Increasing Science Teachers' Ownership through the Adaptation of the PARSEL Modules: A "Bottom-up" Approach

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ABSTRACT: The study describes the process of adopting new curriculum materials, which had been developed in the PARSEL project in several European countries, into the local educational science classroom of another country. The goal of the PARSEL project was to raise the popularity and relevance of science teaching by enhancing students' scientific and technological literacy and by identifying suitable teaching/learning materials, based on relevant context-based educational approaches. All PARSEL materials are organized in a website and are freely accessible by science teachers around the world. In order to increase the teacher's ownership towards the new materials, a "bottom-up" approach that included a teacher workshop for modifying the PARSEL modules for the needs of teachers was implemented. The teachers used the modified modules in their classes and reflect upon the whole process, after it was completed. Data have been collected using various research tools, such as, teachers' questionnaires, teachers' interviews and teachers' focus group interviews. The results indicate that the "bottom-up" process increased teacher ownership towards the PARSEL modules and helped the teachers to align their teaching with the philosophy and the teaching style of the PARSEL project. It was also indicated that the students found the modules to be popular and interesting.

KEYWORDS: Adopting new curriculum, bottom-up strategies, popularity, relevance, teacher's ownership.

Introduction

A growing body of evidence suggests that imposing a curriculum by central professional bodies in what is called "top-down" fashion, whereby teachers are expected to just implement the developers' philosophy, ideas, and intentions, has proved to be ineffective in introducing educational and curricular innovations into schools (Hofstein, Mamlok, & Carmeli, 1997; Mamlok-Naaman, Hofstein, & Penick, 2007).

The importance of supplementing the curriculum guides with materials developed by school teachers during in-service activities has long been recognized (Connely & Ben-Peretz, 1980; Sabar & Shafriri, 1982). According to Bennett, Gräsel, Parchmann, and Waddington (2005), there are several factors that seem to be relevant for teachers in adopting curriculum changes, such as, judgments about the success of a new course, the teachers' perceptions of its effects on students' learning and attitudes, teachers' claims about student interests and motivation, perceived learning outcomes, and enhancement of self-regulated learning.

Teachers usually accept a new curriculum more easily when it is in accordance with learning goals they personally value (Johnston, 1992), or when it is perceived by them as a possible solution to problems they currently experience (Van Driel, 2005). Another aspect that has to be taken in consideration is the time that is required for the change to be implemented. Without the provision of adequate time for professional growth, it is unlikely that teachers will effectively implement new teaching practices (Appleton & Asoko, 1996; Fullan, 1993).

Several studies have emphasized the importance of adequate support for teachers when they are asked to implement a new curriculum (Fishman, Marx, Best, & Tal, 2003). The work of Joyce and Showers (1995) showed that teachers are more likely to make changes in their practice, if talks and workshops have been arranged in which new skills have been described and demonstrated, and when teachers have had opportunities to reflect on their performance.

One conclusion to come out of decades of studying the success and failure of a wide variety of curriculum innovations is that imposed innovations are generally ineffective (Pintó, 2005), and that innovations succeed when teachers feel a sense of ownership of the innovation, or that it belongs to them and is not simply imposed on them (Ogborn, 2002). Pintó, Couso, and Gutierrez, (2005) also insist that only if teachers feel some sense of ownership of an innovation, they will effectively carry it out in the classroom.

Several projects involved groups of teachers in the actual process of curriculum development (Ben-Peretz, 1980; Campbell, & Olsen, 1994; Hofstein, Mamlok, & Carmeli, 1997; Sabar & Shafriri, 1982). In such workshops, teams of teachers were engaged in curriculum development and operated as writing teams. Action research (Feldman & Minstrel, 2000) is one example in which the design and evaluation of the new curriculum was based on the participating teachers. Action research has been described as an informal, qualitative, formative, subjective, interpretive, reflective, and experiential model of inquiry in which all individuals involved in the study are contributing participants (Hopkins, 1993). Action research is primarily intended to provide a framework for qualitative investigations by teachers and researchers in complex working classroom situations. The action research framework is most appropriate for participants who recognize the existence of shortcomings in their educational activities, and who would like to adopt some initial stance in regard to the problem, formulate a plan, carry out an intervention, evaluate the outcomes, and develop further strategies in an iterative fashion (Hopkins, 1993).

Another example for a design and the evaluation of a new curriculum, based

on the participating teachers, is the expert focus group, that is, a group of experienced teachers (Powell & Single, 1996). In the process of producing teaching materials, focus groups can comment on the design and clarity of the initial videos, print materials, or websites, and evaluate their usability for the intended audience, and suggest revisions. Focus groups can also suggest strategies for distributing the materials to the audience.

