Effects of a training workshop on action-oriented environmental education in biology student teachers' professional development

Leopoldo Barreto, Federal University of the Recôncavo of Bahia, Brazil, leopoldo.barreto@ufrb.edu.br
Teresa Vilaça, Institute of Education/University of Minho, Portugal, tvilaca@ie.uminho.pt

Abstract:

This research was designed to analyse the effects of a training workshop on action-oriented environmental education for sustainability (EEfS), in the professional development of biology student teachers, to promote high school students' environmental action competence. Therefore, a training workshop (48h) with biology student teachers (n = 12) was conducted. Data was collected through an initial and final interview to trainees, logbooks of trainees and the researcher and material produced by the trainees. The content analysis of the interviews showed that the workshop had a positive impact on increasing the action-oriented knowledge and skills of these student teachers to carry out action-oriented EEfS, and what most of them valued more in their professional development was to increase their content knowledge and general pedagogical knowledge. Therefore, despite the limitations of this study, it is possible to conclude that the action-oriented methodology was effective in the promotion of these student teachers' professional development. The main implication of these results is the efficiency found in this methodological alternative in EEfS for these university students, suggesting the importance of introducing it in the biology student teachers' training in the future.

Keywords: environmental education for sustainability, biology student teachers, action-oriented learning, action competence.

1. Introduction

Environmental education for sustainability is a topic of relevance and priority in the discussions of various governmental and non-governmental institutions, due to the many broad and global environmental issues such as climate change, anthropic pollution and the extinction of species, which are addressed as factors that negatively modify the environment, influencing the relationships experienced by living beings, and compromising the continuity of species, including the human species.

In Brazil in 2011, more than 94% of schools worked in environmental education (EE), and in the southern states this occurred on an average of 97% of schools (Pereira &

Guerra, 2011). Although data show an increase in EE in the pedagogical praxis, it is necessary to critically analyse whether the educational approach is adequate in providing a true construction of conscious, critical and participatory citizens. In this research, each individual will learn action-oriented knowledge (biological, social, economic and historical) and use this knowledge to understand environmental problems and act with the aim of exercising active and responsible citizenship in order to solve them, taking into account the interaction between the environmental, social and economic dimensions (Vilaça, 2016). In this sense, it is also important to consider the particularities of the States in the construction of the individual proposals of each school for EE which should be appropriate to the context where the school is inserted and to its real needs, being necessary that EE ceases to be marginalized within education as advocated by the Ministry of Education Guidelines of Australia (Chapman, 2004).

Therefore, this research was designed to understand the effects of a training workshop on action-oriented EE for sustainability (EEfS), in the development of biology student teachers' professional knowledge and competences to develop high school students' environmental action competence. More specifically, among the various dimensions analysed, this paper aims: i) to characterize the evolution of biology student teachers' action-oriented knowledge during an action-oriented in-service teacher training programme in water sustainability; ii) to describe the perceptions of biology student teachers about their professional development during the training.

2. Literature review

Speaking about environmental education (EE) and education for sustainable development (ESD) in Brazil, as in any developing country, requires firstly clarifying the understanding of the duality between EE and ESD, a controversy that wins adherents for both parts, being the theme of different studies that explore this conceptual dilemma. This duality also requires a more refined reflection in the sense of sustainability. The characteristics of ESD defined by Tilbury (1995, 2011), are those identified by Giordan and Souchon (1996) for EE, namely holism, interdisciplinarity, clarification of values, integration of critical thinking and active learning. Sauvé (1997) refers to these different currents, emphasizing that SD is the most ambitious EE objective, giving rise to the term 'Environmental Education for Sustainable Development'.

Arima, Konaré, Lindberg and Rockfeller (2005) argue that "ESD should not be equated with EE. EE is a well-established discipline that emphasizes man's relationship with the natural environment, ways to conserve it, preserve it, and properly manage its resources "(p. 46), displaying a discourse that defends an identity proper to ESD, yet different from EE, arguing that SD places EE within a broader context of sociocultural factors and political issues of equality, poverty, democracy and quality of life. Hesselink, Kempen and Wals (2000) report the perception of EE and ESD from the participants of the 1999 Pan European Expert Meeting on Sustainable Development

