Paper 65. Attitude to Sustainability Issues related to some Students Learning Characteristics

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Abstract

The present paper describes the results of an investigation concerning the attitude of different kinds of University student groups towards including *sustainability* in their academic curricula. Within each group and among the groups such characteristic is compared to some aspects of life style which involve adaptation of individual behaviour to some sustainability concepts and practices. Furthermore, such student features are also compared to their *Self-Efficacy* and to some of their learning preferences, the latter being obtained by drawing inspiration from the Multiple-Intelligence inventory. The investigation has been extended from Italy to Honduras, as the survey has been developed on-line on an international web platform developed by the Authors. The survey results provide indications about appropriate approaches to include sustainability topics in Engineering Courses on the basis of analysed students' learning preferences

1 Introduction

Sustainability has become a crucial aspect of the social and economic development (Wiek et al., 2012) and (Wiek, Ness et al., 2012), and so the related Ideas and Theories deserve and require a larger and more detailed dissemination, especially (for under graduate and post graduate students) in terms of Education. For these reasons some Academic Curricula have begun to include some specific Courses dedicated to the Theories and to the Application of Sustainability. However, the concepts that these teaching activities are rather complex and new to most students and therefore the learning process appear to be rather slow and complicated. The Authors of this paper, who have been involved both in teaching and in planning this kind of Course, are going to present an investigation aiming at enlarging the understanding of the most common characteristics of "teaching the Sustainability".

Generally speaking, the education process cannot be drawn out from the social and psychological context, thus there are many complex variables that need to be taken into account (Belfiore et al., 2000), (Belfiore et al., 2002), (Matrisciano and Belfiore, 2003), (Belfiore et al., 2010), (Matrisciano and Belfiore, 2010) and (Belfiore et al. 2011). Furthermore, the themes of Sustainability are rather difficult to be applied to this educational process, especially if they are proposed to different traditions and cultures. Hence, the present investigation's attempt is to offer some useful information about how different student groups react to the inclusion of Sustainability issues within their curricula and how such reactions are related to some of their learning preferences and Self-Efficacy level.

In order to achieve this ambitious scope, the research group has selected nine dimensions to be analysed, two of which being related to Sustainability, one to the Self-Efficacy level (Schwarzer and Jerusalem, 1995) and the other six to a selection of learning preferences inspired by Gardner's Multiple Intelligence Inventory (Gardner 1983).

All questionnaires are anonymous and submitted to three groups of students, with similar basic characteristics, but living in different countries (Italy, Europe – Honduras, Latin America). Another difference in the groups' characterization is the presence of a course on (energy) sustainability in the study plan. The three groups can be described as it follows:

Italian group:
University students of the Engineering Department of "Sapienza" University of Rome, attending the 4th or 5th course year, without an exam on sustainability in their plan of study.

Honduran group:
University students of the Engineering Department of Tegucigalpa University of Honduras, attending 4th or 5th course year, without an exam on sustainability in their plan of study.

TES2013 group:
University students of the Engineering Department of "Sapienza" University of Rome, of the 4th or 5th course year, attending also the course "Sustainable Energy Technologies" in 2013, that includes the analysis of environment impact of energy technologies and some case studies related to the sustainable application of such technologies in various continents (Esposto, 2004), (Micangeli 2010), (Grego 2004).

A new on-line questionnaire has been built in order to measure the above mentioned peculiar characteristics as well as the students *Self-Efficacy* level and their natural attitude to join Sustainability Studies and share their most important ideas and concepts. Technically, the project has been developed on a web page, autonomously built by the Authors, named KinSynth as in Belfiore, (2010), which is a web space open for cooperation and dedicated to the development of C and Octave Codes written by teachers and students and published as Open Source for the scientific community. The principal aim is to understand the mutual relations between the students' characteristics and their openness to the new ideas brought by the Sustainability. A second edition of the on-line questionnaire is in revision process and will be again published on KinSynth web page, open to a wide public.

