

## EVALUATION OF NON-FORMAL ENVIRONMENTAL EDUCATION TRAINING PROGRAM FOR INDUSTRIAL WORKERS APPLIED TO CLEANER PRODUCTION IN BRAZIL

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### ABSTRACT

**T**his study aims to present and systematize the Non-Formal Environmental Education Program as a new Methodology for industrial workers, since this method was tested with the collaboration of industrial workers for the second time. The first application of the Non-Formal Environmental Education Program Approach for hands-on workers applied to cleaner production was in a primary aluminum industry, in the City of Ouro Preto, Minas Gerais. This case study answers the question whether or not a Non-Formal Environmental Education Program for industrial workers can contribute to minimize the core waste and the foundry dust sand waste generated in the core making branch. This research has an exploratory approach as there is little accumulated and systematized knowledge of Evaluation of Non-Formal Environmental Education Programs for industrial workers involved in Cleaner Production. The efficiency of the Non-Formal Environmental Education Program for core makers in achieving a cleaner industrial production with focus on the minimization of industrial solid waste, was evaluated by using theoretical and practical tools. The Non-Formal Environmental Education Program promoted a behavior change process in the industrial workers, which was a consequence of an increase in their environmental awareness level. The positive results of environmental performance indicators demonstrated an improvement in the environmental quality of the workstations, a minimization of 2.5% in foundry wastes, core waste and foundry dust sand waste.

**Keywords:** Environmental Education; Cleaner Production; Waste Minimization; Environmental Indicators.

## 1. Introduction

According to Recommendation Number 96 from the 1<sup>st</sup> United Nations Conference on Human Environment, which took place in Stockholm from June 5-16, 1972, environmental education is one of the essential elements in combating the world's environmental crisis.

Even though the environmental issue became official worldwide beginning with this conference, environmental education within companies is still a recent issue.

The ISO certification states that companies must have programs for managing their solid waste. Regardless of the most suitable technological options for the solution of the solid waste problem, there will always be the need for adopting actions targeted to increasing participants' understanding through environmental education, along with control measures, in order to meet the objectives.

This pilot-project is based upon an evaluation of a Non-Formal Environmental Education Training Program developed in the core making branch of an iron foundry company of the State of Minas Gerais, Brazil. The proposed Non-Formal Environmental Education Program Methodology contributed to evaluate whether or not this project of Environmental Education influenced behavior change of participants in relation to the Foundry Dust Sand Waste and the Core Waste minimization.

This work gives a scientific educational approach to the development of environmental awareness activities in the workplace at a time when some companies in the State of Minas Gerais are in the process of receiving environmental certification.

In a previous research done in a primary aluminum industry, through an environmental performance indicator "Open-Door-Time of the Furnaces Graph", it was verified that the Non-Formal Environmental Education Program did contribute to a behavior change in the furnace-workers. This research returns to the same theme in more depth, and progress made is evaluated using theoretical and practical tools to better understand the influence of Environmental Education Training on the workers' behavior.

## 2. Bibliography Review

### Environmental Education Concept

There are many concepts on Environmental Education. In this case study the concept as stated in Brazilian Federal Law on Environmental Education Policy was adopted. "Environmental Education is understood as the processes through which individuals and groups build social values, knowledge, skills, attitudes and abilities applied to environmental conservation, which is a public good, essential to a healthy and sustainable quality of life". (Lei n° 9.795/1999).

Environmental Education has a wide range of application. In this document, Environmental Education is featured as Technological Non-Formal Environmental Education, which is in favor of Sustainable Development.

As Environmental Education, in this case study, is aimed towards the necessities of hands-on workers in an iron foundry, it applies directly to optimization of the industrial production process through waste minimization and industrial pollution control.

In Medina (2000), the concept of Environmental Education is enhanced and detailed clearly, and according to the educator “It is not only to educate about nature, but also to educate ‘for’ and ‘with’ nature, to understand and act correctly in the face of the large problems of Human Relations with the environment”.

