DOCUMENT RESUME

ED 293 690 SE 049 023

AUTHOR Zoller, Uri; And Others
TITLE Goals' Attainment in Science-Technology-Society (S/T/S) Education: Expectations and Reality. A Probe Into the Case of British Columbia.
PUB DATE 88
NOTE 25p.; Graphs may not reproduce well.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Course Content; Decision Making; Environmental Education; Foreign Countries; Grade 11; High Schools; Problem Solving; *Science and Society; Science Curriculum; Science Education; *Science Instruction; *Secondary School Science; *Technology
IDENTIFIERS British Columbia; Science Education Research

ABSTRACT

Based on the belief that students should have a better understanding of technology and science and their interaction with society, the course Science and Technology 11 (ST 11), was proposed in 1984 for students in grade 11 in British Columbia (Canada) who did not elect one of the existing science courses. In September 1986, this new STS course was implemented and taught to approximately 6,700 grade 11 students (about 18% of those at that grade level). A recent survey revealed that science teachers comprised 38% of the approximately 125 ST 11 teachers; Social Studies teachers and shop teachers each comprised 18.6% of the group. The ST 11 classes were reported to be almost evenly divided between a mix of academic-nonacademic students and nonacademic alone. This pilot study examined a number of questions related to the ST 11 effort. Among them were: Do S/T/S courses actually work? Does the reality match expectations as far as the goals of S/T/S education are concerned? Did the already implemented S/T/S courses have any meaningful impact on students with respect to their views on Science-Technology-Environmental-Society (STES) related issues? One of the specific conclusions reached by the study was that the ST 11 course did have an impact in the "desired" direction on the viewpoints/positions of senior high school students concerning the complex topic "science, technology and society." In general the findings implied that the attainment of S/T/S goals was feasible through the implementation of S/T/S courses within the science curricula. (TW)

GOALS' ATTAINMENT IN SCIENCE-TECHNOLOGY-SOCIETY (S/T/S) EDUCATION: EXPECTATIONS AND REALITY. A PROBE INTO THE CASE OF BRITISH COLUMBIA

Uri Zoller[1]
Haifa University-Oranim, The School of Education of the Kibbutz Movement, Department of Science Education, P.O. Kiryat Tivon 36910, Israel

J. Ebenezer, K. Morley, S. Paras, V. Sandberg, C. West & T. Wolthers

The University of British Columbia, Department of Mathematics & Science Education, Faculty of Education, Vancouver, B.C., Canada V6T 1Z5

S.H. Tan
SEAMEO-RECSAM, Penang, 11700, Malaysia

[1]Currently on sabbatical at the University of British Columbia, Departments of Mathematics and Science Education & Chemistry

GOALS' ATTAINMENT IN SCIENCE-TECHNOLOGY-SOCIETY (S/T/S) EDUCATION: EXPECTATIONS AND REALITY. A PROBE INTO THE CASE OF BRITISH COLUMBIA

Introduction

For more than a decade various modes of Science-Technology-Societal (S/T/S) programmes have been proposed offering a new educational orientation which would compensate and complement the formal traditional science education, in response to the pressing needs of modern societies (Zoller & Watson, 1974; Aikenhead, 1980; Association for Science Education, 1981, Harms and Yager, 1981; McConnel, 1982; Layton et al, 1986).

Several perspectives have been recently advanced, which mutually complement each other in the formation of a conceptual framework and organizers to guide the development and implementation of both S/T/S curricula and teaching methods/strategies (Zoller, 1978, 1983; Gaskell, 1982; Yager, 1984; Bybee, 1985; Waks and Prakash, 1985; Aikenhead, 1986; Nachtigall, 1987; Rubba et al, 1987). Thus, there is a need felt world-wide for a redefinition of the purposes of science education; that is, to establish new goals and then redesign programs, rethink policies and reformulate practices accordingly (Zoller and Watson, 1974; Yager, 1984; Bybee, 1985, 1986; 1987; Rubba, 1987; Zoller, 1987).

The new orientation/focus is clearly associated with new goals of science education for all and the attainment by students - through science teaching - of such superordinate goals as critical and high-level thinking, higher-order cognitive skills, problem-solving/decision-making capacity for citizenry, and rational power as part of personal and societal growth (Yager, 1985; Bybee, 1987, Zoller, 1987). The superordinate goals for STES education have been recently reformulated in terms of the students' "STES problem-solving (PS) - decision-making (DM) act" capacity (Zoller, 1987). Thus, different goals, concepts and skills, learning outcomes, attitudes and behaviors are expected to be attained, acquired, anticipated, changed and modified respectively in S/T/S (or S/T/E/S) education.

Clearly, the assessment/evaluation of the actual short- and long-term extent of attainment of S/T/S goals/learning outcomes of already implemented courses is an issue of major concern in contemporary science education and research (Aikenhead, 1987).

Although impressive progress has been made concerning the monitoring of students' views on the nature of the interaction of science, technology and society and the role that the former two are playing in the latter within the context of S/T/S education (Fleming, 1986, 1987; Aikenhead et al, 1987), there appears to be no study focussing on the crucial issue of goals' attainment by already implemented S/T/S courses/curricula on a large scale. This paper addresses this issue and some closely-related concerns which are central, we believe, to science educators and educational policy makers in considering the implementation of S/T/E/S oriented curricula. That is, do S/T/S courses actually work? To what extent can the courses' expected outcomes be realized? Our study probes these questions through the case study of British Columbia.

