# KNOWLEDGE AND ATTITUDES OF FRENCH AND ISRAELI 12TH GRADERS IN AGRICULTURAL OR RURAL SECONDARY SCHOOLS ABOUT WATER AND IRRIGATION RELATED ISSUES

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**Abstract** – *In arid countries, the use of water by agriculture raises important social, economic, and moral issues. This study attempted to compare the knowledge and attitudes of agricultural secondary schools 12th graders in Israel (essentially a Mediterranean arid or semi-arid country) with those of comparable students in France, a country where water is not a central limiting factor in agriculture, concerning six aspects of the use and misuse of water by agriculture. Students were required to assess the desirability of existing situations, the possibility to change them, and the potential influence of five factors of change (scientific knowledge, government authorities, social customs, laws of economics, and the individual citizen). The Israeli students systematically put a strong emphasis on scientific knowledge and authorities. The reactions of the French students were weaker than those of the Israelis. Also, there were only two aspects in which they considered that any of the factors could have a significant influence. And finally, the individual citizen, and not scientific knowledge or authorities, was regarded by the French students to be the potentially most influential factor – actually the only one.*

## Introduction

There is no agriculture without water, because there is no life without water. The productivity and the profitability of agriculture depend on the availability of water of suitable quality in appropriate amounts. Water, in some countries, as far as the agriculturist is concerned, is a gift from heaven: it rains all year round in sufficient quantities. In some regions, although the annual distribution of rain is not optimal, water resources are still abundant (lakes, rivers), so that agriculture is easily provided with the necessary amounts of water by means of irrigation. In other countries, however, the natural precipitations are so limited, and their distribution often so inadequate, that irrigation is indispensable. In such countries,

the shortage of water is a crucial economic problem. Since agriculture, in arid countries, may use the best part of the available fresh water resources, its allocation to different sectors of the population raises important social issues. A tremendous amount of scientific and agro- or bio-technical knowledge is invested by research institutions, in an effort to increase the efficiency of irrigation methods, so as to reduce the need for water in agriculture.

However, reducing the need of water is not the only problem. In the whole world, water *pollution* has become an acute environmental-educational issue. Already a long time ago, Blum (1979), in a study of environmental curricula in the US, France, Germany and Britain, showed that water pollution was their most common element. More recently, studies like *Quelle Eau Demain?* (Menard 1992) in France, a country where water exists in apparently unlimited quantities, display a symptomatic feeling of urgency about the need to increase teachers' and students' awareness of the nature and intensity of the problem. Because agriculture is one of the main polluters of underground water, various *economic, social and moral* problems are connected with agrotechnical practices. Modern *knowledge* is invested in an effort to solve the conflict between the need for chemicals (fertilizers, insecticides, pesticides) and the need for the prevention of the resulting pollution of ground water.

The topic of irrigation, in countries where water-supply is a crucial issue, appears to possess, built-in, all the elements which may induce a deep involvement of the students. The *scientific knowledge* basis (plant physiology, soil and water sciences), the relevant *technologies* and the *social* issues (economic, moral) should be part and parcel of any rational teaching of the subject. Research about STS (Science, Technology and Society) approaches in science education has shown (see Aikenhead 1994) that involvement may have a strong influence on students' attitudes or feelings towards science related social issues. According to Solomon (1990, 1993) for instance, the involvement of students in discussions about science-related social issues brought about a high degree of enthusiasm, and students became more cognizant of their civic responsibilities.

Israel is essentially a Mediterranean arid or semi-arid country, with some desert areas, and all the summer crops are irrigated. France has an essentially temperate climate, with some southern areas of a Mediterranean type, where irrigation is more common than in other regions. It can therefore be hypothesised that students who have learned the topic of irrigation in a country like Israel, where water-supply is an acute problem, should develop strong attitudes towards relevant social, moral and economic problems (the second S of STS), as a result of their deep involvement in an extremely relevant national issue. In France, on the other hand, water is not a central limiting factor in agriculture, but for a few areas where the rainfall is insufficient, mainly in summer (inadequate

distribution). The role of irrigation in France is less crucial than in Israel. It is either to make up for a temporary shortage of rainfall, or to optimise the production of crops. The social issues are therefore less relevant, and students, while learning about irrigation, could be expected to develop less extreme attitudes in France than in Israel. However, several successive years of drought, together with the increasing pollution of underground supply of fresh water, have recently underlined the role of agriculture concerning water resources. In France, as in Israel, farmers are now regarded to be water polluters, a view to which students of agriculture should not remain indifferent.

It can also be hypothesised that people who live in a small and centralised country like Israel, may develop specific attitudes concerning what can and should be done about the use and misuse of water resources, as compared with people who live in a big country, where the more 'distant' authorities, may be perceived as exerting less direct influence, and as less responsive to influence.

This study attempted to compare the attitudes of French 12th graders in agricultural secondary schools, with those of comparable Israeli students. Because scientifically literate citizens must possess some basic knowledge to be able to 'engage in a scientifically informed discussion of a contemporary issue' (Champagne and Lovitts 1989), and develop sustainable values and reasonable attitudes on the basis on some sound scientific knowledge (Dreyfus 1995), the knowledge of the students was also to be assessed, to some extent.

Two questionnaires were therefore developed, the first to assess students' knowledge concerning plants' physiological mechanisms in the context of the relations between plants, soil and climate, and the second to assess their attitudes towards some issues concerning the use, misuse or pollution of water in an agricultural context.

The questionnaires will first be described, and then the populations of students in both countries.