In recent years, there has been growing evidence of a decrease in the number of students who study chemistry. High-school students find chemistry to be a non-relevant topic with too many abstract principles. Science educators throughout the world have picked up the challenge and, using different approaches to overcome this problem, they are trying to make chemistry more relevant and interesting, and, therefore, more attractive for young students.

A consortium of researchers from eight European nations has successfully applied to the EU commission for funding the PARSEL (Popularity and Relevance in Science Education for scientific Literacy) project. Their aim was to raise the popularity and relevance of science teaching by enhancing students' scientific and technological literacy, and by identifying suitable teaching/learning materials, based on relevant context-based educational approaches. These approaches, identifiable within the teaching/learning materials, are expected to focus on socio-scientific issues and to promote acquiring a range of personal and social skills (including cognitive skills associated with inquiry-based, problem-solving, and socio-scientific decision-making approaches), and to clarify the relevance of science education for the 21st century. Each of the eight participating groups selected 6 innovative modules that fit the PARSEL framework. Teachers from each of these countries were introduced to the various projects and modules, and they then taught different modules in their schools. All PARSEL materials are also organized and are freely accessible by science teachers around the world on a website (www.parsel.eu).

We took into consideration the previous issues, while planning how the PARSEL modules would be implemented into the Israeli science classroom. The gap between traditional science teaching (Holbrook, 2003; Holbrook & Rannikmae, 2007) in the Israeli high schools, and the novel teaching and learning materials of the PARSEL project was wide. The authors had to identify a way to bridge this gap and to change the way science is taught, taking into consideration several guidelines, such as:

- from science taught to enable students to become scientists to science taught for responsible citizenship/careers.
- from science education emphasizing basic cognitive concepts to increased emphasis on relevance, argumentation, and working together to promote cognitive learning.
- from science as an isolated school subject to interdisciplinarity between several school subjects.
- from a teacher-centred approach and limited feedback to a student-centred approach for greater feedback for the teacher.
- from emphasis on summative tests and examinations to more attention to formative and ongoing assessment.

This paper describes the "bottom-up" adapting process, and the parallel process of increasing teacher ownership that were used in order to bridge the gap between traditional science teaching and the PARSEL teaching approach.

Research Questions

The key goal of this research was to evaluate the way of implementing the PARSEL modules in the Israeli high schools. For this purpose, two research questions were posed:

1. Did the "bottom-up" process increase teacher ownership towards the PARSEL modules and the project?

2. How did the "bottom-up" process influence students' attitudes towards the PARSEL modules and the project?

Methodology

Research Tools

The research tools consisted of teacher interviews, teacher questionnaires, and a teacher focus group interview. The data regarding the students was based on the teachers' interviews.

Teacher Questionnaire: In order to study the teachers' point of view, we developed a teacher questionnaire that included close-ended as well as open-ended questions. These questions helped us focus on issues, such as: (a) *Class description:* Details regarding the class (grade level, number of students in the class, gender split, etc.); (b) *Comments on the first lesson(s) (stage 1 – setting the scene)*; (c) *Comments on the stage 2 series of lessons (learning science)*; (d) *Comments on the stage 3 component (relating science content to society),* and (e) *Overall comments.*

Teacher Interviews: Teacher interviews aimed at different aspects of the teachers' perspectives. The interviews focussed on the teachers' opinions regarding the whole PARSEL project. All the participating teachers were asked a series of specific questions, such as:

> *Why did you choose to be a PARSEL teacher?*
>
> *What were your feelings before you started to teach this module?*
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> *What were your feelings during and after teaching this module?*
>
> *What is your impression regarding the students' reactions to this module?*
>
> *Will you use this kind of material in the future?*
>
> *What importance do you give to the wider goals of science education promoted through these modules?*
>
> *Will you recommend PARSEL to your friends?*
>
> *Do you feel that this project, which promoted similar materials across Europe and Israel, is worthwhile?*

In this study, teachers' answers were categorized and analyzed using qualitative research methods. Analyzing the teacher interviews, teachers' perspectives regarding the PARSEL project, the module adaptation process, and their feelings of ownership were identified.