The British Columbia Connection

Based on the belief that students should have a better understanding of technology and science and their interaction with society, the course Science and Technology 11 (ST 11), was proposed in 1984 for students in Grade 11 not electing one of the existing science courses. In September 1986, this new S/T/S course was implemented and taught on a provincial scale to approximately 6,700 Grade 11 students (about 18% of the grade) (Gaskell, 1987). A recent survey (Curriculum Development Branch, B.C., 1987) revealed that science teachers made up 38% of the approximately 125 ST 11 teachers in B.C. Social Studies teachers and shop teachers tied for second with 18.6% each. The remaining ST 11 teachers varied with PE as the largest identified group. The nature of the ST 11 classes was reported to be almost evenly divided between "even mix" (academic-non academic students) and "non academic".

Based on the commonly accepted philosophy and rationale for S/T/S courses (Aikenhead, 1986; Bell et al, 1986, Zoller, 1987), the following three superordinate goals have been established for the ST 11 course:

To provide students with the opportunities to:

1. develop an appreciation of the interactive nature of science, technology, and society.
2. gain knowledge of technologies as applications of science.
3. develop the ability to respond critically to technological issues.

These three goals were operationally detailed in terms of what ST 11 students will be capable of (Science and Technology 11, 1986). The following sub-goals of ST 11 are of particular pertinence to our study:

1.02 understand that society controls technological development;

1.03 understand that society influences and responds to scientific activity;

1.04 understand that technology is both a cause and a result of scientific activity;

2.01 understand that technology is an application of the concepts and principles of science;

3.01 recognize that decisions concerning scientific and technological issues are influenced by values.

Objectives and Purpose

Major questions of concern which guided our work were the following: Do S/T/S courses actually work? Does the reality match expectations as far as the goals of S/T/S education are concerned? Did the already implemented S/T/S courses have any meaningful impact on students with respect to their views on S/T/E/S-related issues?

Specifically, the objectives of this pilot study were:

1. To assess the (possible) impact of ST 11 on the viewpoints of senior high school students concerning the complex topic 'science, technology, and (Canadian) society.'

2. To assess whether and to what extent some or all of the prespecified superordinate goals of ST 11 have actually been attained in the first year of province-wide implementation.

3. To obtain a preliminary data-base from the field, for possible future use in decision-making and educational policy concerning S/T/S courses and curricula.

4. To evaluate some selected aspects involved in the implementation of ST 11 under the particular local constraint of British Columbia.

This *ex post facto* preliminary pilot study/evaluation of ST 11 as a case study was purposed to provide an insight into similar cases of S/T/S curriculum development/implementation efforts elsewhere.

Also it would be interesting to relate the findings to a few recent studies on students' beliefs about science-technology-society (Aikenhead, 1987_a; Brunkhorst, 1987; Fleming, 1987).

Instrumentation, Design & Procedures

A questionnaire comprised of four representative statements (1.7, 4.1, 12.1, and 18.1) selected from the VOSTS inventory form CDN. mc.4 (Aikenhead, 1987b) constituted the research instrument for assessing the high school students' S/T/S-related beliefs/positions. The following are these four statements each accompanied by several positions one of which the responding students were supposed to select.

1.7 Scientists and engineers should be the ones to decide on world food production and food distribution (e.g., what crops to plant, where best to plant them, how to transport food efficiently, how to get food to those who need it, etc.) because scientists and engineers are the people who know the facts best.

Your position, basically: (Please choose one.)

Scientists and engineers should decide because:

A. they have the training and facts which give them a better understanding of the issue.

B. they have the knowledge and can make better decisions than government bureaucrats or private companies, both of whom have vested interests.

C. they have the training and facts which give them a better understanding; BUT the public should be informed and consulted.

D. The decision should be made equally; viewpoints of scientists and engineers, other specialists, and the informed public should all be considered in decisions which affect our society.

E. The government should decide because the issue is basically a political one; BUT scientists and engineers should give advice.

F. The public should decide because the decision affects everyone; BUT scientists and engineers should give advice.

G. The public should decide because the public serves as a check on the scientists and engineers. Scientists and engineers have idealistic and narrow views on the issue and thus pay little attention to consequences.

H. I don't understand.

I. I don't know enough about this subject to make a choice.

J. None of these choices fit my basic viewpoint.

4.1 Canadian scientists should be held responsible for the harm that might result from their discoveries.

Your position, basically: (Please choose one.)

A. Scientists should be held responsible because it's part of a scientist's job to ensure that no harm comes from a discovery. Science should cause no harm.

B. Scientists should be held responsible because, if a discovery can be used for both good and bad purposes, the scientists must promote the good use and stop the bad use.

C. Scientists should be held responsible because they must be aware of the effects of their experiments ahead of time. Science should cause more good than harm.

D. The responsibility should be shared about equally between the scientists and society.

Scientists should NOT be held responsible because:

E. it's the people who use the discoveries who are responsible. Scientists may be concerned, but they have no control over how others use their discovery.

F. the results of scientific work can't be foreseen (we can't predict if the results will be harmful or not). It's a chance we have to take.

G. otherwise scientists would quit doing research and science would not progress.

H. once a discovery is made, others should check its effects. The scientist's job is only to make the discoveries. Science and moral questions are completely separate.

I, J, K - as H, I, J. in 1.7.

12.1 In order to improve the quality of living in Canada, it would be better to invest money in technological research RATHER THAN scientific research.

Your position, basically: (Please choose one).