2 The Research Group Background and Involvement

In the last years the "educational institutions", such as Universities and Schools all over the world, have paid great attention to environmental issues but they paid less attention to the didactic methods, as a possible ways to improve their teaching effectiveness toward a better sustainability *attitude*.

These are good reasons to upgrade the didactic methods upon the student preferences and toward a better degree of student's satisfaction, decreasing the number of students who abandon the curricula, increasing the institution position in the international ranks, gaining an economic feedback, both by public and private institutions.

The research group involved in this research has been working since 2000 in order to contribute to improving teaching effectiveness in some Courses of Sapienza University, as reported in the above mentioned papers. Some of these contributions gave suggestions about new emerging professions in High Education and about new efficient procedures to be adopted in Course planning and managing. Later, the research group focused their attention on the efficiency of the didactical methods and some experimental investigations were planned, involving Cognitive Styles, Leering Styles and Preferences, and some other learning preference inventories. In these investigations, great importance was given to

the role played by the Information Technology in the Contemporary Education. This topic stimulated some new ideas and, consequently, a more ambitious project was attempted, where verbal and mathematical learning capabilities of a Neural Network were compared in different conditions. Some years later the idea of website supporting students led to an early version of *KinSynth* that was compared to other similar initiatives in the field of the Dynamic Analysis of Multi-body Systems. Furthermore, a Correlation Analysis between Students' Cognitive Styles and their Attitude to join Kinematic and Dynamics Open Source Codes Projects was also completed and some interesting results were obtained.

3 The Adopted Questions and Dimensions

The developed questionnaire has been built by asking to select an answer among:

Exactly true - Moderately true - Hardly true - Not at all true

A first group of questions has been collected in two Sets such as the Sustainable Education Set (Sust-Edu) and the Sustainable Life Set (Sust-Life).

Sust-Life Set of Questions was:

- *I walk or bike to places instead of going by car*
- *Companies that are environmentally sustainable are more likely to be profitable over long run*
- *Many times a week I buy and/or eat organic /local food.*
- *I regularly recycle*
- *I have changed my personal lifestyle to reduce waste.*
- *The necessary time for an anthropological and psycho-social response, within a project aimed at producing energy from renewable sources, will cause serious costs and delays in its implementation, indeed as Project Manager I should avoid it.*

Sust- Edu Set of Questions was:

- *The teaching of sustainability principles should be integrated into the curriculum in all disciplines and at all levels of school.*
- *I agree to increase my current curriculum in cost and commitment to study, in order to add skills and models to augment the Sustainability of my future job.*
- *Adding Economical, Social and Environmental evaluations (if not required) to a technical study will double its cost and therefore you will not consider doing it.*
- *The use of renewable resources should not exceed the rate at which they can be regenerate.*
- *I try to avoid purchasing goods from companies with poor track records on corporate social responsibility.*

It was also added a list of *learning preferences related questions* deriving from the Theory of Multiple Intelligence (Gardner 1983).

Furthermore, other two groups of questions were added in order to measure the student involvement in Sustainability, in day life-style and in their educational context.

Finally, Self-Efficacy has been investigated via GSE General Self-Efficacy Scale (GSE, 2013), as a 10-item psychometric scale that is designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life.

3.1 Dimensions related to the Multiple Intelligent Inventory

According to the multiple intelligences model, there are different forms of intelligence that can be clearly distinguished. It is not easy to declare if a type of ability, individually possessed or commonly shared, can be considered as an acknowledged intelligence or not. However, according to the model there are some selective criteria that can be used, among which the appreciation of such ability by the whole society in history, the existence of certain individuals that can be universally acknowledged as exceptionally gifted in that capability in such a way that they can be considered as genius, the loss of that ability due to localized brain damage, the possibility of developing symbolic expressions around that capability.

