BIRZEIT UNIVERSITY

THE EFFECTS OF USING THE JIGSAW METHOD IN TEACHING SCIENCE ON STUDENT AND TEACHER LEARNING: A SELF-STUDY

أثر استخدام طريقة الأحجية في تعليم العلوم على تعلّم الطلبة والمعلم: دراسة ذاتية

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Birzeit, Palestine

May, 2012

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"We must view young people not as empty bottles to be filled, but as candles to be lit."

Robert H. Shaffer

Dedication

I dedicate this work to the memory of my beloved mother Milena Svobodová.

Wherever I go, whatever I do, you are in my heart.

"The aim of education should be to teach us rather how to think, than what to think—rather to improve our minds, so as to enable us to think for ourselves, than to load the memory with the thoughts of other men."

John Dewey

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Abstract

In this self-study, the author gained in-depth understanding of her initial beliefs about teaching practice and the events that led to a shift in those beliefs. Reflection on and analysis of the multiple data sources, including teacher journal, field notes, narration and videotapes, provided many perspectives to portray the shift towards student-centered instruction, particularly the jigsaw method, the changed teacher's role, the role of social interactions in cooperative learning, subject matter acquisition, and assessment. Beliefs about the role of teacher education and collegial inquiry focused on reflective practice in life-long professional development were also examined through qualitative research methods.

The effects of the jigsaw method classroom instruction grounded in the social-constructivist learning principles on students' learning, social interactions, attitudes towards science, and achievement were examined and compared to the traditional whole-class instruction. The intervention with a 120 sixth grade students was carried out using combined quantitative and qualitative data, including pre-test, post-test, student-created materials, student reflections and videotapes of lessons. The findings show that (1) the students appreciated the independence and responsibility for their learning during the jigsaw instruction which increased their interest in studying science, (2) the jigsaw method had a positive effect on the previously low and medium-performing students and a slightly negative effect on the high-performers, (3) no difference was found on the individual post-test results between the experimental and control groups on any level of the Bloom's taxonomy, and (4) the jigsaw group students were able to cope better with

the requirements of the final assignment, creating pamphlets using external sources, both

in terms of social interaction and cooperation and the quality of work.

ملخص الدراسة

اكتسبت الباحثة في هذه الدراسة الذاتية ، فهماً متعمقاً لمعتقداتها الأولية حول ممارسة التعليم والأحداث التي أدت إلى حدوث تحول في تلك المعتقدات. التأمل والتحليل لمصادر البيانات المتعددة، بما في ذلك مجلة المعلم، الملاحظات الميدانية، والسرد وأشرطة الفيديو، قدم كل منها وجهات نظر عديدة لتصور التحول نحو التعليم المتمركز على الطالب ، ولا سيما طريقة جيجسو ، والتغير في دور المعلم ،ودور التفاعلات الاجتماعية في التعلم التعاوني، واكتساب المعرفة بالموضوع ، والتقييم. و قد بحثت أيضا الباحثة المعتقدات حول دور تعليم المعلمين والبحث الجماعي المتمركز على الممارسة التأملية في مدى الحياة التنموية المهنية من خلال أساليب البحث النوعي .

تم فحص آثار طريقة جيجسو في التعليم و المبنية على المبادئ الاجتماعية البنائية للتعلم على تعلم الطلاب، والتفاعلات الاجتماعية، والمواقف تجاه العلوم، وتحصيل الطلبة و تم مقارنتها مع التعليم التقليدي في الصف . و قد تم دراسة تفاعل 120 طالب من الصف السادس باستخدام الجمع بين البيانات الكمية والنوعية، بما في ذلك مرحلة ما قبل الاختبار، وبعد الاختبار ، والمواد المعدة للطالب ، وتأملات الطلبة وأشرطة فيديو مسجلة للدروس. أظهرت النتائج ان (1) الطلاب قدروا إستقلالية ومسؤولية تعلمهم من خلال طريقة جيجسو ،مما زاد اهتمامهم في دراسة العلوم، (2) كان لطريقة جيجسو الأثر الإيجابي على الطبة ذوي التحصيل المنخفض والمتوسط و تأثير سلبي طفيف على الطلبة ذوي التحصيل المرتفع ، (3) لم يوجد فرق في نتائج الطلبة في

الاختبار البعدي بين المجموعتين التجريبية والضابطة على أي مستوى من تصنيف بلوم، و (4)

الطلبة الذين درسوا بطريقة جيجسو كانوا قادرين على التعامل بشكل أفضل مع متطلبات

الوظيفة النهائية، وخلق كتيبات باستخدام مصادر خارجية، سواء من حيث التفاعل الاجتماعي

والتعاون ونوعية العمل .

Chapter 1

Introduction and Theoretical Background

1.1 <u>Introduction</u>

I have been an elementary science teacher for five years now (2012). When I

accepted this job, I had a bachelors degree in biology, a positive attitude towards

work with children and colleagues who were willing to share their expertise with me,

which at the time seemed enough. After two years of what others considered a

successful beginning of a career, I felt increasingly unsatisfied with the outcomes of

my work, particularly the students' learning outcomes. I realized that I needed more

of a formal education to learn teaching strategies that would promote my students'

intrinsic motivation to learn for their future and not just to get a high grade on the day

of the exam. I enrolled to the science education masters program at the Birzeit

University. Very soon I became interested in the concepts of reflection and

metacognition as well as learning in small cooperative groups. I started to explore

those techniques with my students in different projects included in their daily

learning, and I registered an immediate and constant increase of interest and

excitement on the part of the vast majority of my students and colleagues. Towards

the end of my M.A. program I decided to share my experiences in teaching science

and the mental processes that have driven me to challenge my routine in teaching, and

evaluate the beliefs that led me to change my perspectives on what I consider a

successful teaching practice with the broader teaching community by conducting this

self-study. I hope that my openness in describing the whole experience with its

positives as well as downsides will not only help me to improve my teaching but also

inspire others to take a hard look at their practice too.

1.2 Theoretical background

As teachers, we take on a tremendous responsibility in preparing students to become

potent individuals capable of contributing to society by making mature decisions and

exhibiting responsible actions in their private lives and in their future employment.

With this thought in mind, we always seek out the best ways to teach our students.

Whether a new teacher or an experienced one, it is important to continuously evaluate

and re-evaluate our teaching perspectives and practices, and their effects on the

students' learning outcomes. Self-study is the key to building teachers' belief

systems, developing their confidence in their abilities to promote the student's

learning, and in better supporting this learning (LaBoskey, 2004).

The term "belief" in self-study is used in its broad meaning which "*includes one's

conceptions and knowledge from experience*" (Chapman, 2008, p.1). The role of

beliefs is crucial in establishing teachers' identities as practitioners and pinpointing

the ways that have led them there. Those beliefs are associated with teachers'

personal and pedagogical knowledge of their students, their role in the classroom, and

the context of their teaching. During their ongoing practice, teachers may find flaws

or deficiencies in their previous beliefs and alter, or replace, them completely with

new beliefs. "*Acquiring new beliefs or changing old beliefs constitutes learning, thus,*

teacher's learning can be evidenced by changes in their beliefs" (Chapman, 2008, p.2).

Tom Russell (2006), one of the founders and leaders of self-study research, who bases his extensive self-study work on Schön's (1987) perspectives on *reframing* and *reflection-in-action*, prefers to speak of "*changing perceptions rather than changing beliefs*" (p.13). "Framing" refers to how the situation is perceived at present, while "reframing" deals with the shift in perception based on experience. According to Russell (2006), the conceptual changes in teacher education require such reframing of current operational knowledge and perceptions.

Described by Loughran (2006), a professional development, as the word "development" implies, is an ongoing process of heading towards an "advanced state".

> If one is developing, then one is growing in understanding, moving forward, purposefully building on that which is already present. Developing then hints at the value in extending that which one already knows (and is able to do) such that questioning and challenging that which might normally be overlooked, or taken for granted, will be reconsidered in such a way as to offer new insights to an open-minded inquirer (p.3).

The nature of self-study in teaching is a process characterized by inquiry *in situ*, driven by each teacher's own questions, context, knowledge about teaching and knowledge of oneself. "*A recognition of, and response to the behaviors, competences, beliefs, identity and mission*" (Loughran, 2006, p.121) are essential to the shaping of the professional self in relation to the nature of teaching and learning environment.

Three main paradigms have affected the educational research in the field of self-study: teacher inquiry, reflective practice, and action research (Samaras and Freese, 2006). Before the emergence of self-study in the late 1980s (Zeichner, 1999), educational research was considered by teachers as academic-oriented, and the results were simply implemented in the classrooms. Prior to the establishment of self-study as a genre of educational research, a number of educators began to question their practice (LaBoskey, 2004; Russell and Munby, 1992; Zeichner, 1996). Inquiries into teachers' own practices have enabled them to gain more power over and understanding of their teaching and students' learning. One of the innovative approaches to a teacher's practice was "critical reflection", influenced by the works of Dewey (1933) and Schön (1987, 1992). Dewey suggested open-mindedness, responsibility and wholeheartedness as pre-requisite attitudes that allow an individual to reflect. Reflective process, apart from logical problem-solving, involves intuition, emotion and passion. Loughran (2006) points out that the main feature of effective reflective practice is the recognition of a 'problem', its articulation, framing and hopefully reframing. According to Lougran, it is not merely the experience that leads to learning to teach but the reflection on that experience which results in the professional knowledge development. "*Teaching is reflective and requires an inquiry stance*" (p. 129). The concept of "inquiry as stance" introduced by Cochran-Smith (2001) and her colleagues supports teacher learning by linking inquiry, knowledge and teacher practice throughout a professional life. The underlying philosophy that learning is a lifelong process translates to the growing professional development.

After the acknowledgment of reflection in research, other forms of inquiry followed: narrations, autobiographies, and personal histories. These approaches became the foundation of teacher practice studies (Feldman, Paugh, and Mills, 2004). Action research, as a tool for making informed changes towards the improvement of one's practice, has had a significant influence on self-study although in action research, the focus is on the action in its context which may serve as a solution in a particular situation, while self-study is meant to be public, open to discussion and criticism. Paradoxically, even though a self-study concentrates on the development of self, the new understandings are constructed through collaboration with colleagues and students (Samaras and Freese, 2006) and, thus, add to the knowledge base of teaching. Loughran (2006) suggests that student-teachers are the ideal candidates for teacher-research conduction because their creation of new understandings and concern with teaching is associated with the need to discuss, clarify and share insights on their practice based on evidence. Such communication "*moves beyond individual reflection and creates an expectation for professional dialogue, critique and inquiry*" (p.142).

Self-study is a vital and dynamic process seeking to better understand how the connection between teaching and learning impacts the intentions and outcomes (Loughran, 2006) and how alternatives for future experiences are developed. Being a teacher-researcher one constantly needs to seek balance between being both a teacher and a learner. This outstanding feature of a self-study research is of a great usefulness for practice.