and EE, most of whom with experience or academic training in EE, where four perspectives were perceived: 1) those who see ESD as the new generation of EE, which include topics on ethics, equity and new ways of thinking and learning; 2) those who see ESD as part of EE; 3) those who see EE as part of ESD; and 4) those who argue that ESD and EE share characteristics, but ESD is more comprehensive. The authors also conclude that most experts attending the event supported the perspective where ESD is viewed as an evolution of EE (Perspective 1), but also emphasizing that some participants, despite perceiving ESD as an evolutionary process, opposed the concept of SD advocated in the Expert Meeting, and preferred to talk about sustainability education. Mogensen and Schnack (2010), in light of the literature, confirm different perspectives of ESD and EE, explaining that "some claim that ESD is a different discipline from EE (Hopkins & McKeown, 2003), some argue that ESD is replacing EE (Tilbury & Cooke, 2005), while others that ESD is considered a new paradigm in education (Sterling, 2001)" (p.62).

According to Barbieri and Da Silva (2011) in Brazil these perspectives were observed in 2004 through a survey of 1,740 participants in the Fifth Brazilian Forum on EE in Goiânia, where 77% thought that it would not be convenient to change the name of EE to ESD, and showed a strong rejection of ESD. On the other hand, of those who supported the change (23%), 65% justified that ESD involves social and economic issues, not just the ecological ones, 22% thought that this change would represent a natural evolution and 10% mentioned that this change would represent international trends, carrying financial support. These authors confirm that, in fact, many conceptions of EE already incorporate economic and social dimensions according to the perspectives of sustainable development. Therefore, it is indifferent, according to them, to speak about EE or ESD in Brazil.

The United Nations General Assembly, recognizing the importance of water in Environmental Education for Sustainability proclaimed the period 2005-2015 as the International Decade for Water, a source of life. The main objective of this decade is the greater focus on water-related issues at all levels, as well as the implementation of water-related programmes in order to achieve the internationally agreed goals on water issues contained in Agenda 21, the Millennium Development Goals and in the Johannesburg Implementation Plan. Water is a question that involves many actors and therefore has to be considered as a political problem that requires the creation of inclusive and representative deliberative arenas for horizontal democratic communication among all citizens involved (Herrera, 2005). During this decade, the World Water Council, whose mission is to promote awareness, political commitment and action on critical water issues at all levels (World Water Council, 1996), held Forums every three years (2006, 2009, 2012, and 2015) to address water and sustainability issues, understanding water as a shared common good, and therefore, requiring participatory decision making. In December 2010, the United Nations General Assembly declared 2013, the 'United Nations International Year of Cooperation for Water'.

Interdisciplinary knowledge contributes to the promotion of substantial changes in lifestyles and living conditions, but its importance is linked to the construction of environmental action-oriented knowledge that will strengthen the self-confidence and commitment of students to change their values, attitudes and behaviours, or those of their society, related to solving environmental problems, thus developing their action competence (Vilaça, 2008). For Jensen (2000) action competence is a complex competence that must be actively acquired, and not just an ability that is simply passively received. Mogensen and Mayer (2005) agree with Jensen's emphasis on the importance of students to carry out individual and collective actions as part of their learning process. The development of action competence and the realization of actions are only possible through critical education. To speak about critical education does not mean educating 'for the opposition' or 'negation' of existing conditions, but on the contrary, it means educating to promote interest in analysing the structures, conditions and prerequisites underlying the emergence of the problem (Jensen & Schnack, 1997). Jensen (2000) emphasizes that first of all, even before any action can be taken, there must be awareness on the part of the actors regarding the problem. In this perspective, to be characterized as environmental actions, the activities should be oriented to make real changes on the causes of the environmental problem that is being worked on. Jensen and Schnack (1997) argue that activities such as a trip to a natural area are valuable and productive activities, to the extent that they help to motivate and acquire knowledge, however for activities to be characterized as actions, they should be directed to solve the problems identified. The mere act of acting within the conception of environmental education, such as the separation of garbage, does not generate in the student the actual awareness of the behaviour carried out. Therefore, it is crucial that students first build their action-oriented knowledge (consequences and causes of the problem and strategies to eliminate the causes of the problem), because if they do not investigate this interdisciplinary knowledge, they will not able to understand the problem and act competently in its resolution.

3. Methodology

Research design

This study was approved by the Research Ethics Committee (CEP) in Brazil and respected all ethical principles in human research. Due to the research problem, a training workshop including eight face-to-face sessions (24 hours) at the university and eight sessions in the work context (24 hours) was planned, implemented and evaluated (Table 1).

