Individual research projects (with emphases on biology) conducted by students in academic high schools in Israel: a survey and case study

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ABSTRACT

In this study we examined, and described in detail, how research projects are carried out in Israeli high schools, with emphasis on the subject of biology. We attempted to specify the problems and difficulties involved and, where possible, to suggest improvements that can help the student who does a research project to attain the status of independent study.

The work was done in the framework of two methods, namely, the quantitative approach and the qualitative approach, and in three stages:

Stage 1: A national survey by means of a questionnaire (was sent to the principals of high schools).

It was found that: The research projects are generally optional; In some of the schools an individual or group project is required. The principals provided profiles of the student who is qualified to do a research project.

Stage 2: Review of proposals, evaluations, and achievements of students who did research projects in biology.

It was found that: Close to half of those who submit proposals do not complete their projects, instead dropping out at one stage or another of the project. The assessments concentrated on three areas: (1) the external form of the research paper; (2) the use of scientific tools; and (3) the project as a whole.

Stage 3: Multidisciplinary workshop class for doing research projects.

From the information that was obtained from the different questionnaires, it emerged that:

The research projects influenced the development of personal and interpersonal skills, and strengthened self-confidence, initiative, responsibility, and independence.

Background

In this study we examined, and described in detail, how research projects are carried out in Israeli high schools, with emphasis on the subject of biology. We attempted to specify

the problems and difficulties involved and, where possible, to suggest improvements that can help the student who does a research project to attain the status of independent study.

The notion of experiencing *independent work* in a subject that the student chooses, at different levels of learning, has been put into practice by teachers and educators over the past 200 years. Many thinkers, teachers, and scholars—among them Rousseau (1944, 1976), Dewey (1916, 1960), Piaget (1970), and others—have investigated and written about the subject and its importance for students' development throughout their studies and indeed throughout their lives. That importance has grown, especially in our period; in modern technological society, the volume of information and the rapidity with which knowledge changes require citizens of the present and of the future to adapt to being independent learners all their lives (Smith, 1990; Areglado, Bradley, and Lane, 1996). The research project, and particularly the research project in biology, enables the high school student to acquire the skills of an independent student, and constitutes an excellent opportunity to train him in that regard. Research projects are defined as "independent, academic, or academic-practical work, which involves an attempt to summarize and clarify a certain topic only" (Israeli Ministry of Education, 1984). Students have the option of doing a research project to gain credit in the framework of the matriculation examinations. In biology, the project must include laboratory and/or field research.

The research project, as it is known in Israel and as presented in general terms above, differs from every other form of work or project at the high school level that is familiar or is discussed in the general literature. The closest in nature to the research project in Israel is Project Work, used in the study program for the sciences of the Nuffield Project for A-level biology students in Britain (Dowdeswell, 1967, 1981; Eggleston & Kelly, 1970).

The research project was inaugurated in the 1950s in the Reali School in Haifa (there it was called, just as today, the "annual composition," Shapira, 1974), and was required of every student. The research project as defined above is practiced today in all of the high schools in Israel. The student works on the project a full year (outside of the regular study framework), beginning in eleventh grade and ending at the conclusion of the first trimester of twelfth grade.

Over the past decade the number of research projects has increased, and they are now done by more than one thousand students per year.

Projects of this type, in Israel and elsewhere, are reported on in the literature. Projects in the different fields of knowledge, and especially in science, are found throughout the educational system at different levels: in elementary schools, in junior high schools, high schools, and in higher education.

Projects are differ from each other by the array of requirements, by level, and by scope. They extend along a spectrum from summarizing a chapter, or a section of it, to independent research projects that involve many stages (Artzi, 1975). Some projects do not culminate in a written product, but instead in a model or a poster with illustrations (Demchik, 1989), which sometimes are displayed in science corners in the laboratory or at a school science fair (Carlisle & Deeter, 1989). At the high school level in Israel, the research project is often a special experience that students remember as one of the highlights of their high school studies (Levtzion, 1987; Sevar & Brin, 1993).

In various programs for projects, objectives focus on:

Self- or independent learning

Independent investigation

Critical reading and evaluation

In recent years, with the change in the policy on the matriculation examinations (according to the proposals of the Ben Peretz Committee, "Matriculation Examinations 2000," Ministry of Education, 1994), a new perspective has developed on the evaluation of high school students. One of the committee's recommendations was to authorize the schools to evaluate their students, with these evaluations being recognized by the Ministry of Education. Along with evaluation by means of matriculation examinations, alternative modes of evaluation are being considered (Ministry of Education, 1995*a,b*) that involve participation by the schools. In the future students' achievements will be evaluated not only by means of examinations, but also by means of various assignments and projects (e.g., preparation of a "portfolio") that are done over a few years. Research projects clearly accord well with such a policy of combining alternative modes of evaluation with the matriculation examinations. It is important, however, to investigate the subject of research projects in different fields and at its different stages.