A. Invest in technological research because it will improve production, economic growth, and unemployment. These are far more important than anything that scientific research has to offer.

Invest in both because:

B. there is really no difference between science and technology.

C. scientific knowledge is needed to make technological advances.

D. they interact and complement each other equally. Technology gives as much to science as science gives to technology.

E. each in its own way brings advantages to society. For example, science brings medical and environmental advances, while technology brings improved conveniences and efficiency.

F. Invest in scientific research -- that is, medical or environmental research -- because these are more important than making better appliances, computers or other products of technological research.

G. Invest in scientific research because it improves the quality of life (e.g., medical cures, answers to pollution, and increased knowledge). Technological research, on the other hand, has worsened the quality of life (e.g., atomic bombs, pollution, automation, etc.).

H. Invest in neither. The quality of living will not improve with advances in science and technology, but will improve with investments in other sectors of society (e.g., social welfare, education, job creation programs, the fine arts, foreign aid, etc.).

I, J, K. - as in 4.1.

18.1 When scientists disagree on an issue (e.g., whether or not low-level radiation is harmful), they disagree mostly because one side does not have all the facts. Such scientific opinion has NOTHING to do with moral values (right or wrong conduct) or with personal motives (personal recognition, pleasing employers, or pleasing funding agencies).

Your position, basically: (Please choose one.)

Disagreements among scientists can occur:

A. because not all the facts have been discovered. Scientific opinion is based entirely on observable facts and scientific understanding.

B. because different scientists are aware of different facts. Scientific opinion is based entirely on a scientist's awareness of the facts.

C. when different scientists interpret the facts differently (or interpret the significance of the facts differently). This happens because of different scientific theories, NOT because of moral values or personal motives.

D. mostly because of different or incomplete facts, but partly because of scientist's different personal opinions, moral values, or personal motives.

E. for a number of reasons -- any combination of the following: lack of facts, misinformation, different theories, personal opinions, moral values, public recognition, and pressure from companies or governments.

F. when different scientists interpret the facts differently (or interpret the significance of the facts differently). This happens mostly because of personal opinions, moral values, personal priorities, or politics. (Often the disagreement is over possible risks and benefits to society.)

G. because they have been influenced by companies or governments.

H, I, J. - as in 1.7

The issues dealt with in the above "short version" of VOSTS were selected for our study not only because they are representative of S/T/S issues but, they are also related to the pertinent sub-goals of ST 11 specified before (i.e. 1.02 - 3.01).

The four-item questionnaire was administered to 12th-graders (N=473) at six public/comprehensive secondary schools with a total student body of 7585 in the Greater Vancouver area during the first term of the school year 1987/88.

The experimental group (designated as ST 11 students) consisted of 101 students (41 males and 60 females) randomly-selected from the total of 274 ST 11 students (50%:50% M/F) who had taken the ST 11 course in the previous school year. The ST 11 group comprised 15.5% of the total number of 11th graders (1770) in the six schools which participated in the study. The control group (designated as non ST 11 students) consisted of 276 randomly-selected students (130 males and 146 females) who had not taken the ST 11 course.

The questionnaire was also administered to 96 students who were currently (in the school year 1987/88) enrolled in the ST 11 course and had completed about 10% and 30% of the course in two of the participating schools respectively. The responses of these students were not included neither in the non ST 11 - nor in the ST 11 groups.

The science course history and gender of the respondents were also recorded. In five of the schools, the ST 11 students were described by their teachers as "non academic". Only in one school were they characterized as an "even-mix" group of students.

The data/responses collected provided the basis for the construction of an "S/T/S response profile" of ST 11 students for comparison with a corresponding profile of the non ST 11 students. The responses to each of the four statements were grouped into "clusters", consisting of one to four responses each. Based on our judgement, the responses assembled in each cluster express, in principle, the same view/opinion/position on the issue dealt with.

The "response profiles" of male and females (both non ST 11 and ST 11 students were similarly constructed.

A x^2 - test for the difference between the ST 11 students and non ST 11 students was conducted for each of the four-items within the total, male, and female "response profiles" using the corresponding percentage of usable responses.

The results are presented in the form of "S/T/S response profiles" of the experimental sub-populations. The findings are interpreted not only in terms of the superordinate goals' attainment of ST 11 and its impact on the S/T/S viewpoints of senior high school students, but also in taking into consideration some of the key factors involved such as: typical characteristics of the target population, gender differences, the S/T/S issue(s) the students respond to, and the particular local context/reality which the different student target populations are exposed to, and within which ST 11 (or similar courses) are implemented.

Results and Discussion

The "S/T/S response profiles" of non-ST 11- and ST 11 students (N = 276 and 101 respectively) in Greater Vancouver high schools are given in Fig. 1 below. The corresponding "S/T/S male- and female response profiles" are given in Figure 2 and 3 respectively.

Insert Figures 1, 2, 3 here

Noteworthy are the significant differences between the two student populations concerning their positions on the S/T/S issues dealt with in questions/statements 1.7, 4.1, and 18.1. Furthermore, substantial differences between the two populations are apparent almost in all the separated clusters within each of these questions. Clearly the ST 11 course does have an impact on the S/T/S viewpoints of senior high school students.

