

Soft Systems Methodology and Problem Framing: Development of an Environmental Problem Solving Model Respecting a New Emergent Reflexive Paradigm

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Abstract

Problem solving models in environmental education are numerous and diverse due, in part, to the existence of different research paradigms in environmental education. This paper aims at identifying the more representative educational models in relation to the main trends of research in environmental education and the particular nature of the process of complex problem solving.

We suggest, in this paper, that a reflexive paradigm is actually emerging in environmental education. Since most existing models provide little space for defining the problem, and promoting relationships between experts and novices which are felt to be problematic, they are not compatible with this new reflexive perspective. The peculiar strategy for defining a problem situation using the *Soft Systems Methodology* could be added to environmental education activities explicitly dedicated to the development of critical thinking. The results would then enable educators to actualize this emerging paradigm in their practice.

Résumé

En éducation relative à l'environnement, les modèles de résolution de problèmes sont nombreux et divers. Cela s'explique en partie par l'existence de différents paradigmes de recherche en ERE. Cet article vise à identifier les modèles éducationnels les plus représentatifs en relation avec les principales tendances de recherche en ERE et la nature particulière du processus de résolution de problèmes complexes. Les auteurs de cet article observent qu'un paradigme réflexif est actuellement en émergence en

éducation relative à l'environnement. Puisque les modèles existants offrent peu d'espace pour définir le problème et induisent des relations problématiques entre experts et novices, ils ne sont pas compatibles avec la nouvelle perspective réflexive. La stratégie particulière de définition d'une situation-problème proposée par la Méthodologie des Systèmes Souple pourrait être intégrée aux activités d'ERE explicitement vouées au développement de la pensée critique. Les résultats seraient de nature à rendre les éducateurs aptes à actualiser ce paradigme émergent dans leur pratique.

Environmental education is widely believed to be one of the key answers to environmental crises. This brought the UNESCO to define environmental education as :

a permanent process in which individuals gain awareness of their environment and acquire the knowledge, values, skills, experiences, and also the determination which will enable them to act—individually and collectively—to solve present and future environmental problems. (Schneider, 1993, p. 25)

This definition "is the object of a consensus among the majority of the theorists in environmental education . . . [But] . . . most of them have developed on their own a more personal definition of EE, forming the basis of the theoretical framework they have adopted" (Sauvé, 1994, p. 52). For example, the OECD (1994) adds "as well as to meet their needs without compromising those of future generations" (Schneider, 1993, p. 25) to include the concept of sustainable development. This is why there are so many models (see Joyce & Weil, 1980) and strategies in environmental education, all claiming to be true to the spirit of the UNESCO-UNEP definition.

From this definition of environmental education we understand that the solving of "present and future environmental problems"¹ is one of its main goals. Sauvé (1992, 1994), who did a meta-analysis of pedagogical models in environmental education, also believes that "problem solving is at the heart of the global process in EE" (Sauvé, 1994, p. 138). Thus, the problem solving process seems very appropriate, interesting, and relevant to environmental

education. But, how does this strategy translate in practice? Of all the models proposed for problem solving in environmental education, is there one which is more pertinent, more adequate, for environmental education?

Answering these questions is not simple, since the interpretation of any finality of environmental education, as of anything else relating to this field, depends largely on the paradigm espoused (Robottom & Hart, 1993). Since such interpretations greatly influence the shape specific models have taken, we need to consider the paradigm to which a given model belongs at the same time as we consider its particularities.

Luckily, such a task is facilitated by a recent publication on the principal trends of problem solving in environmental education (Bardwell, Monroe, & Tudor, 1994) where a continuum is generated which describes four of the most tentative models. We can draw a parallel between this continuum and another continuum produced with the conventional research paradigms in environmental education (Robottom & Hart, 1993; Stevenson, 1993). This should enable us to determine the paradigm toward which existing models lean, thus giving us a better picture of the limits and possibilities of these models.

