (1975), Hungerford and Peyton (1986), Lahiry, Sinha, Gill, Mallik, and Mishra (1988); UNESCO-UNEP (1990), Glasgow (1996), and Jacobson (1985). In analyzing these models, we focused on identifying the recurrent thematic areas of teachers' knowledge and abilities in environmental education and on defining their scope.

The same procedure was repeated while reviewing a number of preservice and inservice teacher training programs. These were a year-long inservice training program for teachers from five states in the U.S. (Volk, 1987), an elective environmentally focused unit for students preparing to be teachers at the University of Canberra, Australia (Nicholas, Oulton, & Scott, 1993), a one-year Post-Graduate Certificate in Education (PGCE) course in Environmental Science offered by the University of Bath (Oulton & Scott, 1994), a Master's Degree program in environmental education at Griffith University, Australia (Fien, 1991), and a teacher preparation project in environmental education in Minnesota (Kuechle & Carlson, 1997).

After careful examination of all the above, we proceeded with the formulation of a hypothetical model of teachers' competence in environmental

education. This was actually constructed as two separate models: teachers' knowledge base and teachers' abilities base.

The Proposed Model of Teachers' Knowledge Base in Environmental Education

Our proposed model of teachers' knowledge base in environmental education contained 30 items which were classified in 4 general thematic areas (see Figure 1):

- introductory knowledge of environmental education;
- knowledge of teaching practice and evaluation in environmental education;
- knowledge of learning and learners; and
- knowledge of environmental issues and problems

Category A - Introductory Knowledge of Environmental Education	
1.	History of EE
2.	Philosophy, aims, and objectives of EE
3.	Essential concepts in EE (such as environment, sustainable development, quality of life, etc.)
4.	The relationship between EE and other dimensions of contemporary education (such as health education, consumer education, social education, etc.)
Category B - Knowledge of the Teaching Practice and Evaluation in EE	
5.	Greek Ministry of Education's provisions and recommendations concerning EE implementation in secondary education schools.
6.	Pedagogical models in EE
7.	Stages in implementation process of an educational program in EE
8.	Teaching methods and techniques in EE
9.	Evaluation methods and techniques in EE
10.	Available educational material for educational programs and activities in EE
11.	Sources of information in EE (such as bibliographies, resource people, educational centres for EE, etc.)
Category C - Knowledge of Learning and Learners	
12.	Theories of learning
13.	Theories about a person's development in relation to her/his environment
14.	Factors contributing to creation of supportive learning in climate in EE process
15.	Students' views and values about environment and specific environmental problems
Category D - Knowledge of Environmental Issues and Problems	
16.	Fundamental ecological concepts (such as ecosystem, food chain, etc.)
17.	Role of humans and impact of societies on environmental systems
18.	Natural ecosystems
19.	Alternative management strategies for natural resources
20.	Urban environment issues
21.	Cultural environment issues
22.	Social environment issues
23.	Local environment issues
24.	Global environment issues
25.	Ways of managing and resolving environmental problems
26.	Issues in relation to economic devlopment and the environment
27.	Environmental ethics and philosophy issues
28.	Environmental law
29.	Relationship between environment and human psychological processing and well-being
30.	Environment in arts and literature

Figure 1. Proposed model of teachers' knowledge base in environmental education (EE).

The first category, "Introductory Knowledge of Environmental Education," includes four items, which refer to knowledge of environmental education's historical, conceptual and axiological framework. Items in this category were chosen on the basis that their acquisition would conceptually assist a teacher in better understanding environmental education's unique character and its intended role, as well as enabling her/him to identify environmental education's similarities and dissimilarities to other innovative educational trends and practices. In the second category, "Knowledge of Teaching Practice and Evaluation in Environmental Education," more "technical" (i.e., practical) knowledge of environmental education is included. This is subject-matter specific and refers to alternative pedagogical models in environmental education, the possibilities and limits of teaching practice in the existing Greek curriculum, and various teaching aids in environmental education. The third category, "Knowledge of Learning and Learners," refers to theoretical knowledge of alternative pedagogical and psychological approaches to the processes of learning and human development. Four knowledge items were chosen for their contribution to the creation of a well-informed knowledge basis with regard to fundamental pedagogical issues, while a fifth item ("knowledge extracted from educational research regarding students' conceptions about the environment and environmental problems") was also judged to be of value. The fourth category, "Knowledge of Environmental Issues and Problems," comprised 15 items representative of the subject matter of environmental education. Apart from fundamental ecological concepts, other approaches to various environmental issues and problems were also included as they contribute to the development of a more integrated understanding of environmental realities.

