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Environmental education for sustainable management of the basins of the rivers Pirapó, Paranapanema III and Parapanema IV

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(With 1 figure)

Abstract

The growing concern about the quantity and quality of water has led managers and researchers from various countries to concentrate efforts in the study, planning and management of watersheds, considered appropriate units for the rational and sustainable management of water resources. This experience report presents results of the *Program for Communication, Environmental Education and Social Mobilization*, which is part of the project "Monitoring Network of the basins of the rivers Pirapó, Paranapanema III and Paranapanema IV – analysis and monitoring of the hydrological behavior", developed by a multidisciplinary team of researchers and graduate students of the State University of Maringá (Paraná, Brazil). The goals of the program were: a) To develop continuing education for teachers of basic education, active in state schools located in the basins studied; b) To raise awareness and to promote training of various local social actors; c) To produce educational and promotional materials for teachers and general community, respectively. The methodology was the action research, on the basis of collaborative work between university researchers and participants of the program. The results evidence that teachers and representatives of different social groups had a limited view of issues related to water resources of their region. Courses, workshops and itinerant exhibitions, beyond teaching aids and promotional material prepared by the group of researchers and graduate students contributed to broaden the view of social actors about watersheds to which they are part, from the perspective of an active, critical and responsible participation focused on sustainable use and management of water resources.

Keywords: watershed, environmental education, water resources, sustainability.

Educação ambiental para a gestão sustentável das bacias hidrográficas dos rios Pirapó, Paranapanema III e Parapanema IV

Resumo

A crescente preocupação em relação à quantidade e qualidade da água tem levado gestores e pesquisadores das várias nações a concentrarem esforços no estudo, planejamento e gerenciamento das bacias hidrográficas, consideradas como unidades territoriais adequadas para a gestão racional e sustentável dos recursos hídricos. O presente relato de experiência traz resultados do Programa de Comunicação, Educação Ambiental e Mobilização Social, que faz parte do projeto "Rede de Monitoramento das Bacias dos rios Pirapó, Paranapanema III e Paranapanema IV – Análise e Monitoramento do Comportamento Hidrológico", desenvolvido por um grupo multidisciplinar de pesquisadores e pós-graduandos da Universidade Estadual de Maringá (Paraná – Brasil). Os objetivos do programa foram: a) Desenvolver a formação continuada de professores do ensino básico, atuantes nas escolas estaduais localizadas nas bacias em estudo; b) Promover a sensibilização e a capacitação dos diferentes atores sociais locais; c) Produzir material didático e de divulgação para, respectivamente, professores e comunidade em geral. A metodologia de trabalho foi a pesquisa ação, com base no trabalho colaborativo entre os pesquisadores da universidade e participantes representativos do programa. Os resultados obtidos evidenciam que professores e representantes de diferentes segmentos sociais tinham uma visão limitada das questões relacionadas aos recursos hídricos de sua região. Os cursos, oficinas e mostras itinerantes realizadas, além do material de apoio didático e de divulgação elaborados pelo grupo de pesquisadores e pós-graduandos contribuíram para que os vários atores sociais pudessem ampliar sua visão sobre as bacias hidrográficas das quais fazem parte, na perspectiva de uma participação ativa, crítica e responsável voltada ao uso e gestão sustentável dos recursos hídricos.

Palavras-chave: bacia hidrográfica, educação ambiental, recursos hídricos, sustentabilidade.

1. Introduction

The XXI century began with the concern that water, a resource of universal use, may become increasingly scarce and inappropriate for consumption in various regions, to the point of compromising the sustainability of life on the planet (Seckler et al., 1999; Tundisi, 2009).

Data from institutions and specialized organizations indicate an overview of risks and uncertainties regarding freshwater at a global level for the next decades if effective measures are not taken from the perspective of rational and integrated management of this resource (WWAP, 2012).

In this context of crisis, United Nations Organizations (ONU) has striven in creating public policies focused on the management and conservation of water in national and global levels. In 1992, during the United Nations Conference on Environment and Development (UNCED), the General Assembly established the World Water Day, March 22nd, to be celebrated annually with a view to draw attention of society to the problem of fresh water and the importance of sustainable management of this natural resource. Among various initiatives, its representatives declared the decade 2005-2013 as the decade of Water for Life, with the objective of supporting several countries to face problems related to water resources, and established the year 2013 as the UN International Year of water cooperation, by recognizing that cooperation between people and nations is critical for fair and equitable water distribution, considering the needs and priorities of each community or region.

