LEBANESE AMERICAN UNIVERSITY

INVESTIGATION OF THE COHERENCE OF THE SCIENCE INSTRUCTIONAL PROGRAM AT ELEMENTARY GRADE LEVELS

By

RUWA RAWAS

A project
Submitted in partial fulfillment of the requirements
for the degree of Master of Arts in Education

School of Arts and Sciences

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Project Proposal Form

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Department: Education

On (dd/mm/yy) January 16th, 2011, has presented a Project proposal entitled:

Investigation of the Coherence of the Science Instructional Program at Elementary Grade Levels

in the presence of the Committee Members and Project Advisor:

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Proposal Approved on (dd/mm/yy): January 30th, 2011

Comments / Remarks / Conditions to proposal approval (if any):

Date: Jan 30th, 2011 Acknowledged by [redacted]
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Project Defense Result Form

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Investigation of the Coherence of the Science Instructional Program at Elementary Grade Levels

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Comments/Required Changes to Project due on (dd/mm/yy)

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Project approval Form

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Project Title : Investigation of the Science Instructional Program at Elementary Grade Levels

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Investigation of the Coherence of the Science Instructional Program of Elementary Grade Levels

Ruwa Rawas

Abstract

An important feature of an instructional program is the alignment of curricular objectives with instructional practices, materials, assessment practices, professional development opportunities, and the role of good leadership. This alignment has been referred to as instructional program coherence.A qualitative study was designed to examine coherence of aspects of the science instructional program at the fourth and fifth elementary grade levels of a Lebanese school.The results of the analysis show that the degree of alignment between the curricular objectives and the various aspects varied.There was good alignment between the curricular objectives and instructional practices, good alignment between curricular objectives and assessment practices, good alignment between curricular objectives and professional development activities, but partial alignment between curricular objectives and instructional materials.In closing, recommendations are discussed for school leaders and educators to follow and build a coherentscience instructional program.

Keywords: Instructional Program Coherence, Curricular Objectives, Elementary Science, Education in Lebanon

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INTRODUCTION

1.1 - Overview

Science is an array of knowledge that represents the current understanding of natural systems and the process whereby the knowledge is being continually updated. The process includes scientific skills such as observing, collecting and analyzing data, posing questions, measuring, graphing, predicting, conducting experiments and controlling variables. Researchers believe that the acquisition of these skills can enable students to reason scientifically, solve problems, learn about scientific phenomena and appreciate the value of science and its contribution to their life. Moreover, research on learning and instruction has indicated that K-8 students understand science concepts and phenomena by actively engaging in the practices of science that include conducting investigations, participating in discussions and reflection on experimental results which require guidance from the teacher(Duschl,Schweingruber, &Shouse, 2007).

A successful instructional program includes instructional objectives that are clearly written statements of observable learning outcomes that students are supposed to achieve by the end of the program. They have many functions. They can define what the teacher should teach since instructional objectives should be reflected in the goals and purpose of the lesson. According to Ausubel (1968), stating an objective at the beginning of instruction will help learners to structure their own learning. Reiser and Dick (1996) state that students should be informed of what they are supposed to do during instruction. Moreover, activities are developed to ensure that students achieve the objectives. The objectives are also used to guide the evaluation process and assessment procedures. Instruction refers to the variety of teaching methods, instructional materials and activities used to help students master the content and learning objectives (Mager, 1984). Consequently, teachers should focus their instruction on the development of specific scientific skills and the understanding of concepts, and select the most effective instructional materials, practices and assessment procedures to achieve these objectives (Duschl et. al., 2007). That is, there should be alignment between the curricular objectives, instructional materials, andassessment practicesin the classroom.

For the reason of enhancing the quality of science education, the US National Research Council (2007) published a report to help schools develop better instructional program coherence. The report includes items that urge the school to have: A curriculum that presents content and number of topics suitable for each grade level, ongoing professional development for teachers to help them teach science using various teaching approaches, necessary science materials and equipments that support the instruction, and assessments that are consistent with the curricular objectives to evaluate students' learning (Singer &Tuomi, 1999).

Examining the instructional program coherence helps educators improve their teaching practices, deal with students' academic gaps and select the necessary instructional materials for their lessons whichensure that students achieve the desired objectives. In this project, the Science Instructional Program Coherence (IPC) of two elementary grade levels was examined. In light of this some recommendations to make the science instructional program more coherent are put forward.

1.2- Need for the Study

This project examines the instructional program coherence (IPC) at the fourth and fifth elementary grade levels of a Lebanese school including an examination of curricular objectives, lesson plans, assessments, instructional materials and practices and professional development opportunities. That is, the purpose of this case study is to check if the program succeeds in aligning the curricular objectives with suitable instructional materials and practices, assessment practices and professional development activities. It is assumed that instructional program coherence contributes to greater student achievements and learning.

1.3- Literature Review

The following literature review will begin by clarifying what is meant by Instructional Program Coherence (IPC) and why it should be considered by educators. Then, I address how each of the various components of the IPC relates to the curricular objectives.

The term coherence is used in a variety of ways in educational contexts. Some refer to coherence as the alignment of content standards, textbooks, and assessments with each other. Others link coherence to the school's organization, its vision, and a common culture of values (Newmann et. al., 2001).Tucker (2004) provides a useful definition. He states that coherence requires more than the alignment of curriculum and assessments. Real coherence is when parents are informed about the instructional goals students should meet and teachers' time is dedicated to students who need the most help. It is also when assessment practices are designed to assess whether students learned what they are supposed to know.

IPC is present when the curriculum, teaching, resources and assessment are coordinated with each other and implemented among all school staff members. According to Newmann, Smith, Allensworth, &Bryk (2001), IPC can be reached when the following conditions are present at schools. First, all science teachers of the same grade level have to agree on curricular objectives and scientific skills which are consistent with the prevailing science content. One fifth grade teacher with the collaboration of her colleagues agreed on the following scientific skills that students should acquire by the end of the unit that is about differentiating mass and density:predicting, theorizing, summarizing results and relating predictions to results.The teachers illustrated the unit in a “Dots and boxes model” (Michaels et. al., 2008, p. 137) that is implemented in a software program to explain science terms such as density and mass. Each box represents the volume, each dot represents the mass of the object and the number of dots in each box represents the density. The unit also challenged students to perform experiments to determine the sinking and floating of objects using the boxes and dots model. Students listened to their peers asking questions to check predictions and theories and see the relation between the predictions and results (Michaels et. al., 2008).

Second, school staff members should be able to relate the set goals with the various aspects of the instructional program (instructional practices, assessment practices, and instructional materials). For example, if the objective is for students to develop scientific process skills such as controlling variables, science teachers should demonstrate activities throughout the instruction related to the specified skills. For instance, if the science lesson is about sound, teachers can demonstrate how two metal cans connected with a wire can transmit sounds between two people. Then they can challenge their students by asking them to connect different cans and containers of various sizes and compositions to determine which of the objects will transmit the clearest voice sounds.

The final condition is to properly allocate funds that are spent on the proper lab materials and equipments that help meet students’ expectations. Lesson plans might call students to engage in investigations or experiments, thus materials and equipment are required for students’ lab work as well as for teacher demonstrations. Most of the materials such as chemical solutions and lab equipments needed for many science lessons are expensive, thus schools should fund them. Additionally, the facilities and space in a school should be designed for science activities to be carried in classes and labs (Newmann et al., 2001). For example, to show students the bacterial growth in Petri dishes and the existence of microbes, teachers need to buy some cultures of microorganisms from medical clinics or biology labs of universities.

The ultimate goal of IPC is enhancing student achievement and instruction. But how can IPC ensure what students are able to achieve? For students to become better achievers, IPC helps teachers work collaboratively to alleviate academic problems and enhance students' engagement and learning for improvement purposes.

It is essential that the different elements of the instructional program from the instructional practices, teaching materials and assessments to professional development opportunities are all integrated and aligned coherently with the curricular objectives.These alignments and coherences are discussed in the following subsections.

1.3.1- Instructional Practices

One vital aspect of the IPC is the instructional practices (IP's). Effective IPs aim to build understanding through involving students in a variety of practices including gathering data through observation, experimenting, reasoning and applying key ideas to new situations (Duschl et. al., 2007). To understand a science concept or idea, students should engage in an array of practices that support developing that idea. For students to explain and deepen their understanding about certain phenomena, they can perform simple investigations. For example, they can compare the properties of various objects and see how they respond when dropped. They can also predict what will happen when ice is melted.

One objective from the Lebanese curriculum (n.d., p. 1) states that for students to develop scientific curiosity, they should be asked to engage in investigations. To determine what happens when variables are manipulated in a science class, students can cooperatively investigate, predict and discuss the results of the investigation. For example, for students to test the plant growth, they can conduct investigations on seeds under different conditions. They can together predict how each plant grows. After the plants grow, they can discuss and analyze the results of the experiment.

To gradually build students' knowledge and skills, Metz (cited in Duschl et. al., 2007), a researcher, designed a science unit that enables fourth and fifth graders to conduct scientific investigations. The goal behind the unit was to be able to use various research methods and tools to learn about animal behavior. They were asked to think about a new species and propose questions that could be examined throughout their investigations. He realized that through strong instructional guidance students were able to investigate, pose questions and explain the results.

Other than conducting investigations, science teaching involves practicing one's communication skills, thinking out loud and engaging in arguments. Learning science is a long process that requires students to elaborate and restructure the concepts to arrive to new levels of explanations. For example, most students believe that temperatures are cooler in winter than those in summer due to the distance between the sun and the Earth. However, the variation in temperature is due to factors related to the length of the day and the tilt of the Earth and not the distance between the sun and the Earth (Michaels et. al., 2008).

Through argumentation, peers convince each other with their explanations and critiques to reach consensus (Duschl& Osborne, 2002).In one US school, educators developed a science unit about the increased animal mutations in ecosystems. They asked students to search for explanations and come up with hypotheses. One explanation talked about a parasite that can interfere with the development of the frog's limbs and other involved a pesticide that can interfere with the hormonal signals that control the limb development. To support student learning, teachers provided students with adequate instructional materials to investigate the problem. Then, students were asked to discuss their hypotheses in class where their peers shared their critiques (Duschl et. al., 2007).

To encourage students to argue scientifically, teachers should use the 'talk moves' strategy and pose open-ended questions. Examples of such questions would be: "Do you agree or disagree and justify", "Support your answer with more evidence, and "Take your time and let us think out loud". In addition to this, students should be asked to explain their thinking of their ideas to the class using posters, charts, illustrations and models. Advantages of doing so allow students to elicit their prior ideas that help teachers assess their understanding and how students are reasoning when explaining a certain idea in their own words. In this way, students realize that a scientific concept can be explained in different ways (Millar & Osborne, 2001).

