LUND UNIVERSITY MASTERS PROGRAMME IN ENVIRONMENTAL SCIENCE (LUMES)

ADULTS’ ENVIRONMENTAL UNDERSTANDING: HOW DO ADULTS REPRESENT THEIR RELATIONSHIPS WITH THEIR ENVIRONMENT?

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SUMMARY

One of the major challenges environmental educators face is to promote a more sustainable human-environment relationship. This implies that they should overcome students previous ideas and misunderstanding about environmental issues. Based on this ideas, it is considered for this paper that to do so, educators need tools to identify their students ideas and perceptions. Therefore, a methodology for assessing adults environmental understanding was developed and used to survey how students perceive their environment and to identify the kind of thinking that predominates in their environmental understanding. Thirty-seven international masters' students at Lund University were asked to draw conceptual maps showing the origin and destiny of the food they consume. The analysis, based on different authors and on the systems theory, focused on dimensions and relationships that students made between them. The systems approaches that the students showed in their maps were also of interest. Five levels of environmental understanding were identified and the students were classified into these levels. It was found that about half of the group have a moderate environmental understanding. This implies that they were able to identify at least three dimensions to explain the system and to integrate the different relationships among this dimensions. The results suggest that the methodology was useful to assess adults' environmental understanding and awareness of the systemic functioning of it.
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GLOSSARY

**EE.** Environmental Education

**Comestibles.** Any substance that can be used as food

**LUMES.** Lund University International Master’s Programme in Environmental Science

**NA.** Used in tables and figures to express: Not Apply

**s/he.** Abbreviation for “she or he”

**UNEP.** United Nations Environmental Programme
To the baby I am expecting and to the future generations with the hope that we can find the way to leave them a world to live in.
1. INTRODUCTION

1.1 The challenges of environmental educators

The United Nations Conference on the Human Environment held in Stockholm in 1972, conceived environmental education (EE) as a means to create public consciousness about the hazards of the planet’s environmental degradation. Twenty years later, Agenda 21 emerged from the Earth Summit in Rio as a blueprint for environmental work to achieve a sustainable development. Agenda 21 identifies education as critical to promote sustainable development. In conformity with EE’s goals, environmental educators¹ challenge is to develop, in their pupils, awareness and concern about environmental issues. To achieve this purpose, teachers have to provide their students with the knowledge and skills to reinforce changes in values, attitudes and behaviours towards the environment.

The challenge is to develop a society that is aware of environmental problems and concerned with solutions to these problems. This challenge implies a change in people’s behaviours and attitudes to encourage them to act as *environmentally responsible citizens*². In this task, environmental educators have to overcome previous concepts and behaviours that students acquired during their whole lives through several educational systems (mass media, society, family, formal and informal educational programs and so on) which interfere with the achievement of attitudinal and behavioural changes.

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¹ For the purpose of this paper the term educator refers also to trainers, teachers, parents or any other person involved in environmental education projects. When required the specific term will be used.

² Members of the society who are not only aware and well informed about environmental issues, but who are able to act and decide in a responsible manner, avoiding, or at least reducing, their environmental burden.
Smyth (1995) affirm that educational efforts have increased and that the 1990’s population is highly concerned about environmental threats, but that efforts to produce environmental depletion and pollution to date are far from achieving sustainable development. The question Smyth arises from this fact is: if people’s survival depends on the environment, why is it so difficult to shift from awareness and concern to participation and attitudinal change? Then, reflecting on this question: What are the hidden causes that influence human misbehaviour and slowdown progress towards a sustainable society? There is no concrete answer to these questions because they involve more than education, and because human’s behaviour and relationship with the environment are strongly determined by lifestyles, beliefs, social conditions, individual value scales and feelings towards the environment. As Mogensen (1996) states, there are different causes that make EE’s objectives difficult to achieve. Among the principal causes Mogensen mentions the divorce of school educational approaches and EE’s objectives. Thus, as Mogensen explains, traditional school encourage an atomistic and discipline-based learning. Mogensen also highlights that school knowledge has been given the function to enhance individuals status and economic well-being and that the knowledge acquired at school is based on artificial situations rather than applied to real life situations.

Education plays an important role as an agent of change towards a more sustainable human-environment relationship. Therefore, to find the pedagogical methods to encourage a better understanding of the complexity of the world is one of the most important challenges of environmental educators.

1.2 Objectives of the research

Environmental education alone is not enough to assure earth’s conservation nor the achievement of sustainable development. However, it is an important tool in encouraging knowledge and concern about environmental problems.
Aiming to find out how adults do perceive their environment, this study's objectives are:

1. Survey the different ideas and perceptions that adults have about their environment;
2. Identify the kind of thinking that predominates in adults' environmental understanding, and
3. Establish the relationships that adults recognise in their connection with their environment.

Although there are other relevant points intervening in the achievement of EE’s goals, this study’s focus will be on students' perceptions and conceptions of their external environment to understand how adults’ environmental understanding is structured.

1.3 **Hypothesis**

For the purpose of this research it is hypothesised that:

1. Adults have a fragmented view of how their environment functions and therefore it is difficult for them to perceive the complexity of a system.
2. Conceptual maps are useful tools to assess environmental understanding, and
3. Environmental perception is determined by the combination of former learning processes, peoples' perceived needs, desires, experiences and goals.
Chapter 2

2. THEORY

2.1 EE a thread to weave a new relationships with the environment

"The major environmental problems that actual societies face have their roots in social, economic and political systems, and in the world views, institutions and lifestyles' choices that support them", as many authors as Fien et al. (1993) and Miller (1997) suggests (Figure 1 illustrates the major environmental problems). According to Novo (1995), environmental problems and their causes pivot on the relationship that humans have established with the environment.

The answer to alleviate these problems was the revision of economic, educational and social policies in relation with the environment made by the United Nations, and other international organisations as the World Wildlife Found, Green Peace, International Union for Nature Conservation among others. Concerning education, the result of many international meetings (Stockholm, Tbilisi, Rio), was to recognise the need to encourage the development of EE programs to promote a change in the human-environment relationship.

After Stockholm 1992 EE became a strategy to influence a change in values, believes, attitudes and behaviours towards the environment. Subsequently, it was conceived as a thread to weave a different relationship of individuals and societies with their surroundings. Hence, EE seeks to raise public awareness on environmental issues and its ultimate goal, according to UNEP (?) is: "not only to change attitudes of people, but also to motivate and empower them to act for the environment".
In conformity with the above, EE should motivate people to attain a global understanding of the complexity of the environment as a dynamic and interactive system. This could also be helpful to clarify values and to develop critical and participative attitudes towards the human-environment relationship. Such change might include a rational utilisation of natural resources; as well as a review of own lifestyles.

