

RELATIONS INVOLVING SCIENCE, TECHNOLOGY AND ENVIRONMENT IN STUDENTS' PERSPECTIVES

CARVALHO, WASHINGTON L. P.

Physics and Chemistry Department – FEIS – Unesp – Ilha Solteira - Brazil.

Science Education Graduate Program – FC – Unesp – Bauru - Brazil.

Key words: STSE perspective; Environmental education; Science and technology education

OBJECTIVE

In this paper I aimed at analyzing relations concerning science, technology, society and environment that students presented in essays they wrote in an admission examination to a state university in Brazil.

SCIENCE, TECHNOLOGY, SOCIETY AND ENVIRONMENT IN SCIENCE EDUCATION

Students, even at primary school stage, are likely to have ideas about science and technology (S&T). They are frequently exposed to images of the scientific and technological world brought by television news, documentaries, interviews, cartoons etc. These images may contribute to form students' representations of the scientific and technological field. However, public images of science and technology may not correspond to a critical vision that would be expected from an educational perspective.

Fourrez (1997) emphasizes that "Science and Technology Literacy (STL) usually pursues three goals: individual autonomy (the humanistic perspective); communication with others (the democratic and humanistic viewpoints); and management of situations (the socio-economic objective)". If these goals are supposed to be socially relevant they would have to be part of school curriculum, once it is not reasonable to expect that they would be reached through the informality or commonplace visions. But, some authors recognize that the majority of the school students are not effectively included in S&T education (Driver et al., 1996). In science textbooks one can find attempts of authors in emphasizing how important science is by presenting arguments related to technological development. In those texts it is common to observe arguments based on topics of history of science that are selected and arranged to attest the richness of the scientific achievements. In its turn, technology, more than certifying the importance and power of the scientific endeavor, is presented as a synonymous of the progress achieved by the humankind throughout the times. This humble space devoted in science textbooks to S&T issues is not much different than the triviality of the informal visions.

In addition to the role of the media and textbooks in the development of student's ideas about science and technology, teachers can exert an important influence in the images of science that the students construct, even though most of the time in science classes teachers and students are not talking about science from epistemological, philosophical or ontological perspective. Even though results, concepts, theories, models, ordinary exercises and traditional processes of problem solving constitute the typical science classes in

many realities around the world, when social perspectives related to scientific world have some space in science classes, generally they come out through “examples of application” that teachers use to illustrate the importance of studying certain science topics. Unfortunately, the “examples of applied science” in technological devices or processes tend to be accompanied of an enthusiastic and non rigorous view of technology.

For what reasons should students’ ideas about science and technology be interesting for science education? Students do not have uniform and static ideas about that subject and their tendencies of views may represent true obstacles for establishing social commitments through science education. For example, the idea that scientists work fraternally in the name of science (Solomon, 1993) and the idea that technology, as a product of humankind, is socially controlled (Aikenhead, 1988), or that it is a natural consequence of scientific work and is commonly addressed to the social interest are ideas that should be adequately explored in order to have students abandoning what Lemke (1997) called the mystique of science. As science educators we have to explore the fact that most of the power of science is not only at scientists hands. Mainly after the World War II, politics and technocracy have increased their power upon S&T. Would we have to have special forums in order to discuss this kind of issues or science classes could focus them?

DEVELOPMENT OF THE STUDY

In 1999, almost seventy two thousand students were registered to the admission examination of the Universidade Estadual Paulista (Unesp), in Brazil. In the test of Portuguese Language the students were asked to write a one-page long essay. In that year the theme of the essay was “The human intervention in the natural environment”. All the essays were evaluated by pairs of experts who had to observe aspects like coherence, punctuation, orthography, grammar, textual cohesion, verbal concordance, focus on the theme, development of a point of view etc. The essays received marks that ranged from zero to ten. Then, the final score for each essay was the average grade of the two examiners. The general average of all the essays was 4,9.