With privileged position in terms of availability of water resources, Brazil holds approximately 12% of the fresh water available for human consumption on the planet, but is facing problems related to the uneven distribution of water resources (higher concentration in the northern region, where there is lower demographic density and therefore less consumption), waste, and also to pollution and poor management in urban areas and regions with intensive industrial and agricultural activities (ANA, 2012).

Considering the increasing concern about the quantity and quality of water, managers and researchers from various countries have concentrated efforts in the study, planning and management of watersheds, considered appropriate units for the rational and sustainable management of water resources (Sharma et al., 1998; Dourojeunni, 2001; Tiwari et al., 2008).

The development of projects or researches in the view of building or strengthening a process of rational, shared and integrated management of a particular river basin, on the basis of principles of sustainable development, should consider, besides environmental, cultural and socioeconomic aspects, educational variables in their planning.

In this view it was conceived the project "Monitoring Network of the basins of the rivers Pirapó, Paranapanema III and Paranapanema IV – analysis and monitoring of the hydrological behavior", developed by a multidisciplinary team (Environmental Education, Economics, Civil Engineering, Chemical Engineering and Geography) of researchers and graduate students of the State University of Maringá (Paraná State, Brazil).

This study presents results of the research and educational activities of the Program for Communication, Environmental Education and Social Mobilization, part of the aforementioned project. Some initial questions drove the planning of activities, such as: "Do the teachers of basic education active in the watersheds studied have specific and pedagogical knowledge to work with the water issue with their students, future citizens?", "Do the several segments of society that act directly or indirectly on the environmental quality of watersheds have access to basic knowledge to identify the problems of water resources in their region and participate in their resolution?", "Are there educational and informative materials about the studied watersheds, in order to provide scientific dissemination to local social segments?".

On the basis of these questions, the program set the following objectives: a) To develop continuing education for teachers of basic education, active in state schools located in the basins of the rivers Pirapó, Paranapanema III and Paranapanema IV, aiming to enable them to develop a pedagogical practice grounded on the principles of environmental education, with the hydrographic basins as a generating theme[1]; b) To raise awareness and to promote training of various local social actors (environmental technicians and educators, members of the watershed committee and the general community); c) To produce educational and promotional materials for teachers and general community, respectively, so as to provide access and expand their physical, cultural, legal and socioeconomic knowledge about the watersheds under study.

2. Environmental Education and Watershed Management in Brazil

In Brazil, the watersheds were consolidated as units for water management with the creation of the National Water Resources Policy, established by Law 9433/97, which sets guidelines and policies aimed at water management in the country (Brasil, 1997a).

From a proposal for a decentralized, integrated and participatory management, with the support of different implementation instruments, such as the National Water Resources Plan, National System of Water Resources Management, National Water Agency and Watershed Committees, the National Water Resources Policy is considered innovative and democratic, both in Brazil and internationally, since it breaks with the authoritarian and technocratic planning of the previously existing model and other models for water resources management (Jacobi and Barbi, 2007). The democratic character of this policy is mainly expressed by the possibility of different social

[1] The methodology by generating themes was proposed by the Brazilian educator Paulo Freire is widely used in environmental education in Brazil, since it allows the educator to work a particular environmental topic, which is part of the daily life of students, using educational activities that facilitate the action -reflection-action on the various dimensions (environmental, cultural, economic and social) of the theme studied, within a critical, emancipatory and transformative perspective (Tozoni-Reis, 2006).

actors - users in general, civil society and government representatives - members of the Watershed Committee, to equitably participate in debates and deliberations on policies of multiple uses and management of water resources, exercising their citizenship (Machado, 2003).

Nevertheless, despite the conceptual breakthrough observed, it is important to highlight that the consolidation of Watershed Committees in the country is still incipient and slow, and has not been accomplished without resistance, considering the political and administrative rearrangements required and the democratic character of the instrument. Moreover, the various social actors that are part of a watershed have different educational, economic, cultural and social conditions, and consequently, distinct knowledge, interests and expectations regarding the use of water resources, which has led to debates not always consensual. Besides that, for a historical-cultural issue, much of the Brazilian society does not have a participatory attitude towards solving the environmental problems of everyday life, and delegates this responsibility to the government.

Within this panorama of neglect, conflict and negotiation by multiple uses of water that environmental education plays a key role, in order to provide several social actors with access, through education, formal (educational institutions) and non-formal (associations, communities, companies among others) processes, to knowledge, discussions, values, laws and instruments of management of water resources with a view to build a more critical, ethical and participatory vision for the management and improvement of quality of water they use.

Importantly, the importance given to environmental education in the management of natural resources is not new. From the decade of 70, several events ensued, whose discussions and documents based the establishment of policies and actions aimed at implementation of environmental education worldwide.