2.2 The holistic approach in EE

According to the nature and the objectives of EE, concepts like “holistic approach” and “interdisciplinarity” have become a kind of milestone in environmentalist’s jargon. The holistic approach has gained importance because there is a perceived need to increase peoples’ awareness of the interconnectedness of the different elements in the environment. As Smyth (1995) points out, part of the problem is that people have become confused with the different definitions of environment to which the may have access.

Adding to this argument is the fact that traditional education has reinforced a fragmented perception of the different components of the environment and this may reinforce a partial and linear understanding of the environment. This linear understanding could be described as a fragmented perception of the different elements.
that constitute the environment, without establishing interconnections and relations between them.

Then, as Novo (1995) and Smyth (1995) suggest, EE requires a holistic understanding of the complexity of the relationship among the different subsystems that comprise the environment. Smyth (1995) suggests that the holistic approach could be reached through the adoption of a systemic thinking in the teaching methodology which might be combined with an interdisciplinary analysis of the reality. It also implies that education should be issue based and focused on real problems.

Treating the environment as a system and thus, analysing it as interrelated parts that compose the whole, could help in gaining a wider perspective not only of the environment, but of peoples’ roles within it. For the purpose of this paper the following definition of system will be used:

"System is a set of objects together with relationships between their attributes. Objects are simply the parts or components of a system. Attributes are the properties of objects. Relationships tie the system components together and which relationships are meaningful at a given time is a matter of discretion by the investigator. It is important to determine interconnections and dependencies, as well as the static or dynamic nature of the relationship". (Richmond 1994 quoted by Wylie et al, 1998)

Using this definition a systemic interpretation of the environment could help to achieve a more holistic understanding of it. Then, according to Richmond 1994 (quoted by Wylie et al, 1998), a systemic understanding could help to close relationships among the components of the system and thus it might be possible to predict its behaviour.

This paper takes the position that the holistic approach and systemic understanding can increase students’ awareness of the complexity of the environment. This can lead to a better understanding of environmental issues at different scales and can help to engage people into a more reflexive and critical behaviour towards the environment.
2.3 EE and behavioural change

As was stated before, EE aims to encourage a change in the way people behave towards the environment. According to Gardner & Stern (1996) human behaviour plays a decisive role in environmental problems. Nevertheless, there are few careful studies to understand the roots of human behaviour towards the environment. Gardner & Stern (1996) stress the need to understand and to do more research on the causes and factors determining destructive behaviours in order to find effective strategies for changing them. Cassidy (1997) also suggests the need to identify not only the roots, but also the dynamics of human behaviour in order to have a comprehensive view of all the factors determining human behaviour towards the environment. Moreover, Cassidy (1999) emphasises that there is a need to identify which behaviours should be the target for further interventions.

Smyth (1995) comments that given the complexity of behaviour and environment, both should be treated in a holistic manner. This means that behaviour is not an isolated response to certain external stimulus. It should be understood as a complex system of response from humans, which has a strong relationship with attitudes, beliefs and values. Furthermore, the behaviour towards environment should be understood as a complex construct which is influenced by the external environment (physical, social, cultural) and by the internal environment (beliefs, attitudes, values, previous experiences, needs, and motivations) of individuals. For the purpose of this research it is important to keep in mind that behaviour towards the environment is understood as the visible and perceived interaction of humans with their environment.

2.4 Humans’ attitudes in their relationship with the environment

Human attitudes towards the environment have been shaped during history by human interactions with their environment and have evolved with the technologic developments and with the prevailing economic systems. Other factors affecting attitudes are related to social, economic and cultural influences.
Cassidy (1997) argues that, although most people know facts about environmental degradation, they are not aware of the importance of such factors. Some people are well informed about environmental issues but give relatively little importance to them. According to Novo (1995) this tendency could be the consequence of a loss in the sense of unity of the environmental reality. This is due to the fragmentation in our view of reality. Human beings are not perceiving the complexity and the interrelation of all the elements in the ecosystems in which we develop our lives.

It can be assumed that people see their relationship with the environment as if they were isolated from the world surrounding them. They assume themselves to be external observers of the environment. When assuming themselves out of the systems to which they belong, they ignore its functions. In this case, they tend to be insensible to the effects of their behaviour upon the environment. The same occurs when people are not able to anticipate or to connect the effects of environmental problems, which they think are far from them.

It is assumed for this survey that the human-environment relationship is often characterised by a dominant attitude by humans towards the environment, forgetting or ignoring that there is a strong dependence on Earth’s supporting systems. There is a need to understand how humans build their relationship with their environment, and the factors that contribute to the determination of the quality of this relationship. This change in behaviour and attitude of humans towards the environment is especially, the ultimate objective of EE. Also, if there is a need to change behaviour it is necessary to know first which behaviours represent a major damage for the environment and to understand the factors determining the complex human behaviour.

Some definitions of attitudes state that they are complex mental orientations involving beliefs and feelings and values and dispositions to act in certain ways (Word WebPro, 1997), or as expressed by Simpson, R. et al. (1994) attitudes represent feelings towards issues, objects, people and situations. These definitions and the above
description of the human-environment relationship could lead to the affirmation that humans have negative attitudes towards the environment because their behaviours produce damaging effects on the environment. However, as Cassidy (1997) observes, this is not true because although some people have positive attitudes towards the environment (i.e. they think that environmental protection is important) they do not translate their attitudes into behaviour. Another example illustrating this is the acknowledgement by many people that the use of fossil fuels is an important source of air pollution. In some cases these people would be willing to avoid the use of private cars. However, due to their personal circumstances, they continue using cars. Economic factors (prices of public transport), and social causes (culture, status, policies) determine this behaviour.

Attitudes “only predict behaviour in certain circumstances” (Cassidy, 1997). It is important to consider that attitudes are intimately related to values and beliefs. Behaviour is just an image of attitudes. Recalling EE’s goal of promoting an attitudinal change, it is significant to remember that attitudes are only one element of a complex system in which knowledge, feelings, values, norms and beliefs are interrelated and interdependent (see Figure 2). Therefore, a change in attitudes requires a change in the whole system, as well as a holistic comprehension of human behaviour in relation to other contexts (e.g. political, social, economic and educational), which affect and strongly determine the manner in which humans interact with the environment.
2.5 The role of values in the human-environment relationship

According to Simpson et al. (1994), as attitudes refer to a predisposition to respond to places, objects, events or ideas, values focus more on abstract ideas. Values are complex entities that interact with attitudes, and beliefs in different ways and when all are combined they define individual's behaviour towards the environment, as can be seen in Figure 2.