My self-study focuses on the mutual teacher-student relationship in terms of division of responsibility for learning and teaching explored through a cooperative learning method known as "jigsaw" and compared to the traditional lecture method. Similarly, as self-study is based on reflection, consulting with colleagues, scaffolding and metacognition in order to improve teaching, cooperative learning is based on reflection, peer interaction, scaffolding, and metacognition to improve learning (Gillies and Ashman, 2003).

The social context for peer-mediated discussions is based on two prominent theoretical perspectives of how children learn from each other: Vygotsky's (1978) social constructivist view and Piaget's (1932) socio-cognitive conflict theory. According to Vygotsky, children's initial understandings develop based on interpersonal level, through interactions with others, adults or more capable peers who scaffold or mediate learning to help them internalize and transform the content to the intra-personal level, where it becomes a part of their new repertoire of understandings and skills. Children working in groups provide each other with comments, prompts, help and encouragement to complete tasks that any child could not do alone. Moreover, children usually have a way of mentioning what other children do not understand and are able to explain it in ways their peers can easily understand. Piaget's perspective on small group learning is based on the socio-cognitive conflict theory forcing children to re-examine their understandings based on inconsistencies raised from peer interaction. Children then reflect on their understandings, trying to clarify and reassess their perspectives to construct new ones based on the feedback they are receiving. Children are highly motivated to seek change based on peer interaction.

Theoretically, when the teacher abandons his/her needs to transmit the knowledge to the students and to be in total control for student learning to occur, and transfers control over the learning to small groups of students, while acting as a guide and a feedback provider, a higher achievement should be accomplished (Hashweh, 2001; Johnson and Johnson, 2003; Shachar, 2003; Sharan, 2003).

1.3 <u>Statement of the problem</u>

For many years, classroom practices have been mainly dominated by teacher-centered approaches, which greatly enhanced passive learning (Slavin, 1996). There is a strong need for teachers to re-evaluate their teaching approaches and goals and lay more responsibility for learning on their students. According to LaBoskey (1997), educators must take into consideration the complexity of their work, regard different perspectives, avoid taken for granted, and keep their students' best interest in mind. The study analyzed the role of experience-based shifts in teacher beliefs about practice in professional development. This was carried out on the background of a cooperative learning method known as" jigsaw" investigating the impact of such shift on students' achievement, attitudes towards learning science, and development of learning and social skills.

1.4 <u>Aims</u>

The aim of this study was to investigate and present the teacher's initial perspectives on teaching sixth grade science, explore the dilemmas of (1) covering the material and moving on when most of the students understand versus all the students

understand, (2) working mainly with active students versus figuring out strategies to include passive, or perhaps uninterested students in the lesson too, (3) transmitting knowledge to students versus letting students construct their own knowledge; and pointing out and analyzing experiences that led to changes in those perspectives and resolving the dilemmas.

Furthermore, I intended to investigate the effects of shifting responsibility for learning a science unit from the teacher to the students on students' achievement in science. The investigation was carried out through an experiment using a cooperative learning, student-centered jigsaw method for one group of students and a traditional teacher-led lecture method for a control group of students.

1.5 <u>Research questions</u>

1. What professional development happened as a result of my involvement with this self study?
   A. How had the study affected my perception of student and teacher learning, and their relationship to one another?
   B. How was my role as a teacher transformed?
   C. What are my beliefs about social interaction?
   D. What are my beliefs about assessment within the frame of cooperative learning?
   E. How was my practice affected by reflection?
   F. What is my perspective on teacher education and professional development?

2. What were the main learning outcomes for students who learned using the jigsaw method? In particular,

    A. What was the effect on student achievement?

    B. What were the effects on students' attitudes toward learning science?

    C. What were the effects on students' learning and social skills?

3. Was there an interaction between student prior achievement in science and their achievement at the end of the unit which was taught using the jigsaw method?

1.6 <u>Significance of the study</u>

Since the 1990's, reflecting the influence of cognitive science, there has been an increasing focus on the development of teachers' perspectives of science, its teaching and learning (Zeichner, 1999). A new kind of research, a self-study, has emerged to study the relationships between those perspectives and instructional practice, and changing perspectives. Self-studies imply how and why teachers came to be who they are as practitioners (Bullough and Gitlin, 1995). Even though there have been many self-studies written across America, Europe, and Australia (see, for example, Ham and Davey, 2006; Rios, Montecinos and van Olpen, 2007; Russell, 2006; The Arizona Group: Placier, Pinnegar, Hamilton and Guilfoyle, 2006). Over 2000 self-studies in education are available on JSTOR database; however, there seems to be a lack of such research in Palestine.

Most scientific investigations have been done collectively by groups of scientists. Most jobs are also carried out collectively in teams. The benefits of cooperative learning have now been established through extensive research (Johnson & Johnson, 1994; Johnson, Johnson, & Stanne, 2000; Kagan, 2009; Slavin, 1987). In spite of the proven benefits of cooperative methods of learning in general, and the jigsaw-method in particular, it is not one of the commonly used methods of learning in Palestinian classrooms, neither has its use been thoroughly documented and studied in Palestine (Hashweh and Njoum, 1999; Shamasneh, 2001; Yousef, 1998).

Consequently, the present study addresses the relative neglect by educationists in Palestine of self-studies and of the use of the jigsaw method in teaching science. It is of a great value to both teachers and students to recognize that students are capable of greater achievement than initially expected, both by themselves and by their teachers, if they are given the chance to participate actively in their learning. Their self-esteem grows tremendously as they recognize that their individual skills, combined with those of their peers, give them the power to learn and also to teach others. This study attempts to convey this idea so well expressed by Benjamin Franklin (and an ancient Chinese proverb): "*Tell me and I will forget, teach me and I will remember, involve me and I will learn*".

1.7 Operational definition of terms

Self study

"The study of one's self, one's actions, one's ideas, as well as the 'not self'. It is autobiographical, historical, cultural, and political and it draws on one's life, but it is more extensive than that. Self study also involves a thoughtful look at texts read, experiences had, people known, and ideas considered. These are investigated for their connections with and the relationships to practice" (Hamilton and Pinnegar, 1998, p.236).

Reflective practice

A conscious and creative examination and problematization of one's teaching by reflecting on one's own practice.

Teacher inquiry

Questioning and conducting research about one's teaching.

Action research

A systematic inquiry conducted by school-based teachers, teacher educators, and community reformers to make informed changes toward curricula, to facilitate school improvement in their particular context (Samaras and Freese, 2006).

<u>Cooperative learning</u>

Cooperative learning is situated within the social constructivist paradigm. Students work on projects or problems in teams, with both personal and team accountability for conceptual understanding.

<u>Jigsaw</u>

Jigsaw is a grouping strategy in which the members of the class are organized into "jigsaw" groups. The students are then reorganized into "expert" groups containing one member from each jigsaw group. The members of the expert group work together to learn the material or solve the problem, then return to their "jigsaw" groups to share their learning. In this way, the work of the expert groups is quickly disseminated throughout the class, with each person taking responsibility for sharing a piece of the puzzle.

1.8 <u>Limitations</u>

1. Considering the fact that in a self-study the researcher is both the conductor and the subject of the investigation the findings about professional development should be considered tentative.
2. The study was conducted in a private girls' school in Jerusalem during the scholastic year 2011/2012, so it investigated the impact on female students only.
3. The number of participants in this study was too small to warrant generalizations.

Chapter 2

Literature Review

The purpose of this chapter is to (1) present an overview and historical development of self-study research as a relatively new, nevertheless, fast growing genre of educational research, (2) present the basic literature and resources where self-studies may be found and around which the core of self-study educators, teachers and student teachers organize themselves, (3) present relevant research that represents examples of self-studies conducted by university teacher educators, pre-service and in-service teachers, school principals, as well as collaborative groups of teachers, aimed at teacher professional development, (4) point out the increasing influence of self-study research on the reconceptualization of teacher preparatory programs worldwide, (5) show implications for increased sense of collegiality among teacher collectives and preferable student learning outcomes upon employment of reflective practice by cooperating teachers, (6) point out the concerns and criticism related to self-study research, (7) bring to notice the allure of self-study once engaged, and finally (8) review research on cooperative learning in general and the jigsaw in particular, including three studies on jigsaw method of learning carried out in Palestine.

2.1. Literature review of self-study

When Zeichner (1999) traced the development of teacher education over the past decades, he found out that most published research in the field in the 1960s and 1970s involved experimental and quasi-experimental designs seeking to find out ways of training teachers to perform specific actions in the classrooms. The research was conducted by supervisors giving teachers feedback about their teaching. Teachers' cognitive processes and continuous

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use of skills and strategies gained during the research were not a part of the investigation, nor was the role of the university-based student teachers preparatory courses investigated. Perhaps the first one to include both quantitative and qualitative data into educational research was Iannaccone (1963) who explored the experiences of 25 student teachers through the analysis of their journals to provide an insight into the nature of teacher learning during student teaching. Starting from the 1980s educational research began to see a transformation in the dominant theories of teaching and teacher learning, away from the transmission views and toward a more cognitive orientation (e.g. Schön, 1987). Since the late 1980s a shift in the character of research can be noted from the focus of the Third Handbook of Research on Teaching, edited by Lanier and Little (1986). An increasing number of studies became involved in examining practices, contextualized teaching situations and particular ideologies among cooperating teachers and student teachers. Reflective studies, in which teachers and teacher educators were the subjects rather than the objects of interest, have emerged. Since the late 1990s and early 2000s, under the vision of changing conceptions on teacher knowledge and values in quality teaching, an extensive body of teachers' studies of own practice and teacher educators' studies raising questions about the worth of teacher educational programs and their reform (Darling-Hammond, 1998; Loughran, 2006; Russell, 2006) was published in the teacher education literature.

The early papers on self study were published in 1992 in the American Educational Research Association (AERA) session on self-study. For example Russell (1992) presented his paper Holding up the mirror: A teacher educator and his students reflect on teaching. Since then, many teacher educators sharing interest in reflective practice have joined the AERA Special

Interest Group (SIG), called the Self Study of Teaching and Teacher Education Practices (S-STEP) established in 1993. The S-STEP created an environment of collaboration and networking among the self-study researchers' community (Samaras and Freese, 2006). It is now the largest SIG within AERA and is opened to everyone, graduate students, teachers, teacher educators that are interested in self-study.

The next chronological step in formalizing the self-study research was the establishment of the so called "Castle Conference" in England where eighty researchers from Europe, Australia and both North and South Americas participated in 1996. "*The educational researchers in attendance presented papers, created and displayed alternative representations, and explored the philosophy, methodology , and practice of self-study*" (Hamilton and Pinnegar, 1998, p. viii). The results of those discussions were made open to criticism after the publication of Reconceptualizing Teaching Practice: Self-study in Teacher Education (Hamilton, et al., 1998), a book which summarized the conference debates and provided a strong foundation for the self-study field. The Caste Conferences became a regular biannual practice and are always followed by a book publication presenting the main developments and topics discussed at the conference, e.g. Kosnik, Beck, Freese, and Samaras' 2006 publication of Making a Difference in Teacher Education Through Self-study: Studies of Personal, Professional and Program Renewal. The Ninth International Conference on Self-Study of Teacher Education Practices, Castle Conference IX, will be held on August 15 - August 19, 2012. The central theme of the conference will be "Extending Inquiry Communities: Illuminating Teacher Education through Self-Study".