Among them, the I Intergovernmental Conference on Environmental Education, organized by UNESCO, in Tbilisi (Former Soviet Union), in 1977, is considered a major event in the area, whose definitions, goals, principles and strategies for environmental education are adopted so far by various countries. The final document of the conference states that the main goal of environmental education is not easy to be achieved, as it involves a radical reorientation of existing pedagogical practice and should be guided by an integrated and interdisciplinary approach with a view to providing a perception of totality and complexity of the environment (Dias, 2010).

> A fundamental goal of environmental education is to ensure that individuals and the community understand the complex nature of the natural environment and the environment created by man, resulting from the interaction of their biological, physical, social, economic and cultural, and acquire knowledge, values, behaviors and practical skills to participate in a responsible and effective prevention and solution of environmental problems, and the management of the issue of the quality of the environment. (UNESCO, 1997, p. 98).

The United Nations Conference on Environment and Development (Eco-92), held in Rio de Janeiro in 1992, considered the milestone of the global debate on environmental issues, highlighted the importance of the States to provide their citizens with access to environmental knowledge, so that everyone can participate effectively in decision making towards sustainable development (Dias, 2010). The Agenda 21, an instrument of participatory planning, presented at the Eco-92, reinforces the need to involve not only the public authority or government, but also civil society in the management of a particular territory, municipality, state, or even a watershed.

It is noteworthy that from this event, under the influence of the Commission on Sustainable Development (CSD), established by UNESCO and responsible for monitoring and evaluating actions recommended by Agenda 21 in several countries, the role of education in public policy took further dimensions and priorities, focused mainly on sustainable development, which led to the replacement of the term "Environmental Education" by "Education for Sustainable Development" or "Education for Sustainable Future" in several government speeches and documents. The changes were criticized and debated by educators and researchers, with different interpretations and readings for the two conceptions, divided mostly into two groups: those questioning that both expressions have divergent epistemological and pedagogical characteristics and policies (Carvalho, 2002; González-Gaudiano, 2007; Girault and Sauvé, 2008; Lima, 2009) and others who argue that both the "Environmental Education" and "Education for Sustainable Development" are essentially similar, the second being an evolution of the first (Vilches et al., 2010; Barbieri and Silva, 2011).

Despite the dissenting views, the United Nations General Assembly recognized education as a fundamental strategy for achieving sustainable development, and established the period 2005-2014 as the United Nations Decade of Education for Sustainable Development, delegating to UNESCO the responsibility to promote education for all, in view of disseminating knowledge, values, skills and abilities to build a new environmental rationality.

All the events cited above influenced numerous countries in the organization of meetings and national and local conferences and in the creation and consolidation of policies focused on the development of Environmental Education or even Education for Sustainable Development. In Brazil, several actions were developed: the creation of the National Environmental Education Program (PRONEA), in 1984, from the joint action of the Ministry of Education (MEC) and the Ministry of Environment (MMA), in order to promote reflections and actions for the implementation of environmental education in the country; the creation of the Brazilian Environmental Education Network (REBEA), in 1992, and several local networks over the years, formed by educators and representatives of governmental and non- governmental organizations, aiming to expand the dialogue and exchange of experience between them; the implementation of the National Curriculum Parameters (PCN) of elementary and secondary education, in 1997 and 1998, by MEC, which recommends to work with environment in

a cross sectional way, i.e., by all subjects of basic education, also suggesting the interdisciplinary approach for the study with the diverse themes; conduction of regional and national meetings and workshops on environmental education, with the aim of sharing experiences and theoretical and methodological foundations among environmental educators; the establishment of the National Policy for Environmental Education – PNEA (Brasil, 1999), which formalizes and legitimizes environmental education as public policy in the country; the dissemination of continuing education courses in environmental education, provided by public and private educational institutions, by environmental agencies, local or federal governments, and non-governmental organizations, which has struggled in training not only educators, but also environmental managers, with basic and advanced foundations of environmental education, among other initiatives.

Given the above, considering the approximations of policies aimed at environmental education and also to water management, various programs of continuing education for teachers, professional training courses and environmental education projects, with the theme "water resources" or "river basin", have been developed in several Brazilian states, by schools and universities, governmental and non-governmental organizations, watershed committees, for the dissemination of knowledge, skills, and values on the sustainable use and management of water, contributing to the various social actors can effectively participate in decision-making with a view to improve the quality of water resources and also the local quality of life (Tundisi et al., 2008; Oliveira, 2002; Lucatto and Talamoni, 2007; Bacci and Pataca, 2008).