Values are determined by several social factors such as family, school, friends, religion, norms, mass media, and policy. There are other variables interfering with value formation as well as gender, personal experiences, psychological development and the educational context in which people grow. Individual needs are another important factor that determines value formation.

Values have a strong influence on the world-views (see Figure 3) that individuals construct. Thus, they influence the way in which individuals think, act and interact with
their environment. They are also significant variables that determine the role that individuals adopt in their world.

As shown in figure 3, environmental views can differ from atomistic or individual centered to a holistic and earth centered or ecocentric view. Taking into account Figure 2, it can be noted that world views result from the interaction of values, attitudes, affects, beliefs and knowledge. Thus, behaviour combined with world views show individual’s tendencies towards the environment.

### 2.6 Environmental perception

Human perception of the environment is another key in understanding how individuals establish their relationships with the environment. Individuals become aware of the environment through their senses and through the way in which they process the information they receive from the environment. Again, the information that individuals receive from the environment is interpreted and processed under the influences of his/her psychological and cognitive structures. It can be said that individuals perceive the environment through their senses and this information is assimilated and adapted for further interactions with the environment according to the individual’s beliefs, values, attitudes and cognitive structures.
2.7 How do individuals learn

In section 2.1 was stated that EE’s objectives are to encourage an attitudinal and behavioural change in the human-environment relationship. In order to develop EE programs it is important to know more about the learning processes and how individuals build knowledge. The particular aspects of the learning process and acquisition of new knowledge that the programme needs to encourage to shift or to change must be identified if individuals’ relationship with the environment are going to change.

When an individual enters a new learning program s/he comes with a baggage of personal motivations, goals, interests, and previous knowledge about the subject of the programme. As stated by Novo (1996) previous knowledge and ideas about the subjects have great influence on people’s behaviour. It can be inferred that also previous experiences and knowledge interfere with human perceptions and thus influence how the new knowledge is going to be structured by the individuals. Ramsden (1992) states that previous experiences influence students interests and approaches of learning. As learning approaches (meaningful learning and rote learning) have a definitely influence in the concept construction. Furthermore, as has been said in this paper, concepts interact with the individuals’ internal entities\(^3\) and as a result, they may influence individual’s behaviour. According to Jarvis (1992) knowledge, experience and information are not enough to change a person’s behaviour. Jarvis stresses that for an individual to change a reinforcing reasoning and reflection about the theoretical information used in the practice and a constant evaluation of the results are required. Then it could be possible to assimilate the information and this can lead to a change in the person’s behaviour.

A recurring theme of this paper is that EE searches for behavioural and attitudinal changes towards the environment. In fact, many EE programmes seek to encourage a

\(^3\) Internal entities is used to refer to the set formed by attitudes, affects, knowledge, beliefs and values illustrated in Figure 2.
holistic understanding of the world and of environmental problems. Then, the didactic methods and the structure of the programme need to be holistic as well. This means that EE should understand the individual in a holistic manner, also. Using this approach EE accepts that individuals learn about the environment in different circumstances and with different motivations and experiences.

2.8 People's knowledge about the environment

It has been said in this paper that EE deals with the human individual who is a complex entity built up with feelings, knowledge, attitudes, values and beliefs. Also that EE should treat the individual and education in a holistic manner in order to move towards a more holistic understanding of the environment.

In this order of ideas, it is important that environmental educators keep in mind that “the single most important factor influencing learning is what the learner knows” (Mintzes & Wandersee, 1998). As Kearney & Kaplan (1997) say, “people’s knowledge about environmental issues is a central concern in environment and behaviour research”. According to Kearney and Kaplan (1997) the identification of people’s environmental understanding help teachers to identify the kind of information their students need to enrich their environmental understanding. Helldén (1995) also encourage teachers to know more about students ideas about different phenomena. According to these ideas, EE programs should keep in mind the importance of working with students ideas about the issues covered by the program.

However, knowing students ideas about the subjects, issues or phenomena should be combined with a holistic understanding of the individual. It is also important to recognise teachers’ role as mediators and the student as an active subject in the learning process.

Cognitive or concept maps (described in more detail in section 3.2) are helpful tools to identify people’s ideas, and knowledge about the world as stated by Kearney &
Kaplan (1997). This tools can help to identify how people structure and organise the information they perceive from the environment, their beliefs and misconceptions of the world. Concept maps have been proved to be useful to identify students’ knowledge about different subjects and as tools to improve their learning processes, as was showed by Novak and his team at Cornell University after several years using this methodology (see Novak, 1993, 1993 and 1998).
3. METHODS

3.1 Introduction

This study aims to identify adults' environmental understanding. It is designed to identify whether or not students from the LUMES programme have a systemic understanding (holistic view) of the world.

The methodological strategy selected to identify the students' ideas about the environment was concept maps, which are explained below. Among the aspects that this research seeks to survey are:

1. Are the students able to identify different cycles required to fulfil their needs for food?
2. Do they identify different dimensions (e.g. social, economic, political, biological, geographical) in the whole process?
3. Are the students able to establish relations between the different dimensions?
4. How do they understand the complexity of the environment?

The answers to these questions were obtained from the analysis of the student's concept maps.

3.2 Concept maps

As was introduced in section 2.8, concept maps are considered useful tools to identify students understanding about the environmental issues related to food, and to identify how they structure their knowledge and the kind of relations they are able to establish among the different aspects involved in the food system. According to Novak (1993) concept mapping was used in their research as a tool to identify students
representation of concepts and propositions. As Novak (1993) implies: "concept maps are useful tools to illustrate key ideas in assimilation".

Kearney & Kaplan (1997) refer to this technique as cognitive mapping, which assimilates to Novak's concept mapping technique. Kearney & Kaplan imply that "most fundamental human cognitive processes including prediction, decision making and planning would not be possible if people did not have some way of internally representing the external environment".

For the purposes of this research, concept maps are defined borrowing Novak's (1993) definition as concepts linked together by propositions or linking words and organised hierarchically, according to the context, importance, and relationships established between the concepts or ideas. The students were asked to represent their concepts or ideas graphically in the form of landscape conceptual maps. In these maps information is presented in the form of a picture. The maps the students drew were treated as conceptual maps or as mental models represented graphically by the students. In the analysis, students' maps were studied using Novak's definition of concept maps.

Concept maps fit very well into this approach because they provide information that people absorb from their daily interactions with their outside world. Thus, when they are asked about aspects of their routines or their lives, they use the information they perceive, and organise it in their very personal manner. To build concept maps, people use the knowledge they have; they also set priorities that are relevant for the particular aspect of their lives they want to describe. Therefore, concept maps are useful to identify the hierarchical organisation that people have of their surroundings. They also help to identify whether or not the individuals have a systemic comprehension of their world, or whether or not they consider certain relations and linkages between elements and process.

