

CHAPTER 19: TEACHING GLOBAL SCIENCE LITERACY: A PROFESSIONAL DEVELOPMENT OR A PROFESSIONAL CHANGE

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1. INTRODUCTION

Global Science Literacy is an alternative framework for the science education curricula. Like other (older) alternatives it emerges from the new "Science for All" paradigm, the constructivist movement and the Standards (Mayer, 2002; Mayer and Fortner, 2002). The current reform in science education joins several previous reforms, which started about forty-five years ago, while the world attention was brought to bear upon science education with the launch of Sputnik in 1957. Since that "wake-up" call science education policy worldwide has been focused on the need for new curricula, new instructional materials, new reforms, and new approaches to learning and teaching science. The development of the science education does not go in a linear gradual line. Rather, it goes through series of reforms that rise in cycles of about ten years. However, these reforms do not cause a punctual development, since they are characterized as what is called – the pendulum effect. This means that they do not have a pattern of a linear progression. Rather, in each decade, before the existing reform came to maturation, a new one that turned the science education field towards a different direction replaced it. There are several reasons for this pattern of reforming, but there is no doubt that teachers are a central factor for the success or failure of any educational reform.

2. THE CHARACTERISTICS OF A GLOBAL SCIENCE LITERACY TEACHER

The teaching strategies of Global Science Literacy are quite different from the traditional way of teaching science (Table 1).

Table 1. A comparison between the traditional science teaching and the GSL teaching

Traditional science teaching	GSL teaching
Prepare the future scientists of a society	Prepare the future citizens of a society
Disciplinary-centered teaching	Multidisciplinary teaching
A teacher-centered teaching	A child-centered teaching
Content-based teaching	Integration of skills within contents
The teacher is a source for knowledge/information	The teacher is a mediator for knowledge
"Chalk and talk" based teaching	Inquiry based teaching
School-based learning	Multi learning environments: Classroom, lab, outdoors and computer.
Teaching that is derived from the scientific world	Authentic based teaching derived from the real world

Traditional assessment	Alternative assessment
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For many traditional science teachers all over the world, the implementation of the new "science for all" programs in general and the Global Science Literacy approach in particular is not just a professional development. The meaning of professional development is that the subject of the development, in our case science teachers, have a very solid basis of their profession and from this professional core they can grow and expand. However, in order that teachers will move from the right column of Table 1 to its left column, even in relation to some of the six parameters, they have to change their goals, contents, ways and philosophy of teaching. Moreover, the shift presented in table 1 is valid for any genuine "Science for All" teaching, however the GSL teaching demands on top of it two additional new aspects for teachers: (a) Teaching earth systems subjects, which many science teachers in many countries have no scientific background and (b) the using of the outdoor learning environment, which is also ignored by most of the traditional science teachers. Thus, the shift from a traditional science teacher towards GSL teacher is not just a development rather it is a major reform or even a revolution.

It is suggested that at least in relation to the current "science for all" reform, the using of the term professional development is misleading and contributes to the difficulties of making a genuine change in teaching style and focus.

3. THE STUDY

During the last 10 years the author has invested a lot of time and energy within the "storm's eye" of the new Israeli "Science for All" curricula for the junior high school and for the high school. This intensive work has included participating in the committees that designed the new "Science for All" curricula; taking a central role in a team that has developed learning materials for these two programs; leading and taking a practical role in hundreds of in-service training hours in each of the last 9 years both in in-service training centers and in the teachers' schools and classes. Moreover, the main goal of those in-service training programs (INST) was to introduce the new "Science for all" approaches and curriculum materials including some aspects Global Science Literacy.

During our long-term study we explored several models of INST programs. These models were designed for helping or in many cases to push science teachers to adopt new strategies that are in agreement with the "Science for all" approach and to implement the new learning materials that were specifically developed for the new program. More specifically the study was focused on two types of long-term in-service training courses. Both types were designed for 720 hours (one day a week over 3 school years). The first type included INST programs that were conducted in regional teacher centers established countrywide, while the second type included school-based programs. Each of the courses in the regional centers consisted of about 20 teachers who came from different schools. Since only rarely the whole science teachers' team arrived to the course, the working within the schools was

limited and the teachers were expected to update their colleagues and to convince them to adopt the new approaches and learning materials.

