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A PROFILE OF PRE-COLLEGE CHEMISTRY TEACHING IN BEIRUT[1]

Zalpha Ayoubi

Saouma BouJaoude

ABSTRACT. The purpose of this study was to answer the following questions: 1) How well prepared are chemistry teachers in terms of content and pedagogy, 2) What are chemistry teachers trying to accomplish in their teaching and what activities do they use to meet their objectives and 3) What are the barriers to effective chemistry teaching identified by teachers? Eighty six teachers from 39 public and private schools participated in the study. Data for the study came from teachers' responses to questionnaires and records of two classroom observations per teacher. Results showed that the majority of teachers had university degrees, two-thirds majored in chemistry, only 50% had teaching credentials, and most teachers did not have enough training to use computers in their classrooms. Finally, results related to classroom practices indicated that Lebanese chemistry teachers emphasized academic objectives and perceived the purpose of school chemistry as preparation for higher studies.

KEYWORDS. Chemistry Teaching, Teacher Preparation, Barriers to Effective Teaching, Teaching Practices, Teaching Activities.

INTRODUCTION

Lebanon is presently in the midst of an educational reform that started shortly after the end of a fifteen-year civil war (1975-1989). The most important outcomes of this reform included an operational reform plan (1994), a new educational ladder (1995), and new curricula and textbooks for all school subjects, including science. In addition, the reform entailed a series of comprehensive teacher training activities that covered the privates and public sectors nationwide.

According to the national Center for Educational Research and Development (CERD) (1995), the old curriculum has neither met societal needs nor prepared students properly for the future. This is primarily due to the fact that the curriculum was outdated, lacked general and specific objectives, and was mainly focused on the theoretical rather than the practical aspects of knowledge (CERD, 1995).

The outcomes of the educational reform initiatives are currently being evaluated and revised in light of feedback from all stakeholders in the reform. Eventually, the evaluation will

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result in recommendations for change that will be studied and institutionalized after being scrutinized by the appropriate committees and institutions within the Ministry of Education. Concurrently, the Education Development Plan, which is a five- year plan, 2002-2007, funded by a grant from the World Bank, is now well underway. This plan has three components pertaining to the development and administration of the educational system, leadership development, assessment and evaluation, and education infrastructure. The leadership development, assessment, and evaluation component includes three sub-components: a) development of school principals, b) teacher training, and c) assessment.

Science attracted increasing attention in the 1995 Lebanese Educational Reform Plan. For example, the number of hours apportioned to science has increased in the new educational ladder. Biology, chemistry and physics are taught as separate subjects starting in Grade 7, and an issues-oriented science curriculum, labeled "scientific literacy", is being implemented for those students who do not choose science at the secondary level. Moreover, the Science Curriculum Committee that was commissioned by CERD to design and write the new curriculum has decided to give emphasis to hands-on and minds-on science learning (Author, 2002). The current Lebanese curriculum stipulates that chemistry be taught as a separate subject starting at the Grade 7 level. The number of periods of chemistry per week is presented in Table 1.

Table 1. Number of Periods per Year of Chemistry at Each Grade Level of the Lebanese Educational System

Grade	**7**	**8**	**9**	**10**	**11**		**12**			
					S	H	GS	LS	SE	LH
Number of periods per week	1.5	2	2	2	3	1	4	5	1.33	1
Number of periods per years	45	60	60	60	90	30	120	150	40	30

S = Science, H = Humanities, GS = General Sciences, LS = Life Sciences, SE = Sociology and Economics, LH = Literature and Humanities.

Alongside the efforts to reform the Lebanese educational system, there has been some activity in educational research, in general, and science education research more specifically. A comprehensive review of the science education literature in Lebanon between 1992 and 2002 (Author & Abd-El-Khalick, 2004) reveals several limitations in this body of literature. First, even though at least ten universities in Lebanon offer undergraduate and/or graduate degrees in education, the number of empirical studies conducted in these universities is rather small. Actually, the vast majority of the empirical studies in the review came from two universities, the American University in Beirut and the Lebanese University. Additionally, this body of research is poorly disseminated. Only about one third of all reviewed studies were published in accessible resources including refereed journals, international databases, book chapters, and conference proceedings. The rest of the studies were theses or projects available in university libraries with limited access. Moreover, research conducted in Lebanon is limited in terms of its exclusive focus on intermediate and secondary school students. Only a handful of the reviewed studies

focused on elementary students. Another limitation is that several of the reviewed studies did not have substantial mass. For instance, several of the studies that examined science textbooks were limited to the analysis of a few chapters from a single textbook. Finally, there was a clear lack of studies focusing on documenting and investigating classroom practices related to science teaching and of large-scale national studies that aim, for example, to implement and assess curricular innovations or generate comprehensive reports on the status of science education in Lebanon. This is despite the fact that investigating teachers' classroom practices and the possible links of these practices to student academic performance might provide insights into improving the quality of science teaching and learning at all educational levels as suggested by Anderson and Helms (2001), She (1999), Princeton (2000), and Wenglinsky (2000).