Paradigms and Models in Environmental Education

What are the conventional research paradigms? The first paradigm is based on positivistic and reductionist perspectives and came to dominate the vision of education in the western countries. However, these perspectives present: "grave weaknesses that cannot be dissociated from social and environmental degradation in western societies, and probably in other societies where they have been applied" (Schreuder, 1994, p. 35). This increasingly shared opinion has prompted many authors to question the usefulness of the conventional positivistic perspectives (also called positivistic-behaviourist) for research in environmental education (Robertson, 1994; Robottom & Hart, 1993). As a result, other paradigms have emerged.

The interpretative-constructivist paradigm represents a first alternative where knowledge is seen in terms of personal constructs, issued from subjectivity, perceptions, and social

interactions. In this paradigm, knowledge is interpreted through the researcher's understanding of the subject who produced it (Hoffman, 1994; Robottom & Hart, 1993). The major goal of this paradigm is to describe and explain the social interactions, not to generalize findings. It seeks more "to inform rather than change practice" (Stevenson, 1993, p. 7), and it "encourages people to change the way that they think about what they are doing, rather than suggest ways in which they can and should change what they are doing" (Carr & Kemmis, 1983, p. 98).

A second alternative is the social critique paradigm, which also has a constructed conception of knowledge. However, socio-critical research does not limit itself to interpreting the construction of knowledge, but aims also at emancipating oppressed people by enlightening and empowering them (Fien, 1993; Robottom & Hart, 1993; Stevenson, 1993). This latter paradigm is more concerned with changing the practices of participants than the interpretative-constructivist paradigm.

Now, if we compare these paradigms as identified by Robottom and Hart (1993) with the four models selected by Bardwell et al. (1994) (see Figure 1), we find that models which are well structured, where the action is controlled by the teacher, and which require that the investigation of the problem be completed before proceeding to any action can be said to belong to the positivistic-behaviourist paradigm. The models which are less structured, where the teacher is more of a co-learner and where action helps defining the problem could be seen as fitting with the social critique paradigm. The other models position themselves somewhere in-between, being closer to the interpretative-constructivist paradigm than the others.

From this comparison, we can already express some reservations toward models similar to the one of Winther, Volk, and Hungerford (1994), whose work is qualified by Robottom & Hart (1993) as a "prime example" of positivistic stance in environmental education. Effectively, the positivistic-behaviourist approach suffers from weaknesses giving it very little chance of producing the desired changes in environmental