Table 1. Synthesis of the type of classes and contents of the biology student teacher training

Session	Type	Strategies
1 2 hours	TP	• Classroom discussion using a PowerPoint presentation on the concepts of: environment, sustainable development, ecosystem, biotic and abiotic factors; EE, ESD; riparian forest and regional aquatic organisms.

		• Discussion in small group on the 4R's policy (Reduce, Reuse, Recycle and Repair), with a final sharing of the conclusions by the groups.
2 /3 6 hours	TP	• Classroom discussion, with images and key concepts (PowerPoint presentation), on the historical view of EE, ESD and EE for sustainability. • Sequential exploration in small groups, followed by presentation of the conclusions of the groups in class, of the didactic games (McKeown, Hopkins, Rizzi, & Chrystalbrid, 2006) on community dynamics to maintain the sustainability of natural resources.
4 4 hours	TP	• Creation in small groups of visions regarding the sustainable community in which they want to live in the future, and final sharing of ideas in the class. • Class discussion on how action-oriented education for sustainable development can be operationalized. • Discussion in small groups to create sustainability goals for the community. • Elaboration in small groups, followed by class sharing, of a field exit guide to identify the surrounding environmental problems.
5 3 hours	OC	• Fieldwork to carry out the activities planned in the previous session. • Discussion in small groups about what to do in the post fieldwork.
6 3 hours	TP	• Jigsaw in small groups, followed by a final sharing of ideas, on how the aquarium can be used at school to promote the development of student action competence. • Construction of an aquarium, by the group, using a laboratory protocol.
7 3 hours	TP	• Discussion in small groups on how to plan the intervention of each group of biology student teachers with the students of high school. • Discussion in small groups on logbooks, as tools for (self) supervision.
8 3 hours	TP	• Presentation and discussion of the results of the questionnaires applied to the high school students and the implications of these results for the planning of the educational project. • Small-group planning of the "Action-Oriented Water and Environmental Education for Sustainability" Project.
24 hours	High School	Implementation by teachers of the project in the school context with the supervision of the first author.

Note: TP - Theoretical-practical; OC – Outdoor classroom

The participants were voluntary biology student teachers (n=12). An initial interview, previously validated regarding the biology student teachers' conceptions on different aspects, namely in water sustainability action-oriented knowledge (What are the problems, their consequences and causes, and strategies to resolve them) was applied by the first author. This dimension in analysis included the following leading questions: What are the environmental problems that we can find in the city of Cruz das Almas and surroundings? What problems can we encounter related to water? What are the consequences of pollution of rivers and lakes identified in the city? What are the causes of pollution of these rivers and lakes? What are the actions you can take to solve these problems?

At the end of the training, the same interview to complement the data collected during the training process to evaluate, among other aspects, the evolution of the biology student teachers' action-oriented knowledge, was carried out by the first author. This interview also included the student teachers' perceptions regarding their professional development, as a new dimension that was analysed through the following question: What was the most important professional knowledge you developed during the training? Why? Their answers were coded using Shulman's categorization (2005) for the basic knowledge of teachers, as shown in table 2.

Table 2. Subcategories for the basic knowledge of teachers, characteristics and some citations of interviewees

Subcategories	*Characteristics*	*Citations of the interviewees*
Content knowledge	Knowledge about the content to be taught	"I learned concepts… there were several that as a biology teacher I would not be able to teach" (Final Int. 6)
General pedagogical knowledge	Knowledge on principles and strategies of class management and organization that transcends the scope of the subject	"I even learnt the process [...] of planning a project exchanging ideas with high school students ... to feel like a teacher, do you know?" (Final Int. 4)
Knowledge of the curriculum	Knowledge regarding a special mastery of materials and programs	It was not addressed by the interviewees
Pedagogical content knowledge	The main link between matter and pedagogy that constitutes teachers' own special form of professional understanding	"I learnt some strategies, which I will use as a teacher" (Final Int. 7) "I loved learning how to teach, associating theory with practice" (FI2)
Knowledge about students	Knowledge about students' characteristics and learning, where the monitoring of the individual is as important as that of the group	"The training helped me a lot in dealing with the class, how to communicate with the student, respect their knowledge ... I found it cool to work in the classroom with the students" (Final Int. 1)
Knowledge about educational contexts	Knowledge on the functioning of a group or class, school or the community management	"I understood the importance of knowing how the school organization works, the dynamics of the school" (Final Int. 7)
Knowledge about educational aims		It was not addressed by the interviewees

During the training, data was collected on the same aspects through the logbooks of the trainer (first author) and the biology student teachers, and materials produced by the biology student teachers. In order to meet the objectives of this paper, only data collected through the initial and final interviews will be presented and discussed. All interviews were transcribed in full and analysed in a mixed category system (Bardin, 2014), with two independent researchers performing the coding. When there was no

consensus after the sharing of interpretations, the response was not considered. To reduce the data, the frequency and percentage found for each subcategory will be presented and, to deepen the analysis of the most relevant aspects of the interviews, some excerpts will be presented. In these excerpts, to maintain the anonymity, a number will be assigned to the interviewee and it will be indicated if it corresponds to the initial (Initial Int.) or final interview (Final Int.).