### **Environmental Education in Agenda 21**

Another important document which provides theoretical support for Environmental Education of workers is Agenda 21. This document was signed during the United Nations Conference on Environment and Sustainable Development, RIO-92, held in Rio de Janeiro, Brazil. Oliveira and Teixeira (2004) mention the subject: “It is worth highlighting that the signing of Agenda 21 is an instrument of interference in policies, through strategic planning, with the participation of civil society, private and public institutions, and NGO’s”.

Education as a key tool for sustainable development is recognized in Agenda 21 Chapter 36, which called on governments, international agencies, businesses and civil society to integrate sustainable development concepts into all educational programs. Education is critical for environmental and ethical awareness, values and attitudes, behavior consistent with sustainable development, and for effective public participation in decision making. Both Formal and Non-Formal education are essential to sustainable development (United Nations Environmental Programme, 2002).

#### **Non-Formal Environmental Education of Adults**

Non-Formal Environmental Education of adults must employ techniques which involve workers’ direct participation. As Freire (2000) states, the learner becomes the subject of the action: “Thus, as an active method helps man to become aware of his surrounding issues, and of his surrounding condition as a human being, he will become the subject, and will be able to make his own decisions”.

Environmental Education, which has as its sphere of influence the educational system, is denominated Formal Environmental Education. It is an institutionalized educational process which involves education from Pre-School through High School.

However, Environmental Education may occur outside formal educational structure. In this case, it is called Non-Formal Environmental Education, as its activities may be linked or not to the educational system. According to Seara Filho (1987, p. 40-44) Non-Formal Environmental Education has flexibility in methods and program content.

There are many places where Non-Formal Environmental Education activities may be developed, such as: communities, farms, neighborhoods, schools, factories, and industries. In this project, Environmental Education occurred in the Core Making branch of an iron foundry which produces parts for sanitation purposes.

Non-Formal Environmental Education in general is targeted toward the adult audience. Seara Filho (1987) comments that: “As a consequence, it is regularly called Continued Education, since it is unrelated to adult academic education which occurs within school”.

Castro Neto (1991) apud Matos and Schalch (1997, p.6) comment on the importance of Environmental Education inside and outside of the workplace. “(...) information and training provide the basis for collaboration and motivation for workers in the design of proper environmental industrial processes”.

### **The concept of Sustainable Development**

Mathe (2013) explains that the concept of Sustainable Development has been defined in many different ways, but the most widely referred to is given by the Brundtland commission Report “Our Common Future” in 1987:

“...sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs” (United Nations, 1987, p.41).

Leal Filho (2000) comments on the progress of the concept of Sustainable Development: “Sustainability is currently one of the most widely used words in the scientific field as a whole and in the environmental sciences in particular. The evolution of such a concept has been progressing steadily over the past three decades”.

The concept of Sustainable Development was endorsed during the Rio Conference in 1992. At this opportunity, the Action Plan which is denominated Agenda 21 was agreed upon to achieve Sustainable Development (United Nations Environment Programme, 1992).

Annan (2001 cited by Mathe; 2013) states that “our biggest challenge in this new century is to take an idea that sounds abstract - sustainable development- and turn it into reality for all the world’s people”.

As suggested by Epstein and Buhovac (2014) “In their recruitment and development practices, companies may seek to create in their employees a passion and commitment to sustainability”.

### **The Concept of Cleaner Production**

In 1989, UNIDO (United Nations Industrial Development Organization) and UNEP (United Nations Environment Programme) launched the Cleaner Production Program. It reads: “Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products and services. It embodies the more efficient use of natural resources and thereby minimizes waste and pollution as well as risks to human health and safety. It tackles these problems at their source rather than at the end of the production process. In other words, it avoids the ‘end-of-pipe’ approach”.