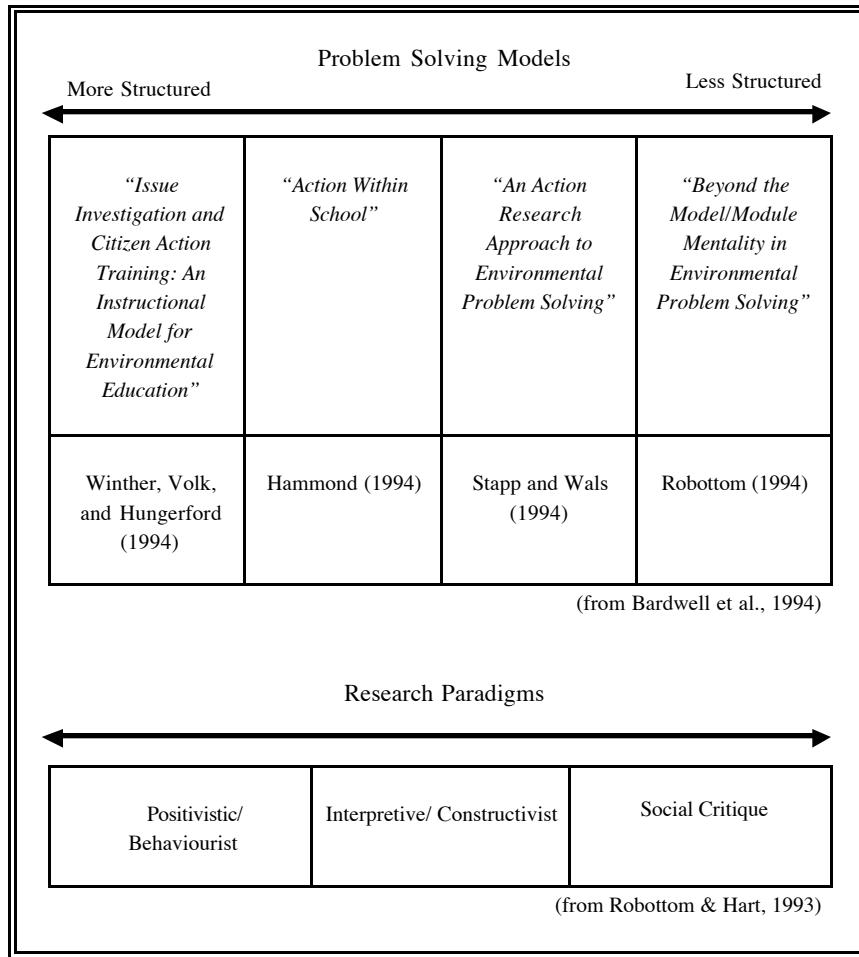


Figure 1. Continuum of problem solving models and of research paradigms in environmental education.

education. For one, its deterministic framework "... imposes the researchers' environmental, educational and social values . . . on pupils and teachers in a way that is fundamentally disempowering" (Robottom & Hart, 1993, p. 42). This acts against the development of independent critical thinking skills, an important goal of environmental education (UNESCO, 1978). Another problematic aspect of this paradigm is its assumption that

knowledge is value free, causing it to disregard many of the moral, ethical, political, and economic implications pertaining to environmental problems (Horton & Hanes, 1993; Robertson, 1994). This position generates the view that curriculum change is “a purely technical or behavioral concern requiring that teachers become competent in implementing the ideas of external curriculum developers” (Stevenson, 1993, p. 6). Many authors consider this view to be, at least in part, at the roots of “a long history of failures of curriculum reform efforts” in environmental education (Stevenson, 1993; Robottom & Hart, 1993; O’Donaghue & McNaught, 1991).

These shortcomings are not superficial and easily fixed but reside in the very nature of the positivistic paradigm:

this model of change is unlikely to result in anything more than the semblance of reform: the empirical-analytic model of research on which it draws has design features which allows it only to describe and predict the expected. (van Rensburg, 1994, p. 12)

Consequently, this model would be best set aside. But, what about the remaining models? Are they equally relevant for the promoting of environmental problem solving? To answer this, let’s consider the nature of environmental problems.

The Nature of Environmental Problems

What are the characteristics of environmental problems? Environmental problems originate from social practices and the values held by people and societies (van Rensburg, 1994; Bardwell et al., 1994). They are “socially constructed, in terms of their conceptualized effects on human individuals, groups and other living things and systems” (Robertson, 1994, p. 29). In other words, environmental problems do not exist by themselves but are perceived and conceived as such by observers through a cultural system of beliefs and values.

Environmental problems are also complex. Bardwell et al. (1994) identify five dimensions constitutive of this complexity:

- their multidisciplinarity;
- the different possible ways of looking at them;

- the lack of information concerning them, or their inconsistencies;
- the necessity of group interaction for decision making; and
- the fact that the solutions themselves are often controversial and value laden.

This complex nature of environmental problems calls for the development of critical thinking skills and of the more complex reflexive competencies, as already stated by the UNESCO (1978). A recent empirical study by van Rensburg (1994) on environmental education, and on the research taking place in this field, described the importance that critical thinking (or reflexivity) is increasingly acquiring in environmental education. In her study, four orientations relating to environmental education are identified. These orientations can be illustrated through four metaphors:

- change as restoring order—the management orientation;
- change as the resolution of practical problems—community problem solving and liberalism;
- change as reconstruction—a critical orientation; and
- reflexivity and social processes of change.