Teacher Focus Group Interview: According to Powell and Single (1996), the method of using a focus group interview is particularly suitable for obtaining several perspectives about the same topic. Focus group research involves an organized discussion with a selected group of individuals to gain information about their views and experiences regarding a topic as well as insights into experts' shared understanding of the topic. The recommended number of participants is usually six to ten. Although a focus group interview is a form of a group interview, Morgan (1997) emphasized the differences between the two. The group interview involves interviewing a number of people at the same time, based mainly on questions and responses between the researchers and the participants. Focus group interviews however rely on the interactions and dynamics within the group in relation to topics that are provided by the researcher. To use the focus group interview as a forum for change, the moderator (the researcher) must allow the participants to talk to each other, ask questions, and express doubts and opinions (Morgan, 1988).

Data Collection

In the current research, the focus group consisted of science teachers that took part in the Israeli PARSEL teacher course and had completed the "trying out" stage of at least one module of the PARSEL project. During a four-hour meeting, the teachers presented their experiences of teaching the PARSEL modules, and reflected on key ideas from the PARSEL philosophy, as it was elaborated in the introduction of this special issue (Holbrook, 2008).

Research Population

Ten Israeli chemistry teachers, who were also teaching general science, participated in the project. In the present paper, we describe two of the Israeli PARSEL teachers. The first teacher, "R," has taught high-school chemistry for more than 15 years. "R" taught one PARSEL module in two different high schools in Jerusalem, an urban high school, in which she taught tenth-grade students, and a highly selective girls' high school, in which she taught ninth-grade students. In both schools, she taught the same PARSEL module "*Smile with healthy teeth*" (Tsaparlis & Papaphotis, 2002).

The second teacher, "L," has taught chemistry for more than 30 years. "L" taught another PARSEL module in a junior high school in the center of Israel, a regional agricultural school, in which she taught seventh-grade highly motivated students, who had already enrolled in the special pre-paramedical track. She taught the PARSEL module "*Milk: Keep refrigerated.*[1]"

In order to introduce the PARSEL modules into Israeli schools, we initiated a course for teachers at the Weizmann Institute. Between November and December 2007, we gathered teachers for three meetings, 8 hours each. The participants were 10 teachers who usually teach general science, chemistry, and biochemistry in high school and junior high school. In addition to the course for teachers, a teacher

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1. The PARSEL module "*Milk: Keep refrigerated*" developed by Tsaparlis, G. from the Department of Chemistry, University of Ioannina, Greece

focus group was organized. The teachers met on June 11th to report and summarize their experience in the classes and to reflect on the PARSEL philosophy after the initial stage. This meeting was analyzed as a focus group interview.

Adaptation of the PARSEL Modules: A "Bottom-up" Approach

The adaptation process of the PARSEL modules was divided into four phases. The design of the process was aimed at increasing teachers' ownership through the adaptation, as indicated in Figure 1, and described in detail in the paper.

Phase 1: Introduction to the PARSEL Project

At the beginning, the project was described and the PARSEL rationale and goals were introduced, while several key words of the PARSEL project were explained:

Relevance: The students recognize that the modules are worthy of study. They understand the purpose in studying the modules and are thus motivated to study them.

Popularity: This refers to students in favor of science lessons and who wish to study the subject in school. It also refers to liking science in general. It is thus an emotional component that stems from the module, but also by the way science is presented.

Scientific literacy: Scientific literacy enhances society's understanding of science by providing skills needed in everyday social and vocational life. It develops a climate for public decision-making based on arguments, and also establishes the fundamentals for more science-oriented career choices.

Next goal of the first phase was to overview an exemplary module, the "*Shampoo: Is there truth behind the advertisement?*[2]" While scanning this module, we discussed how the rationale of the PARSEL project is reflected in the module: Is the module relevant for students? Why is it popular? How does the module fit the philosophy of education through science? What are its cognitive features? And how does it promote scientific literacy?

In the introductory phase, we decided to overview the Israeli modules. The teachers were familiar with the Israeli modules, and most of them even taught some of the modules before. The purpose of this phase was to serve as an intermediate between the known teaching materials and the new concept underlying the PARSEL project. The process in which familiar materials were changed in order to become PARSEL materials was exemplified, in order to emphasize how the PARSEL concepts and philosophy come alive though known Israeli modules.

The aim of the first phase was to identify low-level teacher ownership, since at this phase the teachers acted as listeners, and accepted the PARSEL philosophy as it is. At this stage, they did not have the opportunity to make changes of any kind into the presented learning materials.