In one third grade class, a science teacher asked students to predict whether a football with extra pumps of air is heavier, lighter or weighs the same on a balance, and justify their answers. Some students believed that the light football goes up because he thought that an inflated balloon is lighter than an empty one. Others believed that both footballs would balance because air has no weight. One student said that the football with the extra pumps of air would weigh more on the balance after he remembered that pumping the flat tire made his dad's truck heavy (Michaels et. al., 2008).

Using demonstrations is another helpful teaching strategy that should be integrated in science lessons. Demonstrations stimulate students' attention and thinking, motivate and interest them in a lesson, illustrate concepts, and initiate problem-solving and inquiry (Duschl et. al., 2007). For example, a science teacher can demonstrate reactions that release toxic gases and fumes under a hood rather than asking students to conduct the experiment themselves. To ensure students' understanding of a concept, science teachers should perform demonstrations that engage students in questioning (Clermont et. al., 1994). Shepardson (1994) and other researchers prepared a demonstration for teachers to perform in class for students to understand the concept of air pressure. Through this demonstration, students engaged in answering questions that required thinking and explaining what caused the egg that was on top of the flask to be pushed into the flask and land on the burned paper (Shepardson et. al., 1994).

To make things more concrete, teachers should use models and representations within their instruction. These can be graphs, diagrams, mathematical expressions, tables or computer programs.For students to engage in scientific reasoning, teachers should ask them to construct graphical representations that show the relation between two quantities, derive the resulting implications and evaluate with additional data. To model the growth of plants,third graders in an American school investigated whether the parts of the plants (shoots and roots) grow at the same rate and plotted the growth on a graph to realize that there is a difference in growth.For students to reflect on their experiences and apply their scientific understanding, teachers should ask students to develop presentations and projects. For example, students can analyze forces and motion to explain vehicles or create a project to explain the causes of global warming(Michaels et. al., 2008).

In the Lebanese curriculum, it is expected from students to acquire knowledge about health and safety practices and behave accordingly. To achieve this, they should be shown pictures, statistics and real stories that describe the phenomena where they start to question, collect information and find solutions to the problem. For example, a science teacher can begin her unit about nutrition by showing students pictures of several famous people. Then, she can pose some questions: How do these people get to be what they are now? and Do you follow the same diet as they do? If the objective is for students to create models or synthesize something that helps them understand the importance of a concept, a teacher can ask the students to create a new food pyramid that helps them understand the necessity of a balanced diet and exercise (Michaels et. al., 2008).

The Biology Guided Learning Inquiry Environments (BGUILE) project came up with a science unit known as the "Struggle for Survival". One of the unit's objectives was to develop the student's scientific curiosity and engagement in scientific research. The project asked teachers to present a problem to students in which they should do their research on. The decline of the plant and animal populations in an island was one problem. Students examined the reasons behind the decline through gathering, analyzing and discussing data about the species' characteristics on the island and identify the changes in population (Michaels et. al., 2008).

To develop the learners' intellectual and practical scientific skills, the "Biological and Physical Science Study Committees" exposed students to authentic science learning through engaging in hands-on activities that required observing, measuring, performing experiments (controlling variables) and constructing hypotheses. In addition to this, they made sure that teachers receive intellectual and financial support that enhances their science teaching.

To understand a concept deeply, it has been recommended that students understand better the concept when teachers provide logical explanatory stories and examples related to that concept. One explanatory story related to chemical reactions is illustrated in the following examples:water evaporating and vitamin C tablet dissolving in water .To let students understand the concept of molecules, a teacher can show how the reaction ofsodium with chlorine gives table salt. Then,students can discuss various chemical changes that occur in and outside classrooms such as cooking, burning, and rusting and so on. It is these meaningful explanatory stories that make students learn scientific concepts and remember them (Millar &Osborne, 2001).

In the report, *Taking Science to School*(Duschl et al., 2007, p. 232) which deals with learning and teaching science in grades K-8,Duschl proposed some objectives for teachers to base their instructional practices, materials and assessments on. These objectives address the knowledge and reasoning skills that students must acquire to be fully proficient in science; students should be able to use and interpret scientific explanations of the natural world, evaluate scientific evidence, understand the development of scientific knowledge, and engage productively in scientific practices. Teaching science content alone without being meaningful to students does not lead to scientific proficiency. If the objective is to evaluate scientific evidence, it is necessary that students critique arguments and formulate questions, decide on measures, collect, organize and interpret the data and finally use results to restate theories or arguments. For them to understand the development of scientific knowledge, students should be able to interpret ideas in various ways or investigate further experimental findings. For students to engage in scientific practices, they can be asked to create models and design products. For example, to study the impact of a certain disorder (i.e. obesity, stress, diabetes), students can write a brochure to make the community aware of its risks, prevention and treatments.

One objective stated in the Lebanese curriculum (n.d., p.1) for a science unit about Biodiversity that fifth graders are required to master is to "use scientific knowledge and skills in novel situations." To meet this objective, teachers can ask students to collect data and perform simple experiments. For example, to identify the various living organisms and use measurement instruments and investigations, students can examine the school playground to get samples of plants, insects and other animal species, and record useful information for further research purposes. They can perform experiments on plants under different conditions. They can also examine the life cycle of butterflies and construct some charts and graphs.

Another objective in the Lebanese curriculum (n.d., p.2) is to "encourage learners to be open to ideas of scientists and other people who contributed in advancing science". For example, teachers can lead discussions and allow the students to debate the diverse points of view. In addition, educators can choose texts that talk about certain historical developments in science in which students might agree or disagree with. After observing science classes at the high school, researchers in the US (Weiss, et al., 2003) indicated that instruction was teacher-centered in which teachers were leading the lecture or discussion, instructional practices and materials were not consistent with the curricular objectives, and hands-on activities did not help students develop deep understandings of science concepts. That is why, it is very important that the teacher acts as the facilitator and the instruction is centered on the students.Teachers should have the ability to modify the content and IPs and make them consistent with the instructional objectives to enhance student learning (Printy, 2008).

1.3.2- Instructional Materials

A second aspect of the instructional program of a school deals with selecting the necessary instructional materials (IMs) that are aligned with the curricular objectives that help students understand the scientific concepts and ideas. Teachers need IMs such as textbooks, reading selections, access to human and lab resources, kits, multimedia items such as educational programs that relate to the instructional objectives. With the curricular objectives in hand, teachers can check guide books which contain support materials and resources relevant to the various topics and skills taught within the unit that are useful to integrate in the activities teachers prepare. For instance, if the specific objective of a science lesson plan is for students to be able tomeasure the length, temperature, and time, the suitable tools or devices should be available for students to perform that (Duschl, et. al., 2007). For students to be able to develop inquiry skills and perform a hands-on activity about electricity, teachers should have enough instrumental materials for each student to work on. These materials include bulbs, large paper clips and batteries to connect the materials and light the bulb.

For students to understand basic science concepts better, students should deal with concrete materials. For example, teachers should have access to living things. Students can observe and compare the parts of several plants such as the roots and stems of a cactus tree. Students can also investigate ways to see how plants adapt and react to environmental changes by having access to human resources such as interviewing plant experts.

For students to better understand scientific issues, teachers should know how to integrate software programs within the science lessons. Guthrie and other researchers implemented a research program in 2004 known as “Concept Oriented Reading Instruction” (CORI). It introduces elementary students to several knowledge domains such as ecology and the solar system. Students have to select a topic from these domains such as an animal or plant to study and should chose books accordingly. Then, teachers help them find relevant resources to participate in inquiry such as: specimen collection, observations, experiments and discussions. Guthrie found out thatstudents who engaged in this program understood better the science texts they read and were motivated to read about science than students given a normal lecture (Duschl et. al., 2007).

A science departmental committee of one US elementary school (1999) selected the instructional materials from textbooks and kits which fit with the instructional objectives of a unit. Before they selected the instructional materials, the teachers of that committee checked whether the materials relate to the history of the scientific discipline, whether the materials are challenging, if there are additional explanations or activities provided for gifted and slow learners, and finally whether the students' assignments contain meaningful projects and investigations for students to perform. It is necessary that the school dedicate a budget for the instructional materials because if minimal amount of budget is spent on the materials, students might use inaccurate or outdated materials (Singer &Tuomi, Eds, 1999).

1.3.3- Assessment Practices

A third crucial item of the IPC is the assessment practices. Assessments are used to determine if the objectives have been met. Well-constructed assessments focus on assessing and reinforcing specific learning outcomes. The purpose of assessments is to provide teachers with regular feedback on students' learning and track students' progress throughout the academic years. According to Stern and Ahlgren (2002), one important type of assessment is formative assessment that helps teachers monitor students' progress and observe what new knowledge and skills they developed during the school year. Formative assessments enable teachers to monitor the effectiveness of their own teaching, and thus improve their instructional practices. If a teacher, for example finds out that students have not understood the concept in a lesson, s/he can modify his or her teaching strategies to make sure that students acquire the learning outcomes. This type of assessment allows teachers to know where students are heading, what they accomplished so far and how they can achieve what they have to achieve (National Research Council, 2001).

Another type of assessment is the summative assessment which assesses students' overall achievement, performance and grades, but doesn't monitor their progress. Project 2061 of the American Association for the Advancement of Science stated that the purpose of assessments is to provide students with opportunities to apply what they learned in and outside classrooms and for teachers to know whether to improve their instruction(Stern &Ahlgren, 2002).Assessments should not evaluate only the memorization of information and facts, they should also allow students to use the knowledge and ideas they learned to describe, interpret and predict real scientific phenomena, argue about issues, and solve challenging problems. Instead of relying only on recalling facts that are disconnected, assessments should encourage students to develop skills such as scientific reasoning, and they should emphasize understanding crucial scientific ideas that helps students solve real problems (Stern &Ahlgren, 2002).

For science teachers to categorize test questions, they should use Bloom's taxonomy classification system and understand its composition. Bloom's taxonomy classifies instructional objectives and questions into six levels: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The knowledge level requires students to remember facts they have learned, whereas the comprehension level requires students to use the facts to organize and interpret them. For example, fifth graders not only should define variables and control groups; they should know how to identify the target variable from a statement or an experiment, such as: Does an enzyme function in acidic, neutral or basic medium?At an application and analysis level, for example, students should be able to design an experiment based on the variables and try to manipulate the variables to see their effect on the issue studied (Klahr et. al., 2006).

White (cited in Stern &Ahlgren, 2002)states that assessments should include three essential parts related to the curricular objectives: one part for testing students' knowledge or what they understood, a second for applying what students learned to new situations, and a part that requires students to synthesize and come up with new ideas or solutions.It is essential that teachers use assessments not only for grading purposes but most importantly for diagnosing students' gaps and difficulties. Teachers' feedback and comments help students correct errors and reflect on their work (Duschl et al., 2007).