The first three of these orientations seem to share features characterizing modernity and can be associated with the research paradigms of environmental education (1-positivism, where the view of research is instrumentalist and objectivist, 2-interpretative, where the view of research is subjectivist and constructivist, and 3-social critique, where the view of research is reconstructivist and emancipatory [Robottom & Hart, 1993]). Since such features, like scientism, consumerism and individualism (Beck, 1992; Robottom, 1991), appear to be at the roots of the environmental crisis, van Rensburg (1994) proposes to challenge them by promoting what she defines as a “reflexive reconceptualisation of ways of engaging with the environment crisis” (p. 17). This is found at the core of the fourth orientation.

The recognition of a possible fourth alternative is not something new. Robottom and Hart (1993) themselves distinguish, in their work, a post-positivist tendency. Gough (1987) believes that the distinctions of education *in*, *about* or *for* the environment (other names for the three paradigms) are too centered on the *objects* of

environmental education and advocates instead a shift of attention to the *interrelationships* in environmental education. He prefers to talk of education *with* the environment, more in line with a post-modernistic and ecological worldview. Another empirical study, done in Germany by Eulefeld (1995), also identifies four conceptions of environmental education among its practitioners which are labeled the cognitive, the emotive, the system-critical and the cognitive-experiential models. Could this empirical study, along with van Rensburg's, be pointing to the emerging of a new paradigm in environmental education, one which could be termed the "reflexivity paradigm"? We think so. Other authors are also beginning to feel the need for such a perspective in environmental education research, as the "development for responsible societies" of L. Sauvé (personal communication, 1995) or the "critical thinking perspective in EE" of Guilbert and Bader (1993) can attest.

The fourth orientation, concerned with "broad processes of social transformation through 'critical and contextual review and action'" (van Rensburg, 1994, p. 14), could thus represent the transposition of this reflexivity paradigm² in socio-cultural contexts. It brings the environmental issues to the open, allows people to debate them, and refers to a conceptualization of environmental education where history, global and local socio-ecological context, as well as the political, economic, bio-physical and social dimensions of environmental issues are considered. Promoting a process of active learning composed of reflection, encounters (with the issue), and dialogues (O'Donoghue, 1993), this orientation favors the development of critical thinking among participants.

A problematic aspect of the first three orientations relates to the roles of the expert and of the novice. Defined in relation with the problem solving process, the experts are the persons who have a certain amount of familiarity with the field related to the problem and can "foresee consequences, new problems that might arise, and the implications of the solutions they propose," while the novices are the ones who "find it difficult to sort through information to determine what is important and how the different parts may fit together" (Bardwell, 1991, p. 606). In the pedagogical models, the expert would be the teacher or facilitator and the novices would be the learners or participants.

The relative importance of each of these types of actors differs in the management orientation (expert driven), the community

problem solving orientation (novice driven when implemented in the spirit of the interpretative paradigm according to van Rensburg, 1994), and the critical orientation (where the expert rationally seeks to “enlighten and empower individuals, particularly those who are disadvantaged or oppressed” [Stevenson, 1993, p. 7]). However, their relationship seems to create an obstacle to successful environmental education in each of these approaches. The expert driven, top-down, and conventional research, development, dissemination, and adoption process (RDDA) has failings which prevent it from inducing meaningful changes (O'Donoghue & McNaught, 1991). The changes produced by a novice driven process tend for its part to be only superficial reforms, novices being unable to recognize the constraints on action which have deep and wide systemic roots (Popkewitz, 1984). As for the third orientation, the expert faces “contradictions in the twin roles of group leader/research initiator on the one hand, and ‘facilitator for empowerment’ on the other” (van Rensburg, 1994, p. 13). This difficulty is highlighted in the analysis, done by Greenall Gough and Robottom (1993), of a project on environmental issues involving many schools. They found that “there was little negotiation [between the teachers and the students] once the study was under way” and “the study appeared at some times and at some schools to be teacher dominated” (p. 314). In contrast, in the reflexivity orientation, both expert and novice collaborate to challenge the dominant worldview of modernity within their community, each bringing knowledge to construct a definition of the environmental problem being investigated.