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2. The PARSEL module "*Shampoo: Is there truth behind the advertisement?*" was developed by Linda, B., Nilsson, B., and Kennedy, D.; edited by Holbrook, J., International Council of Associations for Science Education (ICASE(, Sweden
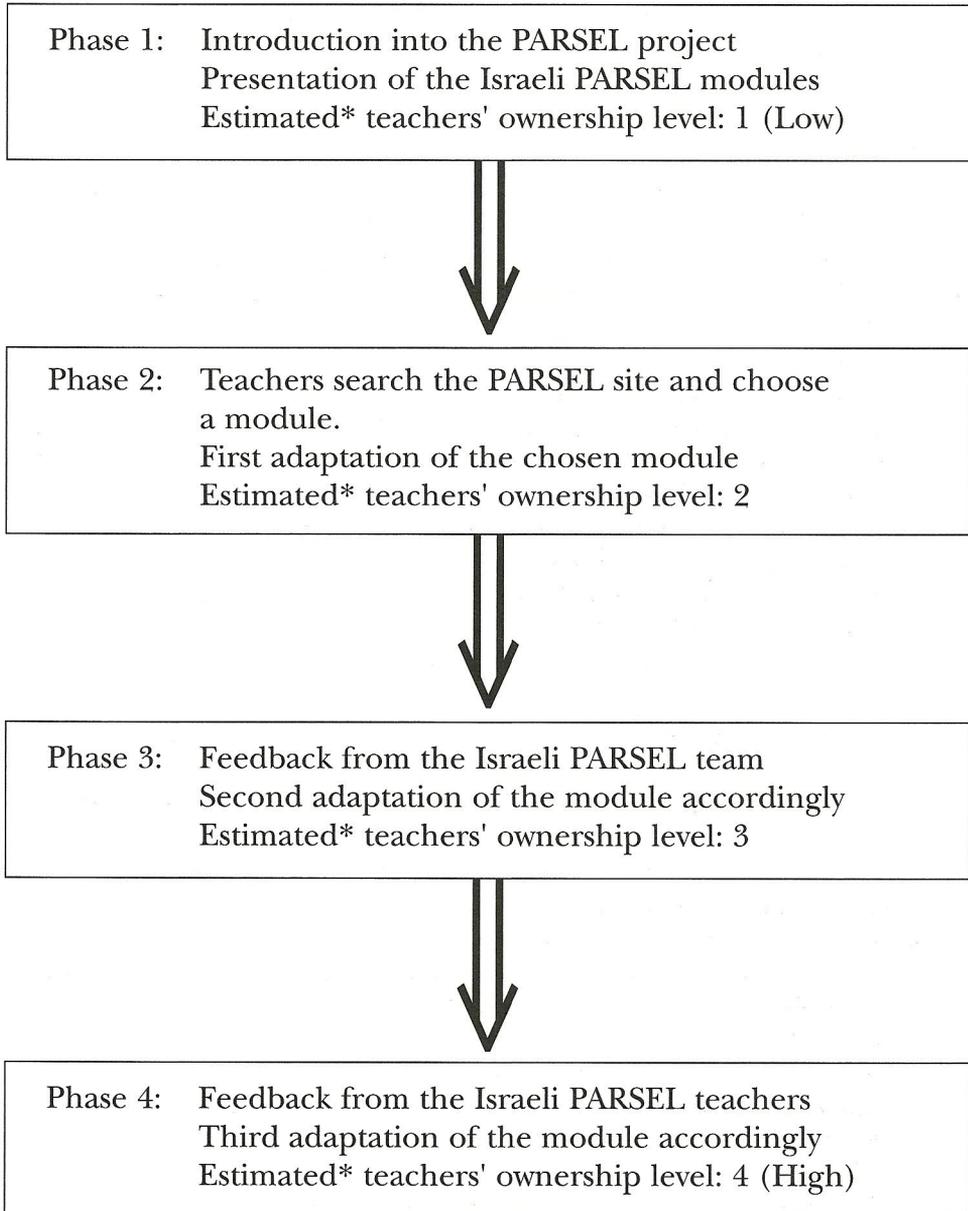
Phase 1: Introduction into the PARSEL project Presentation of the Israeli PARSEL modules Estimated* teachers' ownership level: 1 (Low)

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Phase 2: Teachers search the PARSEL site and choose a module. First adaptation of the chosen module Estimated* teachers' ownership level: 2

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Phase 3: Feedback from the Israeli PARSEL team Second adaptation of the module accordingly Estimated* teachers' ownership level: 3

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Phase 4: Feedback from the Israeli PARSEL teachers Third adaptation of the module accordingly Estimated* teachers' ownership level: 4 (High)

Figure 1: *Levels of Estimated Teacher Ownership During the Different Phases of Module Adaptation.*
* The estimated teachers' ownership level was based on our plans.