In addition to writing the test items, teachers can select the test items from computer test banks. Science teachers should have access to a variety of test items to assess lower and higher levels of thinking and laboratory skills. For teachers to construct valid and reliable tests that assess students' achievement and instructional effectiveness, they should be familiar with the various types of test items and how they are used to assess scientific skills.

If one of the objectives for Grade 6 students is to be able to explain science concepts such as the motion of particles, a teacher can use a computer test bank known as "PRIME Science" which provides assessment tasks that require students to explain scientific ideas such as: "What happens in relation to small particles when milk is mixed with coffee?" (Stern &Ahlgren, 2002, p. 896) Challenging science questions are also posed to students like: Why the sky is blue? and "Why copper shrinks when it cools?" (p. 897).

If one curricular objective calls students to explain scientific phenomena and apply scientific ideas, test items should be constructed based on this objective. For example, to see whether students understand that increased temperature means increased molecular motion, science teachers can ask students to explain why they can smell a chocolate cake taken out from the oven but can’t smell the same cake taken out of the refrigerator or why a sugar cube dissolves faster when placed in hot water than in cold water (Stern &Ahlgren, 2002).

Tests should assess whether students understand the importance of scientific concepts. It is not enough for students to label the human body parts but to know also how they work and how to repair them (Stern &Ahlgren, 2002). If one objective of an exam is to be able to explain the scientific concepts and principles behind some devices and machines used at home, students should know about electricity and that circuits can be built to light up a home. It is necessary that teachers provide opportunities for students to reflect on what they learned from the investigations they performed.

If the objective is to represent data in a table form, the following assessment item can be constructed: Grade 2 students can be shown several pictures of objects that differ in color, size and shape. Then, teachers can ask each student to draw a table describing each object with respect to its properties (Michaels et. al., 2007).

If one objective is that students should be able to acquire concepts through analyzing and understanding diagrams, graphs or charts, teachers can show students an illustration or picture related to the phenomena and pose questions about them. For students to understand that air has weight, a multiple choice assessment item can be constructed in which students are shown illustrations of two empty balloons on a balance and questions are posed. One question can be: Which picture shows what will happen when one balloon is filled with air and the other remains empty? Students have to choose the correct response: 1) Empty and inflated balloons are both balanced, 2) Inflated balloon is heavier and thus it will tip down, 3) Inflated balloon is lighter and it will tip up, 4) More information is needed. From the responses, the teacher can tell if students have understood the concept or not (Michaels et. al, 2008).

To encourage students to work cooperatively and design experiments, teachers can let them engage in performance tasks related to the topic under study. For the topic about matter and energy, "PRIME Science Program" asked students to set an experiment to prove or disapprove scientific statements such as: "Plants grow better if they receive more light" (Stern &Ahlgren, 2001, p. 901). Moreover, to encourage students to use scientific knowledge and skills in real situations, teachers can assess students on how they apply what they learn to new situations from their daily life. One task asks them to think about scientific statements such as: "Microwave heats water molecules inside food." Using their prior knowledge about particles of matter, students can answer questions like: "Why do potatoes sometimes explode in the oven and how one can prevent the potato from exploding?"(Stern &Ahlgren, 2001, p.903)

Furthermore, assessment tasks can be in the form of educational games in which students can be asked to unscramble science terms, solve crossword puzzles and design jeopardy games to reveal scientific concepts and definitions.

To see whether students are able to evaluate information from scientific articles, educators should provide students with articles taken from newspapers, reports and magazines. In this way teachers can assess whether students can extract the scientific ideas from the articles, evaluate the evidence that support the proposed ideas, and finally come up with actions for solving a certain problem (Millar & Osborne, 2001).

1.3.4- Professional Development Opportunities

A fourth crucial aspect of the IPC that improves teaching and learning process is through professional development (PD). To teach science effectively, PD is necessary to help teachers improve their quality of teaching, enhance their knowledge and skills, and develop their own professional identities. The process of going from student teachers to professionally satisfied developed ones is known as professional identity (Nabhani&Bahous, 2010). Professional identity is built, once teachers are empowered and professionally developed in their teaching field (Ronfeldt& Grossman, 2008). Science teachers should continuously update their content knowledge and teaching strategies. They should be informed of new teaching methods, instructional materials and activities that make science teaching more effective. They should also be involved in promoting educational reform in their school and enhancing their instructional program coherence (National Research Council, 1996). For students to become scientifically and technologically literate, science teachers should attend workshops, professional meetings and pursue graduate studies. Moreover, teachers should read professional journals and books on science education to evaluate their teaching, enhance the overall classroom performance and their instruction. Through PD activities that focus on how students learn the content and teachers' use of materials in classes, novices are able to solve challenges they face during the first teaching year as they observe others and develop teaching skills and knowledge (Ronfeldt& Grossman, 2008).

Guskey (cited in Eun, 2008) states that programs offered within the school contribute to the professional growth of both novice and experienced teachers. These programs include workshops, professional organizations, graduate courses and seminars offered by university professors and other experts. When teachers participate in such programs, they learn new instructional approaches and scientific developments to update science instruction. Graduate courses are given to train teachers to implement new content, new science units or lab activities.

Through engaging in workshops, teachers work in small groups to produce a specific product. Other workshops should teach educators to align curricular objectives with instructional practices, materials, assessments. Educational conferences conducted at the Lebanese universities were useful. Among the topics learned could be things like integrating computers in education (integrating web-quests into the instruction and creating blogs that allow students to discuss their ideas on certain scientific ideas and solve online scientific tasks).

In addition, teachers can consult professional journals about science education. These journals inform teachers about new classroom ideas, new materials and resources, and new approaches that can be used in teaching science. One of the most beneficial professional development activities is mentoring in which experienced teachers collaborate with novice teachers to help them select objectives, teaching methods and materials, and solve problems that they face in classrooms (Eun, 2008).

School leaders should create a professional learning community that ensures the ongoing learning and development of all the teachers through PD programs (Nabhani&Bahous, 2010). School principals who support and encourage teachers to try innovative practices, positively allow them to engage in communities of practice (Printy, 2008).One professional learning community for grade two teachers constructed models to understand a concept such as sound. They performed investigations to deepen their understanding, used various materials and demonstrations to help students understand how sound travels, agreed on curricular objectives to put in their lesson plans, got some research on students' ideas about sounds and wrote assessments to reveal students' thinking about how sound travels and how pitch and volume are changed. Through this program, teachers modified the science unit to meet students' needs and expectations making sure that the instructional materials, practices and assessment practices are coherent with the curricular objectives required from students to achieve at the end of the unit (Michaels et. al., 2008).

The ultimate target of any school is the success and achievement of its students. Improving students' achievement lies with the teacher. Kelly (2006) indicated that teachers who are committed to their teaching job, positively influence students' attitudes and achievement and seek improvement to address students' needs and deal with their difficulties. Thus, teachers have to engage in specific programs that enhance their knowledge of scientific practice and understanding of students' ways of thinking and provide them with lessons that address students' learning challenges. These experiences enable teachers to think scientifically, analyze phenomena and learn how to engage in scientific inquiries that align with the set curricular objectives. One elementary novice teacher participated in a PD workshop to work on explaining qualitative phenomena such as: "Why do helium balloons float?"(Duschl et al., 2007, p. 163).

To sum up,through follow up, support and training opportunities which allow teachers to collaborate together, observe and critique others, and learn from each other's work, professional development is achieved. And it should not be forgotten that teachers should be provided with material resources, classroom equipment and professional journals.Students learn what they are being taught; therefore, how well teachers are prepared determines students' achievement.

1.3.5- The Role of Leadership

Finally, to ensure coherence requires good leadership. Management is regarded as essentially a practical activity. The determination of goals, the allocation of resources and the evaluation of effectiveness all involve action. The leadership behavior of a principal has a significant impact on creating more effective schools contributing to higher levels of student achievements and success. An effective self managed school should have a talented team of teachers and other professionals aligned in their efforts to secure success for all students. Principals and their external leadership teams influence the quality of teacher professional learning, the nature of the school culture, the extent of parent involvement and the way the school is organized for learning. It is the leaders' role to align the school's mission with a curriculum, instructional practices and professional development. Thus, achieving school reform, improvement and student achievement requires educators, principals and curriculum designers to establish an organized coherent instructional program that involves the alignment of the instructional materials, teachers' preparation, assessment practices and professional development with the set curricular objectives. According to Stein and Nelson (2003), school principals should understand the learning needs of individuals, create an interactive social environment between the novice and experienced teachers, and ensure that adequate resources and professional development opportunities are available for teachers to support students' and teachers' learning.

To support science learning, school leaders should help educate teachers, students and familiarize parents with the changes they observe occurring in the classroom such as students' work, graphs, diagrams, and lists of students' thinking and hypotheses hanging on the bulletin boards.

One principal in a Chicago public schoolbelieves that teachers, like students are investigators and learners. She interferes when teachers need extra materials or time, encouraging them to collaborate with their colleagues and decide on what instructional strategies to use and what is expected from students for each unit. Moreover, she made teachers receive extensive training and workshops given by external partners, who visit classrooms, demonstrate, circulate examples of students' work and co-teach novice teachers. This strong instructional leadership made teachers agree on the curricular objectives, choose suitable materials that can be adopted to meet students' needs and develop lesson plans and assessments coherent with those curricular objectives (Newmann et. al., 2001).

The poorly coherent instructional program of one school was due to the unorganized resources that were not aligned with the teachers' instruction and students' expectations. The teacher alone decides on the curricular objectives and how the parts of the curriculum are taught. The school's system is based on an uncoordinated instructional leadership without the interrelation across subjects and within the grade levels. As a result, teachers are unaware of what is being taught and discouraged to work and implement their ideas and exert effort for school improvement (Newmann et. al., 2001).

Since not enough studies have been done for analyzing the coherence of the instructional programs of Lebanese schools, I decided to analyze the IPC of a Lebanese school and check whether alignment exists between the various aspects of the instructional program mentioned previously. To examine the IPC of science at the school, a variety of materials were collected. Content analysis was done to identify the pattern of alignment between its components.

The main research question of the study was: Is the science instructional program of elementary grades 4 and 5 in a Lebanese private school coherent?

CHAPTER TWO

METHOD

In this chapter, the participants chosen and the various data sourcescollected will be described. The technique used for data analysis will be addressed and discussed in details.

2.1- Participants

The researcher chose a purposive sample that consisted of two science teachers (one teaches grade 4 and the other teaches grade 5), and the science coordinator of the elementary science department in a Lebanese school. The school was chosen because of the teachers' willingness and interest to participate in filling out the questionnaire and wanting to know whether the instructional program for science subject at grades 4 and 5 is coherent or not. The grade 4 teacher has a BS degree in science education and has a 1 to 2 year experience in teaching life science and chemistry. The grade 5 teacher has a BS in Science and a 1 to 2 year experience in teaching life science and chemistry forelementary and middle grade levels. The science coordinator has a BS in biochemistry and a six year experience in teaching sciences for middle and high school grade levels.