Consequently, Cleaner Production is a concept of a continuous process of improvements which seeks to gradually make the process of production less aggressive to both the environment and to human beings. Vendrametto et al (2008) comment that Cleaner Production offers economic and environmental advantages, and seeks to introduce the theme of sustainability in strategic planning of corporate governance. For Giannetti and Almeida (2006) the implementation of Cleaner Production results in a significant reduction of waste and emissions in the use of raw materials and energy. According to United Nations Environment Programme (2001), Cleaner Production requires changing attitudes, adopting responsible environmental management and evaluating technology options.

Environmental Education is an important tool of Strategic Environmental Management in a landscape where companies have been strategically forced to adopt a new entrepreneurial management pattern concerned with Health, Safety and Environment. Environmental Education plays an important role at the company level. Environmental Education in industry is aimed at promoting a profound change in employee behavior, from the simplest worker to the president of the company, regarding an optimum consumption of natural resources, use of clean technologies, the 3 Rs application (Reduce, Reuse and Recycle), R&D in enterprises, industrial prevention and pollution control, all of these factors in favor of sustainable development.

Nowadays, the best practices in managing corporate sustainability performance have been conducted by global corporations involved in social and environmental matters. According to Epstein and Buhovac (2014) "Many companies have created performance measurement and management systems that include social and environmental indicators in addition to financial performance measures".

The Government of the State of Minas Gerais has taken into account Environmental Education as an important tool of Strategic Environmental Management in enterprises.

Based upon this principle, in 2007, the State approved a regulation named, DN COPAM 110/2007, *The Guideline for Non-Formal Environmental Education in the Environmental Licensing Process in the State of Minas Gerais*, whose objective is to provide orientation in the design of Environmental Education programs that will be introduced by entrepreneurs to the State Environmental System of Minas Gerais (SISEMA) in order to obtain environmental permits to produce legally. It is based upon Federal Law n° 9.795/1999, which establishes the Environmental Education Policy in Brazil, as well as Decree n°4281/2002, which regulates the aforementioned Law.

The Guideline applies to companies which fall within Classes 5 and 6 as defined by Article 16 of State Regulation, DN COPAM 74/2004, of the Environmental Policy Council of the State of Minas Gerais. According to the Regulation, Class 5 companies are either large companies with medium potential to pollute, or medium-sized companies with large potential to pollute. Class 6 companies are those of large size and great potential to pollute.

The target audience of this Guideline is comprised of two main groups: the first is the employees of the company, at all levels, including subcontractors (internal audience). The second group is communities in areas impacted or otherwise influenced by projects, as determined by environmental impact studies required by the Guideline.

### **The Foundry Sector in the State of Minas Gerais**

The Foundry Sector in the State of Minas Gerais accounts for 32% of Brazilian companies, being 28 % micro-enterprises, 56% small enterprises, 14% medium-sized enterprises, and 2% large enterprises (IEL-MG/SIFUMG, 2003).

The sector is trying to maintain its competitiveness in the midst of inherent market difficulties and crises which impact the survival of many industries. There are isolated and difficult initiatives, some of which are postponed for questions of investments in innovation and technological development.

The production of the sector is mainly directed to attend the states of Minas Gerais and São Paulo. The majority of the foundry sector enterprises produce for end-user clients such as household utilities, sanitation, and civil construction. Foundries which supply the automobile industry account for the majority of productivity and revenue within the sector.

As a result of the abundance of sand in nature, many foundries dispose of all used sand, or recover only a portion of this used sand. The rest is deposited in the enterprises' landfills, or in third-party landfills.

The inadequate disposal and lack of treatment of foundry sand contribute to an increase in environmental problems.

### **The Iron Foundry Case Study**

The foundry researched is a Class 3 industry as defined by Article 16 of the State Regulation, DN COPAM 74/2004, which defines the size of industries, as a medium-sized company with medium potential to pollute. It produces parts for sanitation construction.

This foundry is a practical example to be used and replicated as a model to attend to the state regulation: "The Guideline for Non-Formal Environmental Education in the Environmental Licensing Process in the State of Minas Gerais, in its Annex I, "Environmental Technology - Cleaner Production".