In 2004, Loughran, Hamilton, LaBoskey, and Russell edited a two-volume, International Handbook of Self-study of Teaching and Teacher Education Practices which comprises works of authors from many different countries including the United States, United Kingdom, Australia, Belgium, the Netherlands and others. This important book provides the basis for the developing definitions and objectives of self-study (Samaras and Freese, 2006). The Handbook contributes simultaneously to greater theoretical understanding and the improvement of practice (Zeichner, 2007).

Self-study researchers in teacher education have employed many qualitative methodologies and concentrated on diverse issues. Some have analyzed particular instructional approaches and philosophies (Carson, 1997; Elliott, 1993; Grimmett, 1997), others focused on narration and autobiographies (Clandinin, 1995; Russell, 2006), yet others described the contradictions involved in being teacher educators in universities that do not appreciate this work (Boullough, 2005). *Teacher Education* and *Teacher Education Quarterly* journals have published self-studies frequently since their emergence in the 1990s. However, the year 2005 was marked by the establishment of a new journal, *Studying Teacher Education: A Journal of Self-study of Teacher Education Practices,* proving the genuinely growing interest in self-study over the past decade.

2.2. Why self-study?

Barnes (1998) has studied the features of self-study research and concluded that:

> Through dialog and collaboration with other teacher educators and students, the researcher can frame and reframe a problem or situation from different perspectives. Reframing leads one to think about things differently, change one's way of looking at what's going on in classrooms, and ultimately change one's practice in the classroom (p.xii).

Reviewing literature and the numerous self-studies available, it is evident that self-studies are

mainly conducted by beginning teachers and teacher educators aiming to better understand

learning to teach and teaching to teach respectively. "*Self-study is about the learning from*

experience that is embedded within teachers' creating new experiences for themselves and

those whom they teach" (Russell, 1998, p.6). Self-study is thus seen to as an indication that a

professional is willing to accept that experience is a major source of improvement in personal

practice (Loughran and Northfield, 1998). However, as Dewey (1933) mentions, it is not the

experience alone that leads to the improved practice, but the reflection on the experience.

Feiman-Nemser and Beasley (2007) have conducted a collaborative inquiry between a

university educator (Sharon) conducting a research on student teaching and a cooperative

school teacher (Kathy) working with a student teacher. Sharon helped transform Kathy's

initial assumptions about the role of a cooperative teacher and Kathy helped refine and

extend Sharon's views. Initially Kathy thought, as a cooperative teacher, she should transfer

the authority over the class to the student teacher, support her in her efforts to try out what

she has learned in the university courses, and give her feedback afterwards. At the beginning,

Kathy (an experienced teacher) underestimated her spontaneous professional know-how as

she was never encouraged to explicitly articulate her knowledge and to describe precisely her

ways of knowing, and beliefs about teaching. Following an incident with the student teacher

she was surprised to find out how much of her knowledge she took for granted. An inquiry

guided by surprises brought Kathy to appreciate the difference between knowing to teach and

knowing to teach someone else how to teach. Observation and conversations about

contextualized examples of practice underlined by serious analysis, concrete language,

openness to questions of meaning and purpose, and writing became valuable resources for learning from each other to frame the specific teaching situations and reach powerful insights about the teacher's role and the nature of practical knowledge.

Drago-Severson (2004) investigated the effects of collegial inquiry, a concept of reflective practice, on improvement of teaching by developing a shared mission and collaborative decision making. Teachers, who engaged in collegial inquiry, developed greater awareness of their beliefs and assumptions. Shared reflection on one's values, convictions and assumptions, as a part of the learning process, enabled the teachers to seriously consider new ideas and thus develop professionally. The study investigated the underlying reasons for and the use of collegial inquiry according to school principals. Three main reasons found were: (1) helping them to include others in leadership, (2) helping to manage change, and (3) emphasizing the value of learning from different perspectives. Four themes emerged which categorize the ways of employing collegial inquiry by principals: (1) reflection through writing as a tool for clarification of ideas, (2) dialogue and feedback to give teachers sense of purposefulness about their teaching, (3) decision making, and (4) serving as key consultants and /or researchers. One of the school principals, Dr. Cavanaugh, commented: "*Being reflective is the key … and an ultimate way to raise the students' achievement … [self-awareness] changes the focus from 'covering the material' to making student learning and performance the priority*" (p. 112).

Bullough, Jr. and Gitlin (1995) point out that an educational autobiography written on the social, historical and political backgrounds over a period of time helps one to understand one's conceptions of self-as-teacher and the conditions that have led to changes. They argue that, spending many years in educational systems, student teachers bring with them to teaching an extensive amount of "*unarticulated and unexamined beliefs about teaching, learning and the self as a teacher that require scrutiny*" (p.25). Writing and examining life histories explicitly and in context is an important clue to understanding how one's beliefs and assumptions were formed and may lead to their reconstruction. "*Thus, life history is a means to one's future*" (p.25) and autobiography is a means for personal development.

Similarly, Mitchell (2006), a professor of teacher education at Kwa Zulu-Natal University, South Africa, has conducted a self-study of teaching based on the diaries written on a daily bases during her own first seven years of teaching in school, long before she became a teacher educator, and long before she became interested in self-study. She refers to finding future in the past when she encourages her students to reflect on their reflections at the end of each semester and look for the development of their feelings about teaching, how did writing affect their teaching and how did teaching affect their writing, search for common themes and most interesting journal entries. She encouraged journal writing and reflection as a life-long practice which will develop into self-study.

Teacher education has been marked by a trend of research that has had little influence on teachers as the end users of that research (Loughran, 2006). Tatto (2011) stated out that:

> most research on the effects of teacher education on teaching and, thus, on pupils'
> learning outcomes includes a number of variables that serve as indicators of teacher

characteristics, such as gender, years of schooling, and degrees obtained, but, for the most part, they ignore the process of teaching and learning (p. 503).

The growing interest in self-study lies in its focus on teaching and student's learning, elements of teacher education that complement and inform teachers' professional development and knowledge of practice in personally meaningful ways (Loughran, 2006). The allure of self-study is tightly connected to the teacher's need to better comprehend the nature of teaching and learning about teaching and to develop a genuine sense of professional fulfillment in that work.

Similarly, Russell (2006), a senior teacher educator, finds gaps between goals and action, research conducted for the sole purpose of knowledge production regardless of its influence on quality of learning and teaching. Russell concludes: *"Those who would minimize the significance of self-study research appear to be opting for the rigor over relevance. Those who embrace and engage in self-study research appear to be reaching for relevance with rigor in their efforts to improve teacher education"* (p.16).

2.3. Concerns and criticism of self-study research

The value of self-studies has rarely been criticized, whereas the quality and validity are frequent issues of dispute. The main subject of criticism in terms of quality is that researchers often fail to describe their methodology, explicitly state what is considered as data, and the way they analyzed those data (Marcos and Tillema, 2006). Nevertheless, Zeichner (2007) points out that self-study is a qualitative research and as such has long and established traditions in terms of quality of research and the ways of building knowledge and

understanding over time that should be utilized by self-study researchers. In terms of validity, we evaluate whether the study assesses the points it was designed to measure. "*Issues of validity are important because when we engage in reflective processes that focus on ourselves (as in the construction of autobiographical narratives), we cannot be sure of the accuracy of what we see*" (Feldman, 2003, p. 27); therefore, triangulation of multiple data sources that either support or query one another can contribute to our reasons to believe and trust the self-study.

It is likely that colleagues will frame an experience differently than the researcher carrying out the self-study and thus increase the possibility of validation and reframing (Hamilton, 1998). It is fundamental for a self-study researcher to provide both strengths and weaknesses of the research as well as a strong commitment to understanding the situation within its complex settings. An effective self-study requires scrutiny and professional challenge by colleagues. The opportunity of independent data analyses that resonate with each other increases the validity and reliability of data sources. Findings should be seen as tentative in communicating new understandings to satisfy the requirements of reliability, validity and generalizability. In the end, it is the reader who decides on the validity and reliability of the self-study, whether he finds it to be a useful contribution to his personal understandings. For example, Tom Russell (1997) wrote a narrative describing the journey of his twenty-year professional development, his struggles to learn to teach, to understand what teaching is, and to challenge student teachers' assumptions about teaching. He reveals his prejudices and perspectives honestly on the historical background which makes readers go on reading as they can identify themselves in the nodal points of the narration.

Zeichner (1999) depicted the emergence of self-study research around 1990 as a unique advancement in teacher education. Nevertheless, eight years later, in 2007, Zeichner expressed his concerns about publications of books that are collections of self-studies gathered simply for the fact of being self-study inquiries rather than being focused on specific issues. He suggested more efforts were invested into discussions of how individual self-studies built on previous work both methodologically and substantively.

Loughran and Northfield's self-study (1996) is a good example of a continuous self-study. Northfield provided a description and analysis of his experience as a university teacher educator who returned to teach a junior high math/science class. The data used in the self-study contained field notes of a critical friend and observer, who was present at all of the lessons, and reflections of other school teachers who collaborated in reading Northfield's journals and provided feedback. The publication of the book and scrutiny of readers revealed Northfield's inadequacies in teaching. Based on those reader reactions he further evaluated and reframed his work as a teacher educator. Finally, four years after the study was carried out, Loughran (his colleague) returned to the school and conducted interviews with the students who participated in the study and collected their reflections on the experience. These served as data for a third round of this continuous self-study that built-up on itself.

Marcos and Tillema (2006) have conducted a meta-analytical study cross-examining fifty studies conducted between the years 2000 and 2005 to find the relation between research question and research method that would provide the optimal solution to the dynamic relationships between reflection and action. Their findings imply that "*conducting research on reflection and action can be informed by using the standard of closeness; that is, how*

closely a research object is linked to instruments and methods that capture the relationship under study" (p.126). Moreover, Marcos and Tillema found that most studies under their investigation were conducted in the category of "talking the talk" that is descriptive studies of teacher beliefs and personal theories, reflective thinking, and analyses of the relationship between beliefs and practice, all of which are mainly based on data collected through interviews. The least common were studies in the category of "walking the walk" which focus on action and performance and collect their data through video or audio tape records and field notes.

In summary, the methodology of self-study research is grounded in the principles of qualitative research; nevertheless, the validity of the findings is sometimes criticized as the researcher himself is the object of the study. Triangulation of multiple data sources and collaborative community are necessary in determining the authenticity and trustworthiness of the results. The researcher needs to pick instruments that will closely serve the methods chosen in carrying out the self-study. It is important to point out both strengths and weaknesses of the self-study. The findings of self-studies are always tentative and their relevancy depends on the reader's ability to identify himself with the problems under study. Following the first two decades of enthusiasm related to self-study research, the self-study researchers themselves criticize the lack of cumulative knowledge resulting from self-study research (not undermining its value) and recommend building on previous studies methodologically and substantially.