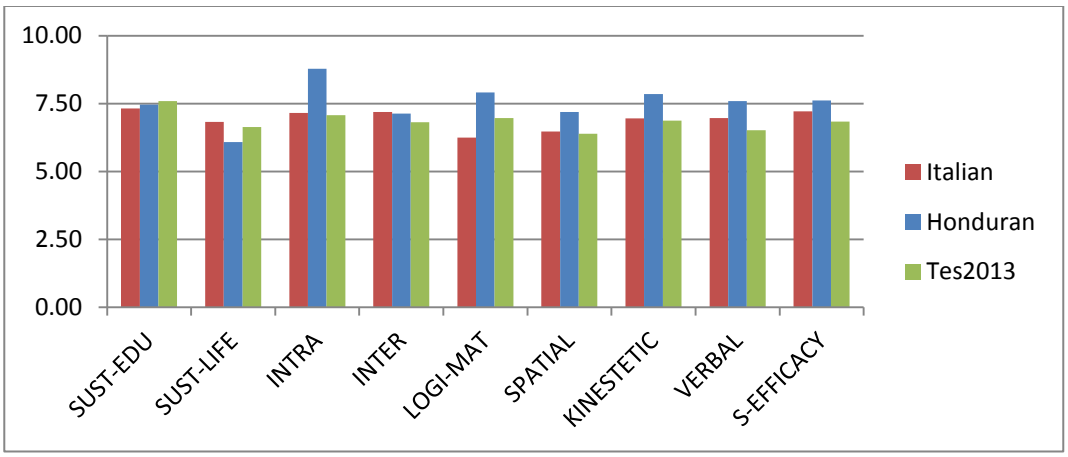

Figure 1: The histogram of the raw scores for the analysed groups.

In its former version, seven distinct intelligences were identified: Verbal, Logical-Mathematical, Musical, Kinaesthetic, Visual, Interpersonal, and Intrapersonal. The Gardner's model, which is nowadays widely known also in non-technical literature, has suggested the idea of identifying a student's frame of mind as a personal learning profile to be applied to the academic environment. However, only six corresponding dimensions have been identified as described in the following paragraphs, since a *musical* style was not investigated.

The questions refer hardly to a general frame of mind, but rather to the students' inclination to use a style related to a specific intelligence in class. Therefore, the variety of the Multiple Intelligences is herein investigated as an inventory model of independent *learning preferences* that can be adopted by the students. The following dimensions have been considered.

INTRA (Intrapersonal): this dimension is evaluated by considering the student's attitude to thinking, studying, solving the difficulties, or even enjoying by drawing resources from his inner self personality.

INTER (Interpersonal): the student's attitude of working, studying or enjoying in company of other people is measured.

LOGI-MAT (Logical-Mathematical): this dimension takes into account the students attitude to use logic and mathematic in a variety of situations, including the learning context.

SPATIAL (Spatial): these questions try to measure the students' preference of didactic supports based on graphical tools, like diagrams, block charts, and so on; for this dimensions there are also elements of a general attitude of thinking spatially and of visualizing solid objects in space.

KINESTETIC (Bodily-Kinaesthetic): an estimation of the student's attitude to use manual or other physical means as support to learning or studying; the inclination to manual or physical activities is also inquired.

VERBAL (Verbal-linguistic): these questions concern the students' inclination to use reading as the preferred way of learning; however, it is related also to the student inclination to enjoy reading and writing in general (out form the classroom context).

