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USING DEVELOPMENTAL SUPERVISION TO IMPROVE SCIENCE AND TECHNOLOGY INSTRUCTION IN ISRAEL

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The professional development of teachers is a priority in any educational system. In particular, the dynamic nature of information in the science and technology domains requires teachers to continually update their knowledge and improve their skills.

For many years the typical Israeli school administrator assumed that routine supervision and evaluation of teacher performance would satisfy the needs of professional development. During the last decade, however, the efficacy of this approach as the primary means of improving instruction has come under scrutiny. As a result, a movement has grown in Israel to promote the professional development of teachers through independent programs using outside professional support. Studies have shown that inservice training courses in the teacher's academic discipline, combined with personalized supervision provided by outside agencies, has a positive impact on teaching quality.[1] These studies have demonstrated that training provided by an outside authority using developmental supervisory strategies enhances instructional improvement.

Glickman's work can inform any program aimed at improving teaching performance through developmental supervision.[2] The developmental supervision model calls for adapting the supervision approach to each teacher's conceptual level (CL). Teachers with a low CL may have difficulty defining a problem and establishing a plan for instructional improvement. They also may exhibit a limited range of instructional strategies and be overly dependent on outside assistance.

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[1] Herbert J. Walberg, "Science, Mathematics, and National Welfare: Retrospective and Prospective Achievements," in *International Comparisons and Educational Reform*, ed. A. C. Purves (Alexandria, VA: Association for Supervision and Curriculum Development, 1989), pp. 121–138.

[2] Carl D. Glickman, *Supervision of Instruction: A Developmental Approach*, 2nd ed. (Boston: Allyn and Bacon, 1990).

These teachers require a *directive approach*. Teachers with a moderate CL can define a problem and develop several solutions but are unable to conceptualize a comprehensive plan. They may seek assistance but want to work independently. For these teachers the supervisor would use a *collaborative approach*. The supervisor would use a *nondirective approach* for high-CL teachers who can view a problem from many perspectives, suggest a variety of alternative plans, and implement their preferred solution. These teachers can generally be described as autonomous, explorative, and creative.[3] In all cases, the supervisor seeks to move gradually from a directive approach to collaboration and then to a nondirective approach.[4]

Greene discusses the efficacy of developmental and clinical supervisory models to enhance instructional improvement through professional development, describing longitudinal research conducted in a school district with some 300 teachers in Alberta, Canada.[5] Three types of factors were found to influence the effectiveness of supervision in a school setting. The first type, *contextual factors*, includes historical context, culture of the school and the district, characteristics of the school staff, and school schedules and timetables. The second type, *individual factors*, includes teachers' beliefs about the model's purposes and structure; feelings about individual autonomy, supervision, and evaluation; and commitment to personal and professional goals. The third type relates to the *supervision model* and includes such factors as leadership, time and resources, and partnerships and payoffs. This type of factor raises issues of collegiality and collaboration.

The study reported here deals specifically with the professional development of teachers of physics, electronics, and mechanics through an external intervention in a school setting. External interventions are becoming more commonplace because of the inadequacies of localized supervisory efforts. Assorted administrative agendas have become so burdensome for building principals that little time remains for instructional improvement efforts. The study was guided by the following research question: Is it possible to develop a model for school improvement through external interventions that customizes the supervision process to the specific context and needs of each school system and academic discipline?

[3]Carl D. Glickman, *Developmental Supervision: Alternative Practices for Helping Teachers Improve Instruction* (Alexandria, VA: Association for Supervision and Curriculum Development, 1981).

[4]Carl D. Glickman and Stephen P. Gordon, "Clarifying Developmental Supervision," *Educational Leadership* 44 (May 1987): 64–68.

[5]Myrna L. Greene, "Teacher Supervision as Professional Development: Does It ... *Journal of Curriculum and Supervision* 7 (Winter 1992): 131–148.