2.4. Self-study influence on teacher program reconceptualization

It is obvious that exploring the problems and difficulties student teachers are facing is helpful in creating a more meaningful understanding of the interactive nature of *what* and *how* is taught in teacher education programs as compared to other domains of teaching where *what* and *how* are rather independent (Whitehead, 1993). Many teacher educators (Freese, 2006; Loughran, 2006; Russell, 2006) recognize the large gap between the theories of teaching taught in university courses and the practice the student teachers than face in schools. Self-studies conducted by student teachers are a very useful tool for those teacher educators interested in change, reconceptualizing and restructuring of educational courses to better fit the needs of student teachers. Freese (2006) has studied eight self-studies, written as formal master theses by student teachers reflecting on their practicum, in search of patterns and themes reoccurring throughout the eight independent self-studies. She found out that seven main themes of concern to the new teachers have emerged: (1) personal theories, taken for granted assumptions about teaching and idealism, and their crash when faced with reality, (2) beliefs and practice contradictions; all four science majors discovered that even though they have criticized the lecture-style teaching of science, they themselves did not create an inquiry environment of learning and resorted to the text-driven learning as the content and facts focused experience from their undergraduate studies had transferred into their own teaching, (3) fear and uncertainty, as a replacement of the initial idealism after "*learning that there was more to teaching then being knowledgeable in their content areas*" (p.71), fear of failure, making mistakes and judgment, or even the wrong choice of career, (4) classroom management, loss of illusions that being more of a friend rather than authority will motivate students to learn, (5) use of metaphors, such as "*I am the ship's navigator on the vast sea of*

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teaching and learning experiences. I'm not the ship's captain" (p.72) or *"[he was] a proficient driver, but was an ineffective driving teacher*" (p.72), (6) shift of focus from self to students, overcoming of personal shortcomings and focusing attention to students' needs, and (7) increased maturity and professionalism. It was evident that by taking risks and making themselves vulnerable, reconstructuring their knowledge, experience and self-image through self-study they grew as professionals and individuals responsible for their students' learning. Freese discussed how viewing learning through preservice teachers' lenses helped her to gain useable, applicable and informing knowledge about the students concerns and reframe her perception of what is important for student teachers to be taught to. She resolved that helping the preservice teachers to synthesize their experiences and effectively reflect on the skills acquired during praxis (journals, philosophy of education, etc.) will help them to understand their teacher selves.

Other teacher educators (Loughran and Northfield, 1996; Russell, 2006) went a step further; they spent their sabbatical year returning to school teaching, involving themselves in a systematic study of their teaching and problems connected to school practice, such as classroom management, problematic students, student-centered classes, lesson-planning, in order to experience what their student teachers are going through, which, in most cases, is an out of reality experience for most university educators. Loughran and Northfield (1998) have expressed it this way: "*Firsthand experience must surely allow for better understanding of current learning issues and could therefore better inform approaches to teacher education*" (p.10). Northfield, the Director of Pre-service Education at Monash University, felt the need to 'practice what he was preaching' to his students about undertaking an authentic inquiry as

a means to a better understanding of the intricate links between teaching and learning by focusing on personal reflective practice. He returned to teaching high school math and science for a sabbatical year in an effort to get back in contact with schools, and with the problems on the ground that teachers are facing, which is easily lost under the burden of academic work. His self-study Opening the Classroom Door: A case study of Self-study (1996) was a firsthand experience seeking better understanding of current learning issues as basis for finding more effective and better informed ways of preparing teachers for their career. Similarly, Russell (2006), a professor of teacher education at the Queens University, Ontario, describes, in his How 20 Years of Self-study Changed my Teaching, how he spent two periods of time teaching high school physics in 1991 and 1992 in efforts to improve himself as a teacher educator of the pre-service program. He comments:

> By returning to the classroom from my vantage point as a teacher educator, I came to perceive differently both my work as a teacher educator and the relationship of that work to what happens in schools. The way in which experience has authority may be the most challenging issue in teacher education: until people have experience in the role of teacher, they seem unable to see how the word and activities we offer them as new teachers relate to their early teaching actions (p.10).

Russell speculated about the closeness of our perspectives to our experiences. His life-long self-study led him to see that people's "resistance to change", so often attributed to teachers, arises from the fact that change is often proposed by material distribution or lecturing rather than addressing the existing practices. "*People have learned what teaching looks like, but they have not learned to teach*" (p.14). Through a reflective self-study, Russell identifies how he perceives his interactions with students and examines how those interactions correlate with his principles and values, and explores new teaching moves to test and develop those perceptions. He points out how reflecting on personal actions as teacher educator and

consequently interpreting those experiences through self-study helps shifting his teaching

perspectives as well as influencing his student teachers.

Many new teachers abandon the occupation, for varying reasons, during the first five years of

practice (Loughran, 2006). LaBoskey (2005) emphasized the importance of the long-term

impact of the embracement of the six principles identified by The Mills College Teachers for

Tomorrow's School credential program, of which she is a member, for the high number of

their graduates who stay in teaching (over 80%, which is much higher than the general

trends). Their prospective teachers were required to write reflective essays or narratives that

were then presented to their colleagues, discussed and analyzed in order to promote

understanding of the principles regarding subject matter, reflection, constructivism learning,

and collaboration. The principles that according to the Mills College Teachers embody the

current wisdom of research and practice are as follows:

> (1) Teaching is inherently moral work that must be guarded by the ethic of care.
> (2) Teaching is reflective work that requires active and systematic inquiry for learning throughout the teacher's career.
> (3) Learning is developmental and constructivist and thus teaching is best guided by those conceptions of how learners come to know.
> (4) Teaching is connected in deep and important ways to subject matter. A central goal of the work is to prepare students to acquire, understand, and construct subject matter knowledge.
> (5) Teaching is collegial in that both teachers and students learn in the contexts of relationship that matter. Colleagues and community are central.
> (6) Teaching is inherently political in that by definition, it is concerned with matters of *change* that are neither neutral nor inconsequential. (p.28).

They are those principles, according to LaBoskey, that are "*the missing link in teacher*

education" (p.34), which would contribute to the effectiveness and educational

transformation of teacher educational programs. Hoban (2005), an Australian teacher

educator, also agrees with LaBoskey et al. that an establishment of a conceptual framework is

necessary to promote coherence and connectedness between the content of university

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courses, approaches to teaching and learning, and the practicum. He criticizes the fragmentation of conventional teacher educational programs which use mechanistic ways of 'training' teachers. According to Hoban, a good teacher educational program must not only establish the goals of teacher education in terms of what kind of a teacher they would like to produce, such as "reflective practitioner", "life-long learner", "developing in-depth knowledge", "inquirer", "collaborative", etc. but also suggest a strategy providing guidelines of *how* such a teacher is to be developed. The internal coherence amongst teacher education courses and external coherence to other settings (schools) promotes quality learning by preservice teachers and its reciprocal nature encourages mutual research which "*suggests that student teachers are more likely to develop skills for the principles of "authentic inquiry" and become "life-long learners" of teaching*" (p.283). The complex nature and uncertainty of teaching, rising from the multiple conceptions of knowledge, conceptual, theory-practice, identity, and socio-cultural, implies that student teachers are more likely to become "reflective practitioners". The model of self-study (Loughran, Hamilton, LaBoskey, and Russell, 2004) offers an opportunity to teachers to find their professional identity within a trusted collaborative community.

Loughran, Berry and Tudball (2006) of Monash University conducted a collaborative self-study which built on the growing interest in the nature of teaching about teaching and learning to teach which brings the work of teacher educators and student teachers under closer scrutiny. In their self-study, they showed how during the three years of developing and teaching a subject (curriculum and pedagogy), working with their students on 'critiquing' microteaching experiences they came to perceive their practice differently. Framing and

reframing was central to the articulation of a developing pedagogy. They have addressed the issue of how the intended learning outcomes of their students influenced the concept of their pedagogy, brought up changes and implied how their learning may be useful to other teacher educators.

In summary, the broad body of teacher educators involved in self-study believes in, and has empirically supported, the importance of collaboration between teachers, students and colleagues in order to frame, reframe and shift perspectives on developing practices that will potentially lead to better learning outcomes.

2.5. <u>Literature review of cooperative learning</u>

There is broad agreement that cooperative learning methods should be promoted in teaching science (Ahles and Contento, 2006; Bandiera and Bruno, 2006; Box and Little, n.d; Doymus, 2008; Doymus, Karacop, and Simsek, 2010; Köse, Şahin, Ergű, and Gezer, 2010; Souvignier and Kronenberger, 2007; Walker and Crogan, 1998). Collaborative learning activities using group discussions, integrating new information actively into one's prior knowledge based on peer scaffolding, collective analysis of a problem and problem solving, giving explanations and writing group reports have shown to be constructive in building the students confidence and self-esteem which seem to be the underpinning of the effectiveness of cooperative learning methods. The jigsaw method as Slavin (1987) argues provides a cooperative learning environment which fosters learner activity, joint acquisition of content and mutual explaining.

An important pivot point that is of major interest of many studies (Box and Little, n.d; DaRos-Voseles, Collins, Onwuegbuzie, and Jiao, 2006), determining the success in academic achievement, is the concept of self-perception or self-concept of the students. The fact that each and every student and his or her opinions matter to the rest of the group members, and the fact that each and every student in the small group is given a chance to contribute and explain his or her field of expertise is very powerful in increasing self-perception of the individuals and has a major effect on predicting the performance of the cooperative learning groups.

Another major point central to numerous studies (Ahles and Contento, 2006; Walker and Crogan, 1998) is the issue of interdependency and helping behavior among the group members. The overall result found in majority of studies on cooperative learning is that cooperation in general and jigsaw in particular have a significant positive effect on academic achievement, liking of peers, racial prejudice, interpersonal attraction and inclusion of low-achieving and even handicapped students (Johnson and Johnson, 1982). The effect of cooperation on achievement is addressed in numerous studies. Stockdale and Williams' (2004) study suggested that low and average-achieving students improved significantly during cooperative (jigsaw) study, but the previously high achievers' achievement decreased somewhat.

In the past, the jigsaw method has successfully been used with students starting in kindergarten through the university level. Souvignier and Kronenberger (2007) investigated an interesting question concerning the minimum age of students as a potential limitation of

the jigsaw method. They have suggested that while using the jigsaw with younger children (third grade), an additional help like a questioning training and well-structured material might be needed for satisfactory learning outcomes.

The jigsaw method of cooperative learning builds on the principles of constructivism (Piaget, 1932) and social interaction (Vygotsky, 1978). The implementation of these two factors combined seems to bring positive learning outcomes when used across the entire scale of ages.

2.6 Teacher development and jigsaw studies in Palestine

Despite the fact that the methods of reflective thinking, metacognition and cooperative learning have globally been recognized as desirable and advisable (Gillies and Ashman, 2003; Johnson and Johnson, 2000), I have been able to locate only three such documented studies in Palestine.