The purpose of this study is to identify the students' ideas about their environment through the conceptual map they drew as an answer to one question. They also were
expected to use a conceptual map of the landscape kind.

3.3 Description of the task

To survey the students’ ideas about their environment they were asked the following question: *Where does the food you consume come from and where does it go to?*

The students received two sheets of A4 paper. The first one contained the description of the task and the question. The same page solicited information that was used for the analysis of the response, like:

a) Academic background, and
b) Name (Optional)\(^4\)

They had to draw their answers on the second sheet which was a blank page.

3.4 The Students

The survey was applied to twenty-two students from different countries between twenty-one and thirty-eight years old, who are starting the 1998-99 LUMES course (LUMES 98). From the twenty-two students ten were male and twelve female. Eleven of them belong to the natural sciences and eleven to the social sciences. The second group who answered the questionnaire were fifteen students from the first generation of LUMES (LUMES97). Eight of the fifteen students are female and seven are male. Ten belong to the natural sciences while five belong to the social sciences. They received the same question, and were expected to answer in the same way as the first group. They answered the question at the same time as LUMES 98 did. They were asked to answer the question in this survey during the second week of the course. They had one hour to work on the task described above.

\(^4\) All the students gave their names.
3.5 Analysis

The analysis of the conceptual maps drawn by the students was based on a concept map which is explained further in this section (see Figure 4). The concept map contains the main aspects involved in the production of food and the final disposition of the refuse after the consumption or during steps in the whole system. The attention of the analysis focused on three main aspects: dimensions, relations between the dimensions and scope of the system.

3.5.1 Analysis categories of the questionnaire

The approach used for the analysis of the students' answers to this survey was influenced by the systems theory. On the one hand, the whole process of food production until the final disposal of wastes generated after consuming foods was considered as a system. On the other hand, it was assumed that the act of consuming food links humans directly to the environment. Although this linkage is not a conscious one, it is one important way in which humans relate directly to their environment. How the students understand this relationship and how able they are to map such a complex system is just a mechanism to comprehend how they understand the complexity of the environment to which they belong.

To facilitate the analysis of the students' answers to the survey a concept map (see Figure 4) was developed. The map covers different aspects related with the origin of food and its destiny after it is consumed. It was developed in an attempt to picture a holistic view of all the aspects related with food.

The concept map shows the interaction and interconnectedness of different dimensions related to the production of food and the elimination of wastes either during the production process or at the end of the consumption. The structure of the map offers a wide perspective on the different elements interacting in the food production process. The interactions are characterised by the exchange of energy or materials between the different elements. The interactions between the different dimensions illustrate the
complexity of the whole system. Thus, it is possible to observe that there are structures depending on others in the whole process.

3.5.2 The dimensions

From the analysis of the concept map, nine analysis criteria were identified to establish the dimensions interacting in the whole system. Each dimension is determined by the kind of information that the student refers to, when s/he described the process of both production and elimination of food.

For the purposes of this thesis, the dimensions are understood as specific processes which require input of resources (energy or materials) and produce output (products or by products). According to this definition of dimensions they correspond to the idea of cycles that Wylie et al, present in their survey (see Wylie et al, 1998). One or more dimensions can be used to explain the behaviour of the whole system of food production and final disposition of residuals, which was the interest for this research.

The identified dimensions for this analysis were extracted from the concept map in Figure 4. These dimensions were:

1. **Biological**: If the student referred to natural processes in the production of food. Also if any of the following elements were included in the description: natural resources, food chains, ecosystems, cycles (e.g. nutrients, water).

2. **Chemical**: If the student referred to the use of chemicals or to pollution processes due to the production or elimination of food. Also if any of the following elements were included in the description: emissions, fertilisers, chemicals and nutrients' cycles.

3. **Cultural**: If the student referred to certain eating customs proper from his/her culture (i.e. vegetarianism)
Where does food come from and where does it go to?

Food Chains
- Trophic levels
- Energy and nutrients flows

Ecosystems
- Aquatic
- Terrestrial
- Globally distributed in climatic zones

Natural Resources
- Plants
- Animals
- Minerals

Productive Systems
- Can be
- Exploited

Farms

Orchards

Industries

Energy

Fossil fuels
- Wind
- Water
- Nuclear

Labour

Production
- Generates

Transport
- Packaging

Emissions

Technology
- Machinery
- Chemicals
- Fertilizers & Pesticides

Wastes
- Sewage water
- Solid wastes
- Waste heat

Market place or Supermarket
- Communities to share or compete with
- Customers
- Eating customs
- Cultural determined
- Government

Household
- Water courses
- Treated plants
- Sludge

Environmental laws
- To reduce
- Pollution

Go back to

Figure 4: Concept map of environmental aspects related to food
4. **Economic:** If the student used artificial or economic productive systems in the answer. Also if any of the following elements or processes were mentioned: industries, transport, marketing supermarkets, market place and household.

5. **Geographical:** If the student referred to different countries, geographical zones, geographical regions, or climates in his/her answer.

6. **Personal:** If the student reflected on the use that s/he makes of foods to build up metabolic processes, or if s/he mentioned that food is used to build muscles or to produce the energy for the body.

7. **Social:** If the student used any of the following elements in his/her answer: workforce, labour, consumers, consumption, communities, government, policymaking and competence.

8. **Technological:** If the student used any of the following elements in his/her answer: machinery, energy use, treatments and packaging.

9. **Others:** If the students referred to other dimensions that did not fit into any category listed above.

### 3.5.3 Systems approach of the students

It was suggested in Chapter 2 that EE require a holistic approach to motivate the understanding of the complexity of the world. This implies that in order to understand the environment a systemic understanding of the world is required. For this reason, the students were asked to draw a map in which they could show where the food they consume comes from and where it goes after being consumed. The purpose of this question was to find out first of all whether or not the students were able to identify a system.

### 3.5.4 Open or closed systems

In addition to the development of the system based on different dimensions, the analysis also considered the ability of the students to close loops or relationships
between dimensions or between input and output from one dimension. The attention was focused also on identifying whether or not the students were able to predict future behaviours from the system based on the relationships they established in the system. Attention was kept on students ability to describe closed or open cycles of matter and flows of energy.

3.5.5 Scope of the system

The analysis also took into account the scope of the students’ systems, which helps in discerning their understanding of the environment. This means that for the analysis it also was important to see if the systems the students created had a global, regional or local scope. With scope in mind it was also important to analyse the kind of relations they established among the dimensions.