All these initiatives for the sustainable management of water resources can be considered a step forward, but there is a long way to go and challenges to overcome. Many of the advances are present in the discourses, recommendations and laws, but in practice, much of the population is not included in this discussion. In fact, most citizens, especially the civil society, has no basic knowledge that motivates them to take part in discussions and deliberations (forums, watershed committees, etc.) or that enable them to perceive or identify problems in a watershed. In turn, the concept of river basin is not treated with all its complexity during basic education. We observe that most teachers are limited in addressing aspects of water rationalization, often disregarding cultural, economic, historical and social dimensions inherent to the conditions of a watershed (Krasilchik et al., 2010).

3. Methodology

The Program for Communication, Environmental Education and Social Mobilization was conducted in formal education (schools) and non-formal education (fairs, events, and watershed committees), from April 2012 to December 2013, by researchers and graduate students of UEM, with the river basins as generating theme (Figure 1).

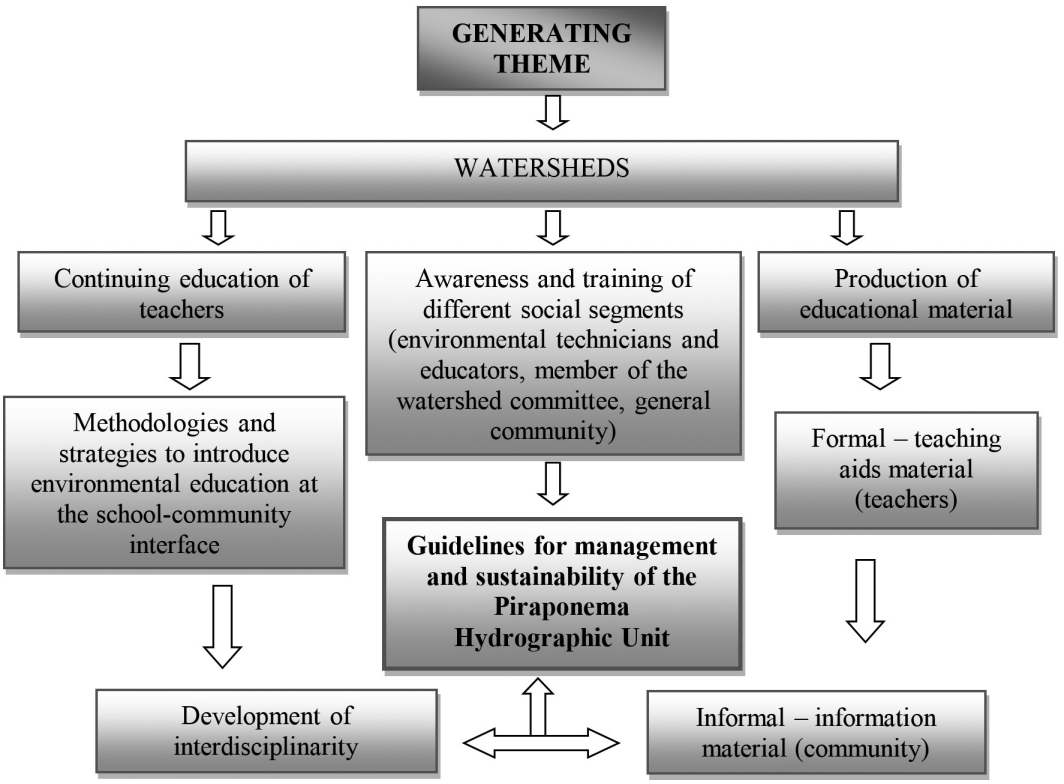

Figure 1. Organogram of the Program for Communication, Environmental Education and Social Mobilization (State University of Maringá, Paraná State).

The methodology used was action research (Thiollent, 2005), since it enabled the investigation of problem(s), analysis and reflection, decision-making and the production of knowledge in relation to the issue of water resources, collaboratively with researchers from the university and representatives of social groups involved in the program.

The goals and steps of the program are described below.

• Continuing education for teachers

The continuing education of teachers was developed in the state education system, because state schools cover most students attending basic school. To this end, partnerships were established with five Regional Education Centers (NREs)[2] of the municipalities of Apucarana, Loanda, Londrina, Maringá and Paranavaí, which are located in areas that comprise the watersheds studied.