Table 1: Significant differences

Group	Sustain - Life	Intra	Inter	Logy-Mat	Spatial	Kinaesthetic	Verbal	Self-Efficacy
Italian - Honduran	weak	strong	-	strong	weak	strong	-	-
Italian – Tes2013	-	-	weak	weak	-	-	-	Weak
Hond. – Tes2013	-	strong	-	weak	weak	weak	weak	Strong

3.2 Dimensions related to the Sustainability

As stated by Rowe (Rowe, 2007 p.324) "Working on problems that were brought to higher education" by cities , businesses , non-profit organizations (Micangeli,2010),and other institutions" the students can test themselves in giving "workable contributions to solutions" also to have "a positive impact on the world through their academic learning" (Rowe, 2007, p.324) in this way they will be more motivated to acquire necessary competences to address sustainability problems, related both to natural (Grego, 2004), and virtual environment (Federici,2005) in their future professional experience.
In order to understand learning preferences on sustainability issues, two dimensions have been selected aimed to investigate students' interest inside and outside the academic life:
SUST-EDU is intended to be a measure of the level of interest to include sustainability issues in academic curricula.
SUST-LIFE is intended to be a measure of the students' involvement in the practical application of Sustainability in their daily life.

3.3 Dimension related to the Self-Efficacy

Self-Efficacy is a measure of the individual ability to complete tasks and reach goals and concerns one's personal belief regarding his or her power to affect situations, which makes this characteristic the image of how a person actually manages to face challenges competently.

S-EFFICACY In this research Self-Efficacy has been measured by means of a 10-items psychometric scale, as suggested by Schwarzer et al. (Schwarzer and Jerusalem, 1995).

4 Results

This section presents the results obtained by analysing the on-line survey submitted to three groups: Italian students (51 people), Honduran students (16 people) and TES 2013 students (a specific course with 34 people). The following paragraph is dedicated to a raw comparison among the raw scores in the proposed dimensions. Then, two other paragraphs will follow, namely, one dedicated to the comparison *between* the groups and one dedicated to the correlation *within* the groups.

4.1 The Raw Scores

Figure 1 shows the raw average scores obtained by each group in every dimension. For each dimension, (the raw score is calculated in such a way that) 0 and 10 represent respectively a null or perfect adherence of the answers to a set of given statements. For each dimension, at least 4 questions

are proposed, except for the Self-Efficacy, for which 10 questions are used. Between the total disagreement and perfect agreement, a score equal to 5 has been used as the reference point for a neutral opinion, which is neither neither disagree nor agree. The analysis of the difference must be done by using the level of significance and therefore the variance analysis has to be invoked, as described in the following paragraph.

4.2 Comparison among the groups

For the analyzed groups, different averages were found in many dimensions, as shown in Figure 1. However, only those significant ones have to be considered. For this reason, a null hypothesis *H*0 has been established according to which the sample groups were extracted from the same population. By imposing weak (α=0.1) or strong (α= 0.01) probability levels, it turned out that the significant differences, according to the t-Student test, were those reported in Table 1.
Concerning the practical application of some Sustainability concepts in life it appears that all the groups are susceptible to the theme, although the Italian students seem a bit more involved than the Hondurans (α=0.1). With regard to the Self-Efficacy, The Honduran students got higher scores, on average, than those involved in the TES Course (α=0.01). Finally, some other differences were found with a significant level concerning the learning preference, and these results will be used for further analysis. For example, the higher attitudes towards individual, logic-mathematical and kinaesthetic learning preference were detected on Honduran students.

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU	1.000	0.286	-0.034	0.211	0.152	0.203	0.238	0.034	0.058
S-LIFE		1.000	0.214	-0.041	0.244	0.315	0.412	0.323	0.279
INTRA			1.000	0.273	0.172	0.227	0.308	0.393	0.201
INTER				1.000	0.069	0.277	0.149	0.155	0.089
LMAT					1.000	0.439	0.252	0.284	0.405
SPAT						1.000	0.510	0.130	0.511
KINE							1.000	0.236	0.373
VERB								1.000	0.238
S-EFF									1.000