Special attention is to be given to the fact that as a Class 3 industry, it has no legal obligation to follow the State "Guideline for Non-Formal Environmental Education in the Environmental Licensing Process" in order to obtain environmental permits to operate the facility. This case study is a unique contribution to extend Non-Formal Environmental Education Programs to small and medium sized industries in the State of Minas Gerais.

### **3. Methodology**

This research has an exploratory approach as there is little accumulated and systematized knowledge of Evaluation of Non-Formal Environmental Education Programs for industrial workers involved in Cleaner Production.

A case study approach was used in this research as it circumscribes a unit of the foundry's production denominated Core Making.

The proposed Methodology in Non-Formal Environmental Education Training Program for workers in industry applied to cleaner production is structured in theoretical and practical steps. The first step was the application of the pre-test questionnaire (see, Annex II), which measured the level of knowledge of the core workers in the Environmental Education field applied to their daily work routine before the Non-Formal Environmental Education Training Program. The second step was the Environmental Education Training Program - EETP (see, Table 1). The third step was the application of the post- test questionnaire (see, Annex III), which measured the core workers gain of knowledge after the EETP. These are the theoretical steps of this Methodology.

The practical phase of the methods is composed of the researcher and company's eco team follow up of the Environmental Performance Indicators, the "Self-Monitoring of Core Waste Graph and the Foundry Dust Sand Waste Graph", which are used by the company in its daily routine to monitor the environmental quality of the workplace.

The “Self-Monitoring of Core Waste Graph and Foundry Dust Sand Waste Graph” data used for evaluating the Non-Formal Environmental Education Training Program considered the period of twelve months. Graph data are not demonstrated in this paper, only their results, since there is no authorization for the publication of data by the foundry.

### **The Selection of the Industry**

To begin the research, 400 letters of introduction were sent to companies in the fields of foundry, transformer production, textile, cement, primary aluminum production, and automotive parts. Eleven letters were undelivered. The response rate was 1.29%.

Five companies made an initial contact to express interest in the research. In a period of 6 months, they were all visited at least once and shown the research proposal.

The company selection phase was completed when an iron foundry industry in the City of Itaúna, State of Minas Gerais, was defined as the setting for the case study.

This foundry was chosen for research among the 05 companies visited because it manifested determination to participate.

The principal motivation of the foundry in participating in the research was the fact that it had industrial solid waste management challenges to be solved, and investment in environmental training of the industrial workers could help.

The industrial solid waste of the foundry was transported and stored untreated in a deposit on the foundry's property. Thus, in order to extend the capacity of the deposit to receive the foundry waste for a longer lifetime, it was important to minimize generating industrial waste.

### **Researcher in the Core Making branch**

Core making is an important branch in a foundry.

In the foundry in question, the branch produces cores which are parts that are placed into casting molds to form internal cavities. Sand cores consist of sand, resin and a catalyst to quickly set the resin. The cores are made of chemically/resin bonded sand molds, which are then taken to the molding branch in the foundry.

### **The participants in the Environmental Education Methodology Research**

The participants chosen by the foundry to participate in the research were the foundry's core makers.

The core makers work in three shifts: night, from 10 pm to 6 am; morning, from 6 am to 2 pm, and afternoon, from 2 pm to 10 pm.

The research started with 42 core workers and ended with 33 due to the company's reduction policy.

During the Non-Formal Environmental Education Training Program in the core making branch, some workers were dismissed. The expectation of those who proceeded with training was, although facing the risk of being dismissed, they were acquiring a differential in relation to workers in other foundries and in other industries.

### Initial Evaluation (Pre-test Questionnaire)

The course program and the training dynamics were planned by using a Pre-test Questionnaire for evaluation. The pre-test phase consisted of administering a questionnaire to collect participants' data. It focused on knowledge level, expectations and perceptions of the core makers, as well as their attitude regarding the impact of their work on the environment.