Yousef (1998) has conducted a study with 892 ninth grade students from the Tulkarem Governorate to explore the effects of two different cooperative methods, Jigsaw and Learning Together Methods, and a traditional Lecture Method on the students' achievement and attitudes towards learning mathematics. He found out that both cooperative methods resulted in higher achievement than the traditional method. Any of the three methods did not bring greater positive attitude towards learning mathematics than the others but an increase in the overall positive attitude was found after the study.

Hashweh and Njoum (1999) explored a case-based approach to education in Palestine conducting a project with six teachers from six different schools in the Ramallah district. Prior to the project, the teachers met to discuss the rationale, philosophy and an appropriate approach to be used in teaching science and democracy cases. Social-constructivist approach and the jigsaw method with all of their theoretical underpinnings were selected. The data collected showed encouraging results in the categories of subject matter knowledge, beliefs about learning, beliefs about knowledge, teaching methods and practices, teacher's role and others. The science teachers, who have hold the social-constructivist views before the project, have registered a more radical change in their beliefs.

Shamasneh (2001) carried out a case study research to investigate the sixth grade students' attitudes, learning concepts, and social interaction as well as the teacher's development, especially the teacher's role in the classroom, during a geometry unit teaching through the jigsaw method. The results were arrived at through a variety of quantitative and qualitative methods, such as tests, observation, interviews, audio and video taping. The study found that students' attitudes and academic achievement in mathematics have improved, and students' active participation on learning created new types of social interactions. The teacher changed his perspective on his role in the classroom from a teacher-centered to a student-centered one with the teacher as a facilitator of learning. He identified the difficulties connected to the project which have resulted in his professional development.

All of the mentioned studies that aimed at teacher development found positive effects of collaboration on professional growth. The central theme of studies that investigated effects of

cooperative learning was the changed role of a teacher in the classroom, a role in which the teacher controls and facilitates the conditions of learning but does not control the learning process. The studies in which the researchers were also the teachers and collaborators in the project planning found a greater positive effect on professional growth while in the studies where the researcher was just an investigator and the method was simply applied as another teaching strategy, less professional development was found.

The main limitation of self-study techniques and cooperative learning strategies lies in the lack of administrative support for such practices. The time-consuming preparations indicate that most such studies conducted by individual school teachers are one time experiments that will not continue in the future unless encouraged by culture of collaboration on the whole school level. These findings point to an obvious gap between the empirically tested benefits of providing teachers with opportunities for professional development, exchange of knowledge and collaboration in curriculum planning coupled with the advantages of cooperative learning, jigsaw in particular, and the reality grounded in traditional lecturing focused on covering the prescribed book. The resolution of this dilemma is up to each teacher's conscience and state of commitment in which he finds himself in his own context. The current self-study models a way of how reflection and action can accommodate the needs of diverse learners during the process of higher order thinking skills acquisition through social interactions.

Chapter Three

Methodology and Study Design

3.1 Research Methodology

The methodology used in this study, in order to examine the teacher's professional

development, followed the five essential epistemological, pedagogical and ethical

elements of self-study approach described by LaBoskey (2004).

(1) Self-study is self-initiated and focused on self. Its goal is self-improvement, and
it "requires evidence of reframed thinking and transformed practice" (p.859).

(2) It is aimed at improving practice: self-study is born out of one's desire to grow
as a professional.

(3) Self-study is interactive and involves collaboration and interaction with
colleagues, students, and literature "to confirm or challenge our developing
understandings" (p.859).

(4) "Self-study employs multiple, primarily qualitative methods" …which "provide
us with opportunities to gain different and thus more comprehensive
perspectives on the educational process under investigation" (p.859). As with
any research methodology, triangulation is important to self study.

(5) Self study requires that we "formalize our work and make it available to our
professional community for deliberation, further testing, and judgment." "Self-
study achieves validation through the construction, testing, sharing, and re-
testing of exemplars of teaching practice" (p.860).

I (as an author of a self-study I shall use the first person in this thesis) hypothesized

that students will benefit more from instruction which allows greater student

responsibility for knowledge acquisition. This I explored through an experiment

involving an alternative learning method called the "jigsaw" and compared to the

control group of students learning a science unit through a traditional lecture-method.

Data for this study were collected during the academic year 2011 / 2012. The qualitative data were derived from multiple sources including my (teacher's) journal, a set of questions regarding my views of knowledge, beliefs and goals of science education and beliefs about learning and pedagogy, videotapes of multiple lessons, photographs, students' assignments, students' and my own reflections, critical discussions with colleague teachers, and parents' comments. The quantitative data included pre-test and post-test results of student achievement.

3.2 <u>The participants, context of the study</u>

The participants in this study were 120 sixth grade students from the Rosary Sisters' School, and I (the teacher / researcher).

The Rosary Sisters' School for girls is a private school in East Jerusalem. Although the school is registered with the Israeli Ministry of Education, it uses the Palestinian curriculum. Science in English is an extracurricular subject taught to all the students starting from the first grade. The school consists of students from kindergarten to the twelfth grade. Most of these students come from middle-class families with educated parents. None of the students has been exposed to the jigsaw learning method prior to this study.

3.3 <u>Research Procedures</u>

In this study, I have conducted an experiment with two different teaching methods, to allow myself the chance to rethink my role as a teacher in the classroom, and to

study the development of my practice in the light of an alternative teaching method known as "jigsaw".

It is a habit in our school to distribute students to the A, B, C, and D sections for the next academic year based on their academic achievement at the end of the year. This is done, by the entire relevant teachers' collective, in such a manner that assures all the sections are as similar in achievement as possible. The two sections that formed the experimental group were drawn randomly in a lottery. The two sections that were not drawn remained as the control group. To make sure both groups started this experiment at about the same level of previous knowledge on the given topic, a pre-test was administered to all students at the beginning of the experiment. The groups worked separately, for a period of about three months (October – December, 2011) - two forty-five minute lessons a week, to acquire the knowledge about honeybees intended in this unit. The experimental group worked in small groups in a jigsaw manner. The control group learned traditionally with no exposure to the jigsaw. A post-test was administered at the end of the experiment to measure the impact of the jigsaw on student achievement.

I have chosen the Honeybees unit to be taught through jigsaw for its convenience in division into the expert groups. The advantage of this unit lies in its lack of learning sequence allowing for all the subunits (honeybee's body structure and function, the queen, the workers, the drones, beekeeping) to be studied simultaneously by the jigsaw expert groups. In the experimental group, each class was divided into five

heterogeneous expert groups, assigned by the teacher, to include students with different skills and academic abilities into each group. In the first stage of the jigsaw, the groups studied the part of the unit assigned to them together. The students in the groups were encouraged to support their peers using scaffolding, questions and individual skills to make sure all the group members mastered their topic. The helping behavior was partly encouraged by group shared grades. Each group generated notes and worksheets as part of their expert group assignments (examples – appendices 1 and 2). During the preparation of those documents, students received constant feedback from me via email. Those materials were later used to teach their part in the home groups. In the second stage, the students returned to their home groups, each one an expert on a different topic. In each of the following lessons, one of the students taught her peers about her topic using the materials she prepared with her expert group. Students were awarded individual grades on their presentations and ability to explain their topic in the home group. Grades achieved in worksheets and exams were also individual. The control group was taught traditionally in a lecture-method teacher-centered classroom using different visual aids, teacher-initiated questions and teacher-prepared worksheets. Both groups were using the English through Science, level 6, McGraw Hill, 2002 science book for non-native speakers as the basis for their learning. The jigsaw group also used external sources at their own deliberation.

Prior to the experiment, and before reviewing related literature, I (the teacher) have answered a set of questions about knowledge, beliefs and goals of science education

and beliefs about learning and pedagogy. I kept a journal, throughout the experiment, to capture the thoughts that have led me to teaching at the first place, secondly to describe the difficulties, like language barrier and classroom management, that I had to overcome, and thirdly, to describe my dissatisfaction with the outcomes of my teaching. It also captures an incident regarding the outcomes of my students' learning described in chapter four that had initially urged me to reconsider my teaching strategies, and to evaluate and reevaluate my perspectives on high quality teaching practice that would benefit my students, as well as my professional ego. Finally, I kept notes about the lessons, students' and colleagues' remarks, and my reflections. I answered the same set of questions about my beliefs of teaching science again after the jigsaw experience.

Several lessons, for both experimental and control groups, were videotaped and photographed as an additional source of data to support the findings. Students from the experimental group were asked to write a short reflection on the jigsaw learning. Additionally, at the end of the experiment, all students were asked to create pamphlets about the interesting facts and importance of honeybees using external sources of information. This last assignment was carried out as a group effort for both experimental and control groups.

3.4 Instruments of Data Collection

3.4.1   Pre-test

A pre-test of student achievement on the science unit that was taught using the
jigsaw method (appendix 3) was administered to both experimental and control
groups to exclude the possibility that any of the groups had greater knowledge
about honeybees, the science unit used, prior to the experiment. The test consisted
of ten types of questions comprising all six levels of the Bloom's taxonomy. The
pre-test was a slightly different version of the post-test.

3.4.2   Post-test

A post-test (appendix 4), which was a slightly altered version of the pre-test, was
administered to all students after the completion of the unit. The post-test
consisted of fifty items divided into thirteen types of questions comprising all six
levels of the Bloom's taxonomy in proportions suitable for the sixth grade.

Table 1. Number of questions (percentage) on the post-test by concept and level.

Level / Concepts	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total Questions (%)
Bee characteristics	3 6%		1 2%				4 8%
Workers	3 6%				1 2%		4 8%
Drones	1 2%	2 4%					3 6%
The queen	4 8%						4 8%
Bee communication			4 8%				4 8%
Body structure & function	3 6%	4 8%		3 6%		3 6%	13 26%
Function in the colony	3 6%				1 2%		4 8%
The hive	1 2%	2 4%			1 2%		4 8%
Beekeeping	1 2%		1 2%				2 4%
Flowers (food source)		2 4%	1 2%				3 6%
Importance for people				3 6%	2 4%		5 10%
Total Questions (%)	19 38%	10 20%	7 14%	6 12%	5 10%	3 6%	50 100%

3.4.3 My journal

I kept a journal (in my handwriting) during the experiment, including personal

teaching history, notes from the lessons, reflections, students, colleagues and

parents' remarks, etc. (a short version is included in appendix 5).

3.4.4   A set of questions about beliefs in science teaching

A set of guideline questions regarding the beliefs about science education, learning, knowledge, and pedagogical knowledge prepared by Dr. Hashweh was answered by the researcher before (appendix 6) and after (appendix 7) the experiment for the purposes of data triangulation.

3.4.5   Videotapes and photographs

Four lessons, one for each section - two for each group, were randomly selected and videotaped for the purposes of further analysis and critical discussion with colleagues. Lessons were photo-documented to portray the different seating distributions and the role of the teacher in the class.

3.4.6   Students' reflections on the jigsaw-method

All the students from the experimental group were asked to write, anonymously if preferred, a short reflection about their jigsaw experience.