## The 'knowledge' questionnaire

Since all the subjects in this study were 12th grade students, all the questionnaires had to be relatively short, so as to interfere as little as possible with their daily schedule. On the other hand, the questionnaire had to be representative of the knowledge which could reasonably be expected of a 12th grader in a rural or agricultural school. However, since its aim was to assess only the students' general literacy concerning water and irrigation, and since the scientific

knowledge was not expected to serve directly as a tool to solve the social problems referred to in the attitudes questionnaire, the questionnaire dealt mainly with what has been termed 'domain knowledge'. Domain knowledge (Alexander, Schallert & Hare 1991) deals with 'familiarity with general information in an area, even though it *may not be specifically referred to* in a particular passage' (Tobias 1994), as contrasted with 'topic knowledge', which is closely related to the material covered in a particular text.

In order to determine 'what to ask', a group of Israeli educators including 6 teachers (in secondary agricultural and/or rural schools), 2 inspectors of the Ministry of Education (Department of Rural Education, Sciences of Life and Agriculture), 2 members of the Department of Agricultural Education of the Faculty of Agriculture (Hebrew University) were asked: '*Which scientific principles, on the subject of 'WATER', would you expect to have been mastered and remembered by graduates of agricultural or rural schools who have studied an agrobiological curriculum*'. The precise meaning of 'on the subject of water' and the selection of sub-topics was intentionally left to the judgment of the members of the group. However, two points were specified: firstly, the question referred only to students in fully academic streams, which lead to full matriculation examinations. Secondly, knowledge of technical know-how was *not* to be referred to in the questionnaire.

A consensus was relatively easily obtained, and the decisions of the Israeli group were sent to the French partners, who checked it with a group of educators more or less equivalent to the Israeli one (teachers and curriculum developers of the INRAP, the national institute for research in agricultural pedagogy). The questionnaire was finally developed on the basis of a consensus between the partners from both countries.

Five sub-topics were specified in that way, all relevant to general biology or to soil and water sciences: a) Evapotranspiration; b) the function of water in the plant; c) the movement of water in the plant and the soil; d) the quality of water; and e) sources – or resources – of water.

An open-answer test was now designed and administered to a group of Israeli 12th graders, (two classes, about 50 students), who were not to participate in the study. All the questions in the final test were ultimately based on the right and wrong answers of this group.

To cover, even superficially, the wide field of required knowledge, while keeping the test, as required, relatively short, the time necessary to read the questions was to be strictly limited. Essay questions could therefore not be used, and even multiple choice questions, which usually require the reading of a stem and three distractors in addition to each right answer, were found to be too time consuming. A 'right – wrong' system was finally adopted, in which the subjects

were required to state if statements were right or wrong. In this way, for each item in the test, the respondents had to read only *one* statement. Because of the high probability that a right answer could be obtained by guessing, the respondents were also asked to indicate the level of confidence they had in the correctness of their answers. This method is believed to reduce the influence of guessing, and also, to some extent, to give a better idea of the 'true knowledge' of the students, such a knowledge being represented by a right answer given with a high level of confidence (Hobden 1989). Anyway, since it was made very clear that the only purpose of the questionnaires was to yield research data, and that results would not be transmitted to the staff of the schools, and would therefore have no influence on marks, the students had no strong incentive to cheat, or not to give an honest answer regarding their level of confidence.

Two items will exemplify the type of items in the questionnaire: (correct) *'In clay soils, a good structure allows both infiltration and retention of water';* (wrong) *'In clay soils, the infiltration of water in capillary spaces is rapid'* (I am **sure** that the statement is correct, I **think** that the statement is correct, I **think** that the statement is wrong, I am **sure** that the statement is wrong).

The test was designed in Israel, where its scientific accuracy was approved by scientists (plant physiologists and soil science specialists). After a pilot run, the questionnaire was translated into French with the cooperation of the French partners, and adapted to the needs of the French students. Some original Hebrew questions had then to be reformulated, in order to ensure the equivalence of the two versions.

The final versions included 44 statements in the Hebrew version, and 42 in the French one. The reason for this difference was that two of the statements referred to a problem which was regarded by the Israeli to be of crucial importance, but which does not exist in France (penetration of sea water into underground layers of fresh water, due to over-exploitation of fresh water reserves).

The final Hebrew version included 25 correct and 19 wrong statements, and the French version 24 and 18 respectively. Obviously, all the statements could not be correct, for no student would ever consider that in a test, all the items may call for a uniform answer. Wrong and correct statements had therefore to be included in reasonable proportions; they could however be expected to confront the students with tasks of unequal difficulty. According to Tamir (1993) for instance, the difference is related to cognitive reasoning requirements, to space memory, to the contents of items and to information processing. However, since in everyday life one is not confronted only with true statements, the wrong statements represented a meaningful and indispensable part of the questionnaire.

## The 'attitudes' questionnaire

In this test, the main idea was to assess the attitudes of the students about various aspects of the use or misuse of water resources. Since the students came from two countries, in which the situation, concerning water resources and their use, is very different, a common ground had to be found. This was done by referring to the situation which was supposed to prevail in an hypothetical '*western modern* country', appropriately named 'Irrigland'. This method had an additional advantage: the students may have found it awkward to express opinions or attitudes about *their own* country i.e., to become personally involved in a social environment which they may have perceived as not entirely friendly.

Six aspects of the allegedly existing situation were included in the questionnaire: a) Agriculture makes use of 80% of the total quantity of fresh water used in the country; b) farmers pay less per cubic metre of water than any other sector of water consumers in the country; c) agriculture causes soil-water pollution because of its use of herbicides, pesticides and chemical fertilizers; d) the major portion of the water used in homes and industry goes 'down the drain' and is *not* recycled; e) part of the household and industrial waste water is used - after purification - to irrigate agricultural crops; f) a part of the agricultural enterprise in the country, 'organic agriculture', does not make use of chemical fertilizers, chemical pesticides or insecticides.