Inspection and analysis of the male and female "response profiles" (Fig. 2 and 3 respectively), reveal that gender difference may play a significant role in accounting for the differences in certain S/T/S viewpoints between non ST 11 and ST 11 students. Thus, although the significant difference between the two groups persists for the positions of both males and females in question 1.7 (differences are apparent, however, in the separated clusters within 1.7), it does not persist in question 18.1: while there is a significant difference between non ST 11 and ST 11 males ($p < 0.005$), there is no such difference between non ST 11 and ST 11 females. As a result, the level of difference between the two total populations drops by about an order of magnitude ($p < 0.005$ ---> $p < 0.025$; question 18.1 in Fig. 2 and Fig 3. respectively). Furthermore, although the Chi-square analysis of 4 1 for males (Fig.2) was not carried out because of low frequency in one of the cells, a very similar "response profile" for males and females is apparent, suggesting no gender difference in the positions related to this issue.

As one could expect, the ST 11 students favored the public deciding on world food production and distribution compared with the non ST 11 students who believed that scientists and engineers should be the "deciders" on this issue (clusters ABC vs. clusters EFG in 1.7). Similarly, as could be expected, ST 11 students strongly believed that scientists should be held responsible for the harm that might result from their discoveries, whereas the non ST 11 students' viewpoint was that scientists should not be held responsible for the potential harm of their discoveries (clusters ABC vs. EFGH in 4.1; Figs. 1, 2, and 3). Significantly, however, most students in both groups preferred the "midway" (shared-responsibility) position on the less emotionally intense issue of food production/distribution (in 1.7). On the emotionally intense issue of potential harm as a result of scientific discoveries, they were very opinionated and did take firm polarized positions. There was a distinct difference between the stands of the two groups and neither was neutral: the ST 11 students envisioned science in its social context whereas the non ST 11 tended to perceived scientists as responsible for science *per se*, not for its consequences.

The issue in question 18.1 is the 'blind idealism' myth propagated by conventional science teaching, that scientists are neutral, completely disinterested objective beings. It is interesting to note that ST 11 male students were more inclined, relative to their non ST 11 peers, to challenge this commonly accepted notion than the ST 11 female students. They believed that personal opinions and moral values do play a role in the interpretation of facts and, consequently, this role affects the position on the issue at point even by scientists (F in Figs. 2, 3 respectively).

T ~ ~n ST 11 students (males in particular), are much more reluctant in challenging the "accepted in-fate" neutrality and objectivity of the scientists. Their position was basically in accord with the commonly held belief in this concern (clusters ABC and DE in Figs. 1-3).

The fact that no significant differences could be found between the responses of the ST 11 and non ST 11 students in question 12.1 may seem surprising. However, the "neutral" position (i.e. BCDE) which did not require the respondents to actually make a choice between science and technology appears to be very appealing to both groups. The "no difference" result may also be interepreted in terms of the difficulty students (and, apparently, the public at large, teachers included) have in distinguishing between science and technology and their distinctive roles in the social context. This interpretation of our results with respect to 12.1 is supported by another study of high school graduates' beliefs about STS which concluded that "' "the students in the study failed to differentiate between the roles of science and technology" (Fleming, 1987).

Our results suggest that the ST 11 students understand that.. "soceitv controls technological developments ... influences and responds to scientific activity" (ST 11 sub-goals 1.02 and 1.03), and recognize that... "decisions concerning scientific and technological issues are influenced by values" (ST 11 sub-goal 3.01). We cannot derive any "hint" from the results with respect to sub-goal 1.04.

They do suggest, however, that sub-goal 2.01 has not been achieved.

As far as the superordinate goals of ST 11 are concerned our results clearly indicate that a meaningful progress towards the attainment of the first and the third goals has been achieved by the ST 11 course. Our results provide no information concerning the second goal.

It was quite surprizing that in spite of the fact that the "non academics" comprise the major portion of students in the ST 11 course (Curriculum Development Branch, 1987), this low-status course (Gaskell, 1987) is capable of making such a "desirable" impact on these high school students' viewpoints concerning S/T/S issues.

This is an encouraging finding for educational policy makers involved with im.lementation of innovations, particularly supporters of the implementation of S/T/E/S-oriented courses within our educational system.

Analysis of another set of data obtained from 96 students in two schools, currently taking the ST 11 course (10% and 30% of the course until the questionnaires were administered) indicated that their "S/T/S response profile" is somewhere between the corresponding profiles of non ST 11 and ST 11 students.

This result could be expected, based on the fact that there is a significant difference between the S/T/S response profiles of the non ST 11 and ST 11 students. It is not surprising, therefore, that the 12.1 profile of these current ST 11 students was found to be essentially the same as the non-different 12.1 profiles of the two other population groups. The striking finding was that with respect to almost half of the questionnaire clusters, the response profile of these students is closer to that of the ST 11 students, even though their exposure to the ST 11 course was rather short (only 10% and 30% of the entire one year course in the two schools surveyed respectively). However, one should be cautious here, since our data were not sufficient to interpret this unexpected finding adequately.

Finally, relating our findings to those of other studies concerning the "S/T/S response profiles" of high school students may provide a deeper insight into the issues of (a) the "contextually-bound" nature of S/T/S-oriented students' viewpoints; (b) the monitoring of these views (Aikenhead, 1987; Aikenhead, et al, 1987); and (c) the base-line frame of refere.... to relate the monitored response profiles.