On the international scene a number of educational research projects have investigated science teachers' classroom practices. One of the established projects is the large scale National Survey of Science and Mathematics Education, conducted in the USA over a number of years to gauge the status of science and mathematics education in the USA. Reports from these studies written by Weiss (1987, 1988, 1994), Weiss, Banilower, McMahon, Kelly & Smith (2001), and Weiss, Pasley, Smith, Banilower & Heck (2003) have attempted to answer the following questions using data from questionnaires distributed to stratified random samples of teachers from all states in the USA: 1) How well prepared are science and mathematics teachers in terms of both content and pedagogy? 2) What are teachers trying to accomplish in their science and mathematics instruction, and what activities do they use to meet these objectives? 3) To what extent do teachers support reform notions embodied in the National Research Council's *National Science Education Standards* and the National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics*? And 4) What are the barriers to effective and equitable science and mathematics education? It is worth noting that no classroom observations were conducted in these studies and all data sources were based on teachers' self reports.

Analysis of the trends between 1993 and 2000 in the above studies showed that science teachers' classroom practices have seen some changes. These changes include the reduction in the amount of time spent on reading about science during class and doing textbook/worksheet problems. Approximately 50% of teachers at all grade levels reported in 2000 that their students completed textbook/worksheet problems in the most recent lesson, representing a small decrease from 1993. Moreover, while there was some increase in the use of hands-on activities at the Grade 1-4 level (from 41% to 50% of classes), the percentage of classes in which hands-on and laboratory activities took place have remained stable and amounted to approximately two thirds of the classes. There does not seem to be a change in the percentage of classes in which computers were used: teachers reported that 10 percent or fewer science lessons included students using computers in 1993 and 2000. However, many more teachers reported using other instructional technologies such as CD-ROMs in 2000 than in 1993.

Another international project that has investigated science and mathematics teachers classroom practices in science and mathematics is the TIMSS 1999 video study, the science results of which were released in 2006 (Roth, Druker, Garnier, Lemmens, Chen, Kawanaka, Okamoto, Rasmussen, Trubacova, Warvi, Gonzales, Stigler, & Gallimore, 2006). This study examined patterns of science and mathematics teaching practices in 439 videotapes of eighth grade science lessons in five countries: Australia, the Czech Republic, Japan, the Netherlands, and the United States. Results of the study showed that there were variations across the five countries in the organization of science lessons, development of science content for students, and student involvement in doing science. For example, the study results showed that students in the Czech Republic were required to master challenging and theoretical science content and that classes were mostly focused on talking about science in whole class settings. In Japan the focus was on presenting science in conceptually coherent ways while stressing the identification of patterns, making connections among ideas, and the interplay between evidence and ideas in an inquiry-oriented approach to teaching. Australian students were mostly involved in making connections between ideas, evidence, and real-life situations using inquiry approaches to teaching similar to those used in Japan. Students in the Netherlands were held accountable for independent learning of science content with emphasis on homework and independent seatwork. Finally, in the United States students experienced variety in instructional approaches, organizational structures, content, and activities with less emphasis on developing coherent science ideas and content. The focus of the activities was on engaging and motivating students rather than on developing challenging content knowledge.

As evident from the above, there is important research on classroom practices being conducted worldwide; research that has the potential to provide useful recommendations for improving science teaching and learning. Even though the Lebanese Association for Educational Studies has conducted a number of research projects that aimed to evaluate the Lebanese curriculum[2] , there is a conspicuous absence of research in Lebanon on teachers' backgrounds, classroom practices, and barriers they face during their teaching; research that has the potential to provide information that is necessary, among other things, for planning teacher training programs and for evaluating the results of implementing new curricula. Consequently, there is a need for research to answer the following questions: 1) How well prepared are chemistry teachers in terms of content and pedagogy, 2) What are chemistry teachers trying to accomplish in their teaching and what activities do they use to meet their objectives and 3) What are the barriers to effective chemistry teaching identified by teachers?