### Definition of an Environmental Performance Indicator in Core Making

In this study the wastes generated in the core making branch are core waste and foundry dust sand waste.

The environmental performance indicators defined to evaluate the Environmental Education Pilot Program in the core making branch in terms of environmental quality, whether the Project would bring gains or not in the improvement of environmental conditions, were the graphs used by the company in its daily routine to monitor the workplace, called "Self-Monitoring of Core Waste Graph and Foundry Dust Sand Waste Graph

### The Environmental Education Training Program

The contents of the Non-Formal Environmental Education Training Course was defined by taking into account the participants' data collected in "Initial Evaluation", the Pre-test questionnaire. The questionnaire was applied to the core makers in order to identify their knowledge level, expectations, and perceptions of the workplace.

The core makers attended Environmental Education Training classes once a month. In total, six training sessions took place. The first class was one hour. In order to work through the scheduled content with more time and clarity, classes were extended to 90-minutes. The total training in Environmental Education was 10, 50 hours, (see table 1).

The core makers who achieved an average of 60% on their pre-test and post test questionnaires, and 70% class attendance received their First Certificate in Environmental Education for foundry workers.

The Non-Formal Environmental Education Training classes were based upon Paulo Freire's educational praxis "Critical Pedagogy".

#### The Environmental Education Training Contents

<b>Activity</b>	<b>Environmental Education Contents (applied to Cleaner Production)</b>	<b>Schedule</b>
Pre- test	Questionnaire	1.0 hour
1 <sup>st</sup> Class	Industrial Ecology	1.0 hours
2 <sup>nd</sup> Class	Industrial Ecology	1.5 hours
3 <sup>rd</sup> Class	Industrial Solid Waste	1.5 hours
4 <sup>th</sup> Class	Household Solid Waste	1.5 hours
5 <sup>th</sup> Class	Mining & Environment	1.5 hours
6 <sup>th</sup> Class	Industrial Solid Waste Minimization	1.5 hours
Post-test	Questionnaire	1.0 hour

Table 1- Environmental Education Training Contents

#### Final Evaluation (Post-test Questionnaire)

As with the pre-test, the post-test consisted of the administration of another questionnaire to collect workers' data. Its goal was to assess the core makers' knowledge level and attitude after having participated in the Environmental Education Training Program.

### **4. Results and Discussion**

#### Pre-Test questionnaire: A global analysis

The pre-test questionnaire data enabled the researcher to verify the existence of two completely distinct worlds in the participants' minds: the natural environment and the core making section. By taking the pre-test, participants subtly gave the researcher the impression that "the core-making section was not part of the environment, and the same is true of core makers." This fact became even more evident during the first training session, during an activity called "natural ecosystem and the core making section's ecosystem".

In spite of the lack of technical information on the environment, demonstrated by the pre-test, it became evident that the core makers had a high degree of interest in the subject and that, surprisingly, they showed a proactive behavior through their willingness to initiate an immediate sanitation plan to solve the problem in question.

#### **Training Sessions Conclusion**

It is possible to conclude that to work with environmental education in industry is viable. However, for this to be realized, two essential factors must exist: the support of company leaders to develop this type of project, which is the political aspect, that can open or close industry doors, and the use of a suitable methodology to work with environmental education targeting industrial workers, which is the technical aspect.

Based upon this pilot experience, some specific characteristics to carry out projects on environmental education in industries were observed. For example, a focus on the universe of environmental training with short classes every 15 days, preferably, or every month in 60-minute sessions or at the most, 90-minute sessions. It is advisable that the training be structured in modules of short duration at progressive knowledge levels. A total load, per module, of between five and ten credit hours per student seems to be most comfortable for industrial workers.

A basic module helps to equalize the level of knowledge in Environmental Education applied to cleaner production initially working with the fundamental notions of ecology as it applies to industry until progressively reaching the environmental problems specific to the company in question. Whenever possible, connections between the company's specific issues and the global environmental perspective are to be made. As it is commonly said in the environmental field, it is about "thinking globally and acting locally". It is important that the workers visualize the company as an ecosystem where all sectors interact among themselves as well as with the environment.