3.6 Scoring

Section 3.5 described the analysis categories for this survey, which were scored in a uniform manner, in order to classify the students according to different categories. The following steps summarise the main actions carried out to score the students answers:

1. The conceptual maps drawn by the students were analysed carefully.
2. The main concepts and ideas represented in the conceptual maps were extracted and listed in a separate sheet.
3. The students’ ideas were analysed and classified according to the dimensions and categories identified in the previous section.
4. The conceptual maps were carefully interpreted to identify relationships established between the dimensions, the scope of the system and the kind of system created by the student.
5. A score sheet was created to summarise all the information of the students (see Appendix 1) for a further quantitative analysis.
6. Using the score sheet and the description of the categories, the students were classified into the levels of environmental understanding described in the following section.

3.7 Levels of environmental understanding

In order to classify the students according to their environmental understanding, the following categories were created:

1. **Linear**: The students grouped under this category showed linear thinking, which included no more than two dimensions. They did not close any relationships of input and output. This was the most basic level of environmental understanding, closest to a fragmented understanding of the environment.

2. **Simple**: This category grouped those students who were able to close any relationship between the input and the output even if they used one or two dimensions to describe the system.

3. **Moderate**: This category grouped those students who understood the system as an interaction of three or four dimensions. They were able to establish different relationships between the dimensions (their input and output), meaning that they closed the system or parts of it.

4. **Complex**: This category was closest to a holistic view of the environment. Students in this category, were able to understand the interconnectedness of the components of the environment. They are able to see five or six dimensions and establish the interrelation of them. They also are able to predict the behaviour of the system under different conditions.

5. **Holistic**: This category is reached when the system is described as the interrelation of more than 7 dimensions which together work as a whole and where it is possible to identify flows of energy and cycles of matter. Students in this category are able to clearly identify input and output and to establish relationships among them. When reached a holistic understanding of the system,
the students should be able to combine different disciplines and perspectives to explain even simple processes.
4. RESULTS

The hypothesis that adults have a fragmented view of how their environment functions and therefore it is difficult for them to perceive the complexity of a system was supported by this survey. The hypothesis that conceptual maps are useful tools to assess environmental understanding was also supported by the study. The hypothesis that environmental perception is determined by the combination of former learning processes, people’s perceived needs, desires, experiences and goals was partially supported. The following paragraphs will give a general overview of the results of the analysis of the conceptual maps using the criteria described in chapter 3.

4.1 The dimensions

Figure 5 shows the frequency of appearance of each dimension. The results for each dimension are described in the order of frequency that the students mentioned them in their answers.

1. Economic: This dimension got the highest score. Twenty-eight (76%) of the students referred to economic factors that intervene either in the production of food or in the elimination of refuse. Most of them perceived the economic dimension as the process of buying foods in a shop, or as the production of comestibles either in factories or farms or as cultivated crops. This dimension can be seen in student 01 in Appendix 2 when she makes emphasis on the transportation needed for foods taken from abroad. Student 09 in Appendix 3 also shows this dimension with the graphs of agricultural crops and livestock, the supermarket and marketing.
2. **Biological**: Twenty-one students (57%) showed that food has its origins in natural processes. There were no representative differences between LUMES 98 and 97 in the frequency with which they identified the biological origins of food (Thirteen (59%) LUMES 98 and eight (53%) LUMES 97). In general, the students perceived the importance of natural processes in the production of food or as the source of natural resources for its production. An example for this dimension can be seen in student 03 in Appendix 2 with the graphical representation of the solar energy entering in the system and the water cycle. Student 34 also shows this dimension by mentioning the supporting elements as soil, water and temperature, and the biospheric variation, required for plant growth.

3. **Technological**: Seventeen (46%) of the students used technological elements which were important either for the production of food or for the elimination of post-consumption residuals. The percentage of LUMES 98 students (55%) who used this dimension was higher than the percentage of LUMES 97 students (33%). An example can be seen in student 22 in Appendix 2 when she shows the treatment plant for sewage water before it re-enters to nature.

4. **Chemical**: Sixteen (43%) of the total students mentioned the chemical dimension as one part in the process of production of food or elimination of the residuals. It is important to notice that the majority of them referred to chemical processes when
they mentioned cycles of nutrients (e.g. Carbon or Nitrogen). There were no differences between LUMES 98 and 97; nine and seven students respectively mentioned chemical processes. See student 08 in Appendix 2.

5. **Geographical**: Twelve (32%) of the students perceived the geographical dimension in the whole system. They did so, when they mentioned the origin of foods in different countries, or when they took into account geographical zones that determine the production of foods (e.g. mountains and arable lands). There were more LUMES 97 (47%) students who referred to this dimension than LUMES 98 students (23%). Students 01, 19, and 37 clearly showed the geographical origin of the food they consume.

6. **Personal**: Seven (19%) of the students perceived their bodies and their metabolic processes as one of food’s destinies. Comparatively there were more LUMES 97 (27%) who perceived this aspect, than LUMES 98 students (14%). Student 22 in Appendix 2 referred to this dimension implying that one of the destinies of the food is to produce the energy she requires for LUMES studies.

7. **Social**: Three students (8%), perceived social aspects as part of the system. The students who referred to this dimension perceived that there are competencies for food among the members of the society or that foods are shared with other human beings. Social aspects also were identified when one of the students clearly mentioned social problems such as unemployment related to the industrial production of food. Student 35 in Appendix 2 gives an example by mentioning the strikes and the hard work required on the fields.

8. **Cultural**: It is important to notice that this dimension was seldom referred to by the students. Only two (5%) mentioned cultural factors in their answers. Here is found the major difference between LUMES 98 and 97 students given that none of the LUMES 98 mentioned cultural factors in their answers. Student 37 in Appendix 2 used this dimension implying the consumption of traditional foods sold in arabic shops.
9. **Other**: Three students (8%) mentioned other dimensions as elements interfering in the system they perceived. These dimensions were: a) Political (see Student 1 in Appendix 2) as there were noted some controls and laws to regulate the treatment of residuals after consumption; b) Physical as there were evaporation process specified in the water cycle; and c) Time dimension as time was described as an important factor which conditions the re-entering of matter into the whole system.

4.2 **How do students perceive the complexity of the system?**

Section 4.1 explains the individual description of the frequency with which the different dimensions appeared in the answers of the students. However, it is important for this survey to see how complex the systems drawn by the students were. Table 1 and Figure 6 show the distribution of the students according to the number of dimensions they include in their drawings.