In light of this new perspective in environmental education, models which explicitly aim at promoting critical thinking (which we previously classified as leaning toward the social critique paradigm) appear more pertinent than the ones only interested in understanding the interactions of the social system (which we associated in Figure 1 with the interpretative-constructivist paradigm). But, are these existing models compatible with the reflexive perspective? To answer this question, we need to analyze the multiple stages inherent in the process of complex problem solving and ascertain the place of reflexivity.

Problem Solving Process

Bardwell et al. (1994) describe three steps in the process of problem solving :

1. *Exploring and defining the problem (or problem-framing)*: where a representation of the problem is built;
2. *Searching for and identifying solutions*: where information is gathered and accessed, and a possible solution is selected by experimentation or by trial and error; and
3. *Implementing an action and evaluating progress*: where initial goals are compared to the chosen solution and the following implementation is monitored.

We can represent this process as a cognitive map made of a problem space and a solution space (Bardwell, 1991; Bardwell et al., 1994). The first step, the construction of a representation of the problem, takes place in the problem space. The second and third steps of the process happen in the solution space. Reflexivity should play as central a role during the construction of the problem's representation, by describing its history and context through multiple perspectives, as during the debate on the possible solution to adopt and its subsequent implementation.

Sadly, most problem solving models in environmental education (including the ones fitting with the social critique paradigm) are designed to rapidly bring the participants to the solution space, spending little time in the problem space (Bardwell et al., 1994). This diminishes reflexivity since the natural tendency of any learner is to try to solve the problem through his personal perspective rather than through a less familiar scientific, social science, or political vantage (Fleming, 1986; Solomon, 1984). Since none of these models "adequately encourages learners to stay in the problem space and develop a problem definition from several perspectives . . . students will have difficulty framing multidisciplinary problems" (Bardwell et al., 1994, p. 84) and, from our viewpoint, developing strong sense critical thinking.

Not only is there a need for envisioning the problem through multiple perspectives, an important aspect of critical thinking (Paul, 1990), but many authors also recognize that the crucial part of problem solving is precisely the construction of a definition (Posner,

1973; Sanford, 1985), especially when dealing with complex or “ill-defined” problems:

it is necessary to provide more time for thought on the conditions and the methodology of the formulation of the complex problems, since it is this formulation which determines the relevancy of the strategies used for solving them. In summary, the solving of complex problems depends mostly on the way they are defined. (Mellouk, 1993, p. 139)

In other words, since they pay little attention to the problem space, social critique related models, of which Robottom is a representative (Greenall Gough & Robottom, 1993), are deficient in regard to the amount of reflection they promote when defining the problem. Does a problem solving model with the needed emphasis to the construction of a problem definition exist in another field? A model from the field of systemics, the *soft systems methodology*, seems to present this important feature (Checkland & Scholes, 1990; Checkland, 1981).

Soft Systems Methodology

Soft systems methodology deals with human activity systems in opposition to natural, designed physical and designed abstract systems (Checkland, 1981). Human activity systems can be easily constructed, modified or improved. They represent groups of unified activities through their goals, their aims, or the human wills generating them (Mellouk, 1993). Human activity systems can be:

manifest only as perceptions by human actors who are free to attribute meaning to what they perceive. There will thus never be a single (testable) account of a human activity system, only a set of possible accounts all valid according to particular *Weltanschauung*.³ (Checkland, 1981, p. 14)

Since one human activity system is constituted of a number of representations, it is not rare that a feeling of inadequacy between what is perceived as “taken place” and what is perceived as “being desirable” appears among its actors. This kind of problem is usually very difficult to define and is characterized as complex, “ill-

structured," or "soft." Checkland (1981) talks about *problem situations* presenting the following characteristics:

- all complex *problem situations* are constructs;
- the conceptualization of the *problem situation* always depends on the perceptions and the perspectives of people and cannot be tested or validated through empirical surveys;
- the perceptions of the *problem situation* depend on the world view (*Weltanschauung*) of a person and, so, derives from the interplay of values, norms, convictions and other cultural, social, and personal referents;
- the *problem situation* is neither rigorously definable nor accessible through a single "scientific" path. This is why we cannot really speak of solutions to *problem situations*, only of improvements, which are relative to the world view used.