2.2- Data Sources

The data sources that were used were: curricular documents; two yearly and weekly science plans one each for grades 4 and 5 selected at random; ten science lesson plans of grades 4 and 5 selected randomly, ten formative assessments for each of grades 4 and 5 related to the lesson plans; classroom observation guide; "Survey Of Instructional Practices, Teacher Survey, Grades

K-8 Science" taken from the project of the Wisconsin Center for Educational Research; and a face to face interview with the elementary science coordinator.

2.2.1- Curricular documents

To see what curriculum is used to guide the yearly lesson plans, I asked the science coordinator about the curricular map they follow and base their lesson plans on. The curriculum map was prepared by the science coordinator. It provided information onthe month each unit is given, the essential questions for each unit, its content, scientific skills, assessment and activities.

2.2.2- Yearly and Weekly Plans

I examined the yearly science plan to see what objectives the two teachers base their instruction on. The yearly science plans were prepared by the teachers. They provide information about the science unit, chapters in each unit, lessons, objectives students need to achieve by the end of the lessons,the month, week, and number of periods each chapter is taught. More detailed weekly science plans were prepared by the teachers. The weekly science plan includes the lessons covered, objectives behind the lessons, activities or teaching methods followed, materials used to explain the lessons, and assignments given to students.

2.2.3- Science Lesson Plans

I collected ten random science lesson plans. Both teachers followed the lesson plans that werefound in the teachers' guide. Each science lesson plan provided information about the objectives students acquire by the end of each lesson, questions that activate students' prior knowledge, lesson explanation and summary, inquiry activities, and ongoing assessment.

2.2.4- Classroom Observation Guide

I observed four science classes every week (grade 4 and grade 5 classes) for a period of 1 month. I prepared an observational guide that consisted of questions related to the instructional practices used by the teacher. These questions described how teachers initiated and proceeded withexplaining the science lessons, the materials used, and activities used to engage students in. To view the detailed observational guide, checkAppendix I.

2.2.5- Survey

I used the "Teacher Survey Grades K-8 Science", developed by the Wisconsin Center for Education Research. The teachers' survey consists of close-ended questions. The first 15questions are demographical information concerned with the teachers' characteristics and the description of the classes taught by science instructors. The rest of the questions are related to instructional science activities done inside and outside the classes, types of assessments, and professional development activities in science education. Questions from 16 till 64 are based on a fixed 0 to 4 scale ranging from 'None' to 'Considerable'. Questions from 65 to 72 indicate how often teachers vary their tests' items. Questions 73 to 79 under 'Instructional Influences' subheading is based on a 0 to 5 scale, where 0 represents 'Not applicable' and 5 represents 'Strongly positive influence'. The rest of the questions are also based on a fixed rating scale (refer to survey). The last two subheadings of the survey require teachers to assess their classroom instructional preparation and provide their opinions about statements in a fixed Likert scale. The responses for the scale range from negative to positive. For example "Strongly Disagree" to "Strongly Agree" and "Not well prepared" to "Very Well Prepared". One statement, for example is whether 'Science teachers in this school regularly observe each other teaching classes.'

To know what professional development activities teachers have engaged in, Irefered to the teachers' answers under the PD section of the survey and ask the science coordinator to see if teachers missed to state any.

2.2.6- Interview

To create a more discussion oriented atmosphere and avoid formalization of responses, I, the researcher conducted a semi-structured interview with the elementary science coordinator without tape-recording the interview. It consists of 8 open-ended questions, designed to elicit elaborated answers from the coordinator. The responses were recorded on the spot while interviewing the science coordinator (Appendix II).

1) What curriculum is used to guide the teachers' yearly planning?
2) How do you ensure the alignment between the curricular objectives, assessments and the instructional practices and materials is available?
3) How do you describe a school with a good coherent instructional program? Are there any additional aspects you are working on to improve science instruction at the school?
4) If you see a teacher having difficulty in selecting the instructional materials and using a suitable teaching method that fits with the curricular objectives, what would you do to help?
5) What are the available resources that teachers use throughout their lessons? How often do you get new materials?Do you permit teachers to request for materials to school every now and then?
6) What materials teachers wish they had access to?
7) What kinds of professional development opportunities are available for science teachers? What workshops have they engaged in recently?
8) What science topics teachers still want to be professionally developed at?

2.3 - Procedure

This study required qualitative methods of data collection that helped me examine and analyze the IPC for the science elementary classes. Before proceeding with my study, I contacted the school's assistant principal to ask permission to conduct research in the school. Upon approval, I gave grade 4 and 5 teachers surveys with a cover letter explaining the purpose of my study, ensuring that names will remain confidential, and filling the survey is voluntary.

I prepared a classroom observational guide to help me see whether the teaching methods followed, activities, and instructional materials used were coherent with the objectives set at the beginning of the science lesson plan and curriculum map, and whether or not there is interaction between the teachers and students. Accordingly, I shall conclude whether the various aspects of the instructional program at the fourth and fifth elementary grade levels of science subject are aligned or not.

I chose the "Survey of Instructional Practices" due to its appropriate topics related to the aspects of the Instructional program coherence in schools with a few modifications and questions omitted without changing the survey content. Both teacherswere asked to participate in filling this survey, with their personal information remaining confidential.

2.4 - Validity and Reliability

Validity and reliability of the instruments are very important in qualitative studies. Validity indicates that the inferences researchers make based on the collected data should be meaningful and useful, while reliability means that these inferences should be consistent over time (Fraenkel&Wallen, 2006).To enhance validity and reliability, as a qualitative researcher, I used a variety of instruments to collect data and support my inferences that should be appropriate and credible. This kind of checking is referred to as triangulation that improves the quality of the collected data and the accuracy of the researchers' interpretations (Fraenkel&Wallen, 2006).

2.5 - Data Analysis

The data analysis technique used was Content Analysis. It is a detailed and systematic examination and interpretation of documents and other material for the purpose of identifying meanings and certain patterns(Berg, 2007). In light of this, I examined and analyzed the different sources of information that describe the curricular objectives and each aspect of the instructional program, and identify themes, such as: the objectives being focused on for each aspect, and the types of instructional practices, assessment practices and materials chosen for students to establish the set objectives. Then, I identified the alignment between the curricular objectives and each aspect of the instructional program, and the alignment of the different aspects with each other.

CHAPTER THREE

RESULTS

In this chapter, the results of the content analysis of the curricular objectives science teachers base their instruction on are presented. In addition, the content analysis of the various aspects that make up the instructional program (instructional practices, materials, assessment practices and professional development activities) is presented. A concluding section presents the analysis of the alignment between the curricular objectives and the various aspects of the program, and the alignment of the various aspects with each other.

3.1- Content Analysis of the Curricular Objectives

The sources of information about the curricular objectives were: the curriculum map, the yearly and weekly plans, and the science lesson plans. The curriculum map of grades 4 and 5 consists of the following three themes: life science, physical science and earth science. Each theme consists of the science topics and the content that students should study throughout the academic school year. Some of the science topics are: nutrition and human health, living things and environment, matter, energy, light, sound and changes in the Earth's surface. For each specific topic, a set of objectives were listed. These objectives are of three categories: knowledge and understanding, application, and a variety of process skills. The science process skills were listed in the context of the specific content. These skills that students should develop while mastering the science content were: gathering and organizing data, observing, measuring, posing questions, comparing and contrasting, describing, listing, communicating ideas, and inferring.Grade 4 and 5 teachers mostly focused during their instruction on the following science process skills: observing, communicating ideas, predicting, making decisions and inferring. For example to understand that nutrients are important for the body and the various food groups of the food guide pyramid, grade 4 students should be able to infer which types of food are healthy, and make decisions on how to stay healthy. To understand that germs can cause diseases, students should be able to communicate ideas on how germs can cause diseases. To understand that plant and animal structures are important for survival, grade 5 students should infer how adaptation helps living things survive.

Each science topic in the yearly and weekly plans of both grades has a set of general and content specific objectives. These objectives that guide the teachers' instruction mainly call students to observe the phenomena under study, understand the purpose behind learning the science concepts, acquire knowledge about health, environment and safety practices, and apply the scientific knowledge in new situations. For example, for the grade 4 topic about ways to stay healthy, students should be able to learn how to use the food guide pyramid, explore how they can exercise safely, and determine why rest and sleep are important for their bodies. For the topic that is about the resources found on Earth, grade 5 students should be able to discover what natural resources are found on earth, and learn how to conserve natural resources.

Content specific objectives and process skills were also stated in the science lesson plans. Similarly, these objectives call for students to understand the scientific phenomena under study and apply what they learned to their everyday life. The process skills that were emphasized were: observing, communicating ideas, predicting, and inferring.

It can be concluded that all sources of information whether the curriculum map, yearly and weekly plans, and lesson plans indicate that science teaching at the school is based on the following types of objectives: students should understand scientific knowledge and apply the science concepts to novel situations; students should develop science process skills throughout studying the science content with emphasis given to: observing, predicting, communicating ideas, and inferring.

3.2- Content Analysis of the Instructional Practices Used

There were a variety of sources of information that were examined to determine the instructional practices. These include the weekly plans, a sample of grade 4 and 5 science lesson plans (10 for each grade level), grade 4 and 5 class observations (10 observed sessions for each grade level), the teachers' survey, and the science coordinatorinterview.

Grades 4 and 5 weekly plans mentioned two major instructional practices that teachers use throughout their instruction. They use mostly demonstrations and classroom discussions to explain science concepts.For example, one activity mentioned in the weekly plan was: "For grade 4 students to be able to explore and observe various forms of energy, grade 4 teacher should perform a demonstration by using a torch and two batteries to explore electrical, heat, and light energy." Class discussions often used diagrams, charts, and photos.To teach a science concept, grade 5 teacher also performed a simple demonstration and then drew charts and diagrams on the board to explain the concept. In one lesson about "Magnetism", for example, the teacher performed a demonstration to show students how magnets attract and repel. After the students observed what happened in the demonstration, the teacher posed questions and students were involved in the discussion.For grade 4 students to find out how volcanoes change the earth's surface, the teacher used class discussion that involved showing students photos taken before and after a volcanic eruption and asking them questions to describe what they see before and after the eruption and explain why these changes occurred.For students to find out how pitches change, the grade 4 teacher performed a simple demonstration in which she plucked the rubber bands between pencils closer and apart on a tissue box, asking students to hear the sounds that were produced when they moved the pencils, and use their chart to record their observations and predictions. After they observed the pitches produced, students discussed their predictions and made inferences about the length, speed, and pitch of vibrating objects.