Considering the impossibility of including all the teachers of the study area, the program has the expectation that participating teachers return to their schools with the function of sharing the acquired knowledge with other teachers, assuming the role of "environmental multipliers". The achievement of the goal followed the steps below:

- Holding meetings: meetings were held among researchers and graduate students and educational coordinators of the 5 NREs for the establishment of partnerships and planning of activities to be developed in the project. During the planning meetings, we defined the questionnaire for the diagnosis of conceptions and practices of teachers, the themes and contents to be discussed in the training, the modalities of intervention (course or workshop), workload, the place for training activities and assessment criteria of the courses and workshops. Teachers to participate in the courses and workshops were selected by their NREs on the basis of curriculum (experience with environmental education), interest and willingness to act as "environmental multiplier".
- Diagnosis of conceptions and practices of teachers on the work with watersheds: the research was conducted to investigate whether the teachers participating in the courses and workshops already had knowledge of river basins and/or teaching-methodological bases to work with the theme with their students, in order to support the planning and development of courses and workshops. Data collection was carried out through questionnaires applied before the training activities. Data analysis was based on the content analysis technique (Bardin, 1977).
- Development of courses and workshops: teachers from each NRE were provided with courses and/or workshops, which aimed to subsidize them with theoretical and practical background about working with environmental education and watersheds. The workload of courses and workshops ranged from 24 to 48 hours. The use of the river basin as the unit for study and research has been recommended by educators, since it combines environmental, economic, historical and social characteristics, favoring interdisciplinary studies and researches and discussion on the management of multiple uses, besides serving as natural laboratory because it enables a comprehensive and integrated view of the various phenomena and processes (Tundisi and Schiel, 2002; Bacci and Pataca, 2008).

• Awareness and training of the various segments of society

Disclosures were undertaken through leaflets and itinerant exhibitions in fairs and events related to environment, in different municipalities, in order to raise awareness in the general community about topics concerning to environmental quality of the watersheds studied. Also, a lecture was given for the members of the watershed committee, the Piraponema Committee, to share knowledge generated by the project.

• Preparation of teaching aids and promotional material

The team of researchers and graduate students with the collaboration of school teachers and environmental technicians prepared an informative leaflet, intended for various social segments, and a teaching aids book for basic education teachers.

4. Results and Discussion

4.1. The continuing training of environmental education teachers with the watershed as generating theme

From meetings with the educational coordinators of NREs, we observed that despite the widespread discourse of a growing concern of management agencies to foster continued training of teachers in environmental education, in practice the provision of courses and other training modalities by the Education Secretariat of the State of Paraná (SEED)[3] is still infrequent in the study area.

In practice, most efforts related to the continuing education of teachers with the environment subject are carried out by universities and non-governmental organizations, since they possess specialized staff and researches completed in the area.

[2] Regional Education Centers, created in 1983, are the regional management agencies responsible for the administration, coordination and supervision of the state, municipal and private education system of the local and of other municipalities in the region. Although they have the goal of decentralized management, all NREs follow guiding principles of the Education Secretariat of the State of Paraná - SEED-PR.

[3] The Education Secretariat of the State of Paraná (SEED) is responsible for defining and implementing the policy of basic and professional education in the State of Paraná.

When coordinators were asked if within the last 5 years, they had promoted some activity of continuing training for teachers of the state system about water resources, only a pedagogical coordinator, from the NRE of Maringá, answered positively, emphasizing the promotion of lectures on environmental issues, especially in the Environment Week. Taking into account that the National Water Resources Policy was established in 1997 and the urgent need for the various social segments to expand their vision on issues concerning the watershed in which they live, punctual activities are not enough, there is the need for courses and training programs for teachers, which effectively enable these actors to resize their teaching practices.

As for courses and workshops prepared by the Program for Communication, Environmental Education and Social Mobilization, 185 teachers have enrolled in and a greater number came from schools and municipalities belonging to NREs of Apucarana, Loanda and Londrina (Table 1).

Teachers from different areas have participated in courses and workshops, but prevailed those responsible for subjects of Science, Biology and Geography and with greater experience, once they usually work with the environmental issue in basic education.

As previously emphasized, even with a consensus from educators and researchers that environmental issues should be dealt with by various subjects of the curriculum, considering the complex nature of environmental issues, as highlighted by PCNs (Brasil, 1997b, 1998a, b), which propose Environment as a theme to be worked by all subjects of the curriculum (cross theme), there is still difficulties by teachers from other areas of knowledge in working with this topic. Therefore, even today, the approach to environmental issues in basic education is performed mostly by teachers of Science, Biology and Geography.

Regarding the diagnosis of pedagogical conceptions and practices of teachers about water and watersheds, when asked if they knew the rivers in the surroundings of their municipality, the majority of teachers (n = 171) said yes, and most of these were teachers linked to NRE of Apucarana (Table 2).