The idea of matching the supervisory approach to the level of development in each teacher is examined against the unique educational needs, instructional environment, and tradition of each of the three disciplines. In Israeli high schools, physics is taken mainly by high-achieving pupils. Although most pupils specializing in electronics are high-achievers, only a minority of pupils studying mechanics fit this category.[6] All three disciplines are studied in comprehensive high schools and can provide credits toward the "Bagrut," the Israeli matriculation certificate. (About 38 percent of pupils finishing high school in Israel achieve the Bagrut.)

Science and technology classes are integrated under one instructional program in Israel. Such curricular integration makes it possible to study the shared and distinctive characteristics of the professional development process for each group of teachers and to examine the dynamics of the supervisory model over time and in all three disciplines. Investigation of which techniques work with particular supervisors and teachers can give relevance to developmental models of supervision and enhance the practice of supervision.[7]

PARTICIPANTS

The study was carried out within a comprehensive program aimed at improving science, technology, and mathematics education in 17 outlying high schools in northern Israel.[8] The two components of the program consisted of weekly inservice training sessions and semiweekly individual supervision meetings. Thirty physics teachers, 35 mechanics teachers, and 60 electronics teachers participated. The length of their participation ranged from two to four years.

The supervisors were experienced teachers, some of whom were candidates for an M.S. or a Ph.D. degree at the Technion—the Israel Institute of Technology. More specifically, the supervisors for the physics teachers were veteran physics teachers with more than 10 years of experience. They all had an M.S. or a Ph.D. degree in physics or science education. Most of them had participated in developing teaching material for physics instruction and had taught inservice

[6]Moshe Barak, Ronen Yehiav, and Nili Mendelson, "Advancement of Low Achievers Within Technology Studies at High School," *Research in Science and Technological Education* 12 (November 1994): 175–186.

[7]L. D. Borders, "A Pragmatic Research Agenda for Investigating Developmental Models of Supervision" (paper presented at the Association for Counselor Education and Supervision, St. Louis, October 7–10, 1988).

[8]Moshe Barak, "To Master the Knowledge, Acquire the Methods, Lead the Pupils" (paper presented at the International Conference for Science Education in Developing Countries, Jerusalem, Israel, January 3–7, 1993).

courses for teachers. The supervisors for the electricity-electronics and mechanics teachers were also experienced teachers or heads of technology departments. Most of them held B.S. degrees in engineering. The fact that the physics supervisors had higher degrees than the technology supervisors reflects a difference that exists between physics and technology teachers in general.

Supervision of teachers does not occur daily in most Israeli schools. Inspectors from the Ministry of Education and Culture visit a school only once or twice a year. Hence, this program of sustained supervisory support and assistance was unusual, although as a result of our work, the need for extensive supervision is more widely recognized. More precisely, educators in Israel are gaining greater appreciation for the clinical supervision model, which emphasizes collegiality in supervisor-teacher relationships with the aim of encouraging teacher autonomy.[9]

Participants in the program were offered the following supervisory assistance: (1) ongoing individual and group conferences with a supervisor; (2) staff development sessions that addressed program planning, teaching strategies, demonstration lessons, and so on; and (3) a range of instructional materials. The supervisors were given a great deal of latitude in their relationships with the teachers. Supervisors sought to avoid evaluative behaviors and encouraged self-disclosure and trust. Initial reluctance among teachers was not uncommon, but as time progressed a collegial relationship developed between supervisor and teacher. Avoiding any reference to or concern with evaluation helped solidify relationships between teachers and supervisors. As the data will indicate, these supervisors were seen as support personnel rather than external evaluators.

PROCEDURE

The long-term goals of the intervention program were to promote science and technology education in the schools and to raise the level of student achievement in the matriculation exams, since, in Israel, obtaining a matriculation certificate (the Bagrut) is a precondition for entering higher education. The matriculation exams consist of compulsory subjects, such as math, Hebrew, and English; and elective subjects in the areas of science, technology, or the humanities.

[9]Robert Goldhammer, *Clinical Supervision: Special Methods for the Supervision* [illegible]

The impact of the supervision approach we applied was assessed using the guidelines for program evaluation outlined by Sanders.[10] The following aspects of the program were evaluated: program needs, goals, and objectives; individual learner needs; resource allocation; process and strategies (for example, curriculum design, classroom process, instructional materials, monitoring of pupils' progress, and learning environment); and achievement outcomes.