About each of these aspects, the students were required to express their opinions on a) the *desirability* of the existing situation (1, desirable; 2, it does not make any difference; 3, undesirable), and b) the possibility to *change* the situation (1, changeable; 2, it may change but not as a result of any human intervention; 3, unchangeable). It can be seen that these scales were actually measures of *un*desirability and *un*changeability.

In addition, 5 potential factors of change were suggested: a) scientific knowledge; b) the government authorities; c) social customs; d) the laws of economics; e) the individual citizen. The students were required to give their opinion about the ability of each factor to bring about changes in each aspect of the situation. The choices were, in ascending order: 'no influence at all' (0), 'some influence', a 'tangible influence' and 'more influence than any other factor' (3).

The questionnaire was presented in the shape of a 6X7 matrix, one line for each aspect of the situation (6 lines), one column for the level desirability, one column for the level of unchangeability, and one column for each potential factor of change, i.e., five columns (a total of 7 columns). The students had thus only to tick 42 cells in the matrix, a task which could be performed relatively quickly (see full matrix in Appendix 1).

## The population samples

The Israeli and the French samples could not be absolutely equivalent, because of the differences between the two educational systems. In the French system, agrobiology is studied in vocational agricultural secondary schools, which serve rural regions, and are expected to provide the future farmers, or other agriculture related professionals, with the necessary practical and theoretical knowledge. Graduates of such schools obtain either a *baccalaureat* (the French matriculation examination, the main aim of which is to open the door to tertiary education), or a degree of agricultural technician (*technicien agricole*) or higher technician (*technicien superieur*), which prepare more than the *baccalaureat* to the professions of agriculture. In Israel, agrobiology is studied in agricultural secondary schools, and also in rural-regional comprehensive secondary schools, which serve the whole population of rural areas, but do not provide any practical training in agriculture. Most of the Israeli agricultural secondary schools are boarding-schools, where students are sent for socio-economic reasons. The main population of agricultural schools in Israel is therefore not of rural origin, and in such schools, agriculture is generally viewed *more as a means than as an objective* of education. Some rural schools in Israel are of a 'mixed' type, both residential-agricultural and rural-regional. There are no post-graduate studies in Israeli rural or agricultural secondary schools, so that they confer no professional diplomas of technicians. The able students sit there for regular academic matriculation examinations, which may lead to tertiary university education.

For the purpose of this study, all the selected classes, in both countries, were of the 'academic' type, in which students are expected to graduate with a full matriculation examination, or with a degree of equivalent or higher level.

### *The Israeli sample*

In view of the extreme heterogeneity of the Israeli population in rural-agricultural schools, the sample included schools of all the types described above, and roughly, of three academic levels:

Level 1: High level secondary schools, where most of the students are admitted to matriculation examination, and on the average obtain marks which are not below the national average (60 students).

Level 2: Medium level schools, where most students are admitted to matriculation examination, but on the average, score below the national average (65 students).

Level 3: Low level schools, where most of the students are not admitted to full matriculation examinations, and where those who are, tend to obtain scores well below the national average (29 students).

4 schools were of the agricultural residential type (67 students), 2 rural regional (30 students), and 3 were mixed regional-agricultural (57 students).

All the Israeli students (N=154, about 10% of the relevant population) were in 12th grade, 17.5 to 18.5 years of age. One school is located in the north of the Negev desert (annual rainfall about 200 mm), one in an area where the annual rainfall (about 400 mm) is somewhat lower than the country average, and the others in areas with the usual amount of rain in central Israel, i.e., between 500 and 600 mm.

*All* the Israeli students in agricultural schools had worked for prolonged periods on irrigated school farms, and *all* the rural areas in these rural areas are irrigated. However, only a minority of parents were active agriculturists. The genders were more or less equally distributed in the Israeli sample.

A reference group of 37 students in a higher technicians course (post-secondary institution) were of a different type: all of them were already *experienced active agriculturists*, either in kibbutzim or in other types of villages, who held full matriculation examinations, and had resumed studies in order to up-date their professional knowledge. The average age of this group was around 32, the youngest member was 28 years old. This group is not shown in Table 1 and its responses to the questionnaires will be treated separately.

*The French sample*

All the students in the French sample came from agricultural secondary schools. Some of them (see Table 1) studied in *terminales* (12th grade) which lead to *baccalaureat* examinations (i.e., *terminale D*), other in *terminales* which confer a degree of agricultural technician (BTAG). A third group was to graduate with a diploma of Higher technicians (TS, *Techniciens Superieurs*). This group includes the high-level and selective *TS Gemeau* (***GEstion et Maîtrise de l'EAU***) students, who are more professionally knowledgeable than any of the other groups. Their results were therefore compared with those of the Israeli technicians, although they were also included in the analysis of the whole French sample, since they were essentially school students, and not experienced agriculturists.

Out of the 447 students, 257 lived in areas of temperate climate, and 190 in the Mediterranean south. The parents of about 40% were active farmers, but only 92 of them (46% of the farms, 21% of the total sample) used irrigation. However, 209 students (47%) had had at least two weeks of experience on irrigated farms. There is a strong predominance of males in the French sample.

The composition of the samples is shown in Table 1.