Phase 2: Teachers Search the PARSEL Website and Choose a Module and Prepare Its First Adaptation

In the second phase, the teachers worked in pairs. The goal of this phase was to choose PARSEL modules for teaching and to adapt these modules for the Israeli students. Each pair of teachers experienced the following stages:

- Browsing the different modules on the PARSEL Website
- Discussing the main ideas of the modules
- Reading, recalling, and reviewing the modules in order to determine which module should be chosen for further work.

By experiencing these stages, the teachers chose one module for further work. Teachers started to develop ownership feelings towards the module they chose. Therefore, this phase was considered by the teachers as increasing their level of ownership.

The Reason for Choosing a Module: Teachers took several considerations into account for choosing one of the modules. All of them searched for a module that could be connected to the subject they wanted to teach. Some of their explanations during the focus group interview were as follows:

"M": *In my class, I intend to teach hydrogen bonds, and their effect on the properties of matter. I plan to teach the CO_2 module in this context.*

"L": *I decided to teach the 'milk' module, because it can be integrated into the subject matter I teach, which is mixtures and pure materials.*

Teachers looked for modules that could benefit their students in the final exams:

"A": *We used the module in the regular development of the lesson, and used the reading comprehension in practicing for the final exams.*

"E": *I teach twelfth-grade students, so I adapted the module into an inquiry laboratory.*

Once they chose a module, the teachers translated the text into Hebrew, while adapting it to their classes. The teachers wrote student worksheets, a teacher's guide, and assessment tools. In the teacher questionnaire, the teachers were asked to write what changes they inserted during the adaptation phase and to explain why they performed those changes. They used similar reasoning to explain the changes:

"R": *I added a group discussion about the issue of choosing toothpaste at the beginning of the module, since I know some of my students have very low motivation to learn, and I thought that such a discussion can connect them to the subject.*

"L": *I divided the student worksheets into more steps, because my students are young and are not experienced in working with science.*

"E": *We decided to raise the level of the scientific concept in the module, since it was intended for twelfth-grade students.*

"A": *I have a big class, so I plan to separate the two groups and to teach the module in a different way.*

The adaptation phase provided the teachers with the opportunity to integrate

their experiences into the innovation. They changed the module according to their students' grade level, motivation, and interests, and according to their own teaching experience. The bottom-up approach reflects the current phase and it is important for developing teacher's ownership towards the innovation.

Phase 3: Feedback from the Israeli PARSEL Team, and the Process of Adapation

The manuscripts of adapted PARSEL modules were mailed to the Israeli PARSEL team for comments. The annotation process was done having in mind to check for the main PARSEL features in the adapted modules. For example, the structure of the three phases in each module (setting the scene, inquiry-based problem solving, socio-scientific decision making), the title that should reflect a socio-scientific issue, and an alternative assessment method for students' evaluation. When the adapted module did not match the theoretical framework, a suggestion or a comment was added to the manuscript. The annotated manuscripts were uploaded on the Israeli PARSEL website to which all the Israeli PARSEL teachers had access. The teachers received the annotated manuscript and corrected it according to the comments. At this phase, the teachers continued the adaptation process by combining their experiences with comments that intended to align the module with the philosophy of the PARSEL project. Eventually, the teachers decided whether to accept the comments and how to change the modules accordingly. The teachers had to agree with the resulting module, since they intended to teach it in their class. After this phase, all of the adapted modules were also uploaded on the Israeli PARSEL site.

Phase 4: Feedback from the Israeli PARSEL Teachers, and Re-adaptation of a Chosen Model

This phase aimed at receiving pedagogical reviews from the Israeli PARSEL group of teachers. Each pair presented their adapted module in front of the whole group and had the opportunity to listen to their colleagues' opinions. After the feedback was received, another cycle of module adaptation was performed. The adapted modules are presented in Hebrew on the Israeli PARSEL website: http://stwww.weizmann.ac.il/g-chem/parsel.

The feedback process that was planned for this phase had an unexpected result as well, because the process of reviewing the adapted PARSEL modules by other colleagues developed teacher's ownership, not only for their own module, but also for the other modules that were presented to them. As a result, teachers decided to try out modules that were adapted by other teachers.

Results and Discussion

The results will refer to the enactment of two individual modules. Each module will be described in a separate case study.

Case Study 1: *Smile with a Mouth Full of Healthy Teeth*

Phase 1: The original Greek module, *Brushing up on chemistry* (Tsaparlis, & Papaphotis, 2002) was described in the PARSEL website as follows. In this module, students should become acquainted with toothpastes and products that we use in everyday life. What are toothpastes composed of and what is the function of each

ingredient? Which are the various kinds of toothpastes, and what is the importance of regular brushing and care of teeth both for maintaining healthy teeth as well as for general health, and the need to regularly visit dentists? For this module, students usually start with initial work at home studying the ingredients of various commercial toothpastes, and then work in groups during class time in order to systematize the study of the ingredients. Next, students should prepare in the lab basic toothpaste and compare its cleaning power with commercial toothpastes, by using them to clean a colored egg.