Participants

The selection of the sample was intentional (Gall, Borg, & Gall, 1996), since students were selected as members of the Institutional Scholarship Program (PIBID) because they had already experienced in some way, the teaching through the programme. All the students were invited under these conditions and 12 accepted to be part of this study. The majority of participants were female (80%) and had a mean age of 23 years old (minimum = 19, maximum = 32, SD = 4.16). More than half (60%) was in the first half of the undergraduate course (1st to 5th semester), foreseen in the pedagogical plan of the course with eight semesters.

4. Results and discussion

Evolution of biology student teachers' action-oriented knowledge during an action-oriented in-service teacher-training workshop in water sustainability

Identification of problems related to drinking water. The three main problems identified were the lack of water supply via public sources (67%), wastage by population (25%) and contamination of water sources and / or groundwater (25%) (Table 3).

Table 3. Environmental problems related to water in the city of Cruz das Almas and surroundings (n = 12)

Environmental problems related to water	Initial interview		Final interview	
	f	%	f	%
Lack of supply via public supply	8	66.7	7	58.3
Waste by population	3	25.0	3	25.0
Contamination of water sources / groundwater	3	25.0	7	58.3
Sedimentation of water sources	1	8.3	4	33.3
Poor water management for agriculture	1	8.3	0	0
Low water quality via public supply	1	8.3	3	25.0
Floodplain / flooding	1	8.3	0	0
Factory effluents released into the environment without treatment	1	8.3	0	0
Deforestation	0	0	1	8.3
Unruly urban growth	0	0	1	8.3
No response given	1	8.3	0	0

Of all the other problems identified, only one individual indicated 'poor water supply quality', stating that itchy skin after bathing is a general complaint felt by colleagues. We noticed that the lack of water supply was the most cited. This reference is related more correctly to a consequence than to a problem, showing that before the training, it seems that the discernment of the biology student teachers about the causes and

consequences was low. Some documents such as the Belgrade Charter (UNESCO-UNEP, 1975) and the final document of the Tbilisi Conference (United Nations, 1978) have guided EE to the need for individuals to develop the capacity to understand environmental problems.

In the final interview, the problems related to water were more equitably referred to, with new perceptions appearing possibly stimulated by the new critical environmental observation developed. Deforestation (8%) and 'disordered urban growth' (8%) were adequately noted as water-related problems, albeit indirectly. Another issue that deserves to be highlighted is the lack of water supply via public supply, which is less perceived as a problem in the final interview, later seen as a consequence of other environmental problems, again corroborating the evolution in criticality about the facts and clarification about what the problems are, their causes and their consequences. The table above also indicates that the problem of public health, pointed out in the first interview due to the poor quality of water via public supply, rose to 25%.

Consequences of the pollution of rivers and lakes in their region. It was observed in the initial interview that half of the biology student teachers mentioned 'Loss of biodiversity' (50%), in which both animals and plants have become extinct, possibly because of other interposed consequences also referred to as 'Equilibrium of the ecosystem (33%) and 'Eutrophication / Pollution of water bodies' (17%) (Table 4).

Table 4. Consequences of the pollution of rivers and lakes identified in the city of Cruz das Almas and surroundings (n = 12)

Consequences of water pollution	Initial interview		Final interview	
	f	%	f	%
Public health	5	41.7	3	25.0
Lack of water supply	4	33.3	7	58.3
Equilibrium of the ecosystem	4	33.3	1	8.3
Loss of biodiversity (animal / vegetable)	6	50.0	6	50.0
Eutrophication / Pollution of bodies of water	2	16.7	0	0
Sedimentation	1	8.3	1	8.3
Economic loss	0	0	6	50.0
Less use of public spaces	0	0	2	16.7
No response given	0	0	1	8.3

The second most frequent consequence was 'public health' (42%). It is well known that water is a disease transmission vehicle representing 65% of hospitalizations in Brazil (Brazil, 2005).