*TABLE 1: The Israeli and the French samples of population*

| ISRAEL (N=154) (*) | | FRANCE (N=447) (*) | |
|---|---|---|---|
| **Level of School** | | **Type of Class** | |
| High Level | 60 | Agricultural Technicians | 129 |
| Medium Level | 65 | High Technicians Gemeau | 58 |
| Low Level | 29 | Other High Technicians | 28 |
| | | Agric. Baccalaureat | 133 |
| | | Other Baccalaureat | 99 |
| **Age of Students** | | **Age of Students** | |
| 17.5 – 18.5 | ALL | 17 – 18 | 156 |
| | | 19 | 125 |
| | | Above 19 | 166 |
| **Gender** | | **Gender** | |
| Male | 67 | Male | 374 |
| Female | 55 | Female | 71 |
| No Information | 32 | No Information | 2 |
| **Prof. of Parents** | | **Prof. of Parents** | |
| Active Agriculturists | 23 | Active Agriculturists | 201 |
| Other | 102 | Other | 241 |
| No Information | 29 | No Information | 5 |
| **Irrigating Farmers** | ALL | **Irrigating Farmers** | |
| | | Yes | 93 |
| | | No | 324 |
| | | No Information | 30 |
| **Has worked on an irrigating farm** | ALL | **Has worked on an irrigating farm** | |
| | | Yes | 209 |
| | | No | 207 |
| | | No Information | 31 |
| **Annual Rainfall (at school location)** | | **Area (climate at school location)** | |
| About 200mm | 18 | Temperate | 257 |
| About 400mm | 11 | Mediterranean | 190 |
| 500-600mm | 125 | | |

(*) 67 Israeli students came from agricultural schools, 30 from regional schools, and 57 from mixed type schools.

## Main findings

*Knowledge*

The results were analysed in three different ways:

a) Correct/wrong answers: any answer in the right direction ('I am sure that the statement is...', or 'I think that...') was marked as correct.
b) Confident/non confident: any answer of the type 'I am sure that ...' was marked as 'confident', whether it was a right answer or not.
c) Correct *and* confident/others: In this method, only right answers with a high degree of confidence were marked as correct.

The test, when administered to the Israeli higher technicians, was found to be very easy: they all answered correctly practically all the questions (98% right answers), with a negligible percentage of wrong, and about 80% correct and confident answers. It can be seen that the difference between the number of correct answers and that of the confident-correct ones stemmed only from some not rare cases of lack of confidence, but not from erroneous knowledge.

The data in Table 2 show that the results of the school students were far from satisfactory.

In both French and Israeli samples, the average level of correct answers was around 60%, with a quite similar distribution (S.D. about 10%). Still, the achievements of the French students (61.1% correct answers) were significantly ($p<0.02$) but only slightly higher than those of the Israeli (56.05%). Actually, in the French group, 18 questions yielded 75% right answers, whereas in the Israeli group, there were only 9 such questions (also, 8 items yielded over 85% right answers on the French side, as compared with 3 for the Israeli).

There was some tendency toward a similar perception of the difficulty of particular items: the correlation between the French and the Israel mean 'correct answer' scores on each item was .63.

It was also found that the *TS Gemeau* group achieved significantly better than all the other French groups. Their average number of correct answers 28.19 out of 42, or 67%, with a narrow standard deviation (2.97), as compared with the agricultural technicians (60.5%), the Baccalaureat classes (58.9% and 59.5%) and a second group of higher technicians (59%). The best school in the Israeli sample was of a 'high-level' mixed type, who scored an average of 28.21 out of 44, or 64.1%, also with a relatively narrow standard deviation (4.24), and significantly higher than all the other schools. No significant differences were found between the other Israeli schools, the means of which were slightly lower than those of the French classes. The best French individual score was 34 (out of 42), and the best Israeli one, 37 (out of 44).

*TABLE 2. Mean scores of the Israeli and the French students on the knowledge test, in absolute numbers and in percentages of numbers of items. (N for Israel= 154; for France = 447).*

| CORRECT ANSWERS | | TOTAL | | WHEN STATEMENTS WERE CORRECT | | WRONG | |
|---|---|---|---|---|---|---|---|
| | | **Mean** | **S.D.** | **Mean** | **S.D.** | **Mean** | **S.D.** |
| ISRAEL | No. | 24.66 | 4.57 | 15.95 | 3.29 | 8.70 | 2.52 |
| | % | *56.05* | *10.39* | *63.80* | *13.16* | *45.79* | *13.26* |
| FRANCE | No. | 25.66 | 3.83 | 16.40 | 2.72 | 8.85 | 2.43 |
| | % | *61.10* | *9.12* | *68.33* | *11.33* | *49.17* | *13.50* |
| **CONFIDENT ANSWERS** | | | | | | | |
| | | **Mean** | **S.D.** | **Mean** | **S.D.** | **Mean** | **S.D.** |
| ISRAEL | No. | 25.65 | 8.74 | 14.95 | 5.22 | 10.70 | 4.13 |
| | % | *58.30* | *19.86* | *59.80* | *20.88* | *56.32* | *21.74* |
| FRANCE | No. | 25.83 | 7.71 | 15.4 | 4.61 | 10.43 | 3.61 |
| | % | *61.50* | *18.36* | *64.17* | *19.21* | *57.94* | *20.06* |
| **CORRECT AND CONFIDENT ANSWERS** | | | | | | | |
| | | | | **Mean** | **S.D.** | **Mean** | **S.D.** |
| ISRAEL | No. | ..... | ..... | 11.08 | 4.43 | 5.18 | 2.92 |
| | % | ..... | ..... | *44.32* | *17.72* | *27.26* | *15.37* |
| FRANCE | No. | ..... | ..... | 11.57 | 3.86 | 5.50 | 2.90 |
| | % | ..... | ..... | *48.21* | *16.08* | *30.56* | *16.11* |

| | **Israel** | **France** |
|---|---|---|
| NUMBER OF ITEMS (TOTAL) | 44 | 42 |
| CORRECT STATEMENTS | 25 | 24 |
| WRONG STATEMENTS | 19 | 18 |

Results in Table 2 also show that the number of *confident* answers was not lower than that of the *correct* answers, but the confidence was not always justified: the number of 'correct *and* confident' answers was much lower in both samples than that of confident answers

The most striking outcome of the knowledge questionnaire is that both French and Israeli pupils found it much easier to identify a correct statement than to recognise a wrong statement as such: the percentage of correct, confident, and 'correct and confident' answers (Table 2) were much lower (and significantly so) when the statements were wrong than when they were right. The percentages of 'correct and confident' answers was only about 48% in the French group, and 44% in the Israeli one, and it decreased to about 30% on both sides when the statements were wrong.