Two Israeli highly experienced teachers worked together on adapting the module to their classes. The adaptation process of this module will be described according to phases 2-4 in the model described above.

Phase 2: Choosing a Module from the PARSEL Website and Its First Adaptation

The teachers searched the PARSEL site and chose the Greek module *"Brushing up on chemistry."* They chose this module, because they considered it to be relevant to students' life, and they thought that it could be used as an introduction to acid-base chemistry content.

> "R": *This module can be used as an excellent introduction to the subject of acid-base. It connects an issue that is relevant to chemistry for everyone.*

At the first stage of the adaptation, the teachers read the English translation of the Greek module and made only minor changes. They replaced the original title with a new title that sounded better in Hebrew: *"Smile with a mouth full of healthy teeth."* They also organized the students' instructions to be friendlier to be used and to serve as a guide for the students. They claimed that the original module contained general instructions and that it was suitable for students who were used to working independently, whereas their own students lacked this experience.

The process of adapting the module by the teachers was an important element in building the ownership of the teacher towards the module. The adaptation stage included two goals, namely:

1. adapting the module to the class, considering the students' age, and the ability level of the class;
2. Adapting the module to the teaching sequence and deciding when exactly to teach the module, during the teaching sequence.

Those two goals are reflected in "R"'s explanations during the focus group:

> *During the adaptation process, I took into consideration the school type, the class size, and the students' knowledge. I have different schools and different types of students in each school. I built a template for the module and then made different adaptations for each class.*

Phase 3: Feedback from the Israeli PARSEL Team and Readaptation of the Module

The Israeli members of PARSEL read the modified module, added comments, and suggested changes and alternations. The main comment addressed the first and the last stages of the adapted module. The first stage of the module was given as group homework; the teachers were asked to set the scene during the lesson, in such a way that the social aspects of the subject would be emphasized. The sugge-

stion aimed at helping the students understand what main questions would be addressed in the module. The teachers were also asked to try to connect the closure of the module to this initial discussion.

The teachers added a class discussion at the beginning of the first stage. The discussion focused on teeth, and included questions regarding illness and aesthetic problems connected with teeth. The class discussion was followed by a group discussion regarding given questions that developed students' curiosity and different toothpastes were investigated. This stage was followed by a home survey (within the same groups) to determine what kinds of toothpastes were used by family and friends, and to check the ingredients of the different toothpastes. The teachers added questions addressing socio-scientific issues and questions that the students had raised at the opening discussion, for a closer examination of the module.

Phase 4: Feedback from the Israeli PARSEL Teachers and Readaptation of the Module

The teachers presented their module in front of the whole group of the Israeli PARSEL teachers and thus they received feedback. The two most important comments were related to the level of the activity and the assessment of the module. The group of teachers suggested that the activity level should be modified in order to fit the required level of the inquiry laboratory program[3]. They also suggested modifying the assessment tool by connecting it more closely to the activity.

The teachers accepted the two comments. They changed the module and its related assessment tool accordingly, and decided to circulate the detailed assessment sheet to the students at the beginning of the activity. They prepared two different instructions for students. The first, for students majoring in chemistry in which they adapted the instructions to the external inquiry laboratory demands, and another for students not majoring in chemistry, which focused on the everyday aspects of the module. In relation to this phase, "R" stated that:

> We work as a team, we share our opinions and we also share our final
> products. This is very important to me.

Case Study 2:"*Milk: Keep It Refrigerated*"

Phase 1: The original Greek module, "*Milk: Keep It refrigerated*" (developed by Tsaparlis, & Kampourakis) was described in the PARSEL website as follows: It is well known that milk and milk products are very important as food. In this activity, students learn about the composition of milk and various kinds of milk. In addition, they study and learn about the role of acidity in making milk sour, as well as the effect of temperature on increasing the acidity of milk. In addition, students prepare yogurt at home. Finally, a distinction is made between healthy food and non-healthy food products.

Phase 2: Choosing a Module from the PARSEL Website and Its first adaptation.