These characteristics concur with the conception of what is a complex problem in a Piagetian constructivist framework (Mellouk, 1993) as well as the proposed socially constructed nature of environmental problems (Robertson, 1994). In other words, environmental problems can also be described as "soft problems."

Two versions of the soft systems methodology exist. The older one, due to its epistemological position, its phenomenological focus on representations, and its neglect of power struggles and social inequities, has been classified by Jackson (1982) as belonging to the interpretative paradigm. The newer one, a more complex methodology considering both historical and cultural aspects in defining the *problem situation*, gives a greater role to critical thinking. If we also consider the place left in this version for debating and exploring the *problem situation*, we can see that this methodology has a lot in common with the fourth orientation of van Rensburg (1994). The emphasis it gives to the problem space and to critical thinking makes it an excellent candidate for reflexive problem solving in environmental education.

Expectedly, the soft systems methodology is not perfect. Some of its fundamental characteristics severely limit its direct transposition to environmental *problem situations*. For one, the soft systems methodology is concerned with only one system at a time, while environmental problems are the results of interactions between many. Another difficulty is the excessive importance of the

expert at the system modeling step, which limits the participation of the novices (Macadam, Van Asch, Hedley, Pitt, & Carroll, 1995), in opposition with its stated role in the reflexive orientation. Nevertheless, we think that the part of this methodology in charge of defining the *problem situation* can be used to improve models in environmental education and make them more compatible with the reflexive paradigm. Such an adaptation of a methodology to fit a new paradigm is not without precedents. For example, the process of action research was first designed by Lewin to meet aims and methods best described as “belonging to positivistic science (determinist, technicist)” (Kemmis, 1988, p. 43). It is now one of the main methodologies of the social critique paradigm.

Defining the Problem Situation with the Soft Systems Methodology

In its simplest version, the soft systems methodology is a process made of seven iterative and non-sequential steps. Through these steps a researcher-expert investigates a *problem situation* in concert with novices-actors from the human activity system. He/she words it, develops a structural definition of the system according to a chosen perspective and proposes a representation of its functioning. He/she then proceeds by comparing this representation with the operation of the system in “reality.” Discrepancies are then identified and used to feed a debate among the participants. The goal of this exercise is not to improve or implement the theoretical representation but to generate desirable and feasible changes to the system. This representation is only a means to achieve valued improvements and not an end in itself.

In the extended version, investigating and defining the *problem situation* must be done through a cultural dimension, which includes the analysis of the intervention, as well as of the social and political systems (Checkland & Scholes, 1990). Throughout the entire process, the historical background must also be taken in account. This investigation results in a root definition of the system, useful for the selection of a pertinent solution to the “soft” problem studied. The wording of this definition must be collective, since social interactions are key elements of any construction based on the perceptions, the interpretations, and the behaviors relating to the

situation (Bouchard, Boucher et Gélinas, 1984). This extreme importance to the appropriation of the process by the actors follows the spirit of a real reflexive and critical approach.