Seidman has stated that interviewing is the most suitable data collection method if we are to understand the experiences of others and the meaning they make of them.[11] In this study, interviews enabled the researchers to learn the complexities of the participant's experiences from his or her point of view. According to Mishler, the best interviews are flexible and open-ended, allowing for natural conversation.[12] The goal is to understand each participant's experiences and perceptions related to a given situation in a nonthreatening way such that "meanings emerge, develop, and are shaped by and in turn shape the discourse."

Researchers used structured interviews with all 20 project supervisors. Each supervisor described the teacher/supervisee's initial level of competence, the nature of his or her interventions with the supervisee, and the process of development as it emerged in the school setting. Information gathered from each supervisor was then compared with data from other sources (for example, records on teachers' participation in the inservice training courses and information on pupil achievement). An external evaluation team collected additional information and examined progress in the 17 project schools using quantitative and qualitative methods.[13] Waks and Barak describe the relationship between the internal and external evaluations.[14]

Following the collection of data from the interviews, we analyzed the data for emergent themes and sorted it into categories. Although an interview protocol served as a guide, most interviews digressed from the protocol after the initial questions, with subsequent questions emerging from respondent replies. Credibility, applicability, and con-

[10]James R. Sanders, "Evaluating School Programs: An Educator's Guide," in *Evaluating School Programs: An Educator's Guide*, ed. J. R. Sanders (California: Corwin Press, Inc., 1992).

[11]I. E. Seidman, *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences* (New York: Teachers College Press, 1991).

[12]Elliot G. Mishler, *Research Interviewing: Context and Process* (Boston, MA: Harvard University Press, 1986).

[13]Arie Lewy, Zipporah Libman, Gila Zelikovitz, and Michal Levy-Keren, *Summative Evaluation of an Intervention Project in Twenty-four High Schools* (Hebrew with English abstract; Tel Aviv: Tel-Aviv University, School of Education, 1996).

[14]Shlomo Waks and Moshe Barak, "Role of Evaluation in an Interdisciplinary

firmability were ascertained through triangulation of data, peer checks, and long-term observations.

The outcomes are presented here as six case studies, using one successful and one unsuccessful case of supervision in each of the three disciplines (physics, electronics, and mechanics). The pairs were chosen out of groups of 16 to 35 teachers in each discipline. Each of the six cases is presented in the same format, covering the objectives of the intervention program, the initial state of the teacher and school, the support given to the teacher, and the outcomes.

FINDINGS FOR PHYSICS TEACHERS

The Context

The study of physics in Israeli high schools carries a great deal of status and usually attracts high-achieving pupils. Schools make an effort to offer physics studies even when the number of pupils attending is low. The training project for physics teachers was aimed ultimately at increasing the number of pupils taking physics at the matriculation level and enhancing their achievement. The two cases presented are intended to show the long-range impact of the project on the school. The case of the teacher named Carl represents successful development, and that of the teacher named Adam, unsuccessful development.[15] Both teachers were dedicated and did their utmost to profit from the program. Each is a teacher of physics but did not specialize in this discipline—a typical situation in Israeli schools.[16]

The Case of Carl

Carl was the only physics teacher in an Israeli comprehensive high school of average size. Most of the pupils come from middle-class families. The teacher was a certified industrial engineer. In the introductory meeting in the school, Carl expressed his goal:

> I think that we must increase the number of pupils taking physics at "five learning units" [the highest matriculation level]. I am trying to attract the better pupils whilst they are in junior high, by means of extracurricular physics workshops.

Only a few of the school's pupils studied physics and sat for matriculation examinations at the basic level. None of the pupils sat for the upper-level exam, which included a personal laboratory test. The supervisor in this case found the equipment in the school's general science lab still in shipping boxes. There was no physics laboratory. The teacher carried out demonstrations only occasionally.