The correlations between the number of right answers and the number of confident ones were significant at any level ($p<.000$), although not very high: .47 in the Israeli sample, and .39 in the French one. When referring only to the part of the questionnaire in which the statements were wrong, these correlations were even lower: .27 ($p<.01$)and .31 ($p<.000$) respectively.

To sum up, the general pattern of response to the knowledge questionnaire in both samples of students was quite similar, although the *average* level of knowledge of the French students was somewhat higher.

### *Attitudes*

As explained above, the matrix of the questionnaire included six lines (aspects of the existing situation in Irrigland) and seven columns (seven vertical scales assessing in part one, the *un*-desirabiltity and the *un*-changeability of the six aspects, and in part two, the potential influence of five factors of change. The reliability of all the seven scales was between .7 and .8 in both samples.

The attitudes of the Israeli experienced and knowledgeable Higher Technicians may be regarded as a frame of reference, to be compared with the attitudes of the French *Gemeau*, and on the other hand, with those of the Israeli and French students.

#### *Part one: un-desirability and un-changeability*

The range of values for this part of the questionnaire was from 1 (desirable or changeable), to 3 (undesirable, unchangeable), mark 2 being the axis of symmetry. Table 3 shows that the patterns of response of the Israeli and the French higher technicians were relatively similar.

*TABLE 3. The attitudes of the Israeli higher technicians compared with those of the French 'Gemeau' group, concerning the undesirability and unchangeability of the six aspects. (Mean ratings on a scale from 1 to 3).*

| THE SITUATION DESCRIBED IS | | ISRAEL (N=154) | | THE ASPECTS OF THE SITUATION | FRANCE (N=447) | |
|---|---|---|---|---|---|---|
| | ITEM | MEAN | S.D. | | MEAN | S.D. |
| 1 | Undesirable | 2.47 | 0.81 | Use of 80% of fresh water | 2.83 | 0.50 |
| | Unchangeable | 1.38 | 0.64 | by Agriculture | 1.17 | 0.50 |
| 2 | Undesirable | 1.41 | 0.69 | Farmers pay less for | 1.79 | 0.96 |
| | Unchangeable | 1.74 | 0.78 | water | 1.48 | 0.72 |
| 3 | Undesirable | 2.65 | 0.64 | Agriculture causes pollution | 2.57 | 0.81 |
| | Unchangeable | 1.29 | 0.62 | of soil-water | 1.07 | 0.31 |
| 4 | Undesirable | 2.91 | 0.28 | Major part of home and | 2.78 | 0.62 |
| | Unchangeable | 1.06 | 0.24 | industrial water not recycled | 1.12 | 0.42 |
| 5 | Undesirable | 1.59 | 0.77 | Purified household and | 2.07 | 0.96 |
| | Unchangeable | 1.76 | 0.77 | industrial water for irrigation | 1.31 | 0.59 |
| 6 | Undesirable | 1.88 | 0.87 | Organic agriculture does | 1.17 | 0.53 |
| | Unchangeable | 1.59 | 0.73 | not use chemicals | 2.03 | 0.81 |

Strong reactions were brought about on both sides by the high consumption of fresh water by agriculture, by the pollution of water by agriculture, and the non-recycling of the water used by homes and industry, which were regarded to be undesirable. In the eyes of both samples, all the other aspects were on the desirability side, although, concerning the utilisation of waste water, and the low price of water in agriculture, the French were less enthusiastic than the Israeli, and the attitude of the Israeli about organic agriculture was more ambiguous than that of the French.

Both French and Israeli considered everything to be 'Changeable', the French doing so a little more than the Israeli. It is worth noting that there was no clear French majority on the problem of the changeability of the organic agriculture situation.

On all measures, French as Israeli, standard deviation is wide, indicating a lack of uniformity in the reactions of the respondents.

The patterns and tendencies found in the samples of students were more or less similar to those of the technicians (Table 4).

*TABLE 4. The attitudes of the Israeli high-school students compared with those of the French, concerning the undesirability and unchangeability of the six aspects. (Mean ratings on a scale from 1 to 3).*

| THE SITUATION DESCRIBED IS | | ISRAEL (N=154) | | THE ASPECTS OF THE SITUATION | FRANCE (N=447) | |
|---|---|---|---|---|---|---|
| | ITEM | MEAN | S.D. | | MEAN | S.D. |
| 1 | Undesirable | 2.49 | 0.83 | Use of 80% of fresh water | 2.71 | 0.65 |
| | Unchangeable | 1.43 | 0.79 | by Agriculture | 1.31 | 0.68 |
| 2 | Undesirable | 1.48 | 0.83 | Farmers pay less for | 1.63 | 0.90 |
| | Unchangeable | 1.61 | 0.83 | water | 1.81 | 0.86 |
| 3 | Undesirable | 2.46 | 0.87 | Agriculture causes pollution | 2.59 | 0.79 |
| | Unchangeable | 1.19 | 0.55 | of soil-water | 1.14 | 0.47 |
| 4 | Undesirable | 2.47 | 0.87 | Major part of home and | 2.68 | 0.71 |
| | Unchangeable | 1.31 | 0.68 | industrial water not recycled | 1.10 | 0.38 |
| 5 | Undesirable | 1.13 | 0.46 | Purified household and | 1.97 | 0.95 |
| | Unchangeable | 1.56 | 0.74 | industrial water for irrigation | 1.79 | 0.60 |
| 6 | Undesirable | 1.30 | 0.68 | Organic agriculture does | 1.27 | 0.64 |
| | Unchangeable | 1.54 | 0.73 | not use chemicals | 2.02 | 0.78 |

*Part two: factors of influence*

The range of values in this part of the questionnaire was from 0 (no influence at all) to 3 (more than any other factor). Mark 2 indicated a clear, tangible influence, and 1, some influence, i.e. a very limited one.