<table>
<thead>
<tr>
<th># of Dimensions</th>
<th>Female</th>
<th>Male</th>
<th>LUMES 97</th>
<th>LUMES 98</th>
<th>Total*</th>
<th>Total Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>16%</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>15</td>
<td>41%</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>21%</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>0**</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 1: Number of dimensions combined in the students’ systems
*
Express the total number of the sum of LUMES 98 + LUMES 97 or the sum of female + male
**
The Student who perceived 0 dimensions is the one that did not answer correctly the question

As shown in Table 1, there was a tendency in both LUMES 98 and 97 to perceive three dimensions. Thirty-eight per cent of the students showed this tendency. The second tendency was to perceive two dimensions. Combining the students who perceived three and two dimensions the total of 27 represents 62% of the sample.
Only one student perceived six dimensions. No students were able to identify more than six dimensions. See Student 35 in Appendixes 1 and 3.

There are some differences between LUMES 97 and 98 students. No LUMES 97 perceived one dimension and the student who perceived 6 dimensions belongs to this group as well. However, no LUMES 97 identified 5 dimensions while one LUMES 98 student did.

As can be seen in Table 1 and Figure 5, the students who perceived four, five and six dimensions were women. It is also significant that all but one of the male subjects ranked in two and three dimensions.

![Figure 6: Gender differences in the number of dimensions used to build the system](image)

### 4.2.1 The most frequent combination of dimensions

Two of the three students who perceived only one dimension, used the economic dimension to represent the origin of food. The other one used the biological dimension.

From the eight students who perceived two dimensions, three of them used the biological and chemical dimensions together. Two students combined the economic
with the technological dimension. In general the biological dimension got the higher frequency.

From the fifteen students who used three dimensions, the most frequent combinations were: four students used the geographical, the economic and the technological, and three students combined the biological the chemical and the personal. The economic was the most frequently used dimension by this group (12 students used it).

Three of the six students who used four dimensions used the following combination: biological, economic, chemical and technological. All 6 students mentioned economic factors that interfere in the system. It is also important to note that the biological, technological, and chemical perspectives appeared with a frequency of five times.

There were no combinations repeated by the students who perceived five dimensions. It is important to notice that three of the three students perceived economic and technological factors in the production of foods as well as in the elimination of residuals.

Only one student used six dimensions. She perceived social, geographical, economic, chemical, technological and cultural dimensions in explaining the whole system.

4.3 System approaches of the students

Considering the maps, the students can be divided into two groups: Those who described the system as a closed one (73% of the students) and those who described it as an open one (24% of the students). One student did not answer the question (3%). Figure 7 resumes these results. The answers of the students showed that the majority of them perceived the process as a closed system in which matter flows from one element
or process to the other. Most of the students perceived that the residuals of all the process are cycling through the whole system.

Those students who did not identify the process as a closed system, tended to draw linear processes, in which the main element of the system was the human body (their bodies). In this linear representation of the system the students tended to show different sources and sinks for the food and its wastes. They did not identify cycles of matter or energy flows through the whole process.

![Figure 7: Type of systems identified by the students](image)

It is important to observe that there are some gender differences in the perception of the system as an open or closed one. As can be seen in Figure 8 there was a higher tendency (80%) in women to perceive the system as closed as opposed to men (59%).
4.4 Scope of the system:

According to the answers of the students, there were no significant differences in their perception of the scope of the system. This means that the students' perceptions were evenly distributed among the local, regional or global view of the system.

4.5 Levels of environmental understanding

According to the levels described in section 3.7, the students were classified into different levels according to the complexity showed in the structure of their conceptual maps. As can be seen in Table 2 and Figure 1 the largest number of students (16) are in
the moderate level. This means that many of the LUMES students were able to identify three or more dimensions to explain the food system and they were able to close some relationships between some of those dimensions.

Nine students (27%) were grouped in a linear understanding of the environment. It is important to notice from the score sheet that four of the students classified under this level perceived three or four dimensions but did not close relations between these dimensions. Therefore, they were included in this level. Students 09, 19 and 26 in Appendix 2 are examples of this level of environmental understanding.

Six students (16%) showed a simple understanding of the environment. Most of them used two dimensions to represent the whole system and closed at least one relationship between these dimensions (see student 08 in Appendix 2).

Seventeen students (46%) were classified under the moderate level of environmental understanding. Twelve of them used three dimensions while five used four dimensions to describe the food system. As with the previous group, they closed at least one relationship between the dimensions. Mostly, they closed the relationship between the initial input at the beginning of the process with the last output, after the food was consumed (see Students 22, 31 and 34 in Appendix 2).

Four students (11%) were in the complex level of environmental understanding. Most of the students who were classified in this group, used five dimensions and only one used six dimensions (see students 01 and 36 in Appendix 2).
There were no students classified in the holistic level of environmental understanding.
5. DISCUSSION

5.1 Introduction

Before starting any discussion about the results presented in the previous chapter, it must be noted that the LUMES students are characterised by having a personal interest in environmental issues. This is an important fact because it might influence the content level of the answers of the students. It might also be considered that the analysis of the results focused mainly on the description of some characteristics to identify how the students understood and represented their environment.

5.2 The dimensions

The dimensions used by the students to describe the system can be used as clues to identify how they perceive and understand the environment. The survey gave data to support that perceptions of the environmental web of food consumption and waste products are represented in the students' maps.

A closer look at the results indicates that the economic dimension prevailed for the majority of the group, even for those individuals who come from the natural sciences. This could be interpreted to indicate a certain kind of recognition by the students of their belonging to an economic system. The most common aspect of the economic dimension represented in the maps was the recognition of human controlled methods of production (crops and livestock) as well as the recognition of the need for transportation of the products from the producer to the consumer (see Student 01, 19 and 36 in Appendix 2). Nowadays the most common way to get food is through its
commercialisation as goods in the economic system. Thus, it is not surprising that many of the students identified economic elements in the system.

The second most commonly used dimension by the students was the biological one. They usually referred to natural processes as the origin of the food they consume (see Students 03, and 34 in Appendix 2). This dimension was mainly represented by the mention of food chains, the identification of energy flows, and by the mention of natural resources needed for the production of food. It should be noted that when they mentioned natural resources as a part of the production of foods they did not mean man's manipulation of the resources.

The third most frequently used dimension in the maps was the technological one, which can mean that the students understood the need for technology either to produce the food or to treat the after consumption residuals. This dimension was mainly used to refer to the treatment of residuals and wastes. This result could indicate that the students believe in technology as a solution for environmental problems. On the other hand, it is important to notice that technology is another important aspect in today's daily life and its inclusion in the students' maps give its recognition (see students 9, 19 and 31 in Appendix 2).

The fourth most commonly used dimension by the students was the chemical one. Eleven of the sixteen students who referred to the chemical dimension came from the social sciences. This may mean that the students who used it were those trained to identify hidden processes as the chemical changes of elements or those who were highly sensitive to the identification of the interaction of different dimensions (see student 35 in Appendix 2).