Two experienced teachers chose this module for tenth-grade students, because they liked the subject of milk and thought that the students would enjoy preparing

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3. Inquiry laboratory program: In Israel, an inquiry-type laboratory was implemented in the framework of the chemistry curriculum for high schools (Hofstein *et al.*, 2004).

yogurt and white cheese from milk In addition, they might find this module interesting and relevant to their life. One teacher explained that:

> "D": *I hope they will enjoy the milk module, because it includes the preparation of yogurt and cheese – two products they use in their everyday life.*

They planed to give the whole module as a home project for the spring vacation, and change the module accordingly. They took out the opening lesson and the last discussion, and kept only the part of the experiment and the scientific concepts.

Phase 3: Feedback from the Israeli PARSEL Team and Readaptation of the Module

The Israeli PARSEL team suggested adding back the deleted parts. We wrote that it is essential to raise the socio-scientific issue before giving the home assignment. The second suggestion was to close the module after the students finalized their home assignment by conducting a summary lesson in which the students would present their results, and refer to the initial issue that was raised in the opening lesson. We suggested that the part of the student evaluation should be based on student presentations, in addition to evaluating the home assignments. The teachers accepted these suggestions, and developed an opening class discussion for the first lesson, and a closing lesson for student presentations. Their choices were justified by stating that:

> Although, we heard in the first meeting about the structure of the modules, by adapting the module as a home assignment, we ignored the two parts that make the PARSEL module different from an ordinary science lesson. The specific comments from the PARSEL team helped us better realize the importance of these two parts, and thus we decided to put them back in our module.

The above paragraph was written by the teachers after they had mailed the module following the second adapting cycle. During the first phase of the process, they were introduced to the PARSEL philosophy and saw some examples of the structure of the PARSEL module, but their degree of ownership towards the PARSEL module was low, and they did not apply the new principles in the first module adaptation. However, receiving the comments for their own adapted module helped them to better conceptualize the PARSEL module and its different philosophy.

Phase 4: Feedback from the Israeli PARSEL *Teachers* and *Readaptation of the Module*

The teachers presented their module in front of the group of Israeli PARSEL teachers. In presenting the module, they called it "our module,"indicating the degree of ownership that they developed towards the module. The Israeli PARSEL teachers suggested adding an introduction for the pH concept after the opening lesson and before the students begin the home assignment. They thought that this module could be an excellent introduction to the teaching and learning of the pH concept. The teachers accepted the suggestion, and developed an experimental activity in which the students measure the pH of some substances that can be found in every home, such as, vinegar, baking soda, cola, and lemon.

As mentioned in the first case study, the phase in which the teachers presented their adapted module in front of the other PARSEL teachers had added value.

This stage transfered the ownership feeling from the teachers who adapted the module to the whole group. Indeed, one teacher, "L", from the group who was at that time teaching in an agricultural school, decided to adapt the module. She added an additional adaptation phase to fit the module to the special school, where she was a teacher and to her different classes.

An Additional Adaptation Phase

The first change "L" made was to adapt the activity to the younger students (seventh-grade students). She changed the name of the module to a more personal name *(Who will keep my milk?)*, divided the activities into more detailed steps, and justified her reasoning by stating that:

> *They [students] need more detailed instructions, they are young, like my grandson, and they don't have experience in lab work.*

She also deleted the group work for the home assignment, since her students had their homes far away from each other, and were unable to meet after school, as she explained:

> *I teach in a regional agricultural school… It is important to understand that group work beyond the school time is impossible!*

In addition to the chemistry concept of pH, which was introduced in this module, she added another chemical concept relating to the differences between mixtures and compounds in connection to preparing cheese and yogurt.

However, the most exiting change was related to the uniqueness of her school, an agricultural school, where "L" was teaching about a dairy farming. "L" decided to begin the module by teaching about a dairy and organized a visit to the school dairy, where her students saw the process of collecting milk, and could ask the school dairy farmer questions regarding the milk.

Teachers' Perceptions

We were interested in understanding the conditions leading to success using the "bottom-up" approach. Importantly, in the interviews with teachers, we found two main factors that positively influence developing teacher ownership.

1. The teacher feels that existing materials do not fulfill her/his expectations and has the desire to make a change (Van Driel, 2005).
2. The teacher personally values the philosophy and the learning goals of the new curriculum (Johnston, 1992).

"R", who taught three different modules of PARSEL, was asked to describe the motivation for becoming a PARSEL teacher. Two main reasons were raised during her interview. The first was her need to connect chemistry teaching to student life. She stated that:

> *This project [PARSEL] seems to have the potential to link chemistry with everyday life. These things can attract students to chemistry learning.*

She repeated this argument several times, and emphasized the link between students' enrollment and connecting chemistry to their life during chemistry classes. She said:

I always aim at connecting chemistry to everyday life in my teaching; I try to combine elements from everyday life in my explanations. Here [in the PARSEL project], I don't have to invent anything. All the materials exist and are ready to be used.