3.4.7   Pamphlets

As a final assignment, both groups, 'jigsawers' who were now used to team work and production of materials and the control group with no experience in group work, were asked to work in small groups to create pamphlets about honeybees using external resources.

3.5 <u>Tests Validity</u>

Both the pre-test and the post-test's contents were discussed with four colleagues
(three of whom are M.A. and one B.A. holders) and three university educators
holding a PhD. in science education. After some alterations to the post-test, they
were found to be valid, i.e. tested what they were designed to test.

3.6 <u>Post-test Reliability</u>

The reliability of the post-test was determined by the Cronbach Alpha coefficient
which was calculated to be 0.88.

3.7 <u>Data analysis procedures</u>

A variety of qualitative and quantitative data were collected throughout this study.
The multiple data sources documenting my professional development were analyzed
using a number of qualitative research techniques described below. In the first step,
my friend teacher and I, separately, read through the narration of my teaching history
and critical moments and experiences I described there. We employed a method of
focused reading, line by line, reading and re-reading, in search of meaningful
segments of the text and marked those segments with inductive codes using
descriptive labels for each category found. Each one of us created a list of the
categories she found. Then we sat together to compare our lists. After merging the
categories that overlapped, we came out with a list of about 25 categories. We
repeated the first step in reading through my journal that I kept during the jigsaw
experiment (fourteen categories), and for the sets of questions I answered before and

after the experiment. In the second step, we synthesized similar categories into clusters of eight more general themes. We extrapolated those eight themes from the two documents regarding my older beliefs, the teaching history narration and the questions answered before the jigsaw experiment, and then from the documents regarding my newer, changed, beliefs found in my journal and the questions answered after the experiment. A comparison and contrasting between the two was then used to present my professional development during the past five years and especially to show the shift in my teaching perspectives and practice based on the current experiment.

Several lessons, for both experimental and control groups, were video documented and photographed. This served two objectives; first to depict the authenticity of the experiment with all its complexity in a credible and trustworthy way, and second to validate the findings by triangulation of the data. Two of my colleagues and I watched the videotapes, of the traditional lecture method and the experimental jigsaw method implemented during this experiment, separately and one time together. We looked for evidence that would support (or not) the changes in the teaching practice, teacher's role, questions generation (by teacher or by students), scaffolding and other evidence found in the written documentation described above. Selected segments of the videotaped lessons including the themes' topic description can be found on a DVD disc attached at the end of this thesis.

An enumeration method was used to analyze the students' reflections on the jigsaw experiment. I have once more applied the focused reading method to find the recurring themes in the students' free writing reflections. I found sixteen topics which I arranged into five themes. Then I read through the reflections again and counted the frequency of the topics in each of the five themes. Some reflections, positive and negative, did not fit into these themes and were mentioned separately.

A final set of qualitative data were the student-created pamphlets. I developed four a priori categories to analyze the quality of this group assignment. Unlike the jigsaw groups, I have allowed the students to divide themselves into groups according to their individual preferences based on friendship or close place of residence to facilitate cooperation. Ten small groups were established in the jigsaw group and ten in the control group. After the completion of this project (four weeks), I analyzed the pamphlets according to the fulfillment of the assignment requisites anchored in the four a priori categories.

The quantitative data were analyzed using the Statistical Package for Social Sciences program (SPSS) program. Cronbach Alpha coefficient was calculated to establish the reliability of the post-test. An independent sample t-test was used to determine the differences in the post-test achievement between the experimental (jigsaw) and control groups. Four additional t-tests were used to determine the differences between the experimental and control groups' post-test achievement on different levels of the Bloom's taxonomy, specifically on the level of knowledge,

comprehension, application, and the higher order thinking (analysis, synthesis and evaluation) jointly.

Two Microsoft Office Excel graphs were constructed to investigate the relationship between the prior and present achievement. The overall grade achieved in science last year (in the fifth grade) was used as an index of the prior achievement, and the grade achieved during the experiment was used as an index of the present achievement. The first graph shows the results the students have achieved during the whole experiment, i.e. the shared group grades are included for the jigsaw group. The second graph compares the prior achievement solely with the post test results (excluding any shared grades).

In summary, various qualitative data sources and analysis techniques were used to analyze the teacher's professional development central to this study. Combined qualitative and quantitative data were used to examine the student learning outcomes resulting from the two teaching methods representing the teacher's previous and more recent teaching inclinations.

Chapter Four

Findings and Results

In a search of an answer to the first research question "What professional development happened as a result of my involvement with this self study?" multiple data sources were analyzed and eight main themes have emerged that capture the essence of my beliefs about my professional development based on the jigsaw experience. I have included many scripts from the students, their parents, my colleagues and my own, where suitable, to underline moments that had a great influence on my professional development and beliefs about teaching and learning. I have also referred to several video clips included at the end of this thesis which portray specific situations I am describing. The second part of this chapter includes the answers to the research questions two and three comparing the effects of the two teaching methods under investigation, traditional and jigsaw.

4.1   Teacher professional development

Beliefs about subject matter knowledge

I have always believed that in the teaching profession, I can never stop educating myself as there always are new discoveries, innovations and technology to be explored and discussed with students in the classroom. Today, although I still believe that I have to continuously seek new knowledge, I have changed my beliefs about the sources of its acquisition. I have previously believed that I should be the source of knowledge dissemination to the students but after the jigsaw experience I have found out how much I

have underestimated my students' knowledge, both based on their family backgrounds and their desire to search for new information in external sources. I have learned that the 120 students I have in the sixth grade each year are an invaluable asset in both mine and my students' knowledge acquisition. For example, in studying the honeybees, the unit chosen for this experiment, I knew that the colony produces drones only when there is a chance of mating with the queen but I did not know *how* they achieve that. One student, whose father is a beekeeper, brought for us a piece of honeycomb which upon closer observation showed that the cell containing a male larva was sealed by the worker bees, was not fed, and consequently was not allowed to develop into an adult. Similarly, I knew the queen bee is fed a royal jelly, food rich in vitamins and proteins produced in the bees' body, yet I never thought of *how*, until one of the students found out on the internet that the nurse bees feed the queen directly from glands located on their heads. Many more examples of subject matter knowledge I have gained from my students could be found in my journal and for this reason I believe now that knowledge is acquired multi-directionally, from teacher to students and from students to teacher and other students.

Beliefs about teacher's role

Following the discovery of how much can I learn from my students, I have begun to reconsider my role of a teacher in the classroom. Observing the satisfaction and pride the students felt when they presented new information which they have found out on their own and thus became the initiators of the class discussion that followed, I came to believe it would be fruitful to shift some of the responsibility for teaching to the students. In this

new approach, my role of a teacher as a source of information has changed to the one of a guide of students' activities, planning for the goals to be achieved, introducing open-ended tasks, and providing feedback and encouragement.

Beliefs about teaching practice

At the very beginning of my teaching practice, while planning for my lessons, I have focused solely on what I wanted to do in order to be successful.

> "I had to do a lot of preparation and lesson planning. I did not know the book, so I had to read it and study it first. When I taught from the same book next year, I have started to expand more and do additional readings on the topics and deepen the information given to the students … it was still about me and my preparations for the lesson (of course with the best intention to be a good, responsible and resourceful teacher)."
>
> (Narration about my teaching development, December, 2011)

My main concern was to imitate the teachers whose lessons I enjoyed as a student. As I grew more confident about the subject matter I was teaching and became more familiar with the book, I became increasingly interested in knowing the students better. In this second stage of developing my teaching practice I explored the students' backgrounds and prior knowledge or even knowledge in subjects other than science. I held frequent discussions with my students, tried to connect the concepts I was teaching them to their lives. My main concern was to motivate the students to learn because they want to, not because they have to.

> "I have to strengthen the position of the students. I have to give them more space … to think, to ask, to inquire. Even the chance to be wrong. But most of all to participate. I thought, why should I, as a teacher, do all the work, research and thinking, and then serve it ready on a plate to the students? It is not me, who should learn and seek information here; it is the students' turn. They have to do it themselves! (With help, of course.)
>
> (Narration about my teaching development, December, 2011)

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I have realized that in order to make the students more interested, I have to involve them in the learning process. The underlying philosophy was that when they work hard towards achieving a goal, they will feel proud of themselves and it will keep them interested. This was when I have started to use cooperative learning, particularly the jigsaw.

Beliefs about learning

> "I have conducted a mini-experiment with my sixth graders; it is three months now since we have completed a unit about cells. I gave them the same test again. I am ready to quit [teaching]. The results are a disaster, waste of red ink."
>
> (Journal entry, January 2010)

This incident was an eye-opener and a turning point for me. I was on the wrong path. If my teaching translated in my students' learning should lead to desirable outcomes, retention of knowledge and capability to transfer knowledge into new situations, I have to stop "serving" them the information ready on a silver plate. We have to concentrate on the process, the experience, of *how* they gain that knowledge and *how* they "digest" it to make sense of it so that it would become a meaningful part of their *permanent* knowledge. This was the time when I have started to use the jigsaw, small groups learning, based on students collaborating to use references to gain information, analyze this information through group discussions and peer scaffolding (video clip 1 and 2), and synthesize their knowledge in a written report or project. The group discussions lead to a deeper understanding and development of higher order thinking skills. The results found in the analysis of research question 3 about prior and present achievement helped to convince me that I am on the right path in shifting my perspectives on student learning

towards the frames of cooperative learning and emphasis on the process of knowledge acquisition.

Beliefs about social interactions

I grew up in a traditional schooling system based on individualism and competitiveness encouraged by reduced fees for the three highest-achieving students in each class. It took me some time to discover and fully appreciate the advantages of social interactions among a community of learners / colleagues. Peer scaffolding, group discourse, constructive criticism among colleagues, and defense of one's opinions and visions have proven to me very beneficial for both me (a teacher) and for my students, especially the ones who need support.

When I first suggested to my school supervisor that I would like to try a jigsaw project in the sixth grade, she did not know what jigsaw was. I had to explain to her about the underlying theories for the use of cooperative learning, what I expect to gain from this innovative approach and how do I plan to execute the project. These questions forced me to think very well and express explicitly what until then I was just feeling intuitively. I used to give her reports of the progress, successes and deficiencies (like noisiness and need of students to learn to listen to each other) during our weekly meetings and also in writing daily reports in my school lesson plan notebook. My reflections were mainly positive, I was very excited almost ecstatic by the success of the project which caused a

wave of teachers from other departments expressing the will to try jigsaw as well. Up to

my knowledge no one have so far.

"Many of my colleagues seeing the excitement of my students, begging for more time to complete their work after the lesson was over, have asked me what was it we were doing in science and have expressed interest in trying the method in other subjects too. "

(Journal entry, November, 2011)

Even though jigsaw takes much more time preparing for the lesson, feedback during and

after the lesson (video clip 4), I believe that social interaction, which is deeply rooted in

the Arab society and is natural to all the people, is advantageous to the individuals who

wish to clarify their points of views and ideas. Dialogs with colleagues and supervisors

bring in fresh ideas and constructive criticism which help to frame and reframe one's

views and create alternative solutions the teacher did not originally thought about.