As a way of applying the soft systems methodology to environmental education, we propose that this defining of a *problem situation* be integrated to a process of research action. Since an environmental problem involves many human activity systems (HAS), a root definition should be produced for each of them. One possible way to achieve this is by identifying for each human activity system the six following characteristics:

- Customers: beneficiaries or victims of the system's activities;
- Actors: the agents carrying, or causing the main activities of the system to be carried;
- Transformation: the process applied to the inputs of the system;
- Weltanschauung: the world view which provides a given meaning to the HAS;
- Ownership of the system: an agency who has a prime concern for the system and the ultimate power to cause the system to cease to exist;
- Environmental constraints: the system's environments and/or wider systems which it has to take as a "given." (Checkland & Scholes, 1990)

In addition to this, the three basic learning activities of the reflexive approach (encountering, dialoguing, and reflecting) should be put in practice to induce a mutual appreciation between both expert and novice of their respective knowledge, values, and beliefs. In this way, the excessive importance given by the soft systems methodology to the expert would be attenuated in our proposed model.

Conclusion

To sum up, problem solving is an educational strategy which could enable educators to achieve some of the main purposes of environmental education. Many models exploiting this strategy exist; however, their specifics vary greatly, depending on which of the three conventional paradigms they rely upon. Due to the complex, and socially constructed, nature of environmental

problems, it is the models explicitly aiming at developing critical thinking in participants which seem especially interesting from the outset.

Nevertheless, after some considerations, none of these models, frequently associated with the social critique paradigm, appear to really induce strong sense critical thinking. This is due mainly to the fact that they do not incite problem solvers to explore in depth the issue investigated nor to frame it in different ways through different perspectives. This led to the development of a fourth orientation among practitioners in environmental education, an orientation more concerned with reflexivity and social processes of change. We interpret this as the emergence of a new paradigm, based on critical thinking and reflection.

This reflexive paradigm also proposes an answer to the problematic dimension of the relationship between expert and novice. The three orientations related to the conventional paradigms all have a conception of expert and novice roles which can adversely affect their interactions. In opposition, this new emerging perspective conceives of the roles of the expert and the novice differently, with both roles being seen as equally essential and complementary.

Finally, since none of the existing models present the characteristics which would make them compatible with the emerging reflexive paradigm, we have developed a new model. This model integrates the first steps of the soft systems methodology to activities associated with action research resulting in more emphasis being put on problem framing. Our model is not a set of pre-defined steps to simply be implemented but instead aims at promoting active learning by favoring reflection, encounters with environmental issues, and dialogue. It must be conceived more as an open-ended process inspired by the postulates of the reflexive paradigm than as a prescriptive, designed-in-advance teaching intervention. It may be composed of any activities which can promote greater collegiality between the expert and the novice by respecting their mutual knowledge, values, and beliefs during the solving process. In this way we believe environmental educators will be able to develop useful complex problem solving competencies in learners.

Notes

¹ Throughout this article we use “environmental problem” since we will be referring to the environmental problem solving process, but the term “environmental issue” would be more accurate.

² A paper is in progress from our perspective about this reflexive paradigm. Since it is emerging, its characteristics are not yet defined and trying to do so at this moment would prevent the necessary debate that we feel needs to take place regarding its definition. Nevertheless we have mentioned some of the possible characteristics that we feel could shape it. Its epistemology would be constructivist, not supportive of a critical or modified realism, replacing any notions of falsehood and truth with the one of “viability” (Robertson, 1994). Its learning theory, relevant to that epistemology, would be socio-constructivist (Gilly, 1989; Pontecorvo, 1988) instead of reconstructivist as for the social critique paradigm (Robottom & Hart, 1993). Finally, the nature of environmental problems would be in the line of a social constructionist conception, where the environment is seen as “a site of intersecting and competing social and cultural definitions and interests” (Hannigan, 1995, p. 185) without referring to an evolution of society from a dominant paradigm to a new ecological paradigm (Fien, 1993). While not precluding the “arrival of an ecologically kinder and gentler society, [...] it cautions that environmental issues and problems constantly rise and fall as do our definitions and understandings of nature, ecology, risk and other elements of the environment-society nexus” (Hannigan, 1995, p. 185).

³*Weltanschauung* is defined by Checkland as the world view which provides a meaning of a system for a given person.

Notes on Contributors

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