Thus, in fitting the usable responses of non ST 11 (12th grade) students in British Columbia (in our study) with those of 900 Saskatchewan 12th graders (rural:urban 45%:55%) (Aikenhead, 1987a), we find significant difference between the profiles in question 1.7 ($p < 0.005$) and rather small differences (p values within the range of 0.08 and 0.3) in the other three questions. As we expected, there is no significant difference between the response profiles of B.C. ST 11 students and Saskatchewan non ST 11 students in 12.1. Based on the local contextually-bound nature of many S/T/S issues, we interpret the difference in the non ST 11 students' response profiles - in 1.7 - in the B.C. sample and the Saskatchewan study, reflecting the difference in the "base-line" beliefs of the surveyed urban B.C. students and the Saskatchewan students. About half of the latter were from rural schools (in agricultural areas) and, consequently, much more personally involved with issues/decisions/responsibilities concerning food production (the issue in 1.7).

A comparison of the B.C. students' S/T/S response profile, as obtained in our study with that of American students (Brunkhorst, 1987) turned out to be nearly impossible due to the different design, target populations, methodology, and purpose of the two studies. However, in probing into this issue through quasi-quantitative meta analysis methodology it appears that the base line S/T/S response profile of the two populations is significantly different. This is to be expected, since "S/T/S issues" are contextually bound; that is, perception by the public is contingent on the particular local socio-cultural norms and realism of economical/political constraints. This suggests that (a) the base-line S/T/S response profile of a certain population as a frame of reference to relate response profiles of different sub-groups should be established for this particular population; and (b) the use of some kind of 'normative' response profile - as a frame of reference even within the same country should be handled with great care. We also compared the non ST 11 response profiles with those of graduate high school students in another study carried out in Canada (Fleming, 1987) with particular reference to S/T/S issues contained in questions 1.7 and 12.1. Again, large differences between the corresponding response profiles were found and thereby appeared to reflect the contextually-bound nature of S/T/S issues.

Summary, Conclusions, and Implications for Science Teaching

S/T/S (or S/T/E/S) courses and programmes constitute the response to the advocated new orientation/focus in science education for all through the inclusion of goals related to the fulfilment of personal and social needs and aspirations. A major concern in this respect is whether S/T/S courses acutally work, and to what extent reality matches expectations as far as their goals' attainment is concerned.

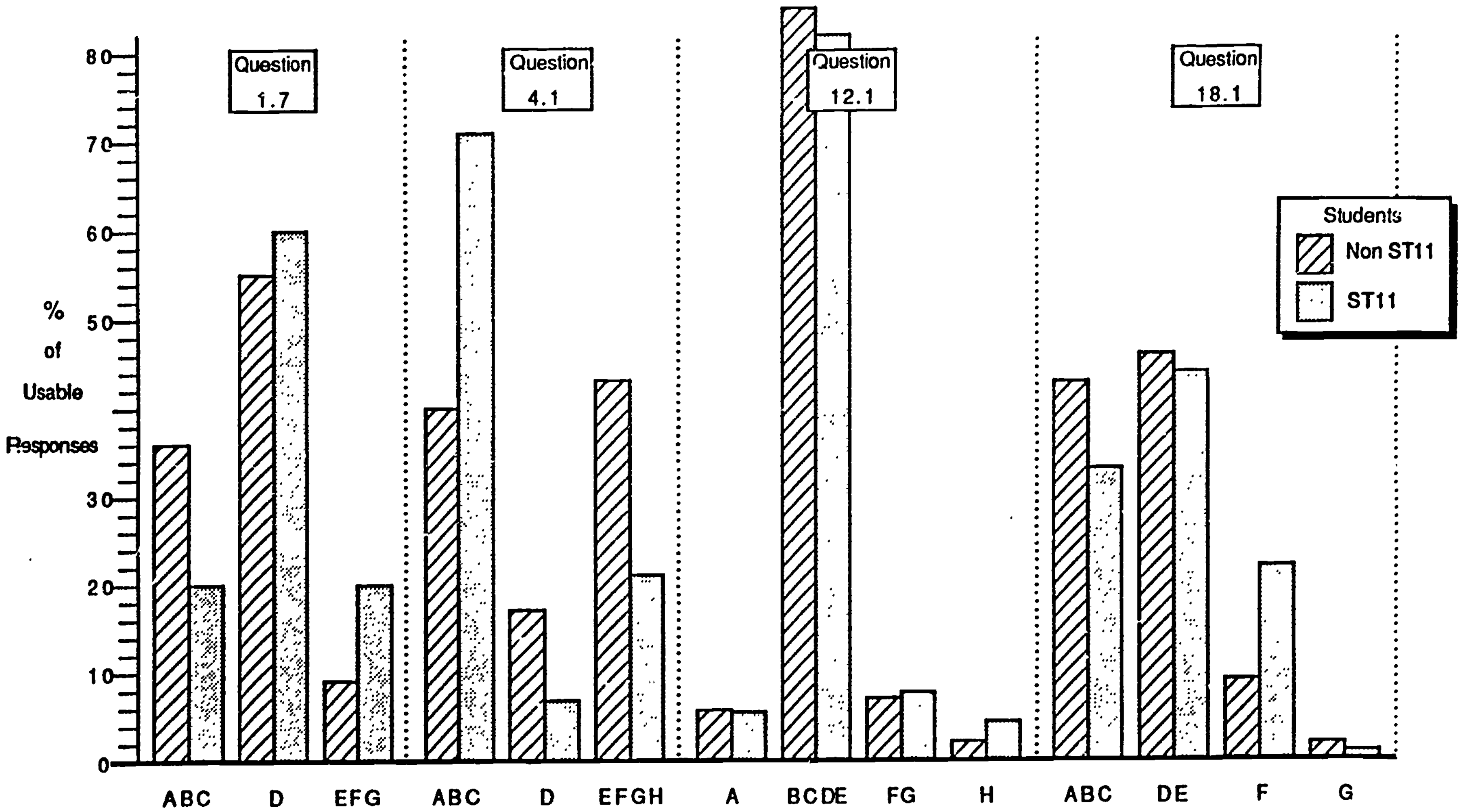
Based on our study of the British Columbia case, and with reference to the prestated objectives of our study, we conclude that:

1. The ST 11 course did have an impact in the "desired" direction on the viewpoints/positions of senior high school students concerning the complex topic 'science, technology and society'.