A basic premise behind the present study is that educational systems are extremely complex, and a full understanding of all their components is beyond the scope of this investigation. However, we have adopted a simplified conceptual model of educational systems used by the National Research Council Committee on Indicators of Pre-college Science and Mathematics Education (Weiss, 1988) that considers teachers' quality and quantity and

[2] See the LAES (Lebanese Association for Educational Studies) (2000-2003). Evaluation of the Lebanese Curriculum (unpublished report). Beirut, Lebanon: UNESCO, Regional Office for Education in the Arab States.

curriculum content as inputs, instructional factors as processes, and student achievement as the primary outcome of any system. This study focused on studying two components of the model, namely science teachers' quality and instructional processes.

METHOD

Sample

The sample for this study was drawn from the greater Beirut area and used a two-stage probability sampling design with schools as the first stage of sampling and teachers as the second stage sample. Schools were classified into private and public, and each was classified into five types: 1) Schools including elementary and intermediate classes (Elementary/Intermediate); schools including intermediate and secondary classes (Intermediate/Secondary); schools including intermediate (Intermediate); schools including secondary (Secondary); and schools including elementary, intermediate and secondary classes (All Levels). A 25% probability sample from each school type was selected for inclusion in the study. The list of schools in the greater Beirut area available from CERD was used in this process (CERD, 2003).

The second stage sampling involved selecting chemistry teachers from the selected schools at the intermediate and secondary levels because these are the levels at which chemistry is taught as a separate subject (Table 1). For this purpose, a list of teachers at each level from each school included in the sample was acquired and up to two teachers from each level was randomly selected for participation in the study. These teachers were asked to fill out a questionnaire designed for the purposes of the study. Then, one or two teachers from each school at each level were randomly selected for in-depth observation for two teaching periods. A special observation log designed for the purposes of this study was used for observation.

Eighty six teachers (73% females and 27% males) from 39 schools (50% public and 50% private) participated in the study. Teachers' ages ranged from 22 to 62 years with an average age of 41 years. The number of years of teaching experience ranged from 1 to 38 years, with an average of 16 years. Finally, the number of periods taught per week ranged from 6 to 38, with an average of 20 periods.

All 86 teachers who participated in the study filled out the questionnaires. Sixty-one teachers from 29 schools agreed to be observed resulting in 114 classroom observations. Fifty-three of the teachers were observed twice while eight were observed once. Approximately, 54% of the observations were in classes that used English as the language of instruction while the rest of the classes used French. It is worth noting that the observations showed that approximately 57% of the teachers used Arabic, the mother tongue of most students, for more than 50% of the time. Table 2 presents details regarding the schools and teachers who participated in the study.

Table 2. Number of Schools and Teachers participated in the Study.

	School education level					
School type	**Elem/ Inter.**	**Inter. /Sec.**	**Inter.**	**Sec.**	**All levels**	**Total**
Public	7	7	3	3	0	20
Private	0	9	1	0	9	19
Total schools	7	16	4	3	9	39
Number of teachers responding to questionnaire (Public)	12	16	6	9	0	43
Number of teachers responding to questionnaire (Private)	0	20	2	0	21	43
Total number of teachers responding to questionnaire	12	36	8	9	21	86
Number of teachers observed (Public)	8	10	6	7	0	31
Number of teachers observed (Private)	0	10	2	0	18	30
Total number of teachers observed	8	20	8	7	18	61
Number of observations (Public)	15	19	12	14	0	60
Number of observations (Private)	0	15	4	0	35	54
Total number of observations	15	34	16	14	35	114

Elem: Elementary Inter: Intermediate Sec: Secondary

Instruments

A questionnaire and an observation log were used to collect data in this study.

Questionnaire: A questionnaire entitled "Intermediate and secondary teachers' questionnaire" was designed for use in this study. The questionnaire was modeled after those used by Weiss (1987, 1988, 1994) to investigate the status of science education in the United States. In addition, elements of a questionnaire used by Author (1987) in studying the needs of teachers regarding the teaching of science in Cincinnati, Ohio were incorporated in the questionnaire.

The questionnaire included six sections. The first section asked teachers for background information regarding their sex, age, and years of teaching. The second section asked teachers to comment on chemistry teaching and identify the barriers to effective science teaching in their schools. In the third section, teachers were asked specific questions about a particular chemistry class of their choice. In the fourth section, teachers were asked questions about a recent chemistry lesson. In the fifth section, teachers were asked about their preparation in science content and pedagogy and about in-service opportunities available to them. Finally, in section six teachers were asked about their involvement in professional development activities.

The questionnaire was written in English and then was translated into Arabic. The English and Arabic questionnaires were then piloted with a number of teachers who were asked

to evaluate the content and ease of understanding of the questions. In addition, a number of general education and science education faculty members at two universities in Lebanon were asked to judge the adequacy and appropriateness of the questions. The pilot study showed that all the questions were understandable by the teachers involved in the pilot study. Moreover, the general and science education faculty who judged the questionnaire indicated the questions were appropriate for teachers.