For the purposes of our study, we were interested in the STSE relations the students presented, and also in the arguments they used to defend them. The sense of taking essays of that nature was that we supposed they could offer pre-reflexive discourses

From that large amount of essays we choose only 320 essays that received grade 5.0 from both examiners. The reason for that choice was based on the fact that the students who obtained that grade were representative of the average performance of the whole group. Also, we separated a group of 11 essays that obtained the highest grade (10.0) from both evaluators, in order to analyze if there were meaningful differences between both groups in terms of concepts, ideas, relations STSE and arguments.

All the 331 essays were analyzed from a content analysis approach (Holsti, 1969). In the analysis we looked for phrases or paragraphs that expressed ideas of the students about relations involving science, technology, society and environment. The detached parts of each essay, or “units of analysis”, were labeled in a way that they could be categorized.

The main categories that were constituted from the analysis of the essays are presented here. Also, it is given explanations of each category as well as examples of the students’ ideas pertaining to them. Although it was relatively common the fact of having, in a given essay, units of analysis that could be allocated in more than one category, for the sake of brevity this fact will not be considered in this paper.

Generic solutions

Assertions proposing generic solutions for social and environmental problems caused by technological devices were grouped in this category. In 17,8% of the essays were found assertions that converge to this category. The units of analysis were constituted of certain clichés or politically correct statements. In my

view this category reflects the fact that a certain number of students seem to have no major difficulties in constructing their arguments with such type of assertions because they do not demand specific information. These assertions have a generic content that is identical to those found in publicity messages.

- *I conclude that we ourselves must take care of our ecosystems because technology is not the solution.* (S.170)
- *We must keep working and not expect that catastrophes be even more trivialized and accepted as characteristics of our generation.* (S.111)
- *It is time to improve publicity campaigns, the works of NGOs, the actions of ecologists and human consciousness.* (S. 210)

Poetic argumentation

This category represents a tendency of 13% of the essays. It includes politically correct ideas that are presented in a poetic and naïve language. The force of the discourse seems to be emphasized through an emotional appeal. The students that used this type of argumentation have not combined it with specific technical information; they just expressed general facts or ideas. It seems that for them what really matters is that there exists a general environmental destruction everywhere in the world and humankind must have compassion for the planet.

- *The earth is dying a little every single day, poisoned and burned by the hands of the men...* (S.001)
- *The results of the destruction of huge areas of forest are bitter to the humankind... Under the mantle of human progress and the beauty of technology the future of the planet hides itself.* (S.087)
- *Nature always will be running in our veins...* (S.011)

Incompatibility between technology and environmental preservation

This category encompasses 6,3% of the essays. The ideas that were included in it manifest an incompatibility between technological progress and environmental preservation. Some of the students manifest objective facts in order to defend their ideas; some of them manifest general ideas. The lack of opportunities to know more about science and technology, in a broad but consistent way, may create a bipolar idea of S&T, that means that depending on the situation they are good or harmful.

- *In this new millennium technology and environmental issues divide the world in two futurist and conflicting options.* (S.028)
- *Pollution and environmental damages are consequences of technology and obstruct human well being.* (S.014)
- *Only when the severity of environmental problems expands, the developed countries consider revising their industrial and technological growth, but soon they postpone that decision.* (S.016)

Science and technology as solution for environmental problems

The units of analysis that were included in this category were found in 4,5% of the essays. They refer to science and technology as sources of solutions for environmental problems. The assertions of the students described some specific environmental problems and specific solutions for them. Differently from other categories, here we have more optimistic students, but their optimism is based on the aprioristic idea that scientific and technological solutions will prevail over business and consumers interests. Moreover, even the solutions that would come from S&T were not viewed critically as, for example, reforestation

- *Reforestation, control of air pollution by using filters or non-pollution fuels come from the modern scientific and technological development and represent solutions for environmental preservation.* (S.009)
- *However, the same science and technology that see holes in the ozone layer, and can warn us, give a solution for this problem.* (S.024)
- *It is necessary the creation of methods, using science and technology, in order to protect the nature (recycle, control of forest devastation, techniques of sanitation).* (S.018)

New concept of development

This category represents 4,3% of the essays, and it involves an interesting type of reasoning. Students argue that the ordinary concept of progress and development is addressed to acquisition of goods, high productivity, profits etc. In such conception, issues related to environmental preservation has a low status. For

these students a new conception of development seems to be the foundation from which it will be possible to reach equilibrium between science, technology and social-environmental issues.