The Proposed Model of Teachers' Abilities Base in Environmental Education

Eighteen items were chosen to make up the hypothetical model of teachers' abilities base in environmental education (see Figure 2). The proposed abilities were grouped in four general thematic areas which correspond to the following fields of processes needed to be exercised by a teacher in environmental education practice:

- teacher's management of environmental education programs;
- teacher's management of interpersonal relations with and among students;
- teacher's self-appraisal of teaching practice; and
- teacher's management of environmental information

Category A - Teacher's Management of Environmental Educaton Programs	
1.	Selecting approriate topics for educational programs and activites in EE
2.	Designing and organizing educational programs and activities in EE (i.e., choice of educational aims and goals, choice of learning activities, scheduling, etc.)
3.	Making use of different teaching methods
4.	Coordinating various pedagogical activities
5.	Evaluating an educational program in EE
6.	Arranging financial matters and bureaucratic procedures in context of an EE program's implementation
Category B - Teacher's Management of Interpersonal Relations With and Among Students	
7.	Identifying students' needs and interests
8.	Cooperating in a team
9.	Resolving problems and controversies among students
Category C - Teacher's Self-appraisal of Teaching Practice	
10.	Self-evaluating her/his personal teaching practice in EE
11.	Exploring her/his personal values concerning environmental issues and problems
Category D - Teacher's Management of Environmental Information	
12.	Analyzing environmental issues and problems
13.	Making use of the various sources of environmental information
14.	Interweaving environmental information and presenting it in a creative way
15.	Designing and conducting environmentally related experimental research (in the lab)
16.	Designing and conducting social research (in field) about environmental attitudes, views, and behavioural matters
17.	Making use of new information technologies in education
18.	Making appropriate use of speech and various teaching aids

Figures 2. Proposed model of teachers' abilities in environmental education (EE).

The first category concerns abilities employed by a teacher in the management of an environmental education educational program. These are processes pertaining to the instructional design, organization, and implementation phase of environmental education. Six items were grouped in this category, some of which refer to abilities needed to bring the various phases of an environmental education program to completion, while the rest referred to abilities connected with managerial processes either in a pedagogical or administrative level. The second category refers to a teacher's general competence in managing interpersonal relations with and among students. These are abilities a teacher should employ in order to gain a better understanding of her/his students, to build cooperation and communication, and to create a supportive learning climate. In the third category, two items were included that refer to a teacher's meta-cognitive level of thinking and professional functioning. Self-appraisal abilities were judged to be important as they give a teacher the possibility to monitor and control her/his overall performance both as a person and as a teacher. The fourth category of the proposed model contains seven abilities related to the management of environmental information, and more particularly, to the acquirement, elaboration, and transmission of this information to others.

Methods

The first in a series of empirical tests that we conducted to validate our hypothetical model's structure and content concerned the identification of the degree of consensus expressed towards them on the part of environmental education practitioners. School teachers involved in the implementation of environmental education were chosen to be the first group to respond to the appropriateness of the model, not only by virtue of their practical expertise but also because they were thought to be personally concerned as well as most directly affected by the formulation of a definition on teachers' competence in environmental education. A cross-sectional survey was selected as the research method. The survey was administered to Greek secondary education teachers involved in the implementation of environmental education. The aim was to determine how relevant they perceived each of the proposed knowledge and abilities items to be to an environmental educator's role and competence.

Instrument

A structured questionnaire based on our proposed model was chosen as the research tool. Two sets of questions were included; the first asked respondents to express their views on 30 knowledge items, the second on 18 abilities items. Participants were asked to indicate to what degree a teacher involved in the implementation of environmental education needs to have a good command and make proper use of each of the items, using Likert-type responses (ranging from 1 [not at all] to 5 [a great deal]). An advisory panel composed of academics and experts in the fields of educational theory and research, environmental education, and statistics provided guidance for the development of the instrument and checked for its face and content validity. Two different panels of professional educators in environmental education were also asked to review the content of the questionnaire and comment on issues like the wording and the sequence of the questions, the instructions' readability, and the questionnaire's general appearance. A pilot study was conducted with 15 randomly selected teachers. Using the test and retest method, Pearson's r was .73.