The PARSEL philosophy of connecting science teaching to students' lives and to make science learning more relevant to the students was found to be identical to the teacher's own philosophy. The teacher adopted this approach and applied it in her teaching before becoming familiar with the PARSEL project. Nevertheless, she appreciated the opportunity to use the PARSEL materials, since they represented a big database of materials that were written according to her philosophy, and were ready to be used in class.

At the end of the interview, another aspect was raised. The meetings of the PARSEL teachers created a community of practice, or a community of chemistry teachers that share a common philosophy, and work together to develop and adapt materials for their classes. She appreciated the opportunity to work in such a community, and simply stated:

Although I don't have much time, this project made me feel innovative, and most importantly, this work benefited others in the community. I made a lot of effort to arrive to the meetings, since I want to be a part of this community. I learned didactics from the group and feel that I have now a deeper understanding of the materials.

"L", who taught two different PARSEL modules, explained why she taught in her special school and tried out the PARSEL project. She was not satisfied with the official program of science, and believed that initially students should possess the necessary scientific skills, and only later they should learn scientific concepts. It should be mentioned that teacher "L" was not committed to implement a certain type syllabus. Thus, she could adapt modules, topics, and cognitive skills that she believed that were aligned with her students' interest, abilities, and their school environment.

I have built a very special program, not according to the official program. My program includes the basic concepts, and inquiry skills... This school emphasizes environmental and animal learning, I try to connect the chemistry lesson to those subjects. I always look for new teaching material that will help me to do so.

Her own philosophy of chemistry teaching was identical with the PARSEL view. Nevertheless, she appreciated the opportunity to use new materials that had the same approach to science education as her own. Thus, the teachers' course and focus group were very important to "L." She arrived to all meetings and was a very active participant.

When the milk module was presented by D. and S, I realized that I had found a perfect module for my students. Of course, I made some changes, but the idea came from the group. It is important to work with a group of teachers that share your beliefs about scienceteaching.

In the two case studies that are presented, the PARSEL modules underwent several phases of adaptation before the teachers adopted them to be their "own"

module. Each of the phases was important for increasing teacher's ownership. Nevertheless, the attitudes of the teachers was an important factor that influenced the development of teacher's ownership. In the two case studies, the teachers were ready for the adaptation process and were willing to introduce changes in their teaching, while they were also searching for teaching materials that could help them perform hanges. The PARSEL project met their expectations and answered their needs.

Student Perceptions

In addition, according to the feedback that we received from the students, students were more willing to learn following the PARSEL approach. We addressed some questions regarding students' perceptions of the PARSEL module that they had just studied: How did the students experience the PARSEL module? Did they see the module as relevant and interesting, and why? To what extent, if any, did the students experience other dimensions of PARSEL, such as, promoting scientific literacy, and cognitive skills, and using student-centered pedagogy and alternative assessment methods?

All students perceived the PARSEL module as relevant and interesting. During the interviews, all students clearly stated that they found the PARSEL module to be relevant to their life as well as enjoyable and interesting. Some examples from the student interviews are indicative of their perceptions regarding the key ideas of the PARSEL project:

Relevance:

It is connected to chemistry, but it is connected to life too.

   … Every time that you are told to brush your teeth, you want to learn what is going on in your mouth, you want to understand what is going on in there.

Interesting:

   It is more interesting than an ordinary class. You perform an interesting experiment. Everybody uses toothpaste.

Scientific literacy:

Most of the students discussed the elements of scientific literacy. They described the ways they were going to use in the future what they have learned. Students pointed out that they will be able to depend on their scientific knowledge in the process of making personal decisions.

   It can help us in many ways. When you buy something, you are sometimes influenced by commercials. So, if you want to know, you have to see, to investigate, before you choose Colgate or some other brand.

Summary

Students' perceptions are briefly presented in this paper (they will be published in detail elsewhere). They represent the students' attitudes towards learning the PARSEL modules. Students found the modules to be popular and interesting. They also felt that the key ideas underlying the PARSEL project were relevance and

science literacy. The students' reactions indicated that the PARSEL teachers maintained the PARSEL philosophy while teaching the modules.

The "bottom-up" approach helped the teachers to align their teaching with the philosophy and the teaching style of the PARSEL project. At the same time, the teachers adopted the modules to their own needs, their schools, and their students, and maintained their own professional identity. Each phase in the adaptation process increased the teacher's ownership towards the PARSEL project and its unique value aided in forming the modules before the teachers met the Israeli students.

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