Observation Log: A special observation log was developed to be used as a guide during the observation stage of the study. The log focused on instructional activities performed by the teacher such as lecture, discussion, teacher demonstration, students' use of hands-on or laboratory materials, students' working in small groups, students working on worksheets, and students doing assigned work from textbook, among other activities.

Data Analysis

Frequency counts and percentages were computed for each of the variables used in the questionnaire to answer the research questions and construct a profile of chemistry teachers in terms of their instructional practices and the perceived barriers to effective science teaching. Analysis of the data from the observation log involved searching and categorizing teachers' activities during the lesson. The first round of categorization resulted in a large number of categories which were reduced in a second round of analysis into four main categories: Teacher-dominated activities, student-dominated activities, interactive activities, and managerial activities. Data regarding teacher- and student-dominated activities were subdivided to 4 and 8 subcategories respectively. Table 3 presents the categories and subcategories used in data analysis.

Table 3. Categories and Subcategories Used in Data Analysis

1. Teacher-dominated Activities
Teacher talking, writing, reading, etc.
Teacher solving problems
Teacher using lab equipment/demonstrating
Teachers using computers
2. Student-dominated Activities
Students doing seat work, worksheets and solving problems, etc.
Students using lab equipment
Students using computers
Students working in groups
Students taking notes
Students writing on the board
Students watching TV
Students taking tests
3. Interactive Activities
Discussion, asking and answering questions, recitation, revision, students explaining or presenting work, students summarizing, students expressing understanding, etc.
4. Managerial Activities
Teacher enforcing discipline, praising a student, checking students' work, distributing and collecting papers, wasted time, etc.

RESULTS

The following sections provide answers to the three questions of this study. These questions investigated teacher preparation in content and pedagogy, Teachers' accomplishments when teaching, and Barriers to effective teaching.

Teacher preparation in content and pedagogy

To answer Question 1 (How well prepared are chemistry teachers in terms of content and pedagogy?), data from the sections of the questionnaire concerning pre-service and in-service education in terms of chemistry content and pedagogy is considered. Data concerning teacher preparation indicate that approximately 93% of the teachers who participated in the study held a bachelor's or license degree, and 7% held a graduate degree. Sixty seven percent majored in chemistry and biochemistry, 23% in biology and 10% in physics, math, health sciences, or other science related areas. Fifty one percent of the teachers had teaching credentials, 55% of whom held teaching diplomas in secondary education, 16% held graduate degrees, while 29% held intermediate or elementary teaching credentials.

With regard to the types of chemistry courses teachers have taken, responses show that

almost 93% of the teachers said that they took general chemistry and organic chemistry courses, 81% took inorganic chemistry, 70% took biochemistry and analytical chemistry, and 60% took physical chemistry. In addition to the chemistry courses, 65% of the teachers said that they took physics courses, 55% took math courses, and 45% took biology courses. Concerning the types of education courses that students took, 62% said that they took general methods courses, 43% took teaching science at the intermediate level and 36% took teaching science at the secondary level, 55% took educational psychology courses, 26% took computer related courses, and 42% said that they participated in student teaching. Teachers also reported that they all took chemistry courses and that 76% of them took six courses or more, 91% took physics courses, 86% took math courses, 42% took computer science courses and 36% took earth science courses (Table 4).

Table 4. Percentage of Courses Completed in Different Subject Areas

	None (%)	1-5 courses (%)	6-8 courses (%)
Chemistry	0	24	76
Biology	36	26	38
Physics	9	71	20
Earth Science	64	30	6
Math	14	71	15
Computer Science	58	42	0

Data concerning in-service professional development revealed that 37% of the teachers have not had any in-service training in science or teaching of science activities in the past 12 months, 40% said that they have spent between 6 and 15 hours on in-service activities, 14% spent between 16 and 35 hours, and 9% spent more than 35 hours. One significant fact reported by all the teachers was that they took no formal chemistry courses since graduating from the university. When asked specifically about their readiness to use computers in their classrooms, 55% said that they felt unprepared and 19% felt that they are well prepared. Additionally, 45% said that they had not been involved in any computer training and 47% said that they had received some training on the use of computers during the last 12 months either by taking college courses (13%) or by participating in in-service workshops (34%) while thirty six percent reported that they taught themselves to use the computer. Moreover 92% of the teachers reported that they had no training in teaching handicapped children. Specifically, 87% felt they are totally unprepared to teach mentally retarded children, 64% to teach physically handicapped children and 59% to teach children with learning disabilities.