Sample

Participants in the study were Greek secondary education teachers who had already been involved in the implementation of environmental education programs. According to the official records for the 1996-1997 school year provided by the Ministry of Education, 2,319 teachers from the 57 Education Districts of the country were reported to have taken part in environmental education programs. A systematic random sampling method was adopted to

select the sample of the study. The invited sample size was set to be the 25% of the overall population (580 teachers). The names of all the teachers were listed. After randomly picking the first name, we continued by selecting every fourth teacher until the predetermined sample size was attained.

Procedure

A copy of the questionnaire was sent by regular mail to each of the participants. The questionnaire was accompanied by a letter of introduction which explained the purpose and significance of the study and asked for the respondents' cooperation. A stamped response envelope was provided. Mailings were sent in October 1998, a number of randomly selected teachers were contacted by phone before mailing and after the deadline for returning questionnaires in November 1998, and the whole procedure was completed by the end of December 1998.

Analysis of Data

Descriptive and inferential statistics were used in the data analysis stage. For each knowledge and ability item, teachers' overall ratings in terms of their relevance to environmental educator's roles were estimated by averaging the responses of all the teachers. Based on their mean values, all knowledge and abilities items were then rank ordered. A factor analysis (Principal Components Analysis) with an orthogonal (varimax) rotation on the data was chosen to test the structure of the proposed model.

Results

The response rate of the fully and correctly completed questionnaires was 51.72% (final sample size = 300 teachers). This was judged to be satisfactory, comparing it with the response rates of other similar studies (Lane et al., 1994; Smith-Sebasto & Smith, 1997). The findings of the survey indicated that according to the respondents' point of view, almost all the proposed knowledge items are important for a teacher involved in the implementation of environmental education (the mean values ranged between 4.70 and 3.49, see Table 1). The following items ranked highest: knowledge of "the philosophy, the aims and objectives of environmental education" (M = 4.70) and knowledge of "local environmental problems" (M = 4.69). Ranked lowest places were knowledge of "the history of environmental education" (M = 3.48) and knowledge of "the environment in arts and literature" (M = 3.88).

Item N°	Knowledge Items	M	s.d.
2	Philosophy, aims, and objectives of EE	4.70	50
23	Local environmental problems	4.69	.54
3	Essential concepts in EE	4.64	.56
16	Fundamental ecological concepts	4.62	.66
17	Role of humans and impact of societies on various environmental systems	4.62	.59
7	Stages in implementation process of an educational program in EE	4.61	.60
11	Sources of information in EE (such as bibliographies, resource people, educational centers for EE, etc.)	4.58	.59
14	Factors contributing to creation of a supportive learning climate in the EE process	4.52	.65
8	Teaching methods and techniques in EE	4.48	.69
15	Students' views and values about environment and specific environmental problems	4.46	.69
10	Available educational material for educational programs and activities in EE	4.44	.68
9	Evaluation methods and techniques in EE	4.38	.77
24	Global environmental problems	4.38	.63
22	Social environment issues	4.35	.73
5	Greek Ministry of Education's provisions and recommendations concerning EE implementation in secondary education schools	4.33	.85
18	Natural ecosystems	4.32	.70
19	Alternative management strategies for natural resources	4.27	.70
21	Cultural environment issues	4.26	.73
25	Ways of managing and resolving environmental problems	4.25	.72
29	Relationship between the environment and human psychological processing and well-being	4.23	.79
20	Urban environment issues	4.23	.74
6	Pedagogical models in EE	4.20	.81
13	Theories about a person's development in relation to her/his environment	4.20	.74
27	Environmental ethics and philosophy issues	4.14	.81
26	Issues in relation to economic development and the environment	4.10	.77
12	Theories of learning	4.08	.83
29	Relationship between EE and other dimensions of contemporary education	4.06	.81
28	Environmental law	3.99	.89
30	Environment in arts and literature	3.88	.89
1	History of EE	3.48	1.04

Table 1. Mean values (M) and standard deviations (s.d.) of percieved degree of relevance of knowledge items.