The 'lack of water supply' appeared again as a consequence (33%), but in this case the understanding was that part of the population makes use of rivers and ponds as a direct source of water for various uses. However, before the training, the identification of the 'sedimentation' (8.3) as a consequence of pollution, leading to a change in the water capacity of rivers and lakes, and contributing to the consequences already mentioned was stated (Loss of biodiversity, Eutrophication, Imbalance).

After the training, the awareness that the pollution of rivers and lakes leads to a 'lack of water supply', almost doubled among the respondents, reaching 58%. This lack of water was indicated both in its unavailability by the public system, as previously mentioned, as well as in the unavailability of drinkable water in the water table, therefore in artesian wells and other aquifers, as narrated by interviewee 3 after the training:

> The water, being polluted will first have to be treated if it is to be used directly ... besides what is going to be lacking there is the availability of safe drinking water, which is scarce, so if we dirty the available water, it will be even more difficult to offer...

The awareness that 'biodiversity loss' is a consequence of pollution continued unchanged, as was reported by half of the biology student teachers. However, 'economic loss' went from no reference to 50%, in addition to the mentioning of 'less use of public spaces' (17%), reinforcing the link between society, the environment and the economy (ONU, 2002) promoted during the training.

This evolution in perceptions of biology student teachers was also confirmed by the connections they made between environmental issues that were not so visible. For example, the link between river and lake pollution with the overburden of the public health system that emerged in the interviews, was related to a economic burden for the state, as well as harming the citizen. 'Sedimentation' was once again referred to by biology student teacher 6 at the end of the training, but it was noted that unlike his first reference, he also concomitantly mentioned biodiversity loss, lack of water supply and economic loss, all interconnected under the same axis and with a logical sequence of events, corroborating the evolution of critical thinking.

Causes of the environmental problems identified. Before the training, the most commonly reported cause of the pollution of bodies of water of their region was 'Improper waste disposal' (42%) (Table 5), as illustrated in the following statements: “[...] people throw a lot of trash on the river's edge, a lot, but a lot. I think this contributes to water pollution” (Initial Int. 8); “People throw a lot of trash on the slopes ... and this garbage falls into the pond” (Initial Int. 11).

Secondly, the biology student teachers reported that 'lack of information' (33%) and 'lack of basic sanitation' (25%) cause people to pollute rivers and ponds. The 'lack of awareness' mentioned by two interviewees, was understood as a conscious act that leads to pollution even when individuals know the causes of water pollution, however they do not give them due importance.

Table 5. Causes of the pollution of rivers and lakes identified in the city of Cruz das Almas and surroundings (n = 12)

Causes of pollution of rivers and lakes	Initial interview		Final interview	
	f	%	f	%
Lack of individual awareness of the population	2	16.7	3	25.0
Lack of information by the population	4	33.3	3	25.0
Lack of basic sanitation	3	25.0	5	41.7
Use of agrochemicals in the surrounding plantations	1	8.3	0	0
Unruly urban growth	2	16.7	1	8.3

Incorrect garbage disposal	5	41.7	10	83.3
Deforestation - riparian forest	0	0	4	33.3
Bad use for other purposes (bathing animals)	0	0	1	8.3
No response given	1	8.3	0	0

The 'disordered urban growth' was mentioned by two interviewees, as is clearly elucidated in the following speech:

> I think it is ... disorderly population growth, like, people start building near aquatic sites, springs ... not just build, but with that they dump their waste in the vicinity, and this causes the pollution of the rivers. (Initial Int.4)

Another perception that deserves attention, although it was mentioned only once, was the 'use of pesticides in the surrounding plantations' as a cause of water pollution, especially when we know that the macro region under study has a strong tendency for agriculture, namely for the production of oranges (*Citrus* sp.), manioc (*Manihot esculenta*) and tobacco (*Nicotiana* sp.), and it is not an unusual practice to use agrochemicals for sanitary control in order to maintain family-based farming (Silva, Nunes, Lima, Silva, Almeida, & Oliveira, 2014). Thus, we realized that there was an understanding of how pesticides used in agriculture have impact on water quality. This perception was observed in the extract below:

> [...] Here there is a lot of planting, I believe that the use of pesticide is intense ... you use it on the spot, but then the rain comes and it ends up dragging; and the final destination of the rain is the river bed or the infiltration into the soil … polluting the water table. (Initial Int.3)

It is noted that the topography of the city under study favours surface runoff, potentiating the cause of pollution of surface water bodies.