The second type was an in-schools INST program. This program included the whole science teachers' team and focused on implementing new strategies and curriculum materials through working with the teachers in their classes in real time. The in-school INST was based on a holistic approach of dealing with all the aspects of implementing a reform within the school. Before, implementing the INST the head master of the school had to commit to be part of the INST and to work together with the teachers to solve problems such as equipment, teaching hours and resources for outdoor activities. Another aspect of this INST was supporting the teachers in their first steps of implementing new teaching methods and new contents and psychological support in order to deal with the initial resistance of the teachers towards major changes.

The data collection included qualitative and quantitative methods and was based on research tools such as questionnaires, interviews and observations. These were conducted as action research in the format of a participant observer and as a part of four PhD dissertations (Kali, 2000; Dodick, 2000; Ben-zvi-Assraf, 2003; Kapulnick, 2003) and one Master thesis (Midyan, 2003). These different studies explored all together about 1000 science teachers and their classes. Most of the studies were conducted with the junior high school level, but also included teachers and students from the elementary and the high school levels.

In addition to the teachers and the students the different studies covered other components and processes of the reform system such as principals, superintendents, curriculum developers, the academic science education establishment, the ministry of education establishment, in-service training programs and pre-service teachers programs.

4. RESULTS

It was found that the initial attitudes of most of the science teachers were positive towards the goals and teaching methods, which are related with the "Science for all" approach. However, at the same time, most of them were uncertain and some even presented negative attitudes towards four aspects of the science for all reform namely the integration of science, technology and society together; Conducting "out of classroom learning"; Combining the computer as a significant learning tool; Integrating the earth sciences as an integral part of the new curriculum.

It was found that most changes during and following the training program in the regional centers were expressed by replacing previous books with new books, while all the four aspects mentioned above remained unclear to the teachers during all three years of the training program, no matter in what program they participated and in which center the program took place. Moreover, the attitudes of those teachers were not found to be altered by their teaching experience, background, gender and their training levels in the regional centers.

The visits and observations of the above population of teachers indicated a gap between their declared practice as expressed in their questionnaires and

interviews and their actual practice in classrooms. This gap was especially clear in regard to their implementation of new teaching methods and new topics (subject matter).

The initial attitudes of the teachers who participated in the in-school long-term INST program were very similar to the other group of teachers. However, a meaningful change was found among them in relation to both their attitudes and the in practice implementation of new teaching methods and new topics (subject matter). These changes were remarkably found in their adoption of earth systems based learning materials and the use of the outdoor as a learning environment.

The study identified three factors, which are involved in the current difficulties of implementing the new reform: the science teachers, the science education leaders and the bureaucrats and politicians who lead the Ministry of Education.

In addition to the difficulties of the teachers to implement new teaching methods and to deal with new scientific topics, the interviews with the teachers revealed four additional factors, which prevent them from a genuine implementation of a new reform. These factors are: (a) an apprehension for changes (b) their feeling that the INST that took place in the out of school regional centers environments did not provide them with practical tools that can help them to overcome their apprehension of moving towards the unknown. (c) The lack of support that they have from the school management, which did not provide them the needed resources for adapting new teaching strategies such a laboratory equipment, computers, a reasonable number of students for working in a laboratory, resources for using the outdoor learning environment and reasonable amount of teaching hours. And (d) A double standards messages from the Ministry Education in general and more specifically from their science education inspectors. The teachers claimed that they were confused, since on one hand the Ministry of Education initiated the reform and their inspectors encourage and push them to participate in the regional centers' INST program, but at the same time the Ministry of Education do not provide them with the needed resources and the inspectors implemented a national testing regime, which was the antithesis of the new "Science for All" approach. Many teachers also claimed that they feel that their inspectors do not really favor the new reform. In the teachers' meetings the inspectors use the slogans and the "buzz words" of the new paradigm, but when it comes to concrete practical issues, those teachers feel that they still hold the perceptions of the former paradigm, which they grew up on.

4. DISCUSSION AND CONCLUSIONS

The findings above definitely suggest that the "Science for All" reform is not just a professional development for the Israeli science teachers. For them it is a paradigm shift and many (actually most) cannot or do not really want to undergo such a huge change. There are two main inhibitions that prevent science teachers from making such a change. One inhibition is their professional background. The author, is well aware of the apolitically correctness of such statement and therefore it is very important to make clear that the teachers themselves are not to blame. They

themselves are victims of the system where they grew up as students and teachers. Actually, the teachers are a product of a vicious circle. This circle started a long time ago with their school teachers who had poor teaching skills, continued with their pre-service training that did not provide them with a powerful and effective modeling of teaching. Thus the continue to imitate their school teachers. Unfortunately, the out of school INST model was also ineffective, since it did not provide the teachers with the practical support and the psychological support they needed to break this vicious circle.