Respondents' perceptions about the degree of relevance of each of the 18 proposed abilities items for a teacher in environmental education were positive (the mean values ranged between 4.84 and 4.13, see Table 2). To be able to "cooperate in a team" was rated as the most essential ability for a teacher involved in the implementation of environmental education programs (M = 4.84). Teachers ranked lowest the ability "to design and conduct experimental research" (M = 4.13) and the ability to "arrange financial matters and bureaucratic procedures in the implementation of an educational program in environmental education" (M = 4.17).

Item N°	Abilities Items	M	s.d.
8	Cooperating in a team	4.84	.40
2	Designing and organizing educational programs and activities in EE	4.71	.51
9	Resolving problems and controversies among students	4.69	.56
7	Identifying students' needs and interests	4.67	.56
4	Coordinating the various pedagogical activities	4.63	.54
13	Making use of various sources of environmental information	4.58	.57
14	Interweaving environmental information and presenting it in a creative way	4.57	.59
18	Making appropriate use of speech and various teaching aids	4.52	.60
10	Self-evaluating her/his personal teaching practice in EE	4.51	.62
1	Selecting appropriate topics for educational programs in EE	4.46	.62
3	Making use of different teaching methods	4.46	.64
11	Exploring his/her personal values concerning environmental issues and problems	4.45	.64
5	Evaluating an educational program in EE	4.43	.64
12	Analyzing environmental issues and problems	4.39	.66
17	Making use of new information technologies in education	4.29	.79
16	Designing and conducting social research about environmental attitudes, views and behavior matters	4.24	.74
6	Arranging financial matters and bureaucratic procedures in implementation of an educational program in EE	4.17	.83
15	Designing and conducting environmentally related experimental research	4.13	.79

Table 2. Mean values (M) and standard deviations (s.d.) of the perceived degree of relevance of abilities items.

In the factor analysis performed on teachers' ratings of the 30 knowledge items, the three-factor solution was judged to be the most appropriate. The total variance explained by all three factors was 52.83%. Table 3 reports the knowledge items pertaining to each of the retained factors and their factor loadings. Factor 1 explained the greatest percentage of the variables' variance (39.47%) and had the highest eigenvalue (11.84). Eleven out of the fifteen knowledge items of Category D (Knowledge of Environmental Issues and Problems) were present in this factor, as well as one item (students' views and values about the environment and specific environmental problems) from Category C (Knowledge of Learning and Learners). Factor 2, with a much lower eigenvalue (2.54), was mainly represented by items which were initially grouped in Category B (Knowledge of the Teaching Practice and Evaluation in Environmental Education). Six out of the seven items came from this category, while the seventh (essential concepts in environmental education) came from Category A (Introductory Knowledge of Environmental Education). Finally, the 10 knowledge items of Factor 3 came from Categories A, C, and D, with Category D (Knowledge of Environmental Issues and Problems) having the strongest representation. Knowledge of "the environment in arts and literature" and knowledge of "the relationship between the environment and human psychological processing and well-being" had the highest factor loadings. After careful consideration of each factor's content we named them as follows:

- Factor 1: Fundamental ecological knowledge and knowledge of management of environmental problems
- Factor 2: Knowledge of teaching practice and evaluation in environmental education
- Factor 3: Knowledge of socio-cultural dimensions of the environment