For students to apply the science concepts they learned, the teachers extended the concept to different contexts by posing them real world applications to consider. These real world applications were new problems, enrichment tasks or mini projects. For example, for the lesson about electricity, grade 5 teacher asked students to engage in the following enrichment task: "Compose mottos that describe ways in which electricity can be used safely, and make posters about electrical safety using the slogans to discuss them with their classmates." For the lesson about Earth and its various landforms, grade 5 teacher asked questions related to the students' daily life: "What cities or places they visited in Lebanon? and What does each town look like?". Then, she drew the various landforms on the board for students to visualize them. As an assignment, she asked them to draw different land forms on their copybooks.

The science lesson plans mentioned three instructional practices that teachers use throughout their instruction. These were: classroom discussions that involve asking questions, conducting investigations or experiments, and teachers performing demonstrations. For example, before explaining science concepts such as sound, the grade 4 teacher was expected to ask students questions that activated their prior knowledge. Questions included: "How does the outer ear help you hear sounds?", and "How do vibrations in the ear become sounds that you can understand?" This set of questions extends the class discussions and allow students to activelyparticipate while the teachers perform the demonstrations.The science lesson plans call for inquiry, but very few actual investigations were observed in the lessons. Grade 4 and 5 teachers rarely relied on other instructional practices such as allowing students to conduct investigations, engaging in tasks that allow them to collect and analyze scientific data to reach conclusions.

From the science lessons I observed, it could be concluded that both grade 4 and 5 teachers follow what can be called a modified teacher-centered approach. Grade 4 and 5 teachers begin their lessons with a hands-on activity or a simple demonstration that leads the class into discussion. Then the teacher explains the lesson, and asks students to read from their textbooks and answer questions.Somegrade 5 lessons begin with a few open-ended questions, followed by a demonstration. Take a lesson on electric current, as an example. Before the grade 5 teacher explained the different types of currents to the students, she performed a demonstration that showed the various types of electric circuits. Then, the teacher asked the following questions to engage students into discussion: “what is a current?; what makes a current?; and what are the differences and similarities between currents?”

From the survey conducted with the two grade 4 and 5 teachers, a number of conclusions could be drawn. The grade 4 teacher indicated that the types of instructional activities that students engage in during science instruction were: watching the teacher demonstrate a scientific phenomenon, working individually on science assignments and writing a report on science topics. The grade 5 teacher indicated that students mostly watch the teacher demonstrate a scientific phenomenon, listen to the teacher explain something about science to the class, and moderately engage in science activities outside the class or in the science lab (for example: fieldtrips or research).

When asked about their opinions on the teaching environment, both teachers agreed that lab-based science classes were more effective than non-lab classes.However,in less than 10 % of the total instructional time grade 4 and 5 students performed investigations and lab experiments. The results of the survey show that grade 4 and 5 students were never assigned to work collaboratively in groups to perform a specific assignment. Moreover, no time was dedicated for students to read science magazines, books, use computers or other resources to organize data in tables, and interpret information. Both grade 4 and 5 teachers believed that the textbooks were helpful in extending their instructional practices and exposing them to new teaching strategies they benefit from.

From the science coordinatorinterview, the following recommendations regarding instructional practices were revealed. The science coordinator wants science elementary teachers to focus on how students make use of the science content and improve the use of certain scientific skills and language. She wants students to effectively use the scientific terms they learn in class. If the science coordinator sees a teacher having difficulty in selecting a suitable teaching method that fits with the curricular objectives, she would provide her with an example of how to explain the science concept using a different teaching method because she wants teachers to be creative in taking into consideration the students' talents and intelligence types. Moreover, the science coordinator pointed out that the science department in the school is participating in a projectentitled: “Health, Food and Nutrition”. The science coordinator and elementary teachers modified the yearly plan and designed the “Nutrition/Health Unit” given during the first term, to proceed later with the project. They asked students to work individually on designing a restaurant menu that serves healthy food, and present it in class.

To conclude, the content analysis of the weekly plans, science lesson plans, classroom observations, teachers' survey, and the science coordinator interview, reveals that the prevailing pattern of instructional practices used to explain science concepts were the classroom discussion and the teacher performing demonstrations. Class discussions mostly used charts, diagrams, and questions. Most of the science lesson plans called for inquiry (students performing investigations or experiments themselves). However, from the science lesson plans that were observed, both teachers followed a modified teacher- centered approach where they performed demonstrations and lead a class discussion. Thus,there was some inconsistency between what was observed and what was indicated in the lesson plans. The science lesson plans called for inquiry and the integration of technology within the lessons, however,both teachers rarely took the students to the science labs to conduct experiments and investigations themselves, and they did not integrate technology in their lessons.

3.3- Content Analysis of the Instructional Materials

When considering the instructional materials, the sources of information included: the curriculum map, the weekly plans, the science lesson plans, the observed lessons, the teachers' survey and the science coordinatorinterview.

The materials found in the curriculum map were listed in the activities section, and those were: lab materials and equipment, posters, access to living things and models. The materials stated in the weekly plan were textbooks, board and lab materials .The materials found in the lesson plans were put under the inquiry additional activity section. These were only lab equipment. Many lesson plans called for students to perform lab experiments.However, the lab materials allowed teachers to conduct demonstrations, but were not enough for students to conduct experiments themselves. In onlyone out of 10 lessons in class did grade 4 and 5 teachers take the students to the lab or make use of lab equipment.Although the science lesson plans had a section about technology, the teachers have not integrated technology in their lessons.

In most of the lessons that I observed, grade 4 teacher used objects present in the classroom and at the students' homes to explain scientific concepts. For example, for the lesson about sound, the teacher asked students to use their rulers to see how they vibrate. To model to grade 5 students a volcanic eruption, the teacher asked students to bring from their homes the following materials: soil, plastic jars, vinegar, baking soda and water. In another lesson about Earth, grade 5 teacher asked her students to collect various small rocks and soil to discover the formation of rocks and soil. To explain science concepts such as magnetism, the grade 5 teacher used lab materials such as iron fillings and magnets to demonstrate science terms such as magnetic field. In the only lesson out of 10, the grade 5 teacher took students to the lab to perform a demonstration about electric circuits. She constructed a series and parallel circuits using wires, batteries, paperclips and bulbs to show the students the difference.

From the survey of grade 4 and 5 teachers, a number of conclusions can be drawn. Grade 4 and 5 teachers stated that students never performed lab activities, experiments and investigations. Instead they watch the teachers demonstrate scientific phenomena. When asked about whether they use computers, calculators or other educational technology tools to learn science in the survey, teachers responded: "never".

When asked about the resources that teachers use throughout their instruction, the science coordinator mentioned the following: American textbooks, internet access, lab materials and access to human resources. For the Nutrition and Health Unit, for example, they interviewed a nutritionist and a dentist. Students also visited sports clubs for fitness purposes and engaged in lots of other outdoor educational activities. For the science topic about 'Forms of Energy', the grade 4 science teacher took her students to nearby Luna Park to see how the forms of energy change from one form to another as they rode the machines.

The science coordinator permits teachers to request materials if they are affordable, depending on the budget and need. When the science coordinator was asked about the materials teachers wanted to have access to, she immediately responded that more than one multimedia room is required because one is not enough for students of all grade levels, though they know that they are costly. If the science coordinator sees a teacher having difficulty in selecting the instructional materials to demonstrate a science concept, she gives her hints of different activities and provides her with internet sites that could be useful.

To sum up, the content analysis of the weekly plans, classroom observations, science lesson plans, and the coordinator interview reveals that the most common instructional materials used were the textbooks, lab equipment, class, and everyday household objects. The teachers used the various lab materials or class objects to perform demonstrations. Many lesson plans called for performing experiments. However, the lab materials were not sufficient for all the students to engage in scientific inquiry where they have to conduct investigations and run experiments on their own or in groups for an extended period of time. Responses to the teachers' survey were consistent with this picture indicating thatgrade 4 and 5 students never performed lab activities, experiments and investigations. Instead they watch the teachers demonstrate scientific phenomena. Although the science coordinator indicated that teachers use resources such as access to human resources (interviewing experts), and internet access, the class observations did not reveal that.

3.4 - Content Analysis of the Assessment Practices

Information about assessment practices used was drawn from the science lesson plans, grade 4 and 5 assessments, and class observations. Under the "Ongoing Assessment" heading of the lesson plans, questions that recall knowledge and facts and higher order thinking were posed for the teacher to ask students. These higher order thinking questions assess students on their predicting, inferring, applying, and problem- solving skills. For example, for a lesson about sound, grade 4 teacher posed questions to students that can be answered orally or in writing: " Why can you hear an airplane flying high above you in the sky?", "Sounds can travel through which forms of matter?", and "Through which object would sound travel the fastest: metal rod, water or air? Why?" For the lesson about electric circuits, grade 5 teacher can assess students orally by asking them, for example: "What are the types of charges objects can have?", "How can negative charges move from one object to another?", "How can you get an electric shock when you reach out to touch something?", and "Predict what would happen if your body had a balanced number of charges and you touched a negatively charged object."

After examining the exams and quizzes of grades 4 and 5, it was noted that they did not explicitly mention the skills and general objectives students are assessed on. The format of the test items in each exam consisted mostly of "objective" questions (multiple-choice, true/false, fill in the blanks), and subjective questions (short essay questions). Most of grade 4 and 5 assessments consisted of objective questions that test students' knowledge and subjective questions that test their ability to apply the science concepts in new situations. For example, for grade 4 students to describe the parts of a food chain, the questions posed were: "Define food chain and predator. Correct the following food chain: Bird→ green leaves→caterpillar, and give a food chain that is made up of three links. The last link has to be a human." Relevant to the idea that matter can be measured, grade 4 teacher asked students to complete a table that consisted of the following headings: the properties of matter, tools to measure the matter, and units of measurement.

A challenging task was posed to grade 4 and 5 students in most of the exams. One challenging task asked students to analyze and infer from a diagram. Grade 5 students were asked to consider the following case: "Sam is trying to construct an electric circuit. He ran short of wires, and he still needs to connect the bulb to the battery. He found a rubber band, a piece of thread, and a paper clip" Students were asked questions such as: "Which of the above materials can he use to complete the circuit?", "What kind of circuit did he construct? Justify", "Would you use this kind of circuit at home? Explain your answer.", and "Describe two ways to use electricity safely."

From classroom observations, both teachers continuously assessed students orally, by giving them pop quizzes and asking them questions to see whether they are able to explain the concepts they learned and apply them to solve exercises. Grade 4 and 5 students are given ongoing feedback and comments during their participation in class.