Supervisory support extended for more than three years. Carl participated in training courses in his specialty areas (optics and mechanics). The supervisor monitored Carl's work in his classroom and helped him expand on specific subjects and plan the pupils' homework assignments. The supervisor, in conjunction with the teacher, ultimately updated the physics curriculum in the school for grades 10 through 12. They obtained additional resources essential for regular lab work and developed new protocols for both basic and advanced lab experiments.

During the intervention process 10 percent of the school's pupils opted for advanced-level physics studies, and another 6 percent took basic-level physics. Compared with the school's situation at the start of the intervention, this is a pattern more reflective of physics studies in established Israeli schools. After three years, the teacher's misconceptions and subject-matter errors were rare. In addition, laboratory sessions were taking place regularly and at a level exceeding curriculum requirements. Tamir has described a similar case resulting in enhanced physics teaching.[17] The teacher no longer required personal support, although he maintained contact with the supervisor in order to stay current and to seek support for specific problems.

Carl's case exemplifies a change in behavior from unfocused teaching (moderate CL) to generating independent solutions and curriculum plans (high CL). The supervisor moved from presenting, clarifying, listening, problem solving, and negotiating (collaborative supervision) in the first stages, toward presenting, encouraging, and clarifying (nondirective supervision) in the third year.[18] The supervisor described the change as follows:

> Supervising this teacher started with overcoming theoretical misconceptions that were the result of lack of knowledge. The combination of the teacher's faithful participation in the training courses and long-term supervision regarding lab work and class experience made the difference.

During one of the visits by program staff to the school, Carl said, "We made great progress in the last two years. Although I will not participate in the courses next year, I hope that the supervisor will maintain contact with me."

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[15] All teacher names are pseudonyms.

[16] Pinchas Tamir, "Characteristics of Senior High School Science Teachers in Israel as Related to Their Educational Goals and Their Perception of the Implemented Curriculum," *Science Education* 74 (January 1990): 53–67.

[17] Ibid.

[18] Carl D. Glickman, *Supervision of Instruction: A Developmental Approach*, 2nd ed. (Boston: Allyn and Bacon, 1990).

The Case of Adam

Adam had been teaching physics for about five years in a medium-sized comprehensive high school serving a middle- to low-income population. He was a certified chemical engineer. Adam stated his goal thus:

> I am trying to prepare the pupils for the matriculation exams in physics, but it is difficult to find in our school enough pupils that will make the effort to study physics . . . it is also impossible to teach physics when most of the pupils lack knowledge in math.

Although the school offered physics courses, only a few pupils in grades 10 through 12 took advanced-level physics. The school's physics lab was well equipped but underutilized.

Adam received individual support for four years (one meeting every two to three weeks). In addition, a special assistant helped him prepare laboratory experiments. He participated actively in the inservice courses.

During the course of the program Adam showed only minor improvement in the preparation and delivery of physics lessons. Although he used the prepared exercises he was given, he experienced problems in the presentation of subject matter in specific topics. He lacked the flexibility to address conceptual issues raised during class lessons, a problem characteristic of novice teachers.[19] Sometimes Adam was distracted by pupil errors and unable to provide effective responses to pupils' questions. Borko and Livingston have described such problems.[20] The lack of theory in Adam's background limited him during laboratory activities as well.

When Adam sought help from his supervisor in setting up lesson plans, he was confused about specific areas of the subject matter and was unable to generate his own ideas. He usually blamed the pupils and wanted to be shown what to do: "What we learn in the course is too complicated for my pupils . . . help me to find simpler explanations . . . I need more examples."

This situation characterizes a low-CL teacher. The supervisor described his work with Adam: "My job was mainly to extend the teacher's knowledge in physics in order to overcome a theoretical gap. We selected together the chapters he would teach, and I prepared the lab experiments with him." The supervisor devoted most of his efforts to encouraging Adam, setting standards, instructing, and directing his activities (directive supervision). The supervisor reported that he was not successful in bridging the gaps in the teacher's knowledge base or in helping him improve his laboratory techniques. The supervision remained well structured, supportive, and fairly controlling.[21] One reason for the limited progress achieved in this case was the teacher's limited knowledge of the basic subject matter. Inservice training did not make up for the lack of a solid foundation in the subject matter.