*The technicians*

Table 5 shows the comparison between the responses of the Israeli higher technicians and that of the French Gemeau.

It also shows how each factor of change was *rated* (the mean score it obtained), and how it was *ranked* (its position in descending order of mean scores).

On five of the six aspects of the described situation, the French *Gemeau* attributed a predominant influence to the *individual.* The Israeli technicians *never* did that. They ranked high *scientific knowledge* or *authorities.* Furthermore, the responses of the Israelis were much more extreme than those of the French: on each of the six aspects, one factor of change at least obtained a mean score above 2, and on three aspects, two factors did so.

*TABLE 5. The attitudes of the Israeli higher technicians compared with those of the French 'Gemeau' group, concerning the potential factors of influence, in rank order of mean ratings, on a scale from 0 to 3.*

| ISRAEL (N=37) | | FRANCE (N=58) | | |
|---|---|---|---|---|
| MEAN | SD | MEAN | SD | |
| **FACTORS OF INFLUENCE** | | | | **FACTORS OF INFLUENCE** |
| **FRESH WATER CONSUMPTION** | | | | |
| The Authorities | 2.32 | 1.05 | 1.64 | 1.09 | The Individual |
| Scientific knowledge | 2.29 | 1.10 | 1.53 | 1.07 | The Authorities |
| Economy | 1.56 | 1.24 | 1.48 | 1.05 | Economy |
| The Society | 1.21 | 1.23 | 1.47 | 0.95 | Scientific Knowledge |
| The Individual | 0.85 | 1.19 | 1.05 | 0.99 | The Society |
| **PRICE OF CUBIC METER** | | | | | |
| The Authorities | 2.38 | 1.16 | 1.81 | 1.11 | The Authorities |
| Economy | 1.76 | 1.31 | 1.60 | 1.19 | Economy |
| The Society | 0.65 | 1.03 | 0.69 | 1.00 | The Individual |
| The Individual | 0.47 | 0.98 | 0.67 | 0.95 | The Society |
| Scientific Knowledge | 0.41 | 0.91 | 0.26 | 0.60 | Scientific Knowledge |
| **SOIL WATER POLLUTION** | | | | | |
| Scientific Knowledge | 2.29 | 1.10 | 2.17 | 0.91 | Scientific Knowledge |
| The Authorities | 2.15 | 1.22 | 1.86 | 1.09 | The Individual |
| The Individual | 1.79 | 1.30 | 1.71 | 1.03 | The Authorities |
| The Society | 1.71 | 1.25 | 1.33 | 1.15 | Economy |
| Economy | 0.97 | 1.20 | 0.95 | 1.04 | The Society |
| **NON RECYCLING OF HOME AND INDUSTRY WATER** | | | | | |
| The Authorities | 2.50 | 0.98 | 2.16 | 1.01 | The Authorities |
| Scientific Knowledge | 2.38 | 1.03 | 1.79 | 1.17 | Scientific Knowledge |
| Economy | 1.76 | 1.37 | 1.07 | 1.14 | Economy |
| The Society | 1.50 | 1.22 | 0.93 | 1.10 | The Individual |
| The Individual | 0.82 | 1.12 | 0.86 | 1.06 | The Society |

**PURIFICATION OF WASTE WATER**

| | | | | | |
|---|---|---|---|---|---|
| The Authorities | 2.09 | 1.22 | 1.66 | 1.17 | Scientific Knowledge |
| Scientific Knowledge | 1.82 | 1.34 | 1.36 | 1.24 | The Authorities |
| Economy | 1.24 | 1.33 | 1.19 | 1.09 | The Individual |
| The Society | 0.82 | 1.07 | 0.93 | 1.08 | Economy |
| The Individual | 0.41 | 0.81 | 0.91 | 1.10 | The Society |

**BIOLOGICAL AGRICULTURE**

| | | | | | |
|---|---|---|---|---|---|
| Scientific Knowledge | 2.53 | 1.01 | 1.48 | 1.22 | Scientific Knowledge |
| The Society | 1.82 | 1.34 | 1.40 | 1.17 | The Individual |
| The Individual | 1.68 | 1.39 | 1.07 | 1.14 | The Society |
| The Authorities | 1.65 | 1.37 | 0.95 | 1.15 | Economy |
| Economy | 1.44 | 1.35 | 0.86 | 1.06 | The Authorities |

On the French side, only two aspects yielded a factor of influence with a score above 2. The French Gemeau tended to attribute a weak influence to *scientific knowledge*: for water consumption, 1.47, compared with the Israeli 2.29; for pollution, recycling, purification of waste water, and organic agriculture, 1.33, 0.93, 0.93, and 1.48, compared with 2.29, 2.38, 1.82 and 2.53 respectively. Although ranking *authorities* quite high, they assigned them low scores, in comparison with the importance that the Israelis conferred to them.

*The high-school students*

The responses of the Israeli high-school students (Table 6) displayed trends similar to those of the Israeli technicians, but the differences between them and their French peers were somewhat less marked than those found between the technicians.