The geographical dimension was the fifth most commonly used dimension by the students. Use of this dimension can provide information on the students' perception of the physical organisation of their environment. It also can mean that the students were able to see that the production of food is dependent on geographic and that certain food
is produced elsewhere and then transported to different countries (see students 01, 19 and 36).

The sixth most commonly used dimension by the students was the personal one. The inclusion of this dimension in the maps gave a very valuable insight into the students’ perceptions of themselves as part of the system. Inclusion of the personal dimension in some cases can be confused with an egocentric perception of the environment. However it should be analysed to identify whether or not the student perceived that the resources are there to fulfil his/her needs or if s/he recognised the role that s/he plays in the whole system (see student 22 in Appendix 2).

Only three students referred to social aspects of the system. The low frequency in the use of this dimension can indicate that it is a difficult aspect to connect with the environment. It is difficult to establish a social relationship with the production system and therefore it might be seen as irrelevant for most of the students. It is interesting that many students used the economic dimension in their systems, while the social dimension was used only by three of them. This fact could show that the students are more familiarised with the economic than with the social aspects. Or it may signify that as economic issues are more tangible than social issues they are easier to identify (see student 35 in Appendix 2).

The cultural dimension presents almost the same situation as the social. Only two students referred to cultural aspects related to their food systems. Those aspects were mainly preferences for certain types of food. It is difficult to establish if the students were really aware of the impact that cultural aspects have in the food system. This is one aspect that could be explored in more depth in a further investigation (see student 37 in Appendix 2).

Taking into consideration that education for sustainability and in the same way EE, are meant to encourage a new paradigm to understand nature and society, it is important to know to what extent students in an EE program understand the complexity of the
environment. As Huckle & Sterling (1996) suggest, education for sustainability can help to encourage a change in peoples’ understanding in order to find a development that coexists with environmental conservation. Following this line of thinking, it is important to consider that for sustainable development, EE should encourage an understanding of the interrelation of the triple bottom line: the economic, the social and the environmental basis of development. Thus, a holistic understanding of the environment should bring the students at least to see and understand the interrelationship between nature, economics and society. The students who answered this survey were exposed to a question that sought to identify how they understand these interrelations. The results obtained show that many of the students are approaching towards an understanding of the complexity of the environment. However, there is still a strong tendency among them to see those dimensions that are close to their academic background. For example, the student who was able to see six dimensions showed a strong tendency to represent those aspects that were closest to the social perspective, rather than those closer to biology.

5.3 The students’ perception of the complexity of the system

According to the results the students tended to use two or three dimensions to explain the system. This could mean that they are aware of the interaction of three dimensions, which are the most obvious for them.

The use of no more than three dimensions by the majority of the group may show that there is an interest from the students in understanding the system using different perspectives but that they are still lacking knowledge or familiarity with other dimensions and components of the system. This may suggests that the majority of the LUMES students are aware of certain aspects of the environment, mainly those related with their daily activities and to their academic backgrounds. Appendix 3 shows that the students who perceived three dimensions perceived at least two dimensions which were strongly related to their academic background. This can also indicate that it is
difficult to see and link other aspects in the process, in particular those aspects for which the individuals are not trained.

Although none of the objectives of this research were to examine gender differences in the perception of environmental aspects, gender differences were significant in assessing the complexity of the responses. The female individuals tended to perceive more dimensions than the male individuals (see Figure 6). It would seem that the females had a wider perception of the different dimensions than the males. However this was a small sample and this cannot be affirmed. It would be very interesting in a further research to investigate whether or not there are meaningful gender differences in the perception of the environment.

Concerning the combinations of dimensions used by the students, it was expected that the most frequent combinations would include at least the biological and economic one. However, the combination of economic and biological dimensions were not frequent for the mean of the group.

5.4 Systems approaches

Most of the students showed a tendency to close at least one relationship between some aspects of the environment. This suggest that most of them perceived the interconnectedness of the different elements of the system. It is significant in the process of acquiring a holistic understanding of the environment and the processes related to it. It also could be used as an indicator of the students’ abilities to perceive cycles and consequently this can lead them to predict the behaviour of the systems.

5.5 The environmental understanding levels

Figure 10 shows a summary of the general distribution of the students in relation to the environmental understanding levels defined for this survey. As can be noticed, nine of the students fell into the linear understanding level. This may imply either that the
students had difficulties establishing relationships between the input and output of the system, or that they really found themselves in a linear level having a fragmented understanding of the events in the environment and having difficulties understanding the relationships between some of the dimensions.

According to the objectives of EE and education for sustainability, it is important to encourage students in the linear level to perceive the interconnectedness of many aspects related to the environment. Therefore, the identification of these students among a group of students is important in order to stimulate, through the education system their learning process to achieve a wider or complex understanding of the environment.

There are other students who showed a simple level of environmental understanding. This is the very initial phase in approaching to see the complexity of the environment. The students in this category showed that they were able to establish some relationships between some of the dimensions they used (maximum of two for this level). It is important to note that the most important difference between the linear and the simple levels is that students in the linear level were not able to close relationships between the input and the output from one dimension to another.

As section 4.5 shows, most of the students were classified in the moderate level of environmental understanding. This suggests that most of the group was able to establish relationships between three or four dimensions and that they were able to close some parts of the system. The students grouped under this category may be able to establish connections between some parts of the system and thus may be able to predict its future behaviour. It could be said that the moderate level of environmental understanding is a previous stage before achieving a more complex level of environmental understanding. Although, it is not possible to affirm that all the students with a moderate environmental understanding will achieve the complex level. One important thing to be remembered is that not all the students may advance to the complex level. This is due to different
reasons but the most basic is that there are strong academic biases which interfere with perceiving aspects unrelated to one’s academic backgrounds. However, it is important to remark that the achievement of EE’s goals requires a holistic understanding of the environment, which implies an integrated perception of different aspects affecting the environment. Thus, EE programs should clearly define the holistic level they expect their students to achieve. This could help to adjust the information, and teaching methodology of the program.

Only four students reached the complex level of understanding. However, it is important to notice that the student who perceived six dimensions, did not refer to the biological dimension at all. This could be an example of the academic biases because this student comes from the social sciences and four of the dimensions she used belong to the social sciences or are close to them. However, as she is using the chemical dimension, it could be used as an indicator of her ability to introduce natural sciences in her thinking.

The holistic understanding, which is the goal of EE should reflect a wider comprehension of the interrelationship of several dimensions and a wider understanding of the complexity of the environment as a whole. None of the LUMES students has achieved this level. It is probably a very ambitious task to try to achieve this level, since it would imply a wider knowledge of the different dimensions interacting in the environment. It also requires from the students the ability to use all their skills to interpret phenomena, causes, effects and to be able to predict future behaviours.