About conceptions of teachers about the term "watershed", 177 answered the question (Table 3). Most teachers (n = 147) had a basic understanding of the concept of watershed. The others had a limited or mistaken view of the concept, and associated it exclusively to a water source or study of water, and there were those who did not answer the question.

When asked about the name of the watershed of his/her municipality, a little less than half of teachers (85) who answered the question had knowledge about it (Table 4). In general, teachers in the areas of Science, Biology and Geography were the ones who were able to identify the watershed in which they live, probably because this topic is formally present in the curriculum of the subjects in question.

In relation to the problems in the watershed in which they live, 137 teachers who answered question, 112 said yes, 13 said they did not perceive problems in the basin and 12 did not answer. Teachers who said that there are problems in the watershed in which they live listed several problems (Table 5).

Considering the development of works with the theme water or watersheds in schools, 132 teachers stated they had already worked with the theme, 41 said they had never

Table 1. Number of municipalities, schools and teachers of the respective Regional Education Centers (NREs) participating in the courses and workshops for continuing education of teachers.

Regional Education Centers (NREs)	Number of Municipalities		Number of Schools		Number of Teachers	
	Total	Course	total	Course	Total	Course
Apucarana	5	5	45	41	1712	58
Loanda	4	4	11	11	588	49
Londrina	16	9	40	40	3960	49
Maringá	15	6	79	14	3365	14
Paranavaí	16	4	40	7	1132	15
Total	**56**	**28**	**215**	**115**	**10757**	**185**

Table 2. Number and percentage of teachers who know and not know the rivers in the Municipality.

Regional Education Centers (NREs)	Know the rivers in the municipality		Do not know the rivers in the municipality		Total	
	Number	%	number	%	number	%
Apucarana	53	32	5	36	58	32
Loanda	46	27	3	21	49	26
Londrina	47	27	2	14	49	26
Maringá	13	8	1	7	14	8
Paranavaí	12	7	3	21	15	8
Total	**171**	**100**	**14**	**100**	**185**	**100**

Table 3. Number and percentage of answers relative to the concept of watershed of teachers.

Categories	Examples of answers	number	%
Set of rivers and their affluents	*"Set of springs and rivers of a region" (Science Teacher) "The watershed comprises a main river, its affluents and subaffluents" (Geography Teacher).*	143	81
Drainage unit delimited by the relief	*"It is related to the relief and hydrological sources" (Geography Teacher). "The rivers located in a relief" (Math Teacher).*	9	5
Region with abundant water	*"It is a region with rivers and water" (Science and Biology Teacher). "All the water of a region" (Philosophy Teacher)*	8	5
Source of water supply	*"Region that supplies water" (Geography Teacher). "It can be defined as a large portion of water with different purposes for living beings" (Geography Teacher).*	7	4
The study of rivers	*"It is the study of a river, its springs, tributaries and effluents" (Science Teacher).*	2	1
Did not answer		8	**5**
Total		**177**	**100**

Table 4. Number and percentage of teachers who know and not know the name of the basin to which they are part.

Regional Education Centers (NREs)	Know the basin to which they are part		Do not know the basin to which they are part		Total	
	Number	%	number	%	number	%
Apucarana*	13	15	43	45	56	31
Loanda**	34	40	12	13	46	26
Londrina	32	38	17	18	49	27
Maringá	5	6	9	9	14	8
Paranavaí	1	1	14	15	15	8
Total	**85**	**100**	**95**	**100**	**180**	**100**

*Apucarana = 2 teachers did not respond the question. **Loanda = 3 teachers did not respond the question.

Table 5. Number and percentage of answers in relation to environmental problems detected in the basin by the teachers.

Categories	Examples of answers	number	%
Pollution (air, water and soil)	"*Water pollution caused by storm sewer, varied industries like industries of starch and metals (factory of faucets), factories of jeans and dairy products among others" (Geography Teacher) "Pollution, mainly by pesticides" (Science Teacher).*	112	32.1
Deforestation, lack of gallery forest	*"Problems with the presence and preservation of gallery forest" "Lack of native vegetation and riparian vegetation" (Geography Teacher)*	110	31.5
Siltation and erosion	*"Siltation of small springs" (Physical Education Teacher) "Siltation caused by impoundments" (Pedagogy Teacher).*	79	22.6
Lack of environmental awareness and surveillance	*"Lack of awareness by some companies that voluntarily or involuntarily deposit waste in rivers, due to lack of control or proper planning and destination of these wastes" (Geography Teacher) "Lack of federal and state control" (Geography Teacher)*	37	10.6
Inappropriate use and management of the basin	*"Channeling of many small rivers to facilitate urban constructions" (Geography Teacher) "Constructions too close to springs" (Science Teacher). "Intensive agriculture and rice cultivation" (Pedagogy Teacher).*	5	1.4
Ecological imbalance	*"Disappearance of species of fish fauna" (Biology Teacher). "Imbalance of insects such as beetles, ants and sauba ants" (Physical Education Teacher)*	3	0.9
Tourism, illegal fishing	*"Decrease in fish populations, I believe that this happens because fishing takes place in October and it would be variable the fishing ban in September when many fish are in ovulation" (Geography Teacher).*	3	0.9
Total		349	100