The Israeli high-school students, just as their experienced technicians compatriots, attributed a strong influence to *scientific knowledge*, on all counts but the price of water, where, quite logically and in agreement with the technicians, *authorities* and *economy* prevailed. The *individual* was, on the average, rated very low. The *authorities* were, in general, given a relatively high rank, but were rated lower by the Israeli students than by their technicians fellows. On the Israeli side, high rankings corresponded to high ratings, (rank 1 above mark 2 on all counts, and rank 2 reached scores above or very near 2 on four aspects). The French students reacted more or less like the *Gemeau* alone, with some differences which made them a little less different from the Israelis: like their Israeli peers, they believed that the *authorities* may influence the price of water; also, concerning the

*TABLE 6. The attitudes of the Israeli high-school students compared with those of the French, concerning the potential factors of influence, in rank order of mean ratings, on a scale from 0 to 3.*

| ISRAEL (N=154) | | FRANCE (N=447) | | |
|---|---|---|---|---|
| MEAN | SD | MEAN | SD | |
| **FACTORS OF INFLUENCE** | | | | **FACTORS OF INFLUENCE** |
| **FRESH WATER CONSUMPTION** | | | | |
| Scientific knowledge | 2.01 | 1.14 | 1.76 | 1.06 | Scientific knowledge |
| The Authorities | 1.91 | 0.98 | 1.65 | 1.05 | The Individual |
| Economy | 1.68 | 1.09 | 1.51 | 1.06 | Economy |
| The Individual | 0.97 | 1.03 | 1.47 | 1.03 | The Authorities |
| The Society | 0.92 | 0.97 | 1.12 | 1.00 | The Society |
| **PRICE OF CUBIC METER** | | | | |
| The Authorities | 2.37 | 0.92 | 2.02 | 1.05 | The Authorities |
| Economy | 2.17 | 0.98 | 1.78 | 1.09 | Economy |
| The Society | 0.83 | 1.03 | 0.78 | 1.00 | The Individual |
| Scientific Knowledge | 0.79 | 1.06 | 0.75 | 0.98 | The Society |
| The Individual | 0.66 | 0.91 | 0.51 | 0.84 | Scientific Knowledge |
| **SOIL WATER POLLUTION** | | | | |
| Scientific Knowledge | 2.28 | 1.04 | 2.30 | 0.95 | Scientific Knowledge |
| The Authorities | 1.98 | 1.06 | 1.88 | 1.09 | The Individual |
| The Society | 1.26 | 1.13 | 1.51 | 1.06 | The Authorities |
| The Individual | 1.18 | 1.10 | 1.41 | 1.12 | Economy |
| Economy | 1.05 | 1.14 | 1.12 | 1.04 | The Society |
| **NON RECYCLING OF HOME AND INDUSTRY WATER** | | | | |
| Scientific Knowledge | 2.19 | 1.07 | 2.02 | 1.00 | The Authorities |
| The Authorities | 1.97 | 1.05 | 1.92 | 1.07 | Scientific Knowledge |
| The Society | 1.37 | 1.16 | 1.33 | 1.12 | The Individual |
| The Individual | 1.22 | 1.18 | 1.31 | 1.08 | Economy |
| Economy | 0.91 | 1.12 | 1.22 | 1.08 | The Society |

**PURIFICATION OF WASTE WATER**

| | | | | | |
|---|---|---|---|---|---|
| Scientific Knowledge | 2.22 | 1.08 | 1.68 | 1.11 | The Authorities |
| The Authorities | 1.72 | 1.07 | 1.67 | 1.13 | Scientific Knowledge |
| Economy | 1.63 | 1.14 | 1.36 | 1.11 | Economy |
| The Society | 0.81 | 1.04 | 1.09 | 1.08 | The Individual |
| The Individual | 0.70 | 0.95 | 1.00 | 1.06 | The Society |

**BIOLOGICAL AGRICULTURE**

| | | | | | |
|---|---|---|---|---|---|
| Scientific Knowledge | 2.51 | 0.91 | 1.79 | 1.21 | Scientific Knowledge |
| Economy | 1.55 | 1.17 | 1.71 | 1.17 | The Individual |
| The Authorities | 1.50 | 1.06 | 1.29 | 1.11 | The Society |
| The Society | 1.17 | 1.11 | 1.27 | 1.16 | Economy |
| The Individual | 1.16 | 1.15 | 1.11 | 1.07 | The Authorities |

consumption of fresh water by agriculture, they ranked *scientific knowledge* in first place, but with a relatively low mark. Furthermore, like the Israelis, they ranked and rated very high *scientific knowledge* in relation to pollution of soil water. The French students displayed a tendency to rate the *individual* higher than the Israeli students did, and to be much more indifferent than the Israelis to the problems of waste water and of organic agriculture. In the view of both sides, the *social customs* had no potential influence on the issues at stake in the questionnaire.

The overall differences between the trends of the Israeli and the French sample of students are well demonstrated by the mean ratings obtained by each of the five factors of change on the whole questionnaire (averages of vertical scales). Such a computation shows the tendency of the respondents to attribute a high importance to a given factor of change. The students had six opportunities to rate each factor (once for each of the six aspects of the described situation). An average score of at least 2 (equivalent to the average of 6 times 2) would obviously indicate the attribution of a strong importance to that factor.

The percentage of French students who rated *scientific knowledge* at or above such an average, was 36.9, as compared with 64.8% of the Israelis. 52.41% of the Israelis allotted such an importance to *authorities*, and only 38.26% of the French. On the other hand, 23% of the French students did so for the *individual*, but only 13.64% of the Israelis.

Also, the Israeli average rating of the six first ranking factors was 2.26, and for the French, only 1.92, indicating, as mentioned above, that in most cases the Israeli students tended to make more extreme decisions.

There were no significant correlations whatsoever between levels of knowledge or confidence and any of the seven scales in the Attitudes questionnaire, or between achievements in any of the sub-tests of the knowledge questionnaire and the attitudes. In the Israeli sample, socio-professional variables (gender, profession of parents) had no influence on either knowledge or attitudes, and in the French sample, gender had no influence at all, and the other social parameters (area, work on a farm, experience in irrigation, profession of parents) had some minor effects which did not change the main patterns. An ongoing research project is now attempting to assess the impact of these variables on a similar French population.