Similarly, upon the analysis of students' reflections on the jigsaw experience: social

interaction, friendship and helping behavior were among the most frequently mentioned

assets of the jigsaw method.

"I love jigsaw because we all work together and I take good marks and I can depend on myself. We study and have fun at the same time and because of that I love jigsaw." (student A)

"I loved jigsaw, it is a nice way to study, it makes us study with energy. Students will be all friends in groups. And you will study and have friends at the same time." (student B)

"I love jigsaw because I explain to the girls and in the group, we help the girl who can't explain something, and we talk about the bees and humans." (student C)

"I love it [jigsaw] so much because I like to work in groups and I like to do something different and I like to do searching about science and I like to explain and to be a teacher." (student D)

Beliefs about assessment and cooperative learning

I came to believe that the assessment typical for cooperative learning, where part of the grade is shared and part is individual, has several advantages. First, the lower-achieving students receive a "push" from the shared grade. I discuss, analyze and explain this issue in more details in research question number 3. They can understand better because in the small group of five or six students they receive much more assistance from their more capable peers than they could ever receive from a teacher who needs to attend to thirty students at a time. It is easy for a student in a large class to pretend paying attention when she is not. This is virtually impossible in jigsaw. In the small group every student becomes visible. Everyone has to participate which in turn helps them to better understand the unit and achieve higher on the individual testing. Second, the higher-achieving students also benefit from their peers. In order to teach their peers and scaffold them into understanding, they have to first understand the material very well themselves. The questions asked by their peers force them to organize their own understandings so that they could express them in a variety of ways. Sometimes, students who are less skilled in grasping scientific concepts are more skilled in computer usage, graphic designs or other areas useful in the collective artifact production as the nature of collective learning projects is interdisciplinary. Finally, it is easier for me as a teacher to address misconceptions (video clip 1) and inconsistencies in students' understandings while listening to the small groups' discussions. When I am teaching the lesson in a traditional way (video clips 1, 2, 4 and 5), I never know if *all* the students understood if they do not ask. Following are reflections of some of my students who had an experience in both traditional instruction and jigsaw method.

"I like jigsaw because when we listen to each other we will understand more, but sometimes there are girls [who] didn't understand from you teacher but don't be sad teacher, me I understand from you and jigsaw." (student E)

"I love jigsaw because we work together and understand better and I didn't understand very much from the teacher and I love to explain to others, I love to work with others." (student F)

"I've really liked the jigsaw very much because I liked the teams work & the ideas we took from each other & the way we study & that's make us understand new material more than any other [way]. A usual lesson we understand 90%, jigsaw 100%." (student G)

Beliefs about reflective practice

All teachers are requested to keep yearly, monthly and daily lesson plans describing objectives, materials to be covered and procedures through which those objectives are intended to be achieved. It is less common, though, to write lesson evaluations after the lessons describing what went right or wrong, students' reactions, teachers' deficiencies, reactions to unexpected questions, interruptions or other classroom developments, project progress, etc. During the past three years I have been keeping such journal (irregularly) and during the jigsaw experiment regularly. I have learned in this experiment that recording my thoughts and reflections immediately as they happen and then reading through them and reflecting on the reflections after a period of time is an extremely useful tool in one's realizing the kind of changes that should be made to improve the future practice and work with students. It was also a priceless tool in analyzing my professional development with my colleague, a "critical friend", and receiving feedback on my teaching practice.

Beliefs about teacher education and professional development

In my belief, teacher education should precede an independent practice and among other goals should equip the future teachers with concepts such as metacognition, reflection, use of different teaching strategies, and collegial collaboration that would serve their continuous professional development. Despite the fact that I am grateful to my school for giving me a chance to start teaching five years ago, and despite the fact I was always able to satisfy the requirements of the job to my employer's satisfaction, I can see now that it would have been a more responsible decision from both of us to insist on completing a formal teaching education before starting to teach. I feel a great amount of responsibility to the children I teach and to the parents who entrust me with their children's education and I cannot say that being a more confident, mature and accomplished teacher today is solely due to my experience in teaching but rather thanks to my subsequent teacher education. I would like to mention here three comments I have received from my students' parents in the parent meeting that followed the jigsaw experiment as they are captured in my journal.

> "Ms. Vera, I did not come in here today to ask about my daughter, I came to thank you for the way you have been teaching them recently. It is the first time for the girls they have learned how to study in a way that will actually benefit them when they go to the university." (parent A)

> "Ms. Vera, I came to ask you what is it exactly you have been doing with the girls in science recently. My daughter is so excited! I always spent a lot of time studying with her for the science exam but this time she new everything from school." (parent B)

> "Ms. Vera, as you know, my daughter has dyslexia and I always have a hard time studying with her for the exams. This time she did so much better, please, always teach them like that." (parent C)

Hearing comments like these reassure me I have chosen the right career and keep me going in seeking improvements of my practice.

Another point I would like to make is that I would find it beneficent if it was a part of our teaching schedule to observe each other's lessons. Not for the purposes of criticism or control but to learn from other teacher's experience. For example, I have a problem with classroom management during laboratory lessons and another teacher claims to have the class under control; I would like to learn her strategy for achieving this goal but the burden of my crowded schedule does not allow me to attend her lesson. There is a science coordinator who watches my lessons and gives me feedback but I believe it would be even more fruitful if I could learn from experienced teacher's methods rather than from my own mistakes or successes alone.

In summary, I came to believe that students are my partners in subject knowledge acquisition and this way learning and teaching are interrelated. Under this perception of mutual learning, my role as a teacher changed to the one of a guide of learning, monitor of progress, and provider of feedback. Students' involvement in learning is emphasized when students work in small groups where everyone participates and asserts her skills. The social interactions in the group reinforce the feeling of belonging, friendship and support resulting in greater self-confidence and positive attitude towards the subject. The helping behavior and responsibility for the slower learners is encouraged by sharing part

of the grades. It is easier for me to monitor the progress of each individual student in the small group of six or so students rather than in the whole class because each student becomes "visible" in the small group. Finally, my teaching has improved through practicing the jigsaw method, a strategy I have learned in my teaching strategies courses, which can be agreed upon by all, the students and their parents' reactions as well as test results.

4.2   The Jigsaw Method

Research question number two "What were the main learning outcomes for students who learned using the jigsaw method?" was explored and analyzed through combined quantitative qualitative methods. These included pre-test and post-test, student created study materials such as notes and worksheets, pamphlets about honeybees, video recordings of the lessons, student reflections on jigsaw, and past achievement in science.

4.2.1   The impact on student achievement

Answering this question was addressed by establishing the equality of the experimental and control groups prior to the use of the alternative jigsaw instruction. A comparison of means of the pre-test results of the experimental and control groups has proved that there were no differences between the two groups at the beginning of the experiment. The result can be seen in Table 2.

Table 2. Pre-test

Group	N	Mean	Standard Deviation
Jigsaw	60	.1509	.3008
control	60	.1477	.3369

Upon the completion of the three-month experiment, the students were subjected to a

post-test examination to find out whether the jigsaw instruction had any significant effect

on the students' total achievement in this unit or on any of the categories of the Bloom's

taxonomy. Five independent sample t-test values were calculated for the post-test (1) the

total achievement, (2) questions in the category of knowledge, (3) questions in the

category of comprehension, (4) questions in the category of application, and (5) questions

in the category of higher order thinking skills (analysis, synthesis and evaluation). The

results of those t-tests can be viewed in Table 3.

Table 3. Post-test analysis

	Group	N	Mean	Standard Deviation	Significance (2-tailed)
Knowledge	Jigsaw	60	3.13	1.05	.88
	Control	60	3.10	1.17	.87
Comprehension	Jigsaw	60	1.43	.61	.62
	Control	60	1.37	.64	.59
Application	Jigsaw	60	1.19	.42	.31
	Control	60	1.10	.48	.27
Higher Order Thinking Skills	Jigsaw	60	2.06	.78	.15
	Control	60	1.80	1.03	.11
Total	Jigsaw	60	1.96	.64	.38
	Control	60	1.84	.74	.37

As can be seen in the above table, no significant differences between the experimental and control groups were found neither in the total post-test grade nor in any of the four subcategories (knowledge, comprehension, application, and higher order thinking skills).

4.2.2   The effects on students' attitudes toward learning science

I analyzed this question through examination of students' reflections on the jigsaw experience. The only instruction the students were given was to write whether they enjoyed learning science through jigsaw or not, and to support their answer. The majority of the statements fell under one of five main themes that have emerged from the analysis. The themes are as follows (1) the social aspects, including friendship, learning from each other and having fun, (2) responsibility for learning and independence, including giving / receiving help from peers, negotiating ideas, working hard / searching for information and better understanding, (3) active participation, including opportunity to express opinions, teaching others and creating own teaching materials, (4) anticipation of higher achievement, and (5) desire to learn through jigsaw in the future. Some statements did not fit into any of these categories and were examined separately.

Enumeration method was used to establish the frequency of the statements in each category. The results are presented in a table showing the five main themes and the frequencies of students' statements found, sorted in a descending order. There were 60 students in the jigsaw group.

Table 4. Student reflections analysis

Themes	Statement frequency (percent)
Responsibility for learning and independence	98.3
Desire to learn science through jigsaw in the future	98.3
Social aspects	80.0
Active participation	33.3
Higher achievement	28.3

The labels of the five themes reveal the generally positive attitudes towards learning science through the jigsaw method. Nearly all of the sixty students expressed a desire to learn through jigsaw in the future because they enjoyed their independence learning and high responsibility for learning during the experiment. Another aspect of jigsaw learning that was highly valued by the students was the social aspect – sharing with and helping each other. One third of the students praised their active participation on the lesson and material acquisition. A high number of students anticipated a higher achievement in science due to the jigsaw method. Before discussing the individual themes, however, I ought to mention some negative statements that did not fit in this positive trend. It is worthwhile to show the negatives in a table as well.

Table 5. Negative student reflections analysis

Statement	Frequency (percent)
Teacher explains better	6.7
Overdependence on the strong student	3.3
Boring	1.7
Fight and did not finish in time	1.7

The characteristic of cooperative learning valued the highest by the students was responsibility for learning and independence, social aspects, active participation and higher achievement as perceived by the students. All but one student expressed the desire to learn through jigsaw in the future which points to positive attitudes towards cooperative methods of learning science.

4.2.3   The effects on students' learning and social skills

The development of learning and social skills students gained from the jigsaw experience was assessed through a creation of pamphlets, a group assignment given to both experimental and control groups at the end of the experiment. The objective of this assignment was to study the students' improved skills in seeking and synthesizing good relevant information, dividing responsibilities among group members, and creating a high quality end product. This assignment was then examined qualitatively, compared and

contrasted between the two groups, in four a priori established categories: (1) group cooperation, (2) quality of information, (3) relevance to the given topic (interesting facts and importance of honeybees), and (4) graphic design.