Strategies that contribute to solving the environmental problems identified. We asked the biology student teachers about actions they would consider possible to reduce the pollution of the above-mentioned aquatic ecosystems. Table 6 lists the proposals that emerged in the interview before and after training, being 'awareness / education' the most referred to action before the training (42%).

Table 6. Strategies to reduce river and lake pollution identified in the city of Cruz das Almas and surroundings (n = 12)

Strategies	Initial interview		Final interview	
	f	%	f	%
Awareness / education	5	41.7	11	91.7
Educate to change behaviours	3	25.0	4	33.3
Punishment for transgressed laws	2	16.7	2	16.7
Action-oriented projects on water sustainability	1	8.3	5	41.7
Direct actions				
Decrease bath time	9	75.0	7	58.3
Use bucket for general services, rather than hose	6	50.0	7	58.3
Close the tap between uses	7	58.3	8	66.7
Reuse of water for other purposes	4	33.3	8	66.7
Check / repair leaks	4	33.3	1	8.3
Decrease water use	2	16.7	0	0

Collect Rainwater	1	8.3	2	16.7
Wash clothes / dishes in larger quantities at one time	0	0	3	25.0
Use of organic products	0	0	2	16.7
Indirect actions				
Influence governments to change public policies on water consumption and treatment	4	33.3	2	16.7
Distribute leaflets	2	16.7	2	16.7
Collective actions to promote water sustainability	2	16.7	1	8.3
Disseminating research on the consequences of unsustainable water consumption	2	16.7	1	8.3
Promote citizenship	0	0	2	16.7
No response given	1	8.3	0	0

'Awareness' was frequently mentioned by those interviewed who argued that people should have a basic knowledge and because of this, there is the need to reinforce this knowledge and to promote the importance of its application in practice, reflecting on the general well-being of the environment and society. This strategy was followed by 'Influence governments to change public policies on water consumption and treatment' (33%), which shows that the subjects believed that it is a strategy to obtain more effective actions of the municipal board to solve the problems posed by the river and lake pollution, such as lack of basic sanitation (25%). They referred to this fact because in the city where this research was carried out, until the last census, there was no installed sewage network (IBGE, 2008), which still continued until 2016, being reported by the respondents as a lack of effectiveness of management efforts in the last three years. This leads the biology student teachers to want to charge governments with a sustainable pro-environment action.

'Educate to change behaviour' was mentioned by 25% of the biology student teachers because they thought that some individuals who practice harmful acts do not realise the consequences of their actions, as exemplified in the statement of biology student teacher 3 before the training: "[...] is to work with those who plant, to show that there are other alternatives for the use of pesticides ... to try to make the person change his/her behaviour." Let us remember that behavioural changes without reflection, under a moralizing character, often fails to solve the problems (Jensen & Schnack, 1997; Jensen & Nielsen, 1996; Vilaça, 2016).

The strategy of 'Disseminating research regarding the consequences of unsustainable water consumption' was also mentioned by two biology student teachers, because they argue that when the direct reflexes of the harmful acts are explained to the population, a greater awareness is promoted. This idea is expressed in the answer transcribed below:

> First doing an analysis and showing the results ... I see many requests to not pollute, but I see that people do not care ... maybe because they lack the necessary knowledge. [...] Then I think that doing a local analysis ... showing what problems those behaviours can cause ... the diseases that could be caused [referring to water pollution] ... or that could be contracted ... for them to be sensitized. (Initial Int.7)

They also mentioned 'Collective actions to promote water sustainability' (17%) for the removal of garbage or cleaning of the aquatic environment that must start from the

willingness of the participants themselves in order to have the power to achieve effective behavioural changes (Jensen, & Schnack, 1997). In the same way, the distribution of leaflets was mentioned by two of the biology student teachers, but they did not believe in this strategy, as we can see in the following answer:

> [...] Speaking for myself, I'm not a hypocrite, I do not read poster, leaflets. I really do not read ... and I do not know if this is a habit of the population, but it does not hurt to try, right? (Initial Int.8)

The proposal of 'Punishment' was also mentioned in the initial interview (n= 2). Only one biology student teacher refers to a sequence of strategies that can be interpreted as an approximate idea of an 'action-oriented project', as we can infer from the following words:

> [...] the people are criticizing, but how could I contribute? I join them, so ... before I take action, make them understand the causes, and understand a little what causes ... and what is the best way to do it, right? It's ... to think in other strategies to make that big idea happen. (Initial Int.11)

At the end of the training it was understood that there was a great evolution in the understanding that, regardless of the strategies to be used, 'Awareness / education' was considered the most effective way to promote changes to reduce river and lake pollution (92%), followed by 'Educate to change behaviours' (33%) and 'Action-oriented projects' (41.7%). As can be seen in Table 6, the number of individual direct actions mentioned above leading to a reduction in water consumption increased after training, namely: 'use buckets for general services, rather than hoses' (50.0% *versus* 58.3%); 'Close the taps between uses' (58.3 *versus* 66.7%); 'Reuse of water for other purposes' (33.3% *versus* 66.7%).

The action that was highlighted in the initial interview was 'Decrease bathing time' (75%), motivated possibly by the massive television campaign promoted by the Federal Government in 2016, as a consequence of the great rainfall that the Northeast and Southeast of Brazil experienced in the first half of the year. Secondly, 'Close the tap between uses' (58%) emerged, being perceived as an important way to promote water economy, which is sometimes not perceived by the population. Another practice reported by half of the biology student teachers was 'Use buckets for general services, instead of hoses', contributing to the reduction in consumption, since inverse behaviours are mentioned by the subjects, as can be observed, for example, in the following statements:

> [...] Today we see people washing cars with an open hose ... they think the water shortage is very far away, in São Paulo. (Initial Int.9)

> [...] Even my neighbour, every day washes the sidewalk with water from the hose. It is not that she can't wash, but she can, for example, use the water she used in the washing machine from the last wash ... (Initial Int. 11)

> First is car washing, motorcycle… staying hours with a hose washing instead of using a bucket. Washing the front of the house with a hose ... (Initial Int. 12)

Other behaviours referred to in the initial interview were 'Check / repair leaks' (33%) and 'Reuse of water for other purposes' (33%) and fixing small leaks, which according

to WWF-Brazil (2006), can save up to 3200 litres of water in one day, which can supply a family of four for almost a month. On the other hand, the reuse of water was more closely associated with the effluent of washing machines, since in Brazil there is no predominance in the use of dishwashers, not even the use of bathtubs for bathing. Collecting rainwater was reported only by a biology student teacher, a practice that has great potential in places with a high rainfall index, such as in the research region, but which receives low incentive, since the Government concentrates its efforts in the semi-arid region of Bahia (Brazil, 2016), which was reflected in the low perception in other regions as a way of minimizing consumption through public supply or surface sources.

Turning to the final interviews, in a comparative sense, the action of 'Reuse of water for other purposes' and' Closing the tap between uses' increased greatly (67%) followed by 'Decrease bath time' and ' Using buckets for general services, rather than hoses' (58%). This inversion may be justified by the perception that some changes in forms of behaviour have already been made explicit in the media lately and others, less explicit, should be promoted because they are less practiced. This was discussed in the training under the view that the Brazilian people have in the last decade, acquired a new purchasing pattern, where the use of household appliances, such as the washing machine, has been increasing in households (Mariano, 2013), but the perception of the consumption of water and the possibility of water reuse, possibly do not accompany this growth.

Likewise, we can imagine that the supply of piped water to a growing share of the population, especially in interior regions that previously did not have an extensive water supply system, sometimes leads to the overuse of water supply. Thus, after the training we noticed a better level of knowledge about the new actions that should be promoted to achieve the desired standard of sustainability.

On a smaller scale, but also importantly, after training, new suggestions for actions to be promoted emerged, most notably 'Washing clothes / cooking in larger quantities at a time' (25%), followed by 'Use of environmentally friendly products' and 'Promote citizenship', both with 17%. Such suggestions demonstrated that the training promoted new perceptions on how small changes in habits and / or attitudes can contribute to saving water because the amount of water used to wash twice as many dishes or clothes is less than double what is needed. In addition, with the technological advances, new products were developed reducing the need for several rinses after washing, even with more conscious production processes under the environmental bias, reducing the ecological footprint. Technology also assists in the optimization of home appliances, where technologically advanced washing machines greatly reduce the consumption of soap and water to wash the same amount of laundry (O Globo, 2014).

In relation to the promotion of citizenship, the biology student teachers reported the concern for the good of the general public, for example, when seeing a leak in the public supply system and then reporting it immediately to the competent body. Such

conduct may seem obvious, but according to the interviewees it is not as common a practice as it should be, making it necessary to promote.