When asked about specific topic in chemistry they find difficult to teach, 62% said they did not have any difficulty while the other 38% reported that different topics were difficult such as atomic structure and chemical bonding to chemical equilibrium, kinetics, electrochemistry, polymers, enantiomers and new materials with no more than 5% of the teachers reporting difficulty in any of these topics. Forty nine percent of the teachers indicated that learning more about the basic concepts would be most useful in helping them teach a difficult topic while 57%

said that leaning more about the applications of these concepts in daily life, careers and technology would be helpful. Similarly 65% said that learning more about teaching materials and techniques would be more helpful.

Ninety one percent of the teachers reported that they would use research if they needed more information about a special topic in education, 87% said they would attend in-service programs and 73% would attend college courses, 82% would consult other teachers, 48% would consult principals, 68% would use magazines or journals and 48% radio and television. Finally 8% said that they would consult books and 19% would use computers and the internet.

In general chemistry teachers said that they enjoy teaching chemistry (96%), think that laboratory-based classes are more effective than non-laboratory classes (91%), hands-on experiences are worth the time and expenses (89%) and that chemistry is not a difficult subject for children to learn (80%). Moreover, when asked about the use of instructional resources other than the required textbooks, 47% said that they used other textbooks, 10% that they used the internet or electronic recourses, and 6% said that they collected extra sets of problems from a variety of sources. The rest said that they did not use any extra resources. When asked about usefulness of science journals, 46% indicated that journals were helpful but only 13% said that they had referred to science or science education related journals during the past 12 months.

Teachers' accomplishments when teaching

To answer Question 2, (What are chemistry teachers trying to accomplish in their teaching and what activities do they use to meet their objectives?) data is presented about the objectives that teachers are trying to accomplish, the nature and time spent on different types of activities, the time spent on using textbooks and teachers' perceptions of the utility and necessity of these textbooks, and the types of activities that involve using computers.

Objectives that chemistry teachers are trying to accomplish

Table 5 shows that approximately 97% of chemistry teachers in this study place moderate to high emphasis on teaching students basic chemistry concepts, this is followed by 95% who say that they attempt to promote interest in chemistry, 94% percent who emphasize on developing a systematic approach to solving problems, and 92% who stress preparation for further studies in chemistry. Moreover, between 83% and 88% of the teachers think that laboratory safety, developing inquiry skills, learning to communicate, and awareness of the role of chemistry in daily life are important objectives. Between 72% and 76% of teachers consider developing laboratory skills, understanding application of chemistry in technology, and career relevance of chemistry as important aims of chemistry teaching. Finally, only 38% of teachers think that learning about the history of chemistry is an objective worthy of being emphasized in the curriculum.

Table 5. Degree of Emphasis Teachers Place on Different Types of Chemistry Teaching Objectives

	Minimal Emphasis (%)	Moderate Emphasis (%)	Heavy Emphasis (%)
Learn basic chemistry concepts	3	18	79
Develop awareness of safety in laboratory	17	18	65
Develop a systematic approach to solving problems	6	31	63
Develop inquiry skills	13	26	61
Become interested in chemistry	5	36	59
Learn to effectively communicate ideas in chemistry	13	29	58
Become aware of the importance of chemistry in daily life	12	31	57
Prepare for further study in chemistry	8	44	48
Develop skill in laboratory Techniques	24	29	47
Learn about applications of chemistry in technology	28	29	43
Learn about the career relevance of chemistry	28	33	39
Learn about the history of chemistry	62	30	8

Activities teachers use to accomplish their objective

Data from the questionnaires (Table 6) indicate that teachers spend on the average 8% of the time in each period on routine tasks such as enforcing discipline, checking homework, and distributing and collecting assignments. In addition, approximately 28% of the time is spent on teacher-centered activities, mainly lecturing and disseminating information, while approximately 50% of the time is spent on student-centered activities such as performing hands-on tasks (25%), reading from the book (11%), and taking tests (14%). Finally, on the average 14% of the time is spent on interactive activities such as discussion, recitation, and asking and answering questions.

Data from the observations (Table 6) indicate that approximately 35% of the time is spent on teacher-centered activities, 31% on student-centered activities, 24% on interactive activities, and 10% on routine tasks. Further in-depth analyses reveal that teacher-centered activities mainly include lectures during which teachers disseminate information rarely using demonstrations or computers. The in-depth analyses also show that student-centered activities are almost equally divided among taking notes, doing seatwork, and solving problems on the board, with rare instances of group work, laboratory activities, and using computers.