The study that we carried out constitutes, is an applied research. It was designed to provide to the educational system data and evaluations that can help in formulating the new array of research projects in Israeli high schools, especially with respect to constructing a new package of instruction in which the student will receive formal guidance and will have the experience of doing a project while in high school.

Objectives

This study was intended to present a detailed picture of the process of doing a research project, with emphasis on the field of biology. What is unique about this study is the attempt to consider the entire process from many viewpoints and at the different levels, including: the national level (the educational system), the school level, and the individual-student level, with the aim of exploring and specifying the problems and difficulties encountered at each level, and with the goal of suggesting improvements that can help students who do research projects to attain the status of independent study. Hence, the questions posed by the study were aimed at clarifying the problems and difficulties that characterize projects at each of the three levels mentioned above.

The main *objectives* of this study are the following:

a) To describe in detail the situation with respect to research projects in Israeli academic high schools.

b) To define the characteristics of schools in which a relatively large number of research projects are done.

c) To examine the degree of concordance between proposals that are presented for research projects in biology and the relevant criteria, in order to specify problems and difficulties that students encounter.

d) To examine the strong areas and the weak areas in research projects in biology according to evaluators' reports.

e) To compare the achievement of students who studied biology and took a matriculation examinations at the level of 5 study units and also submitted a research project in biology at a level of 4 study unites (supplementary work), with the achievements of students who took the same matriculation examination and did not do a research project.

f) To observe a multidisciplinary school workshop class in order to:

   1. Characterize the process that the student doing a research project undergoes in the school workshop class.

   2. Identify problems encountered by those who take part in the process of the research projects, e.g.: between student and coach; between the leader of the workshop and the teachers; between parents and those who evaluate the students' work for the Ministry of Education.

Method

The research integrates two approach that are based on diametrically opposed approaches. The two different models are used in social science research, particularly in the field of education. Various scholars have recommended integrating the two approach (Scriven, 1972; Goetz & Le Compte, 1984). Integration of the approach enables one to surmount some of the limitations of each of them. According to Guba (1978), integration of the systems for the purpose of data gathering increases the reliability and validity of the data that are gathered. The two approach, integrated in this study, are: the quantitative and the qualitative. What is unique to this study is the consideration of the process of preparation of research projects from various viewpoints.

The *positivist-normative* research. This was the quantitative part of the study; it dealt with research projects at the national level, using a national survey. The research was based on the use of objective research tools and their application to a broad population. The results were analyzed by using statistical systems that enable generalization of the findings. For carrying out this part, objectives were formulated (mentioned earlier). For the attainment of each objective, different research tools were used.

The following are the four objectives and the respective research tools:

a) To examine how research projects are carried out at the national level. This examination was done with the help of a questionnaire, which was sent to all of the principals of academic high schools in the country. We expected to derive from the questionnaire results an overview of the situation in the country's academic high schools with respect to research projects in general, and in the sciences and biology in particular.

b) Likewise, we aimed to specify and characterize the schools in which a relatively large number of research projects are done.

c) To review all of the proposals for research projects in biology that were submitted to the supervisor of biology instruction in 1990 and 1991 from all of the academic high schools. All of the letters of reply and the correspondence (including the revisions to the proposals) were given a content analysis according to criteria that were prepared

by the director of the study and approved by two experts: a professor of science instruction and the coordinating supervisor for biology instruction in academic high schools.

d) In compiling the data, we were able to specify problems and difficulties that the students encounter in submitting proposals for preparation of research projects in biology.

e) To review all of the evaluations of research projects in biology that were written in 1991 and 1992 and submitted to the Department of Testing in the Ministry of Education. With the aim of specifying the strong points and weak points of the research projects in biology, a content analysis was done of all of the evaluations. In this case as well, the same experts reviewed and approved the criteria.

f) To review students' performance in certain parts of the matriculation examination, which measured laboratory research skills and comprehension of scientific texts. A review was done of the achievements of students who studied biology at the 5-study-unit level and also submitted a research project in biology at the 4-study-unit level (supplementary work). The achievements of this group were then compared to those of all of the students who were tested in the same matriculation examination and did not do research projects in biology.