2. Some of the prespecified superordinate goals of ST 11 which are typical for S/T/E/S courses world-wide have been attained albeit some of the related sub-goals have not been achieved.
3. A simple straightforward assessment of the key outcomes of the ST 11 course (and, probably, of other similar courses and innovations) is feasible, and the data-base thus obtained is meaningful, and very useful as a basis for decision-making and future educational policy-making concerning S/T/E/S courses and curricula.
4. "S/T/S response profile" (i.e. students' viewpoints/opinions/positions about the S/T/S interactions and closely-related issues) are (locally) contextually dependent and with respect to some S/T/S issues - gender dependent. Although all the students (both non ST and ST 11) are not clear about the different roles of science and technology in society, important goals of the ST 11 course were met by ST 11 students many of whom were described by their teachers as "non-academic".
5. The VOSTS Inventory (form CDN mc.4) is an efficient, useful instrument for assessing students' viewpoints/positions on S/T/S-related issues. Its use for cross-cultural studies and for comparisons between S/T/S response profiles should take into consideration that these profiles are contextually bound

Although our conclusions are based on the B.C. case study limited necessarily by its scope, sample size, students' characteristics, the features of the ST 11 course, and the particular local constraints; we believe that they are valid, transferable and applicable to other S/T/S and S/T/E/S-oriented courses elsewhere.

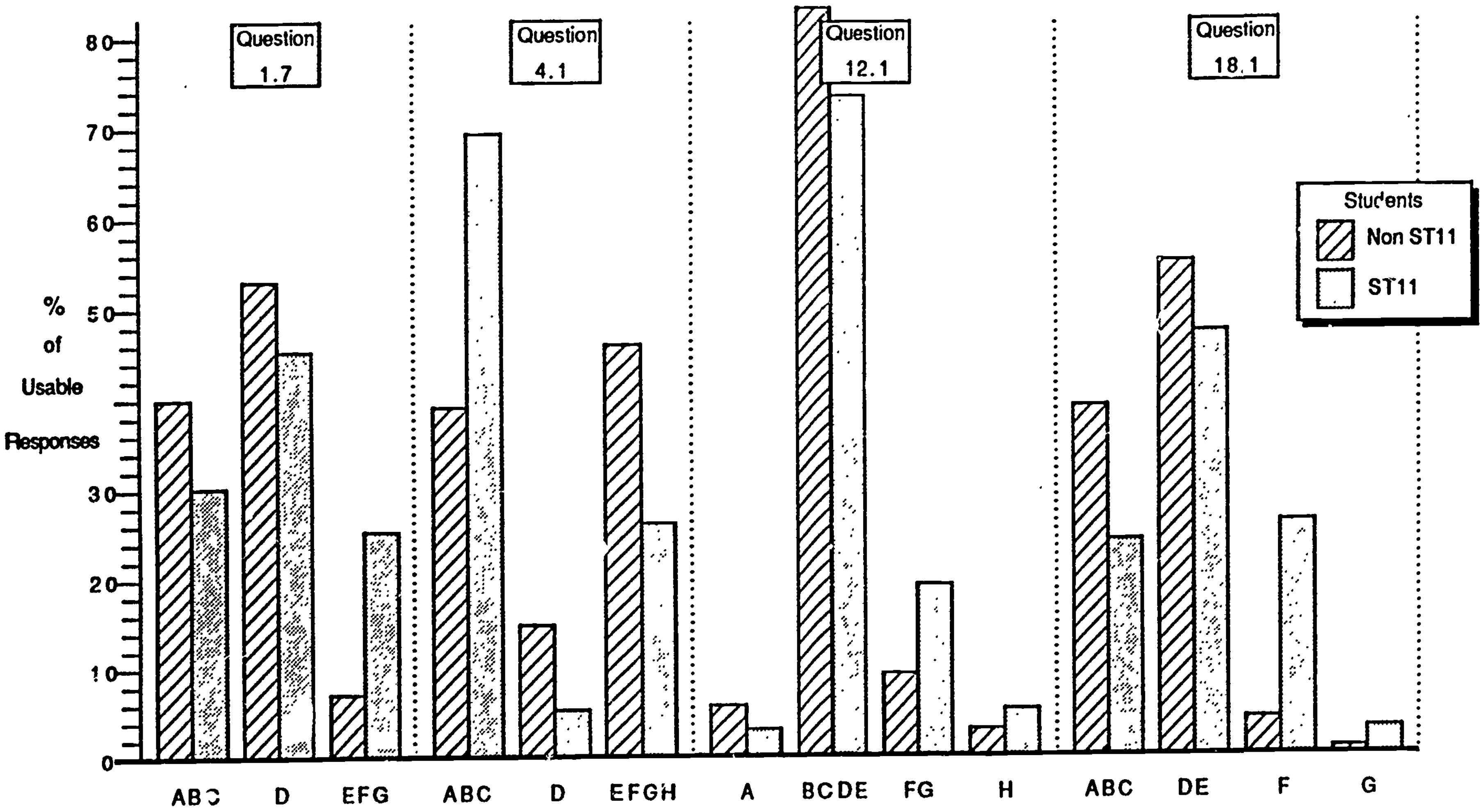
Our findings imply that the attainment of S/T/S theme's goals is feasible through the implementation of S/T/S courses within science curricula in our educational system.