It is necessary that Environmental Education training focus on a specific objective, and the goal is determined by the company itself in order to clean up some of its impact on the environment. It is also

necessary to define means to measure the consequences of behavior change in the workers involved in the environmental training program, and the transference of their internal change into the workstation, in order to improve environmental quality. The construction of a good, scheduled training content is the strategy used to reach the objective and the aim set by the company. In fact, the key instrument in this stage of activities is the objective, a methodologically appropriate approach focusing on the environmental impact to be minimized or controlled.

In addition to the aforementioned characteristics, it is important to note that environmental education in industry fulfills the role of technological environmental education for sustainable development. To reach this level of education, it is necessary to use teaching/learning techniques to facilitate the educational process of industrial students/workers, since they perform operational procedures.

Practical activities such as drawings, collages, quick exercises, games, discussions on specific topics (at an advanced stage), technical visits to the production areas, hands-on lessons, and case studies are recommended for this type of audience.

Another aspect that should also be taken into consideration in the Non-Formal Education Training Program planning is the possibility of workers shift substitution. It means that the company's changes of workers during their shifts is common to happen and these changes have a direct impact on the training program. So, it is necessary to be prepared to deal with the risk of a worker attending the training class on another shift.

The environmental education project in the core making section involved environmental training applied to the reduction of foundry dust sand waste and core waste. It enabled workers to gain knowledge on the topic. The research universe was restricted to the first module of training, the basic module.

In conclusion, based upon the environmental training in the core making section, industrial workers gain in-depth knowledge through Environmental Education. This process is called continued adult environmental education which goes beyond the knowledge determined by the company's environmental policy as well as the mechanical repetition of operational procedures, thus opening the possibility for concrete financial and environmental gains.

#### **Post-test questionnaire (Conclusion)**

The post-training questionnaire data item which had the largest number of correct answers among both work shifts was about solid waste. This could be explained by the core makers' experience, as both domestic and industrial wastes are concrete facts to them.

Conclusions from the analysis of the environmental performance indicator graphs

The "Self-Monitoring of Core Waste Graph and the Foundry Dust Sand Waste Graph were used to assess whether or not the pilot project on Non-Formal Environmental Education in the core making section could improve the environmental conditions of the section researched.

A comparison of the quantitative data from the environmental performance graphs shows reasonable improvement of the core making section. The curves show a tendency for the production process to stabilize. From an environmental perspective, this means that the "reasonable environmental improvement", physically perceived, visualized, and felt by the participants, is mostly due to the reduction of foundry dust sand waste, which causes air pollution in the core making section.

The graph changes, especially the foundry dust sand waste monitoring curve, represent a process of cognitive change in the participants due to the information input provided through their training. There was an increase of knowledge about the environmental issues applicable to each core makers' work.

Although the environmental performance indicator graphs are not included in this work in order to preserve the company's data, the promising changes which are shown in their curves, demonstrate the consequences of the core makers' cognitive change, which led to their proactive behavior change towards the environment in the core making section. The internal changes of behavior in each core maker, taken as a group (33 workers) are reflected in the graphs.

## **5. Conclusions and Recommendations**

This work was conceived based upon the scarcity of evaluation of Non-Formal Environmental Education Training Programs for industrial workers applied to cleaner production by using environmental performance indicators to demonstrate Environmental Education effectively contributes to the betterment of the industrial environment.

This research focused on a short- term environmental training course as well as resulting changes in the environment of the workplace researched. The results were measured in terms of acquisition of knowledge of the core workers from the training program, and the environmental quality improvement in the core making section.

The data analyzed indicated that it is possible to work with Scientific Non-Formal Environmental Education in industry. For this to be accomplished, it is imperative that the methodology be suitable and similar in manner to the industrial production process.