worked and 12 did not answer. Most of the teachers who have worked with the topic are of the areas of Science, Biology and Geography.

Methodologies and methods employed by teachers in their classes are described in Table 6. They used a variety of teaching strategies; however, few of them used investigative and collaborative methodologies and methods, such as projects, discussions, group work, workshops, fieldwork, among others.

According to Scoullos and Malotidi (2005), there is no best methodology or method for developing environmental education, since many factors must be considered in the choice of each teaching strategy, from the theme and objectives of the proposal, characteristics of the method, the profile of teacher and students, until the limiting issues for conducting the work (time, infrastructure, number of participants, etc.). However, for researchers, *more refined* methodologies and methods are those based on the development of critical thinking and participatory attitude towards environmental problems, thus teaching strategies that encourage and seek, above all, interdisciplinarity, development of skills of analysis and problem solving, among others.

Once interdisciplinarity is an essential part of environmental education practice (Carvalho, 2002; Knechtel, 2001; González-Gaudiano, 2005), teachers were asked if the work with the theme water or water basin counted on the experience of using this approach and what are the disciplines involved. The results show that there was still a very strong resistance from teachers in working with an interdisciplinary context. Of the total of 132 teachers who worked with the topic in question, 89 said they had worked alone. Of the 31 teachers who said they worked the topic in an interdisciplinary way, 29 of them highlighted the involvement of 2 to a maximum of 5 subjects and 2 high school teachers cited *all subjects*. This result is worrisome because interdisciplinarity has been widely debated in the school environment, in recent years, especially since the advent of the PCNs, in 1997, by the Ministry of Education (MEC), which brings several recommendations about its practice (Brasil, 1997b, 1998a, b).

Table 6. Methodologies and teaching strategies used by teachers to work with the theme "water" or "watershed".

Methodologies and teaching strategies	Number	%
Use of newspapers, videos, magazines	53	28.6
Construction of local materials (texts, posters, models, leaflets)	47	25.4
Expositive classes	27	14.6
Visits	20	10.8
Discussions, debates, group works	19	10.3
Field works, investigative practices	10	5.4
Projects	6	3.2
Demonstrations	1	0.5
Problematization	1	0.5
Theater	1	0.5
Total	**185**	**100**

With regard to courses and workshops offered in 5 NREs, teachers actively participated in in all activities – discussions, dynamics and group work, planning and interventions in schools. All activities and discussions with teachers were grounded on questioning of their conceptions and practices, and identifying the limits and difficulties in their pedagogical practice, concerning the development of the theme in question, within the foundations of environmental education.

Amongst the limits and difficulties, most teachers pointed out they are aware of the importance of working the various issues and environmental problems, including the problem of water, which are part of the daily life of students, but at school, there are still formation, curricular and structural difficulties to make environmental education a day-to-day practice. More specifically in the formation issue, the speeches of most teachers indicated that their conceptions and practices in environmental education are mainly coupled with the conservationist and traditional tendency, intended to develop environmentally friendly attitudes without delving into social, economic and political-ideological issues underlying the current environmental crisis (Loureiro, 2006; Lima, 2009). Along the development of courses and workshops, many teachers were able to reflect and reconsider their conceptions of how to work with the water theme, expanding their insight into teaching and pedagogical possibilities, in view of a teaching practice consistent with critical environmental education, also known as transformative environmental education or emancipatory, which opposes conservationist environmental education. This more politicized trend is grounded on political ecology, critical theory and complex thinking, whose main goal is the formation of critical and active individuals.

In the planning and interventions performed in classrooms by teachers there was concern in breaking with traditional teaching, from the use of methodologies and methods that encourage dialogue, collaborative work and research, such as the development of projects, group work, practical and field classes, visits to the river or water treatment sector of the municipality, among others, to provide students with the development of the investigative spirit of collective reflection on the water and its problems, according to foundations of critical environmental education.