The *ethnographic-naturalistic* research. This was the qualitative part of this study. It involved monitoring the activities of a small number of students in the framework of the workshop class. The naturalistic research integrated different tools of investigation, such as: open and closed questionnaires and follow-up reports.

The methodological approach used in the study was the case-study. This involves investigation of a phenomenon in its natural context, with more emphasis on description and narration than on causal and factual explanation. Such research sheds light without necessarily evaluating, interpreting, or generalizing. Using this approach, we examined the process of doing a research project in the framework of a multidisciplinary school workshop class (which was developed by the director of the study) in a six-year school in Jerusalem in the years 1991-1993.

The present study also has characteristics of action research, insofar as the investigator was also the leader of the workshop.

A group of students were monitored in order to study the processes and changes that students participating in the workshop undergo, on two planes: (a) study skills, and (2) attitudes. The tools that were used in this part of the study were: a report on the class sessions by the director of the study and an observing teacher; observations; and open and closed questionnaires that were given to the students during the workshop. Questionnaires were also given to the students' coaches; to teachers who observed the students during their work, especially students who were required to write papers of limited scope (paper on ecology—1 study unit; in biology or in social-science); and also to parents whose students did projects in the framework of the workshop. An examination was done of the evaluations that the evaluators sent to the Ministry of Education and also of the grades and evaluations given by the Ministry of Education's evaluators. A study program was prepared that included study materials, exercises, and assignments that were utilized in the framework of the workshop. The study program was structured so as to provide the

students with tools that would help them in writing scientific papers (involving development of skills related to definition of the subject, search for relevant material in the form of a literature survey, use of the library including catalogs and databases, critical reading, scientific composition, etc.). All sessions of the workshop were held in the library, which served as both a study room and a "laboratory"—a laboratory, that is, for study and for enactment of the process of scientific composition, and for learning to use all of the materials that the library provides (involving not just familiarity with catalogs, systems of classification, and the listing and citing of bibliographical sources, but also familiarity with types of books and scientific texts and sometimes also clarification and review of information, definition of concepts, etc.).

Findings (according to the three phases of the research)

First phase: national survey

a) In most of the schools the research project is optional for students; that is, the skills involved in doing a research project are not a required part of the current educational process.

b) In the Israeli secondary schools (most of which are now six-year), most of the research projects are written in the eleventh and twelfth grades. This result was also found by Alexander and Hines (1967), who studied 36 high schools in the United States.

c) Students do research projects in all fields of knowledge; among the sciences, the largest number of research projects are done in biology.

d) Some of the schools require an individual or group research project, but in many cases this is merely an administrative requirement.

e) Schools in which students do research projects are characterized by a special "climate" where there is investment in instruction and in additional school resources (such as the library). In schools that we defined as "supportive," projects are encouraged and the number of students who do them is relatively large. Relevant instruction is offered; moreover, the library has a relatively rich collection, the librarian is educated in librarianship, and at his initiative the library offers guidance.

f) According to the principals' responses concerning the profile of the student who is well suited to do a research project, he is cby: interest, curiosity, and motivation; knowledge of the subject; intellectual ability and writing ability. This accords with and complements the first finding reported above, namely, that the research project is optional and the schools do not regard the relevant skills as part of required instruction.

g) The principals indicate difficulties in finding coaches and in the process of obtaining approval for proposals; they say that the approvals arrive very late and that this situation must be remedied. They also urge that the research projects be reviewed by two evaluators, as is the practice with the matriculation examinations.

Second phase: review of proposals, evaluations, and achievements of students who do research projects in biology

In this phase we dealt with basic aspects of the process involving research projects: the proposals for projects (in biology), the evaluation of the projects, and students' achievements. The following are our main findings:

a) Of those who submitted proposals that were approved, over 40% did not complete the projects but abandoned them at one stage or another.

b) A substantial portion of the proposals (40%) are not approved and revisions are required; a common reason for this is that the topic is inappropriate to a research project in biology because it does not entail experimental/research work, as is required for research projects in this field (Agrest, Statter& Lezrovitch,1997).

c) The grades for 75% of the completed research projects were in the range of 86-100.

d) Among the evaluations, comments tended to focus on three aspects: (1) the external form of the paper and the quality of the writing; (2) use of scientific tools; and (3) overall quality of the project. Defects in the writing were mentioned in 34% of the evaluations; regarding scientific tools, defects that were mentioned involved use of statistics (15%), methoded and materials (10%), presentation of results (15%), and drawing of conclusions (13%). In some cases (22%), after the evaluator's interview with the student, lack of knowledge about the theoretical background of the project was cited.

e) The gender divisions among those who did research projects in biology (during the two-year period under study) accorded with the gender division in the entire cohort of biology students at the 5-study-unit level (girls, 60%; boys, 40%).