## Discussion and conclusions

The comparison between the knowledge of French and the Israeli students is somewhat awkward because the two samples could not be really equivalent. While the French students came from vocational or to some extent, from post secondary professional training, very few of the Israelis who studied agriculture in agricultural schools were there for reasons of 'agricultural motivation'. As for the high level rural schools in Israel, they do not teach agriculture as such. However, all the students of both countries had in common that they were young people who had some relations to agriculture, studied a relevant curriculum, which included water and soil sciences, and had not yet gained personal experience as independent farmers or as professional technicians. In as much as the questionnaire could give a representative idea of the students' knowledge, the French students were found to have mastered a little better the scientific basis of the topic under scrutiny, namely plant, soil and water relations.

In principle, it could be claimed that the knowledge of both samples was quite satisfactory: About 60% of the answers were right in both samples, and, considering that the students had not been warned or given any opportunity to prepare themselves for the test, such a level of achievement is not bad at all. However, the main findings showed that on both sides, the students' knowledge displayed the characteristics of school knowledge, i.e. knowledge which is in great parts ill internalized or easily forgotten. The level of 'true knowledge', i.e., correct *and* confident, was low on both sides. Furthermore, the ability of the students in both groups to recognise a wrong statement as such, was much lower than their already not too high ability to recognise true statements. The students also felt less confident with the wrong statements, and the correlations between confidence and correct answers was quite low. Such findings are not uncommon in the literature (Tamir 1993), but it is also well known that a concept (or a principle) is considered

to have been learned only when the learners are able to recognise positive and negative instances of the concept. In other words, wrong notions, which are not recognised as such, may have the same effect as correct knowledge on the development of the attitudes or opinions of students in a study like this.

The knowledge of the older and already experienced Israeli higher technicians was much more robust. It appeared to have the quality of the meaningful, reality-bound knowledge of educated practitioners, to whom the level required here was that of the already obvious, so that they answered not only correctly, but also with great confidence.

However, as mentioned above, attitudes and opinions on civic issues of the type presented here in the Attitudes questionnaire are seldom directly and clearly related to precise items of scientific knowledge. Everyday life problems are not as well defined as scientific or technical ones. It is only when the 'ill-structured' (Simon 1973) real life problems are divided into smaller, well-structured, *partial* problems that the need for exact 'topic' scientific knowledge becomes predominant. It is therefore quite understandable that students, as citizens, when confronted with wide issues, form opinions on the basis of a general social perception of the nature of the problem. Opinions are influenced by attitudes, and may therefore be quite as consistent as attitudes. Such a consistency was to some extent demonstrated by the relatively high reliability of all the vertical scales in the attitudes matrix.

The Israeli students, for instance, reacted very much as their more knowledgeable and experienced technician fellows, by systematically putting a strong emphasis on *scientific knowledge* and *authorities*. This is quite understandable in a country where agriculture depends heavily on science, and where on one hand, water – a national problem – is provided solely by one central authority and on the other hand, the use of water (price, quota) is strictly regulated by the government. Most of the Israeli students, as individuals, apparently considered themselves to be basically unable to act in such a way as to protect sources and resources of water. Such a perception may influence their approach to situations in which they should be expected to recognise the potential influence of the individual farmer (or citizen). It is indeed disturbing that the Israeli students rate the individual's influence on the issue of pollution of soil water by chemicals so low, since it is well known that many farmers tend to use chemicals indiscriminately, and since scientific and technological education is expected to enhance the students' feeling of personal involvement in issues of public interest.

The French students, including the *Gemeau* group, reacted quite differently. Firstly, their reactions tended to be weaker than those of the Israelis. Secondly, there were practically only two issues in which they considered that any of the factors could have a significant influence: soil-water pollution and

recycling of household water. And thirdly, on both issues, the individual was regarded to be the potentially *most* influential factor. This tendency to consider the individual as the main factor of change was quite consistent on the French side (5 out of 6 fields of intervention). The attitudes of the French students are quite consistent with the fact that in France, the main source of irrigation water is private wells, i.e., and not a central authority. Also, many of the French farmers are just not bothered by problems of irrigation, and when they are, there is no shortage of water. It is worth noting that, while the individualistic character of the French students is encouraging, their lack of perception of the role of scientific knowledge is disturbing.

Finally, the attitudes of the French and the Israeli students could be explained in terms of their social and professional environment. They had in common that their attitudes appeared to have been heavily influenced by a sensible and knowledgeable evaluation of that environment.

The study presented here has not been able to show that subject matter knowledge had a strong influence on the attitudes of the students concerning some issues which are relevant to the farmers of the 20th or 21st century, when these attitudes are not systematically treated in the curriculum. However it has shown that there are some basic differences in the approaches of the students of the two countries. These differences may have strong implications concerning the motivations of the students and their approaches to civic issues, and as such, they may have provided useful information to the rural educational authorities and to the curriculum developers in both countries.

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*APPENDIX 1. The matrix of the 'Attitudes' questionnaire*

| *Aspects of the existing situation* | *In a modern western country* | | *Which of the following factors are responsible for the existing situation or able to modify it?* | | | | |
|---|---|---|---|---|---|---|---|
| | *is the existing situation desirable?* | *can the existing situation be changed?* | *scientific knowledge* | *the government authorities* | *social customs* | *the laws of economy* | *the individual citizen* |
| Agriculture makes use of 80% of the total quantity of fresh water used in the country | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |
| Farmers pay less per cubic meter than any other sector of water consumers in the country | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |
| Agriculture causes soil pollution because of its use of herbicides, pesticides and chemical fertilizers | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |
| The major portion of the water used in homes and industry goes 'down the drain' and is not recycled | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |
| Part of the household and industrial waste water is used – after purification – to irrigate agricultural crops | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |
| A part of the agricultural enterprise in the country, 'organic agriculture', does not make use of chemical fertilizers, pesticides or insecticides | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 | 1 2 3 |