The responses of the survey show that the types of test items teachers mostly prepare to assess students are objective items such as multiple choice and true/false statements, and extended response items that require students to explain and justify their answers. Grade 4 and 5 students were once or twice assessed with oral presentations, never with portfolios or performance tasks.

Thus, it can be concluded that most of grade 4 and 5 assessment practices consist of objective test items that assess students' understanding of science concepts and subjective questions that assess their application in novel contexts. The science lesson plans provide teachers with questions to pose to students. These questions call for recalling knowledge, facts, and higher order thinking.Students were once or twice assessed orally, rarely assessed with oral presentations, never with portfolios and performance tasks.

3.5 - Content Analysis of Professional Development Activities

The sources of information regarding professional development activities were the teachers' survey and the science coordinatorinterview.

Responses of the survey show that grade 4 and 5 teachers attend conferences and workshops related to science education once or twice a year. Both teachers never acted as a mentor to other teachers or staff in the school, but received mentoring once or twice a year. The grade 4 teacher never discussed science topics with her colleagues, never read a journal article on science education or used the internet to enrich her knowledge or skills. However, grade 5 teacher performed all of these tasks once or twice a semester.

Moreover, responses of the survey show that grade 4 teacher often engaged in professional development activities such as enhancing the scope and sequence of the science curriculum (adding to the skills and concepts that students have to master, and selecting the order in which science topics are placed in the curriculum), developing weekly and yearly lesson plans, assessments and tasks. Both teachers never gave a lecture or a presentation to colleagues. Grade

5 teacher was never involved in supporting the school improvement plan that involves enhancing the curriculum, adding or modifying instructional objectives and developing lesson plans.

The grade 4 and 5 teachers benefited from workshops that were about the alignment of science instruction to curriculum, preparing for classroom science assessments, understanding and interpreting assessments, and technology to support student learning in science. They also agreed that the school's principal is interested in the professional development of the teachers and that they can discuss worries and frustrations with the principal. The grade 4 teacher indicated that science teachers in the school do not observe each other teaching classes and cannot trust each other.

From the coordinator interview, the following responses were elicited. When asked about the kinds of professional development opportunities available for science teachers, the science coordinator declared that teachers attend workshops at school during the academic school year and coordination sessions per cycle. An example of a recent workshop was about the "Practical Use of Analogies in Science" given by the science coordinator herself at the end of the academic school year. Additionally, grade 4 and 5 teachers learned how to construct or search for activities that helped them focus on science process skills, how to extend scientific concepts to novel contexts, and how to asses and activate students' prior knowledge throughout instruction. Sometimes, teachers are sent to attend workshops such as those offered by the Science and Math Education Center (SMEC) at the American University of Beirut, and sometimes in other universities.

According to the science coordinator, the major science topic that she thinks teachers should develop their skills in relation to is physical science for cycle 1 and 2. Topics include

Electricity and Magnetism, Energy and others. This is because student teachers who majored in Biology were not given sufficient exposure to physical science courses at university. This results in students acquiring misconceptions from teachers who are not prepared well enough to teach physical science. She recommended that teachers need training inside the school because the school cannot afford sending them to attend courses in universities or abroad.

To sum up, the content analysis of the teachers' survey and the coordinator interview reveals that both teachers engaged and benefited from the professional development activities that were given throughout the academic school year. They learned about the alignment of science instruction to curriculum, preparation for classroom science assessments, interpretation of the assessments, and integration of technology that support student learning in science. In addition, K-8 teachers learned how to construct or search for activities that helped them focus on the science process skills and curricular objectives, how to extend scientific concepts for students to apply them in novel contexts, and how to asses and activate students' prior knowledge throughout the instruction.Nevertheless, the science coordinator believes that the science teachers need training inside the school to develop additional teaching skills and strategies that prepares them to teach physical science topics for students not to acquire misconceptions of physical science concepts.

3.6 - Analysis of Alignment of Objectives with Other Aspects of the Instructional Program

The curriculum map, yearly and weekly plans, and science lesson plans indicate that science teaching at the school is based on the following key instructional objectives: students should understand scientific knowledge, apply the science concepts to novel situations, and develop science process skills throughout studying the science content with emphasis given to: observing, predicting, communicating ideas, and inferring. The alignment of the instructional objectives with each aspect of the instructional program will be examined in this section.

The prevailing pattern of instructional practices grade 4 and 5 teachers used to explain science concepts were the classroom discussion and performing demonstrations, however, within a traditional setting. Class discussions were mostly used with charts, diagrams, photos and questions. Grade 4 and 5 teachers presented demonstration to their students where they had to observe, predict and infer. Throughout the demonstration, the teachers asked questions that allow students to participate in the discussion, and activate their prior knowledge. Examples of such questions were: “How does this happen?” and “Why do you think so?” Then, for students to apply the science concepts they learned, the teachers extended the concept to different contexts by posing them real world applications to solve. These real world applications were new problems, enrichment tasks, mini projects or presentations.

It was observed that when the science teachers initiate the discussion, students start to participate and interact with their classmates. Such instructional practices allow students to develop observing, communicating, predicting, and inferring skills.In class discussions, both teachers extended the science concepts to different contexts, and asked students to predict and explain what happens when she posed on them questions and problems.For example, for the lesson that is about “How Do Living Things Make, Use, and Hear Sound?”, the grade 4 teacher asked students to place their fingers on their throats, and describe what happens inside their throats as they produce sounds. To extend the science concept and integrate it in different context, the teacher used some musical instruments (mallets and cymbals) to strike the cymbal with the mallets. Then, she wanted students to communicate their ideas by asking them: “Why did striking the cymbal with the mallet produce a sound?", and "What happens to the sound if you place your hand on the cymbal after it has been struck? Why?"

Thus, it can be inferred that the instructional practices (classroom discussions and performing demonstrations) align with the instructional objectives that call for students to understand the scientific concepts and apply what they learned to novel situations, and develop some science process skills with emphasis given to: observing, predicting, communicating ideas, and inferring. The science lesson plans also call for inquiry. However, very little of that was observed during the lessons. Grade 4 and 5 teachers rarely relied on other instructional practices such as allowing students to conduct investigations, engaging in tasks that allow them to collect and analyze scientific data to reach conclusions.

Content analysis of the instructional materials shows that grade 4 and 5 teachers used appropriate lab materials for performing the demonstrations to explain scientific concepts. For the lesson about cloud formation, for example, the grade 5 teacher chose to perform a demonstration using appropriate materials such as jars, warm water and ice cubes, so that students understand the science concept on how clouds are formed. Both teachers performed demonstrations that enabled students to observe, predict, communicate and infer.

Although the materials were adequate and appropriate for the science topics, teachers still considered the materials not enough for all students to work on when conducting experiments and investigations. Students did not get the chance to work with the lab materials to perform their own experiments, investigations, and other performance tasks. They did not apply scientific investigative process skills (interpreting data, hypothesizing, and experimenting). Grade 4 and 5 teachers mostly focused on achieving the conceptual understanding objective and applying what they learn in novel situations. Although the science lesson plans had a section about technology; the teachers did not integrate technology (e.g. educational software) in their lessons.

Judgments about alignment of assessment practices with objectives are made based on whether the assessment task items ranging from true/false, multiple choice questions, up through essay questions align with the learning objectives that students should achieve. Most of grade 4 and 5 assessment practices consist of objective items (true/false, multiple-choice questions, and fill in the blanks) that assess students' understanding of science concepts and subjective (short essay questions) that assess their application in novel contexts. For example, grade 4 teacher posed the following questions to assess students' understanding of matter and energy, and their application in different contexts: "How can you tell that something is made of matter?", "Choose an object from your surroundings and give 4 of its properties." "Sam rides his bicycle to school every day: "Where did Sam get the energy he needed from?" and "What kind of energy is the bicycle using to move?"

Thus, most of grade 4 and 5 assessment task items (objective questions) focused on assessing students on their ability to understand the science concepts, and subjective questions that assessed them on the application of the scientific knowledge in novel contexts. The short essay questions and challenging tasks assessed students on some science process skills: observing, predicting, communicating ideas and inferring.Students were once or twice assessed orally. Moreover, the responses of the teachers' survey showed that grade 4 and 5 students were never assessed on portfolios and performance tasks.

Alignment is partially present between the objectives and professional development activities given to teachers. The content analysis of the teachers' survey and the coordinator interview reveals that both teachers engaged and benefited from the professional development activities that were given throughout the academic school year. They learned about the alignment of science instruction to curriculum, construction of classroom science assessments, understanding and interpretation of the assessments, and integration of technology that support student learning in science. Although teachers learned how to integrate technology in their lessons, they did not use it in their teaching. In addition, K-8 teachers learned how to construct or search for activities that helped them focus on the science process skills (communicating ideas and inferring), how to extend scientific concepts for students to apply them in novel contexts, and how to asses and activate students' prior knowledge throughout the instruction.

The science coordinator believed that alignment can be ensured by evaluating students' work that includes activities, quizzes, tests, presentations and projects, in addition to the teachers' weekly plans. She stressed on the importance of the weekly plans that include most of the aspects (teaching methods, objectives, activities, and instructional materials) that make up the instructional program, indicating that the coherence of the science instructional program is achieved when students develop the various science process skills (observing, communicating ideas, predicting, and inferring) that they are expected to achieve.Nevertheless, the science coordinator believes that the science teachers need training inside the school to develop additional teaching skills and strategies that prepares them to teach physical science topics for students not to acquire misconceptions of physical science concepts.

One of the most beneficial professional development activities is mentoring in which experienced teachers collaborate with novice teachers. They help them select objectives, teaching methods and materials, and solve academic problems they face in classrooms (Eun, 2008). From what I observed, the science coordinator at the school did not observe the elementary teachers or assign mentors to visit and help the science teachers.

3.7- Analysis of Alignment between the Other Aspects of the Instructional Program

It is not enough that the curricular objectives are aligned with the different aspects of the instructional program. For an instructional program to be coherent, it is essential that all of its aspects-instructional practices, materials, assessment practices, and professional development activities-are aligned with each other.

The instructional practices mentioned in the weekly plans (classroom discussions and performing demonstrations), were used by both teachers. As for the instructional practices that were mentioned in the science lesson plans (engaging in inquiry and technology). From classroom observations, grade 4 and 5 teachers did not use inquiry and technology. The teachers selected the appropriate materials (lab materials, class objects, and textbooks) for classroom discussions and performing demonstrations. However, the analysis of instructional materials revealed some shortcomings. There were not enough multimedia rooms and labs for all students to perform experiments.Although the science lesson plans call for students to engage in investigations and experiments, the instructional materials were not enough for all students to work on when conducting their own experiments, investigationsand other performance tasks. Thus, I believe that there is poor alignment between the instructional materials (limited lab materials, class objects, and multimedia rooms) and instructional practices that permit students to engage in inquiry and teachers to integrate technology in their lessons.