FINDINGS FOR MECHANICS TEACHERS

The Context

Pupils in Israeli secondary schools are evenly split into two main tracks: "general" and "technological." Pupils taking matriculation examinations (the Bagrut) represent more than 90 percent of the general track but only 50 percent of the technological track.[22]

Technological education in Israel has increased considerably as a result of an influx of immigrants in the 1950s and 1960s, many of whom fell into the lower socioeconomic level of Israeli society. Ortar and Minkovich and others showed that the academic achievement of the children from this group fell short of that of the general population.[23] The goal of technological education was to provide an educational framework for these pupils.[24]

During the 1970s and 1980s technological education in the area of mechanics began to decline in terms of curriculum, equipment, and teacher training. Some 70 percent of high school mechanics teachers lack an academic degree.The support project started at about the same time that the Ministry of Education and Culture enacted a reform of the technological studies curriculums in high schools. The reform called for greater emphasis on academic studies, including the mathematical and physical theories behind technological systems, and the

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[19] Gaea Leinhardt and James G. Greeno, "The Cognitive Skill of Teaching," *Journal of Educational Psychology* 78 (April 1986): 75–95.

[20] Hilda Borko and Carol Livingston, "Cognition and Improvisation: Differences in Mathematics Instruction by Expert and Novice Teachers," *American Educational Research Journal* 26 (Winter 1989): 473–498.

[21] Carl D. Glickman, *Developmental Supervision: Alternative Practices for Helping Teachers Improve Instruction* (Alexandria, VA: Association for Supervision and Curriculum Development, 1981).

[22] D. Sprinzak, E. Bar, and D. Levi-Mazloum, *Facts and Figures About Education and Culture in Israel* (Jerusalem: Ministry of Education and Culture, 1992).

[23] Gina Ortar, "Educational Achievements of Primary School Graduates in Israel as Related to Their Socio-Cultural Background," *Comparative Education* 4 (November 1967): 9–22; Avraham Minkovich, Dan Davis, and Joseph Bashi, *An Evaluation Study of Israeli Elementary Schools* (Jerusalem: Hebrew University School of Education, 1977).

[24] Rachel Peleg and Chaim Adler, "Compensatory Education in Israel: Conceptions, Attitudes and Trends," *American Psychologist* 32 (November 1977): 945–958.

promotion of pupils' attainment of a matriculation certificate. The following two case studies illustrate the difficulties of implementing these changes in technology education.

The Case of Freddy

Freddy, a specialist in the design and production of mechanical parts, had been teaching mechanics for 20 years. He was a certified technician (not a university graduate), taking his first steps toward understanding modern technology and computers. In an interview at the beginning of the project, he expressed pessimism at any possibility for improvement in mechanics studies at the school: "I am ready to accept any aid, but I am skeptical . . . what else can we do to avoid pupils running away from mechanics?"

When the project was first introduced at the school, about 40 pupils were taking mechanics courses in each of grades 10 through 12, all of them at the nonmatriculation level. Most of the pupils took courses aimed at practical application of mechanics, and this was the only track the school offered for low-achievers.

Strengthening mechanics studies at this particular school required addressing principal elements of the school system: setting new goals, renovating the learning environment, changing the resource allocation, and emphasizing individual learner needs. Although teacher development was necessary for achieving improvement, it was not sufficient for the change needed in the mechanics domain.

To improve mechanics studies, the Technion team and the teacher developed a new curriculum, including pupil exercise booklets, special projects, and a computer program. The team and the teacher together constructed a new workshop in which state-of-the-art computerized instructional lathe and milling machines were installed. Other improvements included a computerized system for design, simulation, and control. The new curriculum emphasized independence and personal responsibility—important principles in light of a long history of failure and disappointment experienced by these pupils. The supervisor stated: "I made efforts to foster cooperation with other school agents, such as the principal and the school's educational counselor. This was an important component of my work."