Factor 1: Fundamental Ecological Knowledge and Knowledge of Management of Environmental Problems		Factor 2: Knowledge of Teaching Practice and Evaluation in Environmental Education		Factor 3: Knowledge of Socio-cultural Dimensions of the Environment	
Items N° & Content	Loading	Items N° & Content	Loading	Items N° & Content	Loading
19. Alternative management strategies for natural resources	.765	7. Stages in implementation process of an educational program in EE	772	30. Environment in arts and literature	.744
18. Natural ecosystems	.747	8. Teaching methods and techniques in EE	.735	29. Relationship between environment and human psychological processing and well-being	.649
20. Urban environment issues	.722	9. Evaluation methods and techniques in EE	.700	4. Relationship between EE and other dimensions of contemporary education	.573
26. Issues in relation to economic development and environment	.659	10. Available educational material for educational programs and activities in EE	.620	28. Environmental law	.571
25. Ways of managing and resolving environmental problems	.651	6. Pedagogical models in EE	.582	12. Theories of learning	.562
16. Fundamental ecological concepts	.649	5. Greek Ministry of Education's provisions and recommendations concerning EE implementation in secondary education schools	.577	27. Environmental ethics and philosophy issues	.560
24. Global environmental problems	.644	3. Essential concepts in EE	.571	13. Theories about a person's development in relation to her/his environment	.529
23. Local environmental problems	.636			21. Cultural environment issues	.518
17. Role of humans and the impact of societies on environmental systems	.631			22. Social environment issues	.511
15. Students' views and values about environment and environmental problems	.618			1. History of EE	.506
21. Cultural environment issues	.609				
22. Social environment issues	.604				
Eigenvalue: 11.84 Variance explained (%): 39.47 Cronbach á: .92		Eigenvalue: 2.54 Variance explained (%): 8.46 Cronbach á: .85		Eigenvalue: 1.47 Variance explained (%): 4.89 Cronbach á: .86	

Table 3. Three factors extracted from knowledge items.

Factor 1:		Factor 2:		Factor 3:	
Teacher's abilities in management of environmental information		**Teacher's abilities in management of EE programs**		**Teacher's abilities in management of interpersonal relations and self-appraisal of her /his teaching practice**	
Items N° & Content	Loading	Items N° & Content	Loading	Items N° & Content	Loading
15. Designing and conducting environmentally related experimental research	.803	4. Coordinating various pedagogical activities	.741	9. Resolving problems and controversies among students	.755
16. Designing and conducting social research about environmental attitudes, views and behavior matters	.789	3. Making use of different teaching methods	.702	8. Cooperating in a team	.707
18. Making appropriate use of speech and various teaching aids	.661	2. Designing and organizing educational programs and activities in EE (i.e. choice of educational aims and goals, choice of learning activities, scheduling, etc.)	.677	7. Identifying students' needs and interests	.656
12. Analyzing environmental issues and problems	.642	5. Evaluating an educational program in EE	.671	11. Exploring her/his personal values concerning environmental issues and problems	.614
14. Interweaving environmental information and presenting it in a creative way	.635	6. Arranging financial matters and bureaucratic procedures in implementation of an educational program in EE	.602	10. Self-evaluating her/his personal teaching practice in EE	.606
17. Making use of new information technologies in education	.556				
Eigenvalue: 7.65 Variance explained (%): 42.48 Cronbach á: .84		Eigenvalue: 1.42 Variance explained (%): 7.86 Cronbach á: .81		Eigenvalue: 1.09 Variance explained (%): 6.04 Cronbach á: .80	

Table 4. Three factors extracted from abilities items.

The three-factor solution was also chosen in the second factor analysis which was performed on the data on the 18 abilities items. The abilities items in the extracted factors and their factor loadings are reported in Table 4. Factor 1 explained the greatest percentage of the variables' variance (42.48%) and had the highest eigenvalue (7.65). All six items that appear in this factor came out of the originally proposed Category D (teacher's management of environmental information). Factor 2 had a much lower eigenvalue (1.42) compared to Factor 1. It was strongly represented by items which were initially grouped in Category A (teacher's management of environmental education programs). Factor 3, with a marginal eigenvalue of 1.09, resulted from a merging of Category B (teacher's management of interpersonal relations with and among students) with Category C (teacher's self-appraisal of teaching practice). There was no difficulty in interpreting Factors 1 and 2 as their content remained almost the same as those in Categories D and A respectively. The title given to Factor 3 was produced from a combination of those attributed to the originally proposed Categories B and C. Consequently, the three factors were named as follows:

- Factor 1: Teacher's abilities in management of environmental information
- Factor 2: Teacher's abilities in management of environmental education programs
- Factor 3: Teacher's abilities in management of interpersonal relations and self-appraisal of her/his teaching practice

Discussion

Apart from being an indication of the teachers' approval of the model's content, the fact that all the knowledge and abilities items of our hypothetical model of teachers' competence in environmental education were evaluated as highly contributory to environmental education practice by practitioners in environmental education also provides preliminary confirmation of the validity of our theoretical conception. Participants' positive ratings of almost all the proposed knowledge and abilities items in terms of relevance can certainly be attributed to the fact that all items selections were made on the basis of an extensive review of the related literature.