Contingency Table

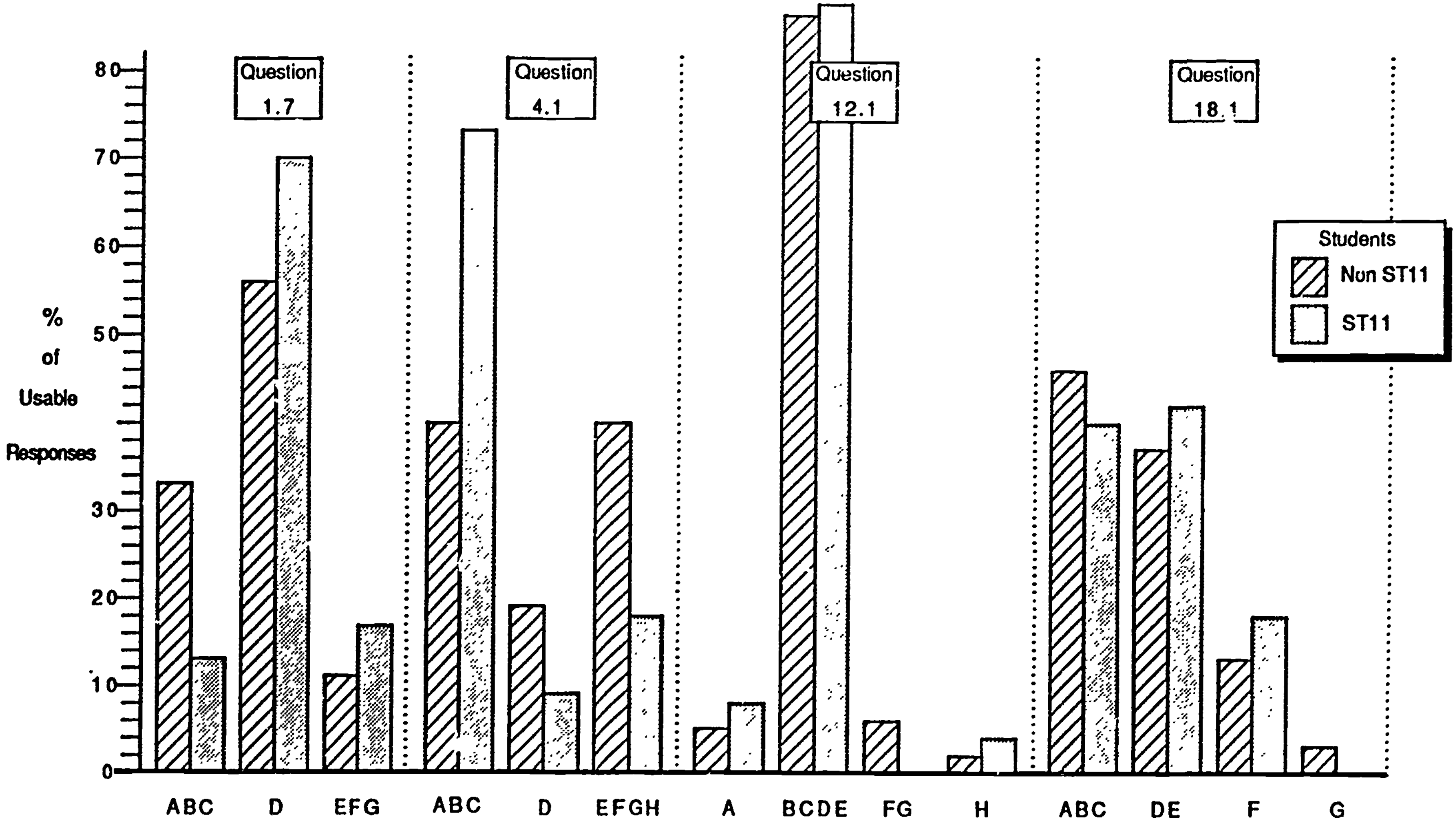
Question	χ^2	p	% of nonusable responses NON ST11	ST11
1.7	12.70	< 0.005	8.7	6.9
4.1	27.60	< 0.005	5.1	6.9
12.1	0.05	n.s.	10.9	10.9
18.1	9.06	< 0.025	14.8	12.9

Fig. 1. Response profile of student's positions: % in terms of total usable responses.



	Question	χ^2	p	% of nonusable responses NON ST11	ST11
Contingency Table	1.7	9.00	< 0.025	7.7	2.4
	4.1	--	--	3.1	4.9
	12.1	--	--	9.2	9.6
	18.1	16.35	< 0.005	12.3	7.3

Fig. 2. Response profile of male student's positions: % in terms of total usable responses



Contingency Table*

Question	χ^2	p	% of nonusable responses NON ST11	ST11
1.7	8.38	< 0.025	9.6	10.0
4.1	16.22	< 0.005	6.8	8.3
12.1	--	--	12.3	11.7
18.1	1.02	n.s.	17.2	16.7

Fig. 3. Response profile of female student's positions: % in terms of total usable responses

REFERENCES

Aikenhead, G.S. (1980). Science in social issues. Implication for teaching. Science Council of Canada.