Industrial Environmental Education can lead workers to environmental awareness, provided they are given enough time in training to absorb and process their new knowledge.

The environmental education training was evaluated in a practical manner through data tabulation obtained from the graphs, and evaluated theoretically, from the data obtained from the pre and the post-test questionnaires. Based upon the final grades (pre- and post-test averages), workers effectively gained knowledge from the training. There was definitely an increase in environmental awareness of the core makers. The acquisition of new knowledge and a finer understanding of the environmental issues of the core making branch led core workers to develop new abilities, acquire new values, change their behavior and attitudes, and act immediately to minimize Foundry Dust Sand Waste and Core Waste in each workstation. This is the original and unique contribution of this case study.

The positive results of the "Self-Monitoring of Core Waste Graph and Foundry Dust Sand Waste Graph" showed an improvement in the environmental quality of the core making section, due to a change in behavior of each core maker, which was a consequence of an increase in their environmental awareness level.

According to the foundry waste's Graphs, concrete positive data results were achieved in terms of the "Non-Formal Environmental Education Methodology for Industrial Workers" applied to Cleaner Production. The Graph data indicated a behavior change in the core makers' habits and attitudes, which were externally expressed in terms of the core making waste minimization.

There were noticeable, improvements in the environmental quality of the core making section. These improvements in the reduction of foundry wastes, can be translated into financial and environmental gains. The Environmental Performance Indicator graphs in the core making branch showed a minimization of 2.5% in foundry wastes, core waste and foundry dust sand waste. In financial terms, this minimization was equivalent to a cost reduction of US\$500.00, and was obtained during the research period of 12 months.

Although this was a short-term course, the success of the core makers who participated in this Non-Formal Environmental Education Training Program was a direct incentive for the foundry to implement the Environmental Management System process. Today, the foundry is certified in ISO 14001.

Despite the fact that the evaluation of this Non-Formal Environmental Education Training Program for industrial workers started in 1989, and yielded promising results, it is still early to affirm how long workers in general will maintain the current level of environmental awareness gained, without a Continued Non-Formal Environmental Education Program. Continued study and training is recommended, as the Non-Formal Environmental Education Program was of short-term one.

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### **Annex I**

Environmental education questionnaire for company selection:

- 1- What are the concerns of the company on the topic of environmental education within your enterprise?
- 2- Does your company have any continued environmental education program?
- 3- Do you have any special teaching methodology applied to your environmental awareness activities?
- 4- Has your company implemented an environmental management system? Have you ever held any environmental education programs for your employees? Was the environmental education held in a school? Was the environmental education held in and for your local community?
- 5- Has your company implemented an environmental management system? Has your company implemented an ISO 14001 EMS? If no, is there any chance for the future?
- 6- Have you ever had environmental education for employees in their work place? Would you have an interest in getting your employees involved in an environmental education training program?
- 7- Would it be possible to develop any metric or mechanism for evaluating the environmental awareness level before and after an environmental education program in your company operation? Could the program be monitored? Could you in parallel monitor the changes in the environmental quality?
- 8- Do you have a solid waste management plan?
- 9- Do you have recycling program?
- 10- Would you be interested in being involved in a multi-national environmental education doctoral research thesis entitled, "Education and environmental engineering in enterprises – an analysis of the training methodologies applied to environmental education in enterprises, with main reference to the industrial and solid waste management"?

### **Annex II**

Your answers to this questionnaire are very valuable and appreciated.