One of the criteria employed by the teachers in their evaluation of the relative importance of each knowledge item seems to be their perception about the practical usefulness of knowledge, that is, the degree of ease of transference to practice. The more theoretical a knowledge item, the lower it is ranked. These knowledge items had limited functional usefulness for teachers which has nothing to do with scientific validity (Eraut, 1994). The *sine qua non* knowledge base primarily consists of an understanding of the basic conceptual and axiological framework of environmental education, fundamental

knowledge of local environmental problems, and knowledge of the principles, processes, and techniques employed in environmental education practice.

As far as an environmental educator's core abilities are concerned, the respondents' views essentially follow the personalistic paradigm of educational practice (Zeichner, 1983). Interpersonal abilities are judged to be most important for an environmental educator. These are abilities that enable a teacher to gain a better understanding of the students to ensure better conditions of cooperation and communication with and among them. Respondents also ranked highly those abilities connected to the teacher's role as facilitator of learning and as information navigator and manager, abilities which are related to a socio-cognitive approach to educational practice. What respondents evaluated very low in the scale of relevance were abilities that were thought to be out of the realms of their pure pedagogical function, abilities related to the arrangement of financial matters and bureaucratic procedures in implementing an environmental education program, or abilities relevant to undertaking new roles like scientific researcher or user of new information technologies.

As far as our model structure is concerned, the study's findings led us to a modification of our initial proposition concerning the knowledge basis, while the proposed structure of the abilities basis remained to a large extent the same. The category of knowledge items which proved to be the most consistent in the respondents' perceptions was "Knowledge of the Teaching Practice and Evaluation in Environmental Education." This is probably because teachers consider these abilities as most directly contributing to environmental education practice, offering them the "technical know-how," or else the conceptual tools to proceed to the instructional design and implementation of an environmental education program (Sauvé, 1994).

Concerning the "environmental knowledge" thematic area, it was interesting to see the initially proposed category split in two, confirming the well-held distinction between the bio-physical and the sociocultural dimensions of the environment. The first knowledge category adopts an objective perspective of the environment, and environmental problems, and is based on a positivist epistemological approach. The second category's perspective emanates from the humanities and places emphasis on a socially constructed environmental reality and on the identification of the human and cultural factors contributing to its formation.

There were no great alterations in the initially proposed structure of teachers' abilities in environmental education. However, what is worth discussing is the merging of two of the initially proposed categories. The new, broadened category ("teacher's abilities in the management of interpersonal relations and the self-appraisal of teaching practice") refers to a set of abilities that form the basis of what we might call "emotional intelligence." These are inter-personal and intra-personal abilities which are thought to greatly contribute to quality performance in many fields of professional activity, including teaching.

While it is not quite clear whether they should be considered as a structural personality dimension or as basic technical skills susceptible to further development and improvement (Furnham, 1990), they are unquestionably perceived by respondents to be at the core of an environmental educator's competence.

Summary and Recommendations

Despite the fact that teachers cannot be regarded as experts in the sense of having broad theoretical and practical expertise, we strongly believe that their ways of thinking are of particular value and should always be taken into consideration by educational theorists and policy-makers (Hart, 1997). It was even more incumbent to do so in the framing of a theoretical model on teachers' competence in environmental education for ethical and substantive reasons. Summing up, the findings of the study indicate that there is a high degree of consensus on the part of the Greek environmental education practitioners concerning the model's content, and there should be some alterations in the initially proposed model's structure.

Of course, these conclusions should be taken only as a preliminary and partial indication of the validity of our proposed theoretical conceptualization. Further and more diversified empirical evidence is needed to be able to put forward a comprehensive and widely approved model of teachers' competence in environmental education. Therefore, we intend to replicate the study to check for any possible variations in teachers' perceptions, to submit the model to other target populations, such as school teachers in the elementary level, school counsellors, teacher educators, policy-makers, and environmental education practitioners in non-governmental organizations, so that additional and more diversified evidence is gathered for the validation of the model, and add an international scope by replicating the study in other countries to compare perceptions due to culture.