Our findings suggest that the in-school INST model is more effective in conducting professional change when it includes the following components:

1. At the first stage the teachers have to experience the new methods and contents as learners. Positive experiences as learners will help both to be convinced of the effectiveness of the new paradigm and later to deal with their students' learning difficulties on the basis of their difficulties that they experienced as learners.
2. The school's management should be an integral part of the INST and to take the commitment for facilitating the implementation of the new reform.
3. The first teaching experiences of the new methods of contents should be done with a close support of the INST experts.
4. The INST leaders should be equipped with psychological knowledge and skills to deal with reservation and oppositions, which are the result of a change fear.

Our findings also suggest that even the most powerful and effective INST alone cannot guarantee a long-term sustainable reform. Unfortunately, education in Israel (as in many other countries) is controlled by economic and political decisions and not by pedagogical decisions. Thus, in order to lead the teachers to such a paradigm shift a lot of resources should be invested during a long period of at least ten years. However, in addition to the policy makers unwilling to allocate the needed resources, a genuine conceptual change cycle is much longer than a political cycle (the time from election to election). Therefore, the process never comes close to maturation.

It is suggested that the heart of the problem is the science education leadership. This leadership has the duty to educate the teachers and to convince the Ministry of Education to invest the needed resources. Thus, the failure of the science education reforms is primarily the failure of the science education leadership. The following reasons might be suggested as the main cause for this long-standing failure:

1. Many leaders never served as science teachers or they did it many years ago. So they can say what should be done, but they cannot show how to do it.
2. Many science educators do not have the social/psychological knowledge and skills needed to lead human beings towards a major change.
3. There are great models of professional development, but their effectiveness is too local. It seems that we are more successful to enhance professional development with professionals. Thus, unless we realize that most of our target population is not professional, we will continue to miss our target.
4. The development and maintenance of the science education establishment is heavily dependent on constant reforms' regime.
5. Most of the academic leaders grew up and based their career on the previous paradigm. Many of them fail to lead a genuine paradigm shift because of the following reasons:

- Some jumped on the wagon, but without genuine internalization of the meaning of the slogans such as “educating the future citizens”, “science for all” etc.
- Some cynically use the new slogans for perpetuating what they really believe and
- Some do not believe in the new paradigm and therefore become as a Trojan horse for its failure.

It is very important to note that the author of this chapter does not blame any of the above groups namely teachers, academic science educators, the Ministry of Education bureaucrats and policy makers for sabotaging the reform. However, it is to analyze this situation not by cognitive psychology tools, but through psychoanalysis tools. According to the psychoanalysis many aspects of the individual's behavior is controlled by her/his subconscious and by his/her conscious. Moreover, it is also well known amongst psychologists that it is very difficult to promote changes amongst individuals. According to some psychological approaches the first step for change is the understanding of the gains of resisting the change and holding to old behavior. So, what might be the gain of the three above groups of investing so much money and energies for decades in talking and walking towards the long awaited change but not getting there?

Science educators (academy): The development and maintenance of the science education establishment is heavily depended on constant reforms' regime.

Teachers: They agree that changes are needed, but not from their end. There is a huge gain in the stand that if everything is against me (Ministry of education, principals, students, parents), what ever I could do in my class is a great achievement. It is not my fault and therefore it is not my responsibility. For them to admit that they need to change means that they take responsibility of what happened in their classes. A responsibility is a huge burden and leaving without a responsibility is a huge gain.

Policy makers/politicians: The most common way for a politician to show success is by making reforms. By that they transmit two messages: a) Look, we are doing something and b) we fix the faults of the previous Minister – they are the responsible of the problems that we have today, so please be patient since fixing all their faults will take time.

There is no doubt that this chapter is far beyond being politically correct. However, everything that appeared above is based on solid data. It is time for the science education establishment to look into the mirror and to take responsibility for the almost 50 years of failing reforms. In order to implement a reform we should adopt and internalize the following elements:

1. To stop the “Dissonance” syndrome and to face and internalize the reality.
2. To consider teaching as a real profession.
3. To bridge the gap between theory and practice.
4. To adopt a system approach for teachers' professional change.

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