Most of grade 4 and 5 assessment practices consist of test items that assess students' understanding of science concepts and their application in novel contexts. The science lesson plans provide teachers with questions to pose to students. These questions call for recalling knowledge, facts, and higher order thinking. In this sense, both teachers have succeeded in aligningthe professional development activities they learned (how to select the appropriate choice of test items that are matched with the curricular objectives) with the assessment practices that they have constructed.Grade 4 and 5 teachers engaged and benefited from the professional development activities that were given throughout the academic school year. They learned about the alignment of science instruction to curriculum, and interpretation of the assessments. In addition, grade 4 and 5 teachers learned how to construct or search for activities that helped them focus on the science process skills (communicating ideas and inferring), how to extend scientific concepts for students to apply them in novel contexts, and how to asses and activate students' prior knowledge throughout the instruction.Thus, there is a good alignment between professional development activities and assessment practices. Both teachers learned how to search and select the appropriate assessment items that are compatible with the curricular objectives, including the scientific process skills.

There was no alignment between the instructional materials and professional development activities. The professional development activities did not teach teachers the importance of using the materials when performing experiments and demonstrations, and selecting the suitable materials for each science activity.

There was full alignment between the instructional practices and the assessment practices. Grade 4 and 5 students were continuously assessed; oral and written questions were posed during the classroom discussions to see whether they were able to explain science concepts and apply them in novel situations.

Figure 3.1 summarizes the degree of alignment (good, partial and no alignment) between the objectives and the various aspects, and the aspects with each other. There was good alignment between: the curricular objectives and instructional practices, curricular objectives and assessment practices, and curricular objectives and professional development activities. Partial alignment existed between the objectives and instructional materials. The degree of alignment between the other aspects also varied. Instructional practices were aligned with the assessment practices, partially aligned with instructional materials and professional development activities. Instructional materials were partially aligned with assessment practices, but poorly aligned with the professional development activities. Assessment practices were aligned with professional development activities.

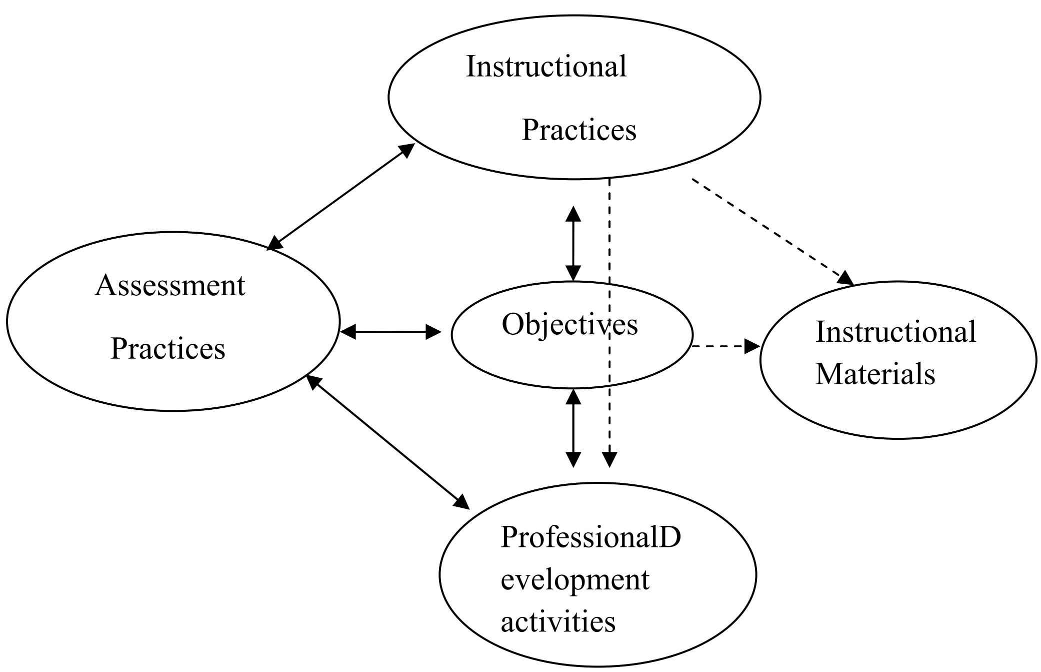

Figure 3.1: Degree of alignment diagram

←→ Good alignment

- - -► Partial alignment

Absence of alignment

CHAPTER FOUR

DISCUSSION AND RECOMMENDATIONS

In this chapter, a discussion about the various aspects of the Instructional Program will be presented in light of the literature review, and some recommendations that may help improve the overall coherenceof the program.

4.1- Instructional Practices

The result of the alignment analysis revealed that there was good alignment between the instructional practices and objectives, good alignment between the instructional practices and assessment practices, partial alignment between the instructional practices and instructional materials, and partial alignment between the instructional practices and professional development activities.

Instructional practices should be consistent with the objectives included in the curriculum map, science lesson plans, and weekly plans. Before teachers proceed with their instruction, they should refer to the curricular objectives especially the science process skills objectives, and select the suitable activities, demonstrations, and experiments to explain the science concepts and allow students to apply what they learn in novel situations. It is important that the instructional practices are varied. The effectiveness of each teaching method depends on the teacher's ability to use it appropriately and relate it to the science instructional program and the needs of students.

Metz (2004) and other researchers integrated problem-solving tasks and investigative activities in a Grade 6 science unit in Detroit Public School for a period of 3 years. They posed questions to students such as: “How can you move big things?” and asked students to create projects to explore the concept of forces and various machines. They found out that students who accomplished the tasks understood the concept and performed better on exams than those who didn’t engage in such tasks.

The content analysis of the weekly plans, classroom observations, science lesson plans, the teachers’ survey, and the coordinator interview revealed that the two instructional practices used more frequently were guided classroom discussions and demonstrations. Grade 4 and 5 teachers explained the science concepts through demonstrations and permitted students to engage in classroom discussions.Classroom observations revealed that grade 4 and 5 instructional practices align with the instructional objectives that call for students to understand the scientific concepts and apply what they learned to novel situations, and develop some science process skills with emphasis given to: observing, predicting, communicating ideas, and inferring.Although the science lesson plans called for inquiry, in most of grade 4 and 5 classes that I observed, the teachers’ ideas were driving the instruction and students did not have the chance to perform experiments and investigations themselves. As stated previously in the literature review, Duschl and other researchers (2007) indicated that K-8 students understand science concepts and phenomena by actively engaging in the practices of science that include conducting investigations, participating in discussions and reflecting on experimental results which require guidance from the teacher.

Although demonstrations are useful in teaching science, they also have some limitations. From what I observed, I noticed that not all students were able to see the whole demonstration. This might probably be due to the limited lab space or classroom.In addition to this, the grade 4 teacher was not able to maintain students’ interest during some of her demonstrations because not all students were actively involved and thus, misunderstood the purpose of the demonstration.

Out of all the classes that were observed, students were never assigned to groups to discuss on scientific issues. Not only can cooperative learning enhance student communicating and problem-solving skills, but it allows students to improve their concept development and the mastery of the content. Through argumentation, peers drive the instruction, and convince each other with their explanations and critiques to reach consensus (Duschl& Osborne, 2002). I believe that students should work in teams, observe, gather supporting data and then record their observations. When they build on their knowledge, they ask more questions, which, in turn, leads to new experiments. As they progress, they become more comfortable with scientific procedures and processes that allow them to build and conduct their own experiments based on questions they want to answer.

To fill these gaps, I recommend that both teachers should vary their instructional strategies and not limit their instruction to one or two strategies. It is important that science teachers use a variety of instructional strategies throughout their instruction to accomplish the curricular objectives and allow students to actively engage in the lesson and benefit from. Teachers should set up situations that will encourage students to explore and find out more about scientific concepts. When the instruction is planned to consider students as the active agents in the class,they will have more curiosity and interest in learning the scientific ideas and finding them more meaningful (Duschl et al., 2007). Scientific inquiry includes more than constructing knowledge through hands-on activities or demonstrations. Michaels et al. (2008) suggested that teachers should encourage students to develop presentations and projects during the inquiry process and to obtain information from a variety of sources to reflect on their experiences, and apply their scientific understanding.

4.2- Instructional Materials

The result of the alignment analysis revealed that there was partial alignment between instructional materials and objectives, partial alignment between instructional materials and instructional practices, partial alignment between instructional materials and assessment practices, and no alignment between instructional materials and professional development activities.

Instructional materials should relate directly to the objectives of the science lessons and should be consistent with the instructional methods teachers useto explain scientific concepts and extend the science content. Teachers should engage in professional development activities that teach them how to use the instructional materials to explain science lessons, consider the objectives, instructional practices used, the learning environment and the available resources at school.

The content analysis of the weekly plans, classroom observations, science lesson plans, and the interview reveals that the most common instructional materials used were the textbooks, lab equipment, and class materials. The lab materials were not sufficient for all the students to engage in scientific inquiry, conduct investigations, and run experiments on their own or in groups. Teachers should think of the teaching materials when planning their lessons and ensure that they are available when needed. As stated previously in the literature review, Newmann et al. (2001) stressed that Instructional Program Coherence is achieved when the school properly allocates funds that are spent on suitable lab materials and equipment that help studentsachieve the instructional objectives. Materials and equipment are required for students' lab work and teachers' demonstrations. Singer and Tuomi (1999) stated that teachers should check whether the instructional materials are updated and challenging, and enough for all students to use when performing certain activities. Grade 4 and 5 teachers mostly focused on the conceptual understanding objective, thus, they used various lab materials or class objects to explain the science concepts throughdemonstrations. Both teachers used the lab materials to perform demonstrations, but students did not have the chance to use these materials to perform experiments themselves. Thus, grade 4 and 5 teachers could notengage students in inquiry and thus, the students were not actively involved in learning.

Most of the science lesson plans consist of a section about technology that teachers preferably should integrate within their lessons.According to Duschlet al. (2007), one way to help students understand and apply effectively science concepts can be through instructional technologies such as educationalsoftware. This software can blend text, diagrams, animation and videos to help studentsdevelop the mental scientific skills and knowledge that they can apply to their everyday life. Using such programs is appropriate when the teacher cannot demonstrate certain phenomena, or wants to demonstrate parts of a dynamic science process (Duschl, et al., 2007). I believe that teachers should not rely on the textbooks and lab materials, but make use of a variety of resources to help students understand and apply science concepts.

Although the science coordinator indicated that teachers have access to human resources, grade 4 and 5 teachers barely used human resources and the community. Duschl et al. (2007) stated that the community offers opportunities for students to leave the class to study real science processes when visiting libraries, museums, and factories.