Apart from the apparent theoretical value of developing a conceptually complete and broadly approved model of teachers' competence in environmental education, the practical implication is that such a model could be used as a base for the design, development, and evaluation of teachers' training in environmental education. As we have already stated, teachers' professional development in environmental education has to be built on an agreed (by all interested groups) concept of teachers' competence in environmental education. Such a model could serve both as a theoretical frame of reference and as a practical guideline for policy-makers, teacher education providers, and evaluators. It could also assist teachers in reflecting on, assessing, and identifying their training needs. Finally, even though we acknowledge that we are only at the initial stage of the model's development, we believe that it can enrich ongoing local and international dialogue on the issue of teachers' empowerment and their professional education in environmental education.

Note

[1] Other approaches were those stemming from the behaviourist research tradition and those adopting a generic view of competence. (For a more detailed report, see Eraut, 1994).

Acknowledgments

The authors would like to thank Professor Antonios Danassis-Afendakis and Professor James Georgas from the Department of Philosophy, Education, and Psychology at the University of Athens, for their support and insightful comments throughout the design and implementation of the study. We also thank Assistant Professor Vassilios Yialamas from the Department of Early Childhood Education, for his assistance in the statistical analysis of the research data. The partial financial support from the National Foundation for Scholarships of Greece for conducting this study is also appreciated.

Notes on Contributors

Maria Daskolia teaches graduate courses in environmental education in the Department of Philosophy, Education, and Psychology at the University of Athens. She is also a research assistant in the Center for Environmental Education in the Faculty of Philosophy. She holds a masters degree in environmental psychology from the University of Surrey, UK, and a doctorate in environmental education from the University of Athens. Her current research interests are in the area of teachers' professional development in environmental education, the design and evaluation of teachers' preservice and inservice training in environmental education, informal and non-formal environmental education, environmental values education, and children's and adults' conceptualisations of the environment and environmental problems.

Evgenia Flogaitis is Associate Professor of environmental education in the Department of Early Childhood Education at the University of Athens. Her research interests focus on the development of educational material in environmental education, the evaluation of environmental education, teacher education, and students' understanding of concepts in environmental education. She has published several articles, books, and educational material in the field and has been the coordinator of many European research projects in environmental education.

References

Bennett, N. (1997). *The acquisition and development of core skills in higher education and employment*. Paper presented at the 7th European Conference for Research on Learning and Instruction, Athens, Greece, August 26-30.

Ben-Peretz, M. (1995). Curriculum of teacher education programs. In L.W. Anderson (Ed.), *International encyclopedia of teaching and teacher education* (2nd Edition) (pp. 543-547). Oxford: Elsevier.

Chung, R.G. (1991). *Inservice training for incorporating environmental education into the industrial/vocational education system at the secondary education level in Taiwan the R.O.C.* Unpublished doctoral thesis, Iowa State University, USA.

Daskolia, M.K. (2000). *Secondary education teachers' in-service training needs in environmental education*. Unpublished doctoral thesis, Faculty of Philosophy, Education, and Psychology. University of Athens, Greece.

Engleson, D.C. (1987). Recent Wisconsin initiatives in environmental education. In J.M. Stone (Ed.), *Environmental education: Transition to an information age*. Proceedings of the Annual Conference of the North American Association for Environmental Education (pp. 123-127). Troy, OH: NAAEE.

Eraut, M. (1994). *Developing professional knowledge and competence*. London: Falmer.

Fien, J. (1991). Accepting the dual challenge for professional development in Environmental Education. *The International Journal of Environmental Education and Information*, *10*(1), 1-18.

Furnham, A. (1990). A question of competency. *Personnel Management*, *6*(June), 37.

Glasgow, J. (1996). Environmental education in the formal system: The training of teachers. In W. Leal Filho, Z. Murphy, & K. O'Loan (Eds.), *A sourcebook for environmental education: A practical review based on the Belgrade Charter* (pp. 72-91). London: Parthenon.

Grossman, P.L. (1995). Teachers' knowledge. In L.W. Anderson (Ed.), *International encyclopedia of teaching and teacher education* (2nd Edition) (pp. 20-24). Oxford: Elsevier.

Hart, P. (1997). Teachers' ideas about environmental education. In R. Abrams (Ed.), *Environmental education for the next generation: Professional development and teacher training. Selected papers from the 25th Annual Conference of the North American Association for Environmental Education* (pp. 184-188). Troy, OH: NAAEE.