- *It is necessary to promote changes in our idea of development (S.006)*
- *For this reason, it is necessary to balance technology with environmental issues. (S.007)*
- *... the current concept of development is troubled equivocate (S.224)*

Capitalism and S&T against environment

This category, that represents 3,3% of the whole group and was formed by units of analysis that emphasized the relationship between S&T and financial interests. Some students sustained the idea that nowadays science and technology are committed with financial interests, and for that reason it is even more difficult to avoid or solve environmental problems.

- *The voracity of the capitalist world allied to technology will change violently the environment and harm the life of our descendents. (S.029)*
- *Human being thinking only in profits and advantages will destroy what give us life: nature. (S.329)*

CONCLUSIONS

From a quantitative point of view, the whole set of categories can be considered meaningful because it expresses the amount of students who had a specific position about the theme, in opposition to the majority of the students who limited themselves to express general descriptions of types of environmental damages.

The qualitative analysis of the ideas of the students gave an indication that much must be done in order to have them presenting more consistent ideas about the relations involving S&T and social-environmental issues. Also, the fact that it was not observed any meaningful difference between the two groups of essays (grade 5.0 and grade 10.0), suggests that the facility of writing correctly do not necessarily come with reliable ideas.

The frequent absences of specific information, as well as the general diagnosis about a large amount of facts, cases, episodes etc. reflect the way that information has been used everywhere. Such superficiality suggests that it would be difficult for the students to sustain a consistent and socially significant point of view, if they had to face some real problem related to certain use of technology and its environmental impact, for example. In this sense, it would be desirable that schools could provide more opportunities for the students through eventual but consistent projects, particularly through an interdisciplinary perspective.

The variety and simplicity of some of the ideas of the students indicate that there is a minimal starting point for exploring them at school. For example, the student's ideas about the need of a new concept of development, which appeared among fourteen of them, can contribute for debates or projects that could explore contradictory indications of progress in some social groups that appear due to factors related globalization, high productivity, incentives for consumption etc. As examples it can be cited the use of computers and lack of basic sanitation and the extensive use of cellular phone and lack of potable water.

By considering the fact that most of our secondary students present a low motivation for reading, and the fact that school system is based on a weak interaction among areas of knowledge, is it possible to infer that the source of information for the students about impacts caused by science and technology, on the society and natural environment, are the television programs.

If the students' assertions, in the whole set of categories, are viewed from the perspective of individual autonomy, communication with others and management of situations, it can be said that we have a curricular problem to face. For one side, if through science classes students may learn to walk on the soil of S&T, for another, they also should have opportunities to walk on the soil of the social sciences to deal with S&T issues. But it would be even better if it were one soil formed by both cultures, scientific and humanistic.

REFERENCES

- AIKENHEAD, G. S. (1988). An analysis of four ways of assessing students' beliefs about STS topics. *Journal of Research in Science Teaching*. Tempe. v. 25, n. 8, p. 607-29.
- DRIVER, R., LEACH, J., MILLAR, R. & SCOTT, P. (1996). *Young people's images of science*. Buckingham: Open University Press.
- FOUREZ, G. (1997). Scientific and Technological Literacy as a Social Practice *Social Studies of Sciences*, Vol.27, pp. 903-936.
- HOLSTI, O. R. (1969). *Content Analysis for the Social Sciences and Humanities*. Reading, MA: Addison-Wesley.
- LEMKE, J. (1997). *Aprender a Hablar Ciencia: lenguaje, aprendizaje y valores*. Barcelona: Paidós.
- SOLOMON, J. (1993). *Teaching Science, Technology and Society*. Buckingham: Open University Press.