The achievements of the students who did a research project in biology and also took the matriculation examinations in that field (at the 5-study-unit level), during 1992-1993, were found to be higher than those of the entire cohort of students who took the matriculation examinations in biology (at the 5-study-unit level) during the same year and did not do a research project in that field. We had hypothesized that students who did research projects in biology and engaged in active research would have greater achievements than students who did not do research projects. The results corroborated our hypothesis.

Third phase: the multidisciplinary workshop class for doing research projects

From the information that was received by means of the different questionnaires that were given to the students of the workshop class, their parents, the coaches, and the teachers, the following findings were compiled:

a) All of the students in the workshop chose to do a research project and showed great motivation for doing one. The motivation stemmed from a desire to widen and deepen knowledge in the chosen subject area, from enthusiasm for learning for its own sake, as well as from the intention to exploit the opportunity to earn additional points toward the matriculation degree.

b) The students' expectations about the research project as well as the workshop were fulfilled, in regard to both research skills and information skills (search for materials, use of library resources, writing skills).

c) The students regarded the research project as a personal challenge, as a means for acquiring knowledge and broadening horizons, and as an opportunity to acquire tools for study in the future, and intended to recommend doing research projects to siblings and friends. Most of the students felt that the work was enjoyable, interesting, provided an opportunity for high achievement, and contributed to their ability to think and work independently.

d) Most of the students participated in the workshop because they regarded doing so as desirable and interesting. All of the parents, the teachers, and some of the coaches knew about the students' participation in it, including the information about its contents.

e) The students indicated that the workshop mainly contributed to: preparation of a proposal for a research project, finding a coach, receiving encouragement, and receiving support. In the process of doing the research project, the workshop also made important contributions to: increasing familiarity with the library, search for sources, preparation of section titles for the paper, and summarization of material from sources.

f) The work done in the workshop was meaningful to the students (according to the testimony of the students, the parents, and the teachers) in terms of providing encouragement and support and aiding most of the students while they carried out their research project.

g) Among the 17 students who began projects, 14 completed them (82%), a relatively high proportion. The three students who abandoned their projects prepared work of more limited scope instead, and like the rest of the students received credit in their matriculation certificate for participating in the workshop and doing a research project.

h) The achievements of the students, as assessed by the Ministry of Education's evaluators, were very good (the average grade for the whole group, 89.6, was very good).

In summary, the research project, according to the testimony of the parents, coaches, and teachers, affected the development of both personal and interpersonal skills, and strengthened self-confidence, initiative, responsibility, and independence.

Recommendations Based on the Findings of the Study

The recommendations that were submitted fell into two categories:

Recommendations on the pedagogical plane:

a) Some of the principals suggested that the research project be made a requirement for all students and become an integral part of the matriculation examinations. This approach accords with the change in the Ministry of Education's policy concerning the matriculation examinations that has been crystallizing in recent years as the decade of 2000 draws near (Ministry of Education, 1994, 1995 *a*). If the objective is that all students will do a research project, then the school must change its concept and assume the central role in development of skills for doing research projects as part of the basic educational process. But the system, too, must change; it must train appropriate teachers and allocate hours of instruction to the subject.

b) In keeping with the lessons drawn from the holding of a school workshop, recommendations are here submitted for operation of a multidisciplinary school workshop for doing research projects in high schools:

To operate and gain experience with a multidisciplinary school workshop, which will be conducted by a staff of teachers (two teachers from different areas of knowledge and a librarian), and for which the recommended room for study is the library. It is recommended to use a study program for the workshop that is based on the present study (including a time schedule and exercises). Also available are publications that include ideas and sometimes also tools for operation of a workshop (Biran, 1976; Statter, 1986; Ben Dov, 1987; Vardi, 1981; Ministry of Education and Culture, 1995 *a*; Levtzion, 1994; Agrest, Statter, and Lezrovitch, 1997).

In order to hold workshops according to the proposed model, it is necessary to train a staff of suitably qualified teachers as noted above.

Recommendations on the organizational plane:

a) To create a position of coordinator of research projects in the schools and to provide more training to teachers in this area.

b) To help in finding coaches (and to publish lists of coaches according to areas of knowledge).

c) To simplify and shorten the process of approval of proposals for research projects.

d) To have research projects evaluated by two evaluators (instead of one, as today), as practiced with matriculation examinations.

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