Figure 3: Correlation Matrix for the group of Italian students

4.3 The Correlation Analysis

Within the single groups it was possible to perform the correlation analysis among the dimensions. Such kind of analysis is useful, for example, to understand if there are some characteristics that are mutually related (either positively or also negatively). Figure 3 and 4 refer to the group of Italian students without specific courses on Sustainability. Figure 3 reports the correlation coefficient matrix, while Fig. 4 shows a matrix (whose not null elements the not null elements of which) are the levels of significance for the corresponding elements of the correlation matrix. In particular,

- Self-Efficacy has been found to be strongly related to Logic-Math, Spatial and Kinaesthetic;

- the two dimensions concerning sustainability are significantly correlated;
- Sustainability-EDU is correlated to the Kinaesthetic preference;
- Sustainability in life is correlated to Log-Math, Spatial, Kinaesthetic and verbal learning preference and also to Self-Efficacy

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU		0.05					0.10		
S-LIFE					0.10	0.05	0.01	0.02	0.05
INTRA				0.05			0.05	0.01	
INTER						0.05			
LMAT						0.01	0.10	0.05	0.01
SPAT							0.01		0.01
KINE								0.10	0.01
VERB									0.10
S-EFF									

Figure 4: Correlation Level of Significance for found correlations for the group of Italian students (critical levels 0.231; 0273; 0.322; 0.354, respectively, for the levels 0,10; 0,05; 0,02 and 0,01)

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU	1,000	0,474	-0,475	-0,295	0,674	0,497	-0,047	0,393	0,524
S-LIFE		1,000	-0,534	-0,569	0,770	0,788	-0,182	0,630	0,647
INTRA			1,000	0,774	-0,083	-0,305	0,406	-0,311	-0,225
INTER				1,000	-0,093	0,009	0,499	0,079	-0,027
LMAT					1,000	0,767	0,080	0,577	0,776
SPAT						1,000	0,094	0,873	0,799

KINE							1,000	0,443	0,502
VERB								1,000	0,893
S-EFF									1,000

Figure 5: Correlation Matrix for the group of Honduran students

Analogously, Figures 5 and 6 refer to the group of Honduran students. There are also negative correlations, such as those between the Sustainability dimensions and the Intrapersonal and Interpersonal preferences.

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU		0,10	- 0,10		0,01	0,05			0,05
S-LIFE			- 0,05	- 0,05	0,01	0,01		0,01	0,01
INTRA				0,01					
INTER							0,05		
LMAT						0,01		0,02	0,01
SPAT								0,01	0,01
KINE								0,10	0,05
VERB									0,01
S-EFF									

Figure 6: Correlation Level of Significance for found correlations for the group of Honduran students (critical levels 0.426, 0.497, 0.574 and 0.623, respectively, for the levels 0,10; 0,05; 0,02 and 0,01)