#### **Pre-Test questionnaire**

Name:

Position:

**1- Age:**

18-30     30-50     over 50

**2- Level of Education:**

4<sup>th</sup> grade    8<sup>th</sup> grade    high school    college

**3 - How important is this environmental education project for me?**

( ) very much ( ) regular ( ) little ( ) no opinion

**4 – How long have you worked in the Core-Making Sector?**

- a- up to 3 months
- b- from 4 to 12 months
- c- from 1 to 3 years
- d- from 3 to 5 years
- e- more than 5 years

**5 - Marital Status:**

( ) married ( ) single ( ) divorced ( ) widow ( ) widower ( ) other

**The Environmental Education Project**

**1 - Do think that the Core-Making Section:**

- a- Helps to preserve the environment
- b- Does not interfere in the environment
- c- Causes impact to the environment
- d- No opinion

**2 - The River -----is part of environment of Itaúna City**

- a- Doce
- b- São Francisco
- c- Amazonas
- d- São João
- e- No opinion

**3 - What is the closet Environmental Protection Area to this foundry?**

- a- Apa Andorinhas
- b- APA da Barragem do Benfica
- c- APA Sul
- d- APA Aldebarã
- e- No opinion

**4 - Which of the items below provokes the least or no damage to the environment**

caused by sand obtained from mining operations?

- a- Deforestation
- b- Mining dust
- c- Preservation of part of natural vegetation
- d- Debris dam
- f- No opinion

5 - What is the best way to remove sand from the Core-Making Section and return it to the environment?

- a- Storage
- b- Incineration
- c- Landfill
- d- Private waste removal
- g- No opinion

6 - What is the objective of the Environmental Education project in the Core-Making Section?

- a- Sand reuse
- b- Send sand to an industrial landfill
- c- Reduce the generation of sand
- d- Illegal dumping of sand
- e- No opinion

7 - To what extent can the Environmental Education project improve the environment in the Core-Making Section?

- a. To no extent
- b. A little
- c. A reasonable amount
- d. Very much
- e. No opinion

8 - What type of pollutant in Core-Making Section can cause water and soil pollution?

- a- Cast Iron
- b- Core parts
- c- Resin
- d- No opinion

9 - Which is the best hierarchy for solid waste management?

- a- recycle, reduce, reuse
- b- reduce, reuse, recycle
- c- reuse, recycle, reduce
- d- no opinion

10 – What should I do to enhance the environment in the Core-Making Section?

- a. Nothing
- b. Study the issue
- c. My job has no interface with this subject
- d. It is impossible to enhance the environment in the Core-Making Section

### Annex III

#### Post - Test questionnaire

Name:

Position:

#### PART I

Please answer:

- 1 - The pilot Environmental Education project in the Core-Making Section interested me:  
( ) very much ( ) regular ( ) a little ( ) no opinion
- 2 - In your opinion the Environmental Education project should:  
( ) Be discontinued  
( ) Go on only in the Core-Making Section  
( ) Go on in the Core-Making Section and be extended to other units of the company  
( ) Be extended to other units of the company

#### PART II

#### Evaluating quantitatively the Environmental Education project:

- 1 - The Ecosystem of the Core-Making Section is composed of: (1 credit)
  - a- basic sand and resin
  - b- sand with resin and core parts
  - c- refuse-waste and sand
  - d- soil and men
  - e- light and air
- 2 - To what extent was the environment in the Core-Making Section enhanced by the Environmental Education project? (1 credit)
  - a- No change
  - b- A little
  - c- Medium
  - d- Very much
  - e- No opinion
- 3 - Certain negative effects on the environment provoked by mining cannot be contested, except: (1 credit)
  - a- When operations are finished, refuse is accumulated
  - b- There are many changes in the topography of the region
  - c- Introduction of a recovery plan to impacted mining areas.
  - d- Deforestation
  - e- Loss and extinction of seed banks.
- 4 - Fulfill the parenthesis: (4 credits)
  - 1-Industrial waste ( ) batteries
  - 2- Household waste ( ) sugarcane bagass
  - 3- Hazardous waste ( ) sand of the Core-Making Section  
( ) organic matter

5 - These are viable options *under research* for foundry sand reuse, except: (1 credit)

- a- Structural concrete
- b- Bricks for civil construction
- c- Road Construction
- d- Ceramic bricks
- e- Concrete artefacts

6 – Make a self-explanatory drawing of each chain of the life cycle of Sand of the Core-Making Section, from the “Cradle to the Grave”. (2 credits)