Aikenhead, G.S. (1986). The content of STS education. STSRN Missive, 2 (3), 17-23.

Aikenhead, G.S. (1987). An analysis of four methods which assess students' beliefs about science. Paper presented at the 60th Annual Meeting of the National Association for Research in Science Teaching. Washington, D.C.

Aikenhead, G.S., Fleming, R.W., & Ryan, A.G. (1987). High-school graduates' beliefs about science-technology-society. Methods and issues in monitoring student views. Science Education, 71 (2), 145-161.

Aikenhead, G.S. (1987_a). A field trial of a new type of assessment instrument. Project Report for Saskatchewan schools. College of Education, University of Saskatchewan.

Aikenhead, G.S. (1987_b). Views on Science-Technology-Society. Form CDN.mc.4. Department of Curriculum Studies, University of Saskatchewan, Canada, S7N 0W0.

Association for Science Education (1981). Educating through science. Hatfield, U.K.

Bell, P.E., Williams, W.F., et al. (1986). A model for a one year course in STS. STS Reporter, 2 (4), 7-21.

Brunkhorst, H.K. (1987). A comparison of student/teacher positions on selected science/technology/society topics: a preliminary study. In K. Riquarts (Ed.). Science and Technology Education and the Quality of Life. Proceedings of the 4th International Symposium on World Trends in Science and Technology Education, Kiel. Vol. 2, pp. 613-625.

Bybee, R.W. (1985). The Sisyphean question in science education: what should scientifically and technologically literate persons know, value and do - as a citizen? In Bybee, R.W. (Ed.), Science-Technology-Society, 1985 NSTA Yearbook. Washington, D.C: National Science Teachers Association.

Bybee, R.W. (1986). Science-Technology-Society: an essential theme for science education. In James, R.K. (Ed.), 1985 AETS Yearbook, Association for the Education of Teachers in Science, and SMEAC Information Reference Center, Columbus, Ohio. pp. 3-14.

Bybee, R.W. (1987). Science education and the Science-Technology-Society (S-T-S) theme. Science Education, 71 (5), 667-683.

Curriculum Development Branch, B.C. (1987). Science & Technology 11 Survey Results. Ministry of Education, British Columbia, Canada.

Fleming, R.W. (1986). Adolescent reasoning in socio-scientific issues. I. Social cognition. II. Non-social cognition. Journal of Research Science Teaching, 23 (8), 677-698.

Fleming, R.W. (1987). High school graduate beliefs about Science-Technology-Society. The interaction among science, technology and society. Science Education, 71 (2), 163-186.

Gaskell, P.J. (1982). Science education for citizen. Perspectives and Issues. Studies in Science Education, 9, 33-46.

Gaskell, P.J. (1987). Science and technology in British Columbia: A course in search of a community. Paper presented at the 4th International Symposium on World Trends in Science and Technology Education. Kiel, Germany. August.

Harms, N., & Yager, R.E. (1981). What research says to the science teacher. Vol. 3, National Science Teachers Association Monograph. Washington, D.C.

Layton, D., Davy, A., Jenkins, E. (1986). Science for specific social purposes (SSSP): Perspectives on adult scientific literacy. Studies in Science Education, 13, 27-52.

McConnel, M.C. (1982). Teaching about science, technology, and society at the secondary school level in the United States. An educational dilemma for the 1980's. Studies in Science Education, 9, 1-32.

Nachtigall, D.K. (1987). New priorities in science and technology teacher education. Paper presented at the 4th International Symposium on World Trends in Science and Technology education. Kiel, Germany.

Rubba, P.A., Wisenmayer, R.L. (1987). Goals and competencies for precollege STS education: recommendations based upon recent literature in environmental education. Paper presented at the annual meeting of National Association for Research in Science Teaching. Washington, D.C.

Science and Technology 11 (1986). Curriculum Guide. Province of British Columbia, Ministry of Education, Curriculum Development Branch.

Waks, L.J., Prakash, M.S. (1985). STS education and its three step-sisters. Bulletin of Science, Technology and Society, 5 (2), 105-116.

Yager, R.E. (1984). Defining the discipline of science education. Science Education, 68 (1), 35-37.

Yager, R.E. (1985). An alternative view. Journal of College Science Teaching, 14 (3), 223-224.

Zoller, U., & Watson, F.G. (1974). Technology education for the non-science students in the secondary school. Science Education, 58 (1), 105-116.

Zoller, U. (1978). Technology (and science) for social action; an alternative curriculum model for science teaching. SISCON Newsletter, 7: 3-5, 10.

Zoller, U. (1983). Interdisciplinary decision-making science curriculum in the modern socio-technological context; relevance assurance of contemporary (and future) science teaching. In G.G. Harrison (Ed.), World Trends in Science and Technology Education, Trent Polytechnic, Nottingham, U.K. pp. 76-78.

Zoller, U. (1987). Problem solving and decision-making in Science-Technology-Environmental-Society (STES) education. In K. Riquarts (Ed.), Science and Technology Education and the Quality of Life. Proceedings of the 4th International Symposium on World Trends in Science and Technology Education, Kiel. IPN-Materialen, Kiel. Vol. 2, pp. 562-569.

Captions of Figures 1-3

Fig. 1. Response profile of students' positions: % in terms of total usable responses.

Fig. 2. Response profile of male students' positions: % in terms of total usable responses.

Fig. 3. Response profile of female students' positions: % in terms of total usable responses.