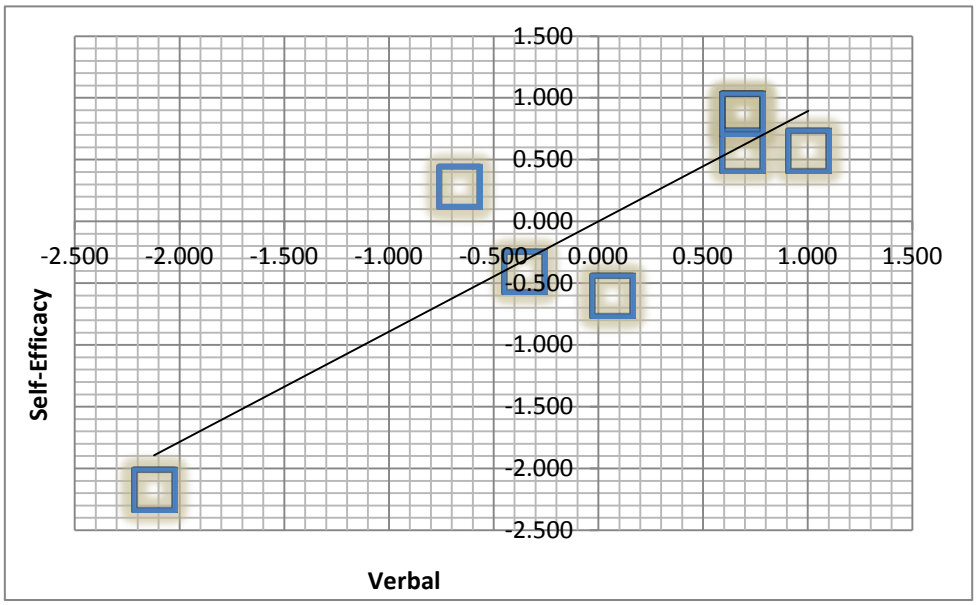

Figure 7: Scatter diagram for the Verbal-Self Efficacy Correlation for the group of Honduran students

There is a very strong correlation between Self-Efficacy and Verbal preference (r = 0.893) and so the corresponding scatter diagram has been presented in Figure 7.

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU	1,000	0,234	0,122	0,071	0,017	-0,052	0,116	0,404	0,194
S-LIFE		1,000	-0,145	0,076	-0,016	-0,257	-0,198	0,332	-0,084
INTRA			1,000	0,035	0,080	0,115	0,257	-0,034	0,310
INTER				1,000	0,532	0,116	0,455	0,522	0,533
LMAT					1,000	0,285	0,314	0,418	0,179
SPAT						1,000	0,015	-0,084	0,197
KINE							1,000	0,176	0,417
VERB								1,000	0,211
S-EFF									1,000

Figure 8: Correlation Matrix for the TES2013 group

	SUST-EDU	SUST-LIFE	INTRA	INTER	LOGI-MAT	SPATIAL	KINESTETIC	VERBAL	S-EFFICACY
S-EDU								0,05	
S-LIFE								0,10	
INTRA									0,10
INTER					0,01		0,01	0,01	0,01
LMAT							0,10	0,02	
SPAT									
KINE									0,02
VERB									
S-EFF									

Figure 9: Correlation Level of Significance for found correlations for the TES2013 group (critical levels 0.231, 0.273, 0.322 and 0.354, respectively, for the levels 0,10; 0,05; 0,02 and 0,01)

Finally, the correlations between the TES 2013 group have been reported in Figures 8 and 9.

5 Conclusions

This paper has shown a possible way to understand the attitude of students attending Engineering courses towards inclusion of sustainability concepts and themes in academic curricula in different Countries. The adopted method has been based on the submission of an on-line questionnaire which measures seven dimensions, two of which strictly dedicated to Sustainability. Three different kinds of analysis were possible: analysis of the raw average scores between the different groups of students; analysis of the level of significance for the found difference, considering the probability levels and according to the t-Student test; correlation analysis among the dimensions within the single groups. Hence, such results provide enhanced information about the attitude towards Sustainability.

The correlation between Sust-edu, Life-style and Self-Efficacy turns out to be highly significant, since those students of the three groups who are more interested in sustainability have a lifestyle increasingly sustainable (i.e. biking, buying food and items produced in their own Region, etc.) thus being more self efficient as well.

The correlation between the verbal variable and the Sust-edu one within the TES2013 Group of students is strictly connected to the fact that they have already approached the theme of Sustainability in their Energy-sustainability course where projects on renewable Energy and sustainability in Europe, Asia, Africa and Latin America are examined(Grego, 2013), (Esposto, 2013), (Micangeli, 2013). This increases the attitude of this group of students towards studying and examining a higher number of data on the matter.

The correlation between verbal preference and life-style is to be found in the higher inclination of students towards sustainable behaviours in daily like if they usually study and tend to examine issues in depth.

Hopefully this work might be useful to begin a difficult and ambitious attempt to understand *why* some issues related to Sustainability may be more or less successful in a single student, or a class, and provide useful indications on the appropriate approaches to be explored and implemented so as to include sustainability topics in Engineering courses or even in Countries education planning.

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