A series of interviews with the pupils noted a positive change in learning atmosphere.[25] The students expressed high motivation and a willingness to make an effort to progress, first in mechanics lessons and later in other lessons, such as math and English. A significant decrease in absenteeism was observed, along with fewer cases of sending pupils out of class or summoning their parents to school to deal with discipline problems.

All the pupils in the mechanics program sat for matriculation exams. The program was extended to additional schools in the area. After three years, Freddy became a leader in the school and deputy headmaster. He was autonomous, explorative, able to generate a variety of alternative plans and choose the most appropriate. He had become a high-CL teacher.[26] Freddy's initial change from a low-CL to a moderate-CL teacher resulted from the significant changes in mechanics studies at that school. His supervisor described the change: "Our intervention turned the reform into a vehicle for staff development and change in the traditional teaching habits of staff at the school." Freddy's eventual shift from a moderate-CL to a high-CL teacher reflected his individual ambition and effort.

The Case of Sean

Sean had more than 20 years of experience teaching mechanics. Although he had no formal education, he was the head of the mechanics department in his school. He was highly committed to his duty and was considered a top educator. "I take care of my pupils like I am their father," he said. "Many come to visit me years after they leave school."

A number of the pupils studying mechanics in Sean's school took the matriculation exams—a situation that occurred in only a few Israeli schools. But new standards reflecting the reforms of the Ministry of Education and Culture presented Sean with an overwhelming challenge. The number of pupils taking mechanics studies decreased from year to year.

Although state-of-the-art equipment was brought into the school, Sean appeared to despair of being able to absorb the new curriculum. He did not take part in the inservice training courses and continued teaching outdated material. Sean rationalized his behavior, arguing that the new curriculum, which significantly reduced the total number of workshop hours, would not inspire the pupils with the traditional values of the trade—technical skills, systematic planning, precision, neatness, and readiness for hard work. Ausubel, Novak, and Hanesian have described this view of pupils as future "workmen."[27]

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[25] Moshe Barak, Ronen Yehiav, and Nili Mendelson, "Advancement of Low Achievers Within Technology Studies at High School," *Research in Science and Technological Education* 12 (November 1994): 175–186.

[26] Stephen P. Gordon, "Developmental Supervision: An Exploratory Study of a Promising Model," *Journal of Curriculum and Supervision* 5 (Summer 1993): 293–307.

[27] David Paul Ausubel, J. C. Novak, and H. Hanesian, *Educational Psychology: A Cognitive View* (New York: Holt, Rinehart, and Winston, 1978).

The school implemented the program for advancing low-achievers (described above in the discussion of Freddy). At first, Sean seemed to commit himself to the program. Four months later, however, it became clear that no change had actually taken place. He did not use the necessary process and approach needed to move pupils to the matriculation level—the central aim of the intervention program. He used the learning materials selectively, according to his personal bias, maintaining the focus on practical training. "Come and see the pupils in the workshop," he said. "This is the place where we can educate them . . . too much theoretical studies are just frustrating for them and for me."

Sean matched the profile of a moderate-CL teacher. He was able to describe professional problems and generate his own alternatives. Initiating the new curriculum required a short period of direct supervision. Sean rejected the supervisor's attempts to set new standards, redesign the school schedule, or introduce new software (directive supervision). The supervisor reported:

> The fight to break the resistance to changing the learning environment was a lost battle. My attempts to change the teacher's attitude towards the low-achieving pupils was bound to fail because he repeated the claim that his pupils were not able to cope with the new curriculum.

The school administration expressed support but did not demonstrate this concern. As the head of the mechanics department, Sean became an obstacle for teachers who wanted to introduce changes. He did not make the necessary changes to incorporate the new curriculum requirements and failed either to introduce new teaching methods or revitalize mechanics.

FINDINGS FOR ELECTRONICS TEACHERS

The Context

For the last 20 years the study of electronics has been the epitome of technological education in Israel. Most pupils studying electronics in high school are regarded as highly motivated pupils. The intervention program was introduced following the curriculum reform described above. The results described here illustrate a way of improving the quality of teaching against a backdrop of a tradition of self-motivation characteristic of this dynamic field.