Table 6. Percentage of Time Spent on Different Categories of Activities as Revealed by Classroom Observations (N=114) Compared to Teachers' Responses on Questionnaires (N=70)

Activities	Questionnaires	Observations
Teacher centered	28	35
Student centered	50*	31
Interactive	14	24
Managerial	8	10

*Hands-on: 25%, reading: 11%, testing: 14%.

Teachers' use of textbooks

Approximately 81% of the teachers responding to the questionnaire said that they usually finish 75% or more of the textbook while only 6% finish less than 50% of the book. Table 7 also reveals that more than 70% of the respondents consider the language of the book easy and at an appropriate reading level for the students. Although 66% of the respondents agree that the textbook explains concepts clearly, 75% said that it needs more examples to reinforce concepts. More than 50% of the respondents said that the book contains examples not relevant to students' experiences, lacks examples of the use of chemistry in everyday life, provides good suggestions for activities and assignments, helps develop problem-solving, and is clear and organized. Almost one third of the teachers indicated that the textbook they use has high quality supplementary materials and provides applications of chemistry in careers and 45% considered the book as not very interesting to students.

Table 7. Teachers' Opinions of the Chemistry Textbook

	Agree	No opinion	Disagree
Is at an appropriate reading level for most students	74	5	21
Uses easy language for students	71	6	23
Explains concepts clearly	66	10	24
Needs more examples to reinforce concepts	75	2	23
Contains examples not relevant to students' experiences	32	11	57
Lacks examples of the use of chemistry in daily life	35	10	55
Provides good suggestions for activities and assignments	51	12	37
Helps develop problem-solving	52	11	37
Is unclear and disorganized	32	14	54
Has high quality supplementary materials	35	14	51
Shows applications of chemistry in careers	38	19	43
Is not very interesting to students	45	20	35

Teachers' use of computers

Approximately, 70 % of the respondents said that computers are not available for use in the chemistry classrooms and this percentage increased to 91% when those who said that computers are available but difficult to access were included. Only 12% of the respondents (10 teachers) reported that they use computers in the chemistry classroom. Seven out of these teachers said that they use computers for teaching science content, 4 as a laboratory tools, 3 for simulating scientific processes, and 1 to perform problem-solving activities. It is worth noting that none of the teachers said that they use computers for drill and practice and games. In addition, 2 respondents mentioned that students use computers to conduct research and prepare power point presentations. As for the time students spent working with computers during one week, two teachers reported less than 15 minutes and one 15-29 minutes.

Barriers to effective teaching

To answer Question 3, (What are the barriers to effective chemistry teaching identified by teachers?) data mainly comes from a number of questions that asked teachers to identify the barriers that hinder effective chemistry teaching.

As can be seen in Table 8, more than 90% of the respondents think that inadequate language proficiency among students, lack of sufficient time to teach chemistry, and lack of materials for individualizing teaching are somewhat of a problem or serious barriers for effective chemistry teaching. Other barriers identified by between 80% and 86% of the teachers included the language used for teaching, lack of student interest in chemistry, inadequate curriculum coordination across grade levels, inadequate facilities, and lack of funds to purchase equipment and supplies. Finally, between 74% and 79% of teachers said that student absenteeism, large class sizes, perception that chemistry was not an important subject, disciplinary problems, and poor quality textbooks were barriers to effective chemistry teaching. It is noteworthy; however, that only 55% of the teachers thought that inadequate access to computers did not constitute barriers to effective teaching.

Table 8. Teachers' Perceptions of the Barriers to Effective Chemistry Teaching

	Serious Problem	Somewhat a Problem	Not a Significant Problem
Inadequate student language proficiency	57%	36%	7%
Not enough time to teach chemistry	57%	34%	9%
Lack of materials for individualizing teaching	38%	52%	10%
Language of chemistry teaching	43%	43%	14%
Lack of student interest in chemistry	47%	38%	15%
Lack of teacher planning time	61%	21%	18%
Inadequate coordination of teaching across grade levels	34%	49%	17%
Inadequate facilities	42%	39%	18%
Insufficient money to purchase equipment and supplies	36%	45%	19%
Student absences	44%	35%	21%
Class sizes too large	54%	24%	22%
Belief that chemistry is less important than other subjects	30%	47%	23%
Difficulty in maintaining discipline	35%	41%	24%
Poor quality of textbooks	37%	38%	25%

DISCUSSION

Five trends emerged from the data regarding preparation for teaching. First, the overwhelming majority of teachers had university degrees. Second, approximately two-thirds of the teachers majored in chemistry, while the other majored in other science areas. Third, almost

half the teachers did not have teaching credentials and out of those who had those credentials, only fifty percent did not have a secondary teaching certification. That is, only 25% of the chemistry teachers in the sample were certified to teach at the secondary level. Fourth, all teachers reported that they did not take any content matter course since their graduation. Finally, most teachers reported that they did not have enough training to use computers in their classrooms.