Hungerford, H. & Peyton, R.B. (1986). *Procedures for developing an environmental education curriculum*. Paris: UNESCO-UNEP.

Jacobson, W.J. (Ed.). (1985). *Environmental education: Module for in-service training of social science teachers and supervisors for secondary schools. Environmental Education Series 10*. Paris: UNESCO.

Kuechle, J. & Carlson, S. (1997). Minnesota teacher prep project in environmental education. In R. Abrams (Ed.), *Environmental education for the Next generation: Professional development and teacher training. Selected papers from the 25th Annual Conference of the North American Association for Environmental Education* (pp. 222-226). Troy, OH: NAAEE.

Lahiry, D., Sinha, S., Gill, J. Mallik, U., & Mishra, A. (1988). *Environmental education: A process for pre-service training curriculum development*. Paris: UNESCO-UNEP.

Lane, J., Wilke, R., Champeau, R., & Sivek, D. (1994). Environmental education in Wisconsin: A teacher survey. *Journal of Environmental Education*, *25*(4), 9-17.

Messick, S. (1984). The psychology of educational measurement. *Journal of Educational Measurement*, *21*, 215-238.

Nicholas, J., Oulton, C., & Scott, W. (1993). Teacher education for the environment: A comparative view from Australia and the UK. *International Journal of Science Education*, *15*(5), 567-574.

Oulton, C. & Scott, W. (1994). Improving teachers' contribution to environmental education. *Journal of Teacher Development*, *3*(1), 23-29.

Peyton, B., Hungerford, H., & Wilke, R. (1980). Epilogue. In M. Bowman & J. Disinger (Eds.), *A diagnosis and prescription in case studies of teacher education programs for environmental education* (pp. 189-196). Columbus, OH: ERIC/SMEAC.

Sauvé, L. (1992). *Éléments d' une théorie du design pédagogique en éducation relative à l' environnement*. Thèse de doctorat (PhD), Université du Québec, Montréal, Canada.

Sauvé, L. (1994). *Pour une éducation relative à l' environnement. Éléments de design pédagogique*. Montréal: Guérin.

Simmons, D. (1995). Developing a framework for environmental educator performance standards. Working paper #3. In D. Simmons (Ed.), *The NAAEE standards project: Papers on the development of environmental education standards* (pp. 60-94). Troy, OH: NAAEE.

Smith-Sebasto, N.J. & Smith, T.L. (1997). Environmental education in Illinois and Wisconsin: A tale of two states. *Journal of Environmental Education*, *28*(4), 26-36.

Stapp, W. B. (1975). Preservice teacher education. In N. McInnis & D. Albrecht (Eds.), *What makes education environmental*? Louisville, KY: Data Courier.

Tamir, P. (1990). Teachers' knowledge. In T. Husen & T.N. Postlethwaite (Eds.), *The international encyclopedia of education, research and studies, Supplement, Volume 2* (pp. 652-656). Oxford: Pergamon.

Tilbury, D. (1993). *Environmental education: Developing a model for initial teacher education*. Unpublished doctoral thesis. University of Cambridge, UK.

United Nations Educational, Scientific and Cultural Organization-United Nations Environment Program (UNESCO-UNEP). (1988). *International strategy for action in the field of environmental education and training for the 1990s*. Paris: UNESCO.

UNESCO-UNEP. (1990). Environmentally educated teachers: The priority of priorities? *Connect*, *25*(2), 1-3.

Volk, T.L. (1987). Teaching teachers to teach environmental issues. In J.M. Stone (Ed.), *Environmental education: Transition to an information age. Proceedings of the Annual Conference of the North American Association for Environmental Education* (pp. 118-123). Troy, OH: NAAEE.

Wilke, R., Peyton, R.B., & Hungerford, H. (1987). *Strategies for the training of teachers in environmental education*. Paris: UNESCO-UNEP.

Wood, R. & Power, C. (1987). Aspects of the competence-performance distinction: Educational, psychological and measurement issues. *Journal of Curriculum Studies*, *19*(5), 409-424.

Zeichner, K.M. (1983). Alternative paradigms of teacher education. *Journal of Teacher Education*, *34*(3), 3-9.