About half the normal electronics curriculum deals with the basic theory of electricity, analog electronics, or digital systems. More recently, emphasis has been placed on teaching the physical and mathematical bases for these theories as well. For example, the teaching of electrostatics and electromagnetism has been broadened.

Because of the rapidity of change in the field of electronics, Israeli teachers tend to specialize in narrowly defined areas, such as the analog electronics of microprocessors. The training program for electronics teachers was placed within the context of this tradition. In the first stages of the project, individual supervision and inservice training courses were gauged for a broad range of teachers. The aim was to update teachers in general electronics topics. In the third year, however, the effort was driven more by the specialties of the teachers. For example, a supervisor specializing in digital electronics worked with a teacher in that field.

The Case of Alice

Alice was an electronics teacher in a small outlying school. She specialized in microprocessors. At the start of the program, most of her work was with the 8080 microprocessor. In the new curriculum, however, she had to provide instruction in the 8086 microprocessor and its peripheral components.

The supervisor met with the teacher biweekly for one year. He familiarized her with the new microprocessor and led her through associated lesson planning, pupil exercises, and exams. After one year, this teacher had prepared the pupils for the matriculation examination with good results. "She had collected and organized the learning materials she would need for future teaching," said the supervisor. He decreased the number of school visits to an average of one every two months and began to move to a nondirective approach. "I tried to transfer the initiative for school visits to the teacher, but this left a vacuum which slowed down the pace of the teacher's progress," the supervisor said. It is possible Alice slowed down deliberately, being overwhelmed by the pace of change in the electronics field.

The Case of Rita

Rita was a certified senior technician teaching in a comprehensive high school serving mostly middle-class students. Once the new national curriculum was in place, she spent many hours studying the physical aspects of electricity.

The supervisor reported: "We focused our work on content analysis, lesson planning, and laboratory experiments. I provided Rita with learning materials such as sets of exercises." Efforts to raise the sophistication of the curriculum for pupils in the physical aspects of electrostatics, however, revealed the teacher's lack of basic knowledge in physics. Rita lacked, for example, the skill in mechanics theory to calculate the effect of forces acting on a charged object in an electric field and an electromagnetic field. Galili points to the need for a background in mechanics to learn electromagnetism.[28]

The way Rita approached the teaching of physics theory within the electronics course showed her to be a low-CL teacher. She received direct supervision over two years but did not achieve the ability to work effectively with conceptual issues. Rita's case paralleled that of Adam, the physics teacher. In both cases, the lack of an academic foundation in the basic subject matter was a serious obstacle to their professional development.

DISCUSSION AND CONCLUSION

We have presented two cases—one successful and one unsuccessful—in each of three fields: physics, electronics, and mechanics. By comparing the situation in each school at the beginning of the study and tracing the process of supervision for the teachers, we can identify both the common and unique elements influencing the effectiveness of supervision in each of the three disciplines.

Glickman's model offers a way to identify the starting point for each teacher, trace the supervision process, and describe the outcomes.[29] In the study, matching the supervisory behavior to each teacher's conceptual level was a basic criterion for real progress among physics teachers because in this area the main problem was insufficient mastery of basic theoretical knowledge. In mechanics studies, it was necessary to introduce new curriculums, bring new technology into the workshop, and most importantly, apply a new educational vision. In these cases, the success of the supervision plan relied heavily upon collaboration between all elements of the school system. The comprehensive view suggested by Greene seems to be appropriate for situations in which the educational program aims to introduce a far-reaching change, as in the case of mechanics studies presented here.[30] Using Greene's model, the success of the supervision depended on "contextual factors" in the school, that is, the culture of the individual school and its district and the commitment of the school staff.

In the case of electronics studies, the teachers were accustomed to dealing with continuous changes in subject matter. Our experience showed that the supervisor's support was more easily and readily accepted by teachers when they regarded it as a means to shorten their learning curve. Supervision was directed to individual teachers and focused mainly on professional matters. Problems emerged when attempting to incorporate more theoretical physics background into electronics studies. Here, obstacles occurred similar to those encountered when trying to improve the teaching of physics; teachers' theoretical background had the most impact on success.