These results have many implications. The fact that the majority of teachers held university degrees, while necessary, is not sufficient. Many of these teachers tend to teach the same way they were taught (Scott et al., 2003) neglecting the current findings of research on teaching and learning which suggest that students achieve higher when their teachers have the required pedagogical preparation (Scott et al. 2003; Darling-Hammond, 2005) and have had extensive practical experience in their pre-service programs (Cannon, 1997). Another possible implication from these results emanates from the fact that almost one third of the teachers were not chemistry majors, with possible effects on the quality of chemistry learning of their students.

The fact that teachers did not take any courses in chemistry since their graduation may have serious implications. The new Lebanese curriculum introduced many new chemistry topics and advocated the use of student centered approaches to teaching. To intensify the problem, not all teachers participated in the workshops organized by the Center of Educational Research and Development (CERD) to update teachers' knowledge in chemistry and in pedagogy. Consequently, students may not acquire the depth of understanding of chemistry required for pursuing higher learning opportunities or using chemistry in their everyday lives.

The use of Information and Communication Technology (ICT) in the classroom has become a necessity to prepare students for a world that is increasingly dependent on technology in all realms of life. Educational systems that do not encourage the use technology are disadvantaging their students and depriving them from important opportunities to function properly in higher education and the world of work. Lebanese teachers may not be blamed for not using ICT because the educational system does not provide them with infrastructure to do so.

Results related to classroom practices indicate that Lebanese chemistry teachers place a great deal of emphasis on academic objectives and seem to perceive the purpose of school chemistry as basically preparation for higher studies. While these teachers say that they attempt to develop a systematic approach to solving problems, this should be understood within the context of a Lebanese system that is examination driven and in which teachers stress on teaching algorithmic problems in chemistry (Author & Barakat, 2000). Thus the systematic approach to problem solving may be interpreted as one focused on solving algorithmic chemistry problems. Nevertheless, even though teachers say that they value academic objectives, they seem to appreciate science-technology-society (STS) objectives such as relating chemistry to real life, understanding the role of technology in chemistry, and career awareness. Scrutiny of the results,

however, shows that teachers are almost equally divided between those who place minimal, moderate, and heavy emphasis on STS objectives. Finally, it is evident that the majority of Lebanese teachers do not find any relevance of history of chemistry to their teaching. In summary, there emerges from the results a view of chemistry teaching that is heavily focused on academic objectives, with some apparent attention to STS objectives, and almost total negligence of history of chemistry. While the emphasis on academic objectives is understandable in a curriculum that focuses on such objectives, the lack of emphasis on history of chemistry is in contradiction with the general objectives of the Lebanese science curriculum that highlight the importance of understanding the development of science across history (Author, 2002).

Data related to teachers' classroom practices were collected from two sources: A teachers' questionnaire and classroom observations. As evident in the results, Lebanese chemistry teachers perform a variety of student-centered, teacher-centered, and interactive activities when teaching chemistry, a finding that is consistent with what takes place in science classrooms in the USA (O'Sullivan & Weiss, 1999; Weiss, Banilower, McMahon, Kelly & Smith (2001); and Weiss, Pasley, Smith, Banilower & Heck (2003). A close examination of the results, however, shows that many of the student-centered activities, such as taking exams, taking notes, and reading from the textbook may be passive rather than active in nature.

An interesting issue that emerges when the results from the questionnaires are compared with the results from the classroom observations is the fact that the percentage of time teachers seem to think they are spending on student-centered activities is less than the time that these activities are actually performed in the classroom (50% vs. 31% respectively). This is similar to results reported by Simmons et al. (1999) in their research with pre-service teachers. Moreover, teachers seem to spend more time on interactive activities, such as question-answering sessions, then they think they do; a situation that may be due to the fact that teachers may think the question-answering sessions are student-centered rather than interactive because questions are typically initiated by students. Yet, even if all the time spent on interactive activities is added to student-centered activities, there is a still a difference between teachers' perceptions of what they do and what actually happens in the classroom. This finding highlights the importance of finding methods to help teachers obtain valid and reliable information about the practices they actually use in the classroom, information that is necessary if they are to benefit from reflection on their teaching. Peer observations followed by feedback sessions, or peer observation along with videotaping followed by feedback sessions can be beneficial in this regard.