Overall, these results show that the action-oriented knowledge of these biology student teachers evolved positively.

Perceptions of biology student teachers about their professional development

After the training, the biology student teachers were questioned about the most important knowledge that they had acquired. All considered the 'Content Knowledge' as the main knowledge acquired, referring specifically to the content of biology / ecology applied in EE (Table 7).

Table 7. Perception on the most important professional knowledge developed after the training (n = 12)

Knowledge	f	%
Content knowledge	12	100
General pedagogical knowledge	7	58.3
Pedagogical content knowledge	5	41.7
Knowledge about students and their characteristics	1	8.3
Knowledge about the educational contexts	3	25.0

In addition, 'General Pedagogical Knowledge' was emphasized by 58% of the participants, referring to the learning developed to plan and manage student behaviour, and evaluate a project, among other things. Also, references related to the 'pedagogical content knowledge' (42%), as expressed in the following excerpts of the interviews, were observed:

> [...] let me see something else I learned ... the same activities, which I learned, I'll use some in other contents. (Final Int.7)
>
> I learned how to use play activities and how good these are. (Final Int.9)
>
> I learned to conduct activities in EE, to better fix learning (Final Int.1)

'Curriculum knowledge' did not emerge in the responses to any of the biology student teachers as learnt knowledge, in part because several biology student teachers mentioned that the EE curriculum was well treated by the curricular subject of EE which is part of the Master's degree course, especially the curriculum proposed by the Ministry of Education, the Environmental Education Program of the Educational System and the State Education Secretariat. It is noted that the Municipality has not recently presented any project or programme focused on EE in the area of education (through the Education Department) or even society (through the Environment Secretariat). In the school studied, the EE approach in the Political Pedagogical Project (PPP) was not clear and the PPP did not refer to the cross curricular character of EE, as recommended by the Law of Bases (Brazil, 1996) and National Curricular Parameters (Brasil, 1998).

Regarding the educational context, 25% of the biology student teachers said they knew about it by dealing with the school management and administration, but also by understanding the characteristics of the community and its culture (8.3%). The

teachers' sense of belonging to the school community was demonstrated at the end of the training by the greater commitment of the biology student teachers with the local environmental problems.

5. Conclusions

The training workshop had a positive effect on these biology student teachers' ability to identify problems related to water sustainability and in their knowledge regarding the consequences of environmental problems that evolved to better distinguish the consequences of the causes of the problems. Likewise, after the training workshop, they increased their knowledge about the indirect consequences and therefore, providing the biology student teachers with a greater understanding of the issues related to the pillars of sustainability, such as economy and society. The most frequent consequence was related to the problems with public health and the understanding that environmental problems lead to a lack of water supply that was repeated by the trainees as an important consequence of pollution of rivers and lakes, demonstrating a connection of the anthropic action with the availability of drinking water. This understanding progressed with the training because they improved their awareness of the economic consequences in the form of economic and social losses, and in the form of a low use of public spaces. Knowledge about the causes of environmental problems evolved, firstly, because at the end of the training they understood the differences between consequence and cause and, secondly, because they identified as the main causes, the lack of awareness and lack of information of the population. They also increased their knowledge regarding economic and social causes. The most common cause of river and lake pollution was the incorrect disposal of garbage, followed by a lack of basic sanitation.

The possible actions to reduce water consumption perceived by the biology student teachers increased after the training workshop, being among the most cited 'closing the tap between uses' and 'water reuse for other purposes'. It was also noticed that indirect actions emerged after training, linked to technological solutions such as the 'use of ecological products', both referring to products that require less water for washing, and the use of equipment that saves water based on their technological development. To reduce pollution of rivers and lakes, most of the biology student teachers after the training workshop, believed in education / awareness, having more than doubled the support for the strategy when compared to the initial moment.

The training also showed that what most of the biology student teachers valued more in their professional development was to increase their content knowledge and general pedagogical related to the EEfS. These teachers also highlighted the methodological / technical skills and the personal / interpersonal skills as the most important skills acquired during the training.

Therefore, despite the limitations of this research, namely the small number of participants, which does not allow generalization of results, even in very similar contexts, and the fact that they are volunteers, which can always influence the results

since they are more willing to be motivated to learn and participate, one of the main implications of the results of this study is to show the importance of including action-oriented environmental education in the initial training of these biology student teachers at University in order to promote their critical and reflective thinking and democratic education.

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