4.2. Awareness and training of different segments of society

The school is responsible for providing the integral formation of future citizens, leading them to active participation in society; however it alone cannot meet all training requirements. In this sense, the non-formal education comes to fill the gap by contributing to the dissemination of knowledge, legal instruments, values, attitudes about

the sustainable management of water resources outside the school environment.

The present program performed disclosure of 5000 leaflets and presentations of scientific exhibitions in fairs and events in some municipalities – Apucarana, Loanda, Maringá, Colorado, Paranacity, Terra Rica, Paranavaí, Miraselva, Bela Vista do Paraíso – belonging to the studied river basins.

Most people approached had no basic knowledge about the watershed in which they live. On the other hand, many were able to identify problems related to the river that supplies the municipality.

In relation to the lecture given to the Piraponema committee, from a total of 40 members who are part of the collective body, 21 were present, including 50% of representatives of government, 25% of users, and 25% of civil society.

The lecture presented the objectives and goals of the project, as well as preliminary results, surveyed by the research group of UEM, in relation to environmental and socioeconomic aspects of the studied river basins.

The questionnaire applied to the members indicated that among the 21 members, 13 were able to identify environmental problems in the watershed in which they live, specifically: erosion and siltation of rivers (33.3%), deforestation (22.2%), pollution from industries (11.1%), lack of action of the government (7.4%), household waste (7.4%), pollution from agriculture (7.4%), changes in the riverbed (3.7%), sewage (3.7%) and disordered human occupation (3.7%).

Another question about the major objectives of the Watershed Committee indicated that the 13 members who answered the question had a partial view of the responsibilities of the committee, assigning to the collegiate body the following tasks: to manage actions for use and occupation of the basins (38%), to identify and solve environmental problems of the basins and bring improvements to the environment (31%) and to provide clarification and information to the local population (31%). The other members (n = 8) could not answer the question.

Notably, among the 8 members who were unable to answer the questions, 5 of them had basic education and the others had completed higher education. In comparison with the other 13 members who answered the questions, 9 had higher education and 4 of them had completed graduate-level specialization (n = 1), Master's (n = 1) and Doctorate (n = 2).

At the end of the lecture, the chairman and the members showed interest in developing a collaborative work with the project team.

4.3. Preparation of teaching aids and promotional material

With an earlier survey at libraries and sites of different education institutions and environmental agencies and discussions with teachers and environmental technicians, we detected a lack of information on the watersheds studied, adapted to different levels of education. The information is mainly found in scientific publications, results of researches from universities or technical bulletins of environmental agencies, for a specialized audience.

In agreement with Yassuda (1993, p. 11), the level of interest and participation of different social segments in the water management is directly related to

> [...] the quality of information available by components of the system. It will be presented the results of the ongoing measures and the needs for the future in three types of publications: one aimed at experts in water resources, other to public authorities and businessmen users of water, and the third, understandable for society in general.

Based on this reality, the leaflet prepared by the researchers and graduate students with a basic characterization of watersheds and a concise presentation of the goals of the project fulfilled the objective of raising awareness in the general community on the issue of water resources of their region. Besides the leaflet, it is being prepared a teaching aid material for basic education teachers, with environmental and socioeconomic information on the watersheds studied, surveyed by the various areas of the project, as well as didactic and pedagogical foundations to work the watershed as a generating theme.

5. Conclusions

The results indicate that the various social actors addressed by researchers and graduate students lacked basic knowledge and information about the watersheds in which they live. Teachers in turn lacked theoretical and methodological foundations for a pedagogical practice allied to the construction of environmental citizenship.

In this context, courses and workshops, distribution of informational material and the holding of itinerant science exhibitions allowed the individuals to expand their vision of the basin in which they live, and also in relation to teachers, on the methodological possibilities of working the issue of water resources using the river basin as a unit for study and research.

Although these initiatives are important for strengthening the participation of various social actors, especially civil society, which has always been at the margins of decision making in different public spaces dedicated to the management of river basins under study (Jacobi, 2006), they are still insufficient considering the emergency of the problem. It is essential to create public policies that guarantee the continuity of the educational processes started by this program, on the basis of an integrated work between the government, basic and higher education institutions, non-governmental organizations and environmental institutes, with a view to create a solid foundation for citizen participation in decision-making about the rational and sustainable use and management of water resources in the region.

Finally, the research team expects that the actions of the Program for Communication, Environmental Education and Social Mobilization, along with the results of the socio-environmental diagnosis from other areas of the project, bring positive perspectives for the sustainability of natural and cultural resources in the basins under study.

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