Textbooks are major sources of information in an educational system that is examination driven, such as the Lebanese educational system. Consequently, how teachers perceive textbooks is an important issue to consider when discussing classroom practices. The view regarding textbooks that emerges from the results is that textbooks are heavily used, with a large majority of teachers (81%) covering most of the textbook content, and that textbooks are appropriate in

terms of alignment with students' reading and language abilities and in terms of explaining concepts, findings that are consistent with the teachers' emphasis on academic objectives. However, textbooks seem to be lacking in terms of the number and quality of examples and resource materials. In addition, teachers seem to be divided on the quality of suggestions that the book provided for activities and assignments.

The minimal use of computers in science classrooms seems to be an international phenomenon. Findings from this study show that a very small minority of chemistry teachers report using computers in their classes, a finding that is consistent with findings about the USA reported by Weiss, Banilower, McMahon, Kelly & Smith (2001), and Weiss, Pasley, Smith, Banilower & Heck (2003). One major difference between Lebanon and the USA, however, is access to computers, because a large majority of teachers report that they do not have access to computers, which is not the case for teachers in the USA. What is intriguing is that science teachers in most cases do not use computers even if they are present in their classrooms despite the fact that we are living in a world in which the use of Information and Communication Technology (ICT) is indispensable if students are to function successfully in the world of work. Therefore, there is a need to think carefully about meaningful ways to integrate the use of ICT in teaching science and other subjects, provide teachers with appropriate professional development (Author, 2005, 2006), and find ways to incorporate ICT activities in assessment approaches to encourage teachers to use them in classrooms.

The problem of inadequate language proficiency of students seems to be a serious barrier for effective chemistry teaching and raises an important issue that has not been addressed adequately in education circles in Lebanon. While the language of science instruction in Lebanese schools is either English or French, even though the mother tongue is Arabic, there is a conspicuous absence of studies that investigated the benefits and burdens of using a foreign language in teaching science; studies that are needed to shed light on the intricacies of this situation, provide practitioners with recommendations to help students acquire coherent knowledge in chemistry while at the same time mastering one or more foreign languages (Author & Sayah, 2000), and prepare students to benefit from science resources in foreign languages available electronically and in print. Such studies are indispensable if the aim is to improve student achievement in and understanding of chemistry.

The lack of enough time to teach chemistry is an authentic problem for many chemistry teachers, especially at the secondary level (Association of Secondary Public School Teachers in Lebanon, 2001). The number of periods apportioned to chemistry at the intermediate and secondary levels is small compared to the size of the curriculum. This situation has put tremendous pressure on chemistry teachers who end up completing the curriculum without being able to involve students in meaningful and useful hands-on activities.

The general view of chemistry teaching that emerges from this study is that of teachers who joined the teaching profession with university degrees but with minimal teaching credentials, rarely get involved in professional development activities, are very interested in academic objectives and preparation of students to pursue further studies in chemistry, are heavily dependent on textbooks, and do not make an effort to integrate computers in their teaching for a variety of reasons, the most important of which is the apparent difficulty of having access to computers. These teachers are concerned about the foreign language skills of their students particularly that chemistry is taught in a foreign language. The view is of students who are involved in a variety of activities that are mostly teacher-centered and who spend a significant amount of time in reading from the book, taking notes, and asking and responding to questions but who do not spend a significant amount of time on doing hand-on activities.

The emphasis in the new Lebanese science curriculum is on the knowledge of science, the investigative nature of science, and the interactions of science technology and society, but neglects science as a way of knowing (Author, 2002). This emphasis, however, is not reflected in the teaching practices prevalent at the present time in Lebanese classrooms. The reasons for this mismatch are numerous including the current examination system, the scarcity of supportive instructional materials, and most importantly the amount and quality of professional development activities available to teachers. Providing opportunities for teachers to participate in meaningful professional development activities (see for example Anderson & Helms, 2001; Fletcher, 2004; Judson & Sawada, 2001; Moussiaux & Norman, 1997; Monk, Swain, & Johnson, 1999; O'Sullivan & Weiss, 1999; Richie & Rigano, 2002; Schneider & Blumenfeld, 2003; Schneider, Krajcik, & Blumenfeld, 2005; Shaka, 1997; She, 1999; Sheau-Wen, 2001) can be the key to the implementation of the objectives of the curriculum and improving the quality of chemistry teaching in Lebanon.

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Saouma BouJaoude

Department of Education

American University of Beirut

P.O. Box 11-0236

Beirut, Lebanon

Telephone: 00961-3-382689

Email: boujaoud@aub.edu.lb