This kind of holistic view of the environmental problems can be difficult to achieve with an EE program. It would be desirable to adjust the objectives to a more realistic level of environmental understanding in which the students achieve at least a moderate level with the ability to link at least three dimensions (preferably economic, natural and social) that influence the environment, and which are definitive in decision making.
The importance of the environmental understanding levels for EE is that they may influence people’s attitudes towards a behavioural change. So, the more complex or holistic the environmental understanding, the higher the openness to analyse the own behaviour and to understand one’s impact on the environment. Therefore, it could increase people’s sensibility to accept and assume their own behavioural and attitudinal changes to meet solutions to environmental problems. Finally, the advance in environmental understanding levels may imply the use of knowledge acquired in different subjects to analyse environmental issues.

5.6 About the differences between LUMES 97 and 98

As can be noticed from Table 1 and Figure 9 there are some differences between LUMES 97 and 98. The most important one is that there were more LUMES 98 students than LUMES 97 who reached the complex level of environmental understanding. Although this is an important difference this should be treated very carefully, given that LUMES 97 students did not use all the time given to answer the questionnaire and this could affect their answers. For this reason the analysis of the survey was not focused on the differences between the two groups. It would be interesting to test the LUMES 98 students after the LUMES studies are finished to find out if there are significant changes in the environmental understanding levels of the same group.

Last but not least, another important aspect which may have affected the categorisation of LUMES 97 students is that some of them showed simplicity in their answers. However a careful analysis of their conceptual maps showed that they are not split in lots details and rather show a complex understanding of environmental processes. There was one student whose answer showed a very simple understanding of the system but in fact, he had developed a complex map composed of a maximum of three dimensions and summarising a careful analysis of the problem. Therefore, simplicity should be treated very cautiously because a very simple model can be reached after a very complex analysis.
5.7 About the research method used

The method used to survey students’ ideas about the environment was useful. Students’ answers to the questionnaire gave information about the aspects they perceive about their surroundings and the relationships they establish within those aspects.

Though the results in this case were satisfactory, it is important to make a more extensive research using this method to adjust its validity and reliability and to prove its behaviour under different phenomena and subjects. As well as to find the way to reduce difficulties when classifying students into the different categories.

In order to test the validity of the method it would be desirable to apply it in the future to the same group of students or at least with LUMES 98 students to identify whether or not there are changes in the perception of the problem by the same group of students.

It should also be noted that this kind of methodology present some difficulties when it comes to the classification into groups. As was noted before, some students were difficult to classify into the categories although they perceived more than 2 dimensions they were classified into the linear thinking because they did not closed any relationships among the dimensions. One reason for this could be that these students did not put much effort on their answers. Another reason may be that since this kind of survey is based on graphical representation, for some people it can be an obstacle to express their ideas.

Though the difficulties mentioned, it can be suggested to apply this kind of tool in different areas, to identify initial ideas and understanding about other subjects or concepts. It could help to identify the kind of information needed to improve the comprehension of that subject.
6. CONCLUDING REMARKS

This thesis has described a methodology to research and analyse adults’ environmental understanding. In this methodology conceptual maps were used as tools to identify the ways adults establish relationships and connections between the elements that constitute the environment. The results showed that 36 of the 37 students surveyed were able to identify a system of at least one dimension, and that the students’ environmental understanding differ from a linear to a complex understanding.

In terms of the validity of the survey, it should be kept in mind that the data collected was based on the student’s ability to draw conceptual maps. They were engaged in the development of food systems in which they exposed their ideas about its origin and the final destination after it is consumed. Their maps gave enough information to classify them into the different understanding categories.

The identification of the different dimensions and categories used to classify the environmental understanding levels of the students is an important tool for environmental education because it helps to identify how adults perceive and organise their environment. Thus, it can be very useful to discern the knowledge and ideas supporting their thinking structure and so, the curriculum for EE programs could be structured taking them into account to encourage a better understanding of the environmental complexity.

The conceptual maps can be used to assess students’ understanding of certain environmental issues, as well as a tool to stimulate a deeper analysis and understanding of processes and aspects related to the environment.
This kind of assessment tool could be used in other areas and subjects to identify previous ideas and information that people use to assimilate other information.

It is recommended to combine conceptual maps with interviews as complement for the information. This could help to find out the knowledge and external influences that support people's environmental understanding.

Finally, it is important to continue researching on how students understand the environment in order to find out the methodology and information needed to achieve better relationship with the environment.
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It is recommended to combine conceptual maps with interviews as complement for the information. This could help to find out the knowledge and external influences that support peoples environmental understanding.

Finally, it is important to continue researching on how students understand the environment in order to find out the methodology and information needed to achieve better relationship with the environment.
REFERENCES


UNEP (?). *For Life on Earth.* (Brochure)


**Other recommended literature**


Jörgensen, Michael et al. (1994) *Inventory on Cleaner Production Education and Training* UNEP, UETP-EEE, IACCE pp. 1-51


## APPENDIX 1: SCORING SHEET

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**Scores:**
- 1: Linear
- 2: Simple
- 3: Moderate
- 4: Complete
- 5: NA

**Environmental Dimensions:**
- Biological
- Chemical
- Cultural
- Economic
- Geographical
- Personal
- Social
- Technological
- Other
APPENDIX 2: STUDENTS CONCEPTUAL MAPS
Asia (fruit, herbs, etc.)

Europe (vegetables, fruit)

South America (apples, etc.)

Coffee plantation

Milk products

Supermarket

Garbage from cooking, leftovers

Compost at home

Toilet

Final disposal

Fertilizer in agriculture

Lake

Student 01
cropped (farms) ➔

(gathering, refining, packing etc)

'WASTE'

STORE ➔

Belly (me)

WASTE (gARbage)

DUMP ➔

E NERGY FOR
L UHES ST UDI E S

(renhältningswerk)
"Cleaning"

GROUND
(Final cleaning in the ground)
Symbol for myself = J

where food comes from!

soil water temperature

plant growth

vegetable use

livestock food

surplus food

human waste

back to environment (soil, water)

natural processes of degradation

Collects in soil/water as sediment or dissolved matter used to complete the cycle.

Biophysical variations (sun)

climate variability

climate type
NATURE

Farms not forests!

- Supermarkets
- Traditional foods sold in local shops
- Spices

Consumption

- Disposal
  - Toilets
  - Garbage
    - Sewage
    - Dumps
    - Sea

- Recycled Compost

? I don't know

? Maybe back to nature!

- Foods from different countries
### APPENDIX 3: SAMPLE OF ACADEMIC INFLUENCES

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**Adult’s Environmental Understanding**