The present study posits the idea that it is necessary to develop a model that customizes the supervision process to teachers' conceptual levels, in the context of the entire school system, program goals, and needs. The first stage of such a model is systematic diagnosis of the school's situation, taking into account a variety of factors, such as the educational and social context of the school; the extent to which the program aims to formulate new goals, standards, or methods; the unique needs and context of each discipline; the functioning of professional teams of teachers in subjects related to the proposed change (as opposed to a situation in which teachers work individually); the readiness of teachers to accept changes; the extent to which a school is already involved in making changes and implementing new programs; and the degree of commitment from the school administration to adopt the desired changes.

The second stage involves identifying diverse supervision approaches and matching the supervisory approach to the given situation of the teachers and the school. For example, in one school new science and technology labs are built with the support and involvement of management, but only a few teachers are updated in the relevant subject matter. In another school, science and technology get little attention and are considered irrelevant to the local student population. To facilitate curriculum development, different supervision approaches are needed. In the first school, supervision should focus on training teachers in the subject matter and establishing a faculty team. The second school, in contrast, calls for supervision to achieve a breakthrough in the school's attitude to science and technology studies. This can be realized by implementing a unique and attractive project with a specific group of students. In the third stage, the goal of supervision is to increase a school's ability to operate on its own to initiate new programs, locate additional sources of information, and develop unique school programs.

In conclusion, Glickman's model helps match supervisory behavior to the needs of a single teacher. Extending this idea we suggest matching supervision to the needs of the subject or discipline. What is needed is a multidimensional supervision model to analyze instructional needs and match levels of teaching competencies to different supervisory behaviors. This sort of developmental supervision proved

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[28] I. Galili, "Mechanics Background Influences Students' Conceptions in Electromagnetism," *International Journal of Science Education* 17 (May–June 1995): 371–387.

[29] Carl D. Glickman, *Supervision of Instruction: A Developmental Approach*, 2nd ed. (Boston: Allyn and Bacon, 1990).

[30] Myrna L. Greene, "Teacher Supervision as Professional Development: Does It Work?" *Journal of Curriculum and Supervision* 7 (Winter 1992): 131–148.

to be particularly beneficial in our study in Israel, given our cultural norms, educational system, and unique needs of teachers.

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WHAT I HAVE LEARNED SOME THINGS I HAD TO LEARN

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One of the things no elder can resist is giving advice to the younger generation, which, of course, pays no attention whatsoever. So I no longer even try to resist opportunities to speak out on what I have learned and what I believe. Better now than after Alzheimer's catches up with us.

Editor Craig Kridel gave me an opportunity to look back by asking, "What is your advice to today's younger generation of teacher educators?" My response appeared as the first article in the first issue of his *Teaching Education*, one of the handsomest journals ever published by the education profession. Here it is:

Acquire somehow a broad liberal education. Venture into both worlds—the humanistic world of literature, the arts, the social sciences, history, philosophy, and so forth, and the scientific world of mathematics and the several physical and natural sciences. Wrestle with the tough interdisciplinary problems of humankind that cut across the arbitrary boundaries of the separate subjects. Experience widely. Travel. Grow.

Obtain a solid professional education. Know your specialty, but don't let it imprison you. Stress the foundations of education—philosophical, psychological, historical, and social. Master needed technical skills, such as the uses of the computer, statistics, language. Explore and recognize the realities of school and society, yet keep your faith in your hopes and goals.

As early as possible, learn who you are. A teacher? A researcher? A generalist or a specialist? Are you a writer? A counselor? A community activist? An administrative facilitator? A leader of organizations? Some combination of several such elements? Do what you do best, most naturally, most joyously, whatever is most *you*. Welcome the rewards and avoid complaints about whatever penalties accompany being yourself. And if in midstream you

EDITOR'S NOTE: This article is an expansion of the author's Chapter 49, "What I Have Learned," in his autobiography (revised second edition), *My Way of Looking at It* (San Francisco: Caddo Gap Press, 1996), pp. 442–446.

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