4.3- Assessment Practices

The result of the alignment analysis revealed that there was good alignment between assessment practices and objectives, instructional practices, and professional developmental activities.Assessments should align with the instructional objectives teachers want students to achieve. It is essential that teachers vary the assessment approaches, considering these objectives. It is necessary that teachers use assessment methods other than paper and pencil tests including portfolios, journaling, concept mapping, open-ended questions, and performance tasks. Rubrics should be used in conjunction with the assessments to make judgments about students' work. Assessments are used not only to determine the final achievement and grades, but should be applied before and during instruction to diagnose student learning problems, monitor student progress, and guide teacher planning.

Grade 4 and 5 students' assessment practices mainly assess students' understanding and application of science concepts. Most of grade 4and 5 assessments that I examined consisted of test items that ask students to recall facts and knowledge and apply what they learned to solve easy problems.According toStern and Ahlgren (2002), assessments should include 3 essential parts related to the curricular objectives: one part for testing students' knowledge, a second for applying what students learned to new situations, and a part that requires students to analyze, synthesize and come up with new solutions.So while alignment was good between the emphasized objectives and the assessment practices;expanding objectives to include more inquiry would require expanding assessment practices.

The focus of assessments should not be limited to student understanding of scientific facts and concepts. Assessments should provide information about students' ability to inquire and reason scientifically, to use science to make decisions (Stern &Ahlgren, 2002).One way for students to use and apply the scientific knowledge is through evaluating scientific information from magazines, articles and reports that teachers provide them with. In this way teachers can assess whether students can extract the scientific ideas from the articles, evaluate the evidence that support the proposed ideas, and finally come up with actions for solving a certain problem (Millar & Osborne, 2001). It is necessary that teachers remember that assessments are for teachers to improve their instructional practices to ensure that all students meet all intended objectives.

4.4- Professional Development Activities

The results of the alignment analysis revealed that there was good alignment between professional development activities and objectives, and assessment practices. Professional developmental activities were partially aligned with instructional practices. There was no alignment between the professional developmental activities and instructional materials. The content analysis of the teachers' survey and the coordinator interview revealed that grade 4 and 5 teachersengaged and benefited from the professional development activities that were given throughout the academic school year. Alignment was present between the professional development activities and the curricular objectives especially the science process skills objectives. They learned about the alignment of science instruction to the curriculum, understanding and interpretation of the assessments. In addition, grade 4and 5 teachers learned how to construct or search for activities that help students develop certain science process skills such as communicating ideas and inferring, how to extend scientific concepts for students to apply them in novel contexts, and how to asses and activate students' prior knowledge throughout the instruction. Although grade 4 and 5 teachers attended workshops about using technology in education that support student learning in science, they did not integrate these into their lessons.

I recommend that teachers attend workshops that teach them how to align the objectives with the various aspects of the instructional science program (instructional materials and practices). The lesson plans call for teachers to engage students in inquiry, for them to develop investigative skills; professional developmental activities should tackle this issue. Teachers did not attend workshops on how to select the suitable materials for performing the demonstrations and experiments, thus, professional developmental activities should focus on this aspect as well. One problem the science coordinator mentioned was that the science teachers need training inside the school to develop additional teaching skills and strategies that prepares them to teach physical science topics for students not to acquire misconceptions of physical science concepts. Thus, I believe that professional developmental activities should educate teachers on this issue. Through professional developmental activities that focus on how students learn the content and teachers' use of materials in classes, novices are able to solve challenges they face during the first teaching year as they observe others and develop teaching skills and knowledge (Ronfeldt& Grossman, 2008).

One of the most beneficial professional development activities is mentoring in which experienced teachers collaborate with novice teachers. They help them select objectives, teaching methods and materials, and solve academic problems they face in classrooms (Eun, 2008). From what I observed, the science coordinator at the school did not observe the elementary teachers or assign mentors to visit and help the science teachers. Through follow up, support and training opportunities which allow teachers to collaborate together, observe and critique others, and learn from each other's work, professional development is achieved (Printy, 2008). Newmannet al. (2001) suggest that school principals should interfere when teachers need extra materials or time, encouraging them to collaborate with their colleagues and decide on what instructional strategies to use and what learning outcomes and skills students areexpected to achieve behind each science unit.

4.5 - Conclusion

This study has included the detailed analysis of grade 4 and 5 science instructional program that consisted of various aspects: instructional practices, materials, assessment practices, and professional development activities. This analysis can be helpful for grade 4 and 5 teachers to improve their teaching practices and reform the science instructional program in a way that can better promote students' scientific understanding and application of the scientific knowledge, and develop science process skills. In addition, the results of this study can be useful in providing data for other researchers who are interested in studying the importance of aligning the curricular objectives with the various aspects of the instructional science program at the school, and their influence on students' learning in science.

The degree of alignment between the objectives and the different aspects varied. There was a good alignment between the curricular objectives and assessment practices. Partial alignment existed between the objectives, instructional practicesand professional development activities. The instructional practices used (classroom discussions and performing demonstrations) align with the instructional objectives that call for students to understand the scientific concepts and apply what they learned to novel situations, and develop some science process skills with emphasis given to: observing, predicting, communicating ideas, and inferring. The science lesson plans call for students to engage in inquiry, however very little of that was observed during the lessons.There was poor alignment between the objectives and instructional materials. The degree of alignment between the various aspects also varied. The science instructional program of grades 4 and 5 at the school could be coherent if the science coordinator and teachers collaborate together and work on aligning the objectives with the various aspects. Grade 4 and 5 teachers rarely relied on other instructional practices such as allowing students to conduct investigations, engaging in tasks that allow them to collect and analyze scientific data to reach conclusions. Although the materials were adequate and appropriate for the science topics, teachers still considered the materials not enough for all students to work on when conducting experiments and investigations themselves. They did not practice on developing scientific investigative process skills (interpreting data, hypothesizing, and experimenting). Although the science lesson plans had a section about technology, the teachers have not integrated technology in their lessons. Students were once or twice assessed orally through written pop quizzes, and never assessed on portfolios and performance tasks.

Alignment is partially present between the objectives and professional development activities given to teachers. Although teachers learned how to integrate technology in their lessons, they did not use it in their teaching. The science coordinator believes that the science teachers need training inside the school to develop additional teaching skills and strategies that prepares them to teach physical science topics for students not to acquire misconceptions of physical science concepts.

The curricular objectives, effective instructional practices, materials, and assessments should all be considered when planning the science instructional program. Effective planning involves the consideration of all aspects of the program, and not just the delivery of instruction. The teacher should plan the science instructional program in which all of its aspects (IPs, IMs, APs, and PD activities) are aligned with the set instructional objectives. Thus, I believe that science educators should focus and strengthen the instructional program coherence to improve the quality of science education and enhance students' achievement.

CHAPTER FIVE

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CHAPTER SIX

APPENDICES

6.1- Appendix I: Classroom Observational Guide

Grade ______ Date_____

- Length of session:
- Number of science sessions per week:
- # of students in class:
- # of students with learning difficulties in class:
- Is there enough space for all the students to conduct experiments & carry investigations?

Instructional practices

- Does the teacher familiarize the students with the instructional objectives at the beginning of each topic?
- Are children told exactly the purpose behind an activity, or are they expected to figure it out throughout the instruction?
- Does the teacher relate the topic of the lesson to students' ideas?
- Do the teacher's questions promote thinking and discussion or only recalling facts?
- Does the teacher use a variety of instructional materials & resources to explain scientific concepts?
- Are the science concepts explained correctly and clearly throughout the instruction?
- Does the teacher invite the students to share their ideas about the topic before the lesson begins?
- Do the classroom assignments and activities challenge students into thinking & problem solving?
- Does she connect the prior lesson to the current one?
- What does the teacherdo when students don't understand a science concept?
- Do students engage in activities outside class and visit places that may help them understand science issues?
- Does the teacher find time to give feedback & comments to each student during the session?
- Does she allow students to work collaboratively in groups?

6.2- Appendix II: Science Coordinator Interview

1) What curriculum is used to guide the teachers' yearly planning?

   Modified Lebanese curriculum is used. They follow the set curriculum map.

2) How do you ensure the alignment between the curricular objectives, assessments and the instructional practices and materials is available?

   Alignment can be ensured by the evaluation process of students' work that includes activities, quizzes, tests, presentations and projects, in addition to the teachers' weekly plan.

3) How do you describe a school with a good coherent instructional program? Are there any additional aspects you are working on to improve science instruction at the school?

   The science department is working on a good coherent instructional program. They are doing a connecting classrooms project that is titled: "Health, Food and Nutrition". Teachers and coordinators modified first the yearly plan and made the Nutrition/health unit given during the first term, in order to proceed later with the project.

   Additional aspects: - They are trying to improve the use of scientific skills and language. Students are good in English, but not good in using scientific terms. They are implementing the use of skills starting from cycle 1 according to the age level. For example, the same scientific term is used from grade to grade but more expanded when going to higher levels.

   - *They are working on focusing on the use of content and not just the content itself.*

4) If you see a teacher having difficulty in selecting the instructional materials and using a suitable teaching method that fits with the curricular objectives,what would you do to help?

   I give her hints of different teaching methodologies with one example on how to explain a certain curriculum objective and provide the teacher with internet sites to look for. I follow a deductive method because I want teachers to be creative taking into consideration the students' talents and intelligence types (visual, practical…)

5) What are the available resources that teachers use throughout their lessons? How often do you get new materials?Do you permit teachers to request for materials to school every now and then?

   - Resources used are: American textbooks, internet access, lab materials, and access to human resources. For the Nutrition and health topic, we interviewed a nutritionist and a dentist for the health unit. A lab technician from AUH also visited our school. We took students to sports clubs for fitness purposes and lots of other educational outdoor activities. We took students of middle grade levels to hospitals to see the growth on bacterial cultures.

   - If affordable, teachers are allowed to order materials (every year depending on the budget and need).

6) What materials teachers wish they had access to?

   More than one multimedia room is required because they are not enough for students of all grade levels. But we know that they are very expensive.

7) What kinds of professional development opportunities are available for science teachers? What workshops have they engaged in recently?

   Teachers attend workshops at school during the academic school year and coordination sessions per cycle. One workshop was about the "Practical Use of analogies in science" given by me. Other workshops were about: Science and Math Educational center (SMEC). Sometimes we send teachers to attend workshops at other schools.

8) What science topics teachers still want to be professionally developed at?

   The major science topic that I think teachers should be professionally developed at is Physical science for cycle 1 and 2 (Electricity, magnetism…) This is because student teachers who majored in Biology were not given more emphasis on physical science courses at university. This caused students to have misconceptions from teachers who are not prepared to teach physical science sessions. Elementary Teachers need training inside the school because the school can't afford sending teachers to attend courses in universities or abroad.