Before the analysis, it is interesting to mention the reactions the two groups, jigsaw and control, had and the positions they took towards the assignment. The jigsaw group, who had some experience in group work now, immediately started to organize who can visit whom, who has a computer, printer, etc. They were obviously excited about the assignment. The control group, right after the announcement of the assignment, started to look for reasons why they cannot work in groups and suggested each student working alone.

Category 1: group cooperation

The result is that in the jigsaw group, all ten groups have completed the assignment in the team we have originally agreed on and shared responsibilities for carrying out the project while in the control group two teams split and two students were not able to cooperate with their teams and dropped out of the project.

Category 2: quality of information

Six teams from the jigsaw and five teams from the control groups produced high quality information found in external sources, which was one of the requirements. Three teams in the jigsaw and two teams in the control groups produced pamphlets that contained no or almost no new information about bees. One of the jigsaw teams produced a low quality work and five of the control group teams have copy-pasted information that did not make

sense (partial information), or was way above the level of understanding of sixth graders' language capabilities.

Category 3: relevance to the given topic (interesting facts and importance of honeybees)

Nine of the jigsaw teams and nine of the control group teams adhered to the topic, one jigsaw team produced a funny pamphlet with bee jokes which did not match the topic interesting facts and importance of honeybees and three of the control group teams produced pamphlets that carried neither interesting nor important facts about bees (e.g. concentrated on body parts).

Category 4: graphic design

In both groups there were teams that came up with surprisingly high quality designs. In both groups, some teams used a high quality paper, clever way of folding the pamphlet, picture and text alignment, etc. Both teams had a high amount of grammatical errors. The main difference was that only two jigsaw teams chose not to use the computer to design their pamphlet, while six of the control group teams used handwriting and glued on pictures. A summary of the findings is presented in Table 6.

Table 6. Analysis of the skills gained during jigsaw through a pamphlet creation

Category	Jigsaw group (10 teams)			Control group (12 teams after splitting)		
Group cooperation	100%			Less than 80%		
Quality of information	High	Medium	Low	High	Medium	Low
	6	3	1	5	2	5
Relevance to the given topic	Yes		No	Yes		No
	9		1	9		3
Graphic design	Computerized		Hand-made	Computerized		Hand-made
	8		2	6		6

4.3   The interaction between prior achievement and jigsaw

The third research question "Was there an interaction between student prior achievement
in science and their achievement at the end of the unit which was taught using the jigsaw
method?" was analyzed by construction of two graphs. Figure 1 shows the interaction of
the present overall achievement trends (for jigsaw group includes both individual and
shared grades) compared to prior achievement in science (5th grade) for jigsaw and
control groups. Figure 2 represents the grades achieved in the past (5th grade) compared
to the post test.

Figure 1. The interaction between prior achievement and teaching method (jigsaw versus traditional)
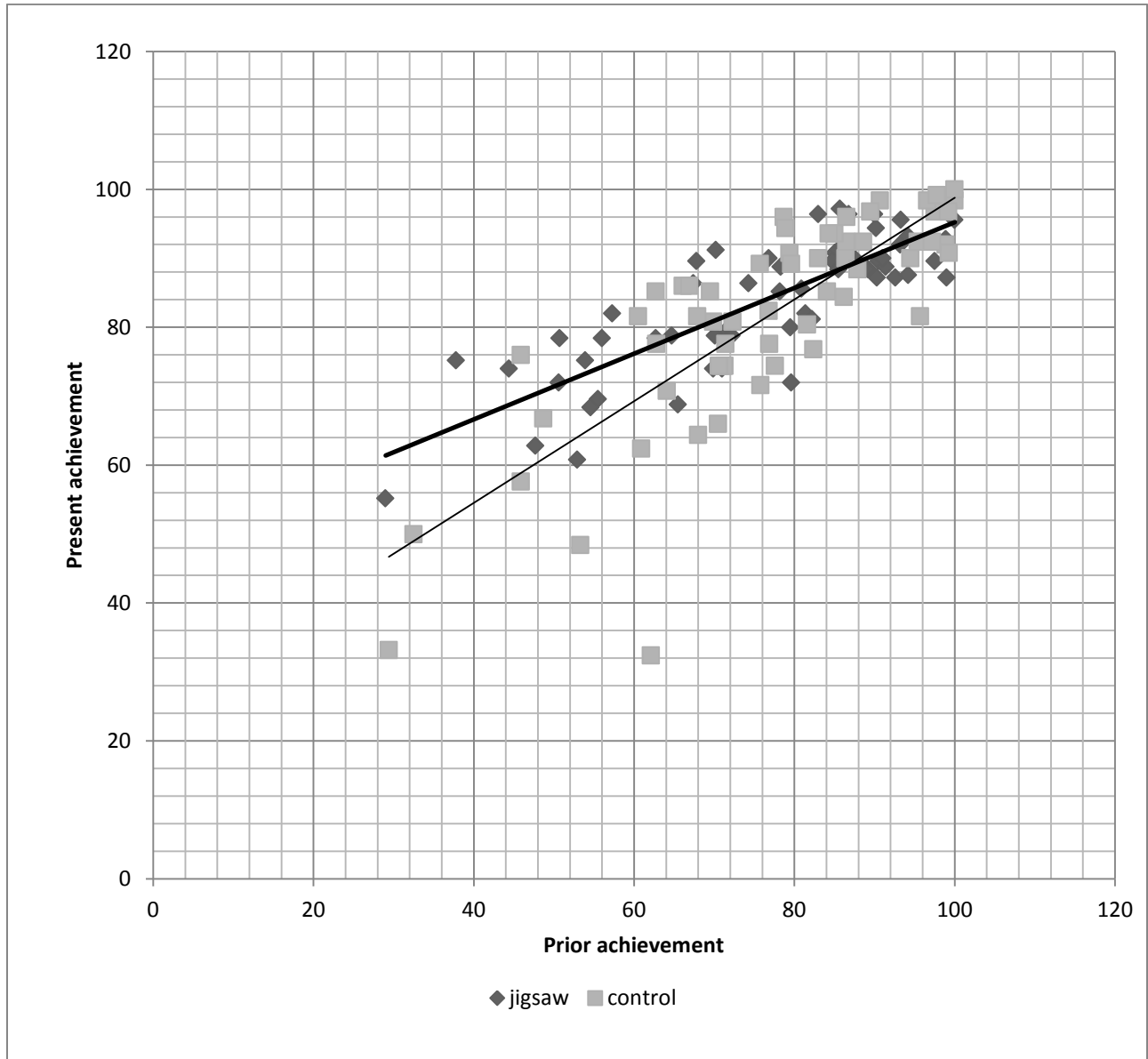
Upon the achievement graph analysis we can say that the general trend extracted from the graph shows improved achievement of the previously lower and medium-performing students in the jigsaw group while the previously higher-performing students have slightly decreased.

Figure 2. Interaction of the prior achievement and the post test results
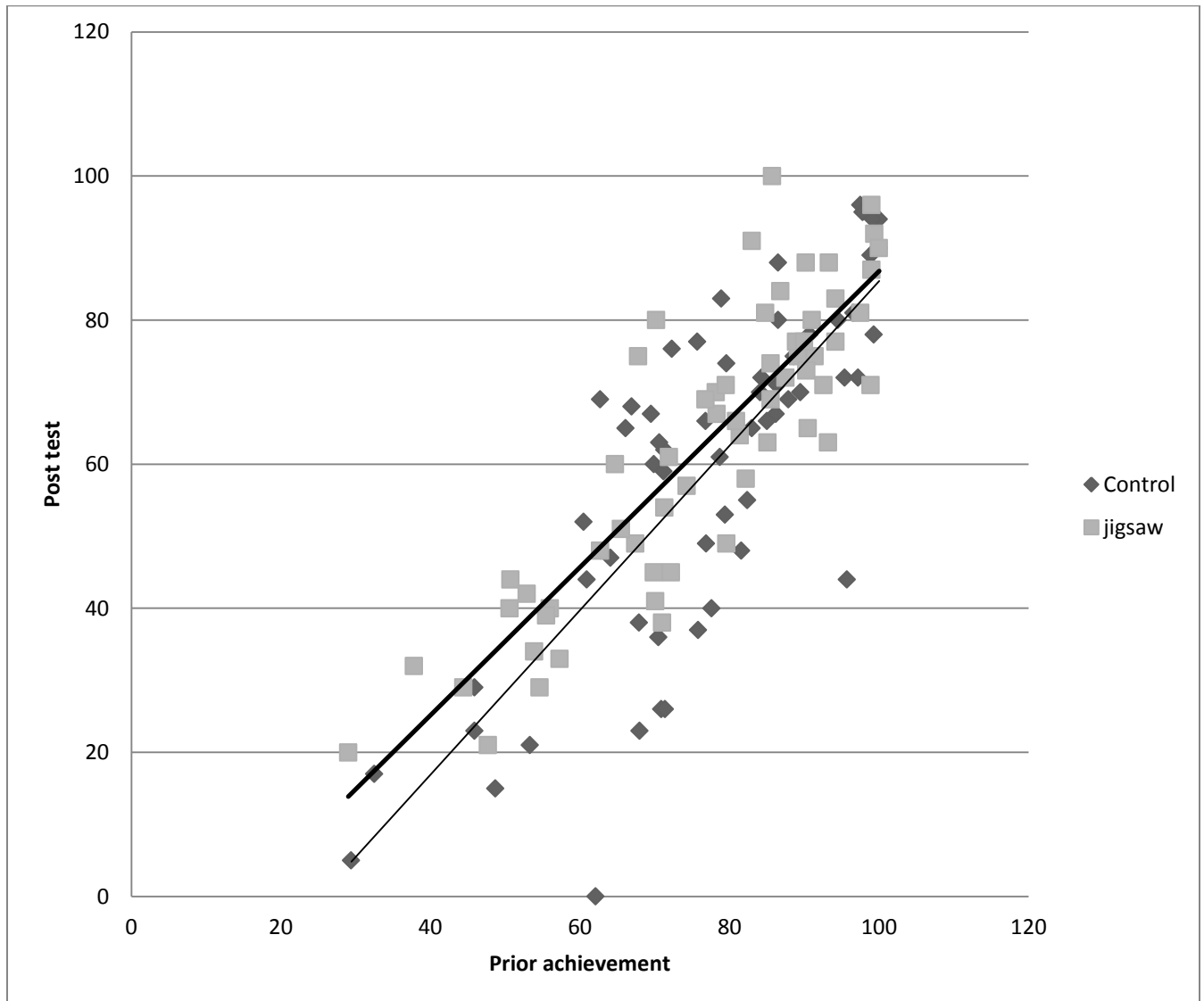
It can be read from the above graph that the previously lower-performing students achieved slightly better on the post test while the higher-performing students remained almost unaffected. Overall, the difference between the jigsaw and the control groups on the post test achievement is minor.

In summary, we can draw three main conclusions about the effects of jigsaw learning on the students; (1) the students asserted positive attitudes toward learning science cooperatively, (2) their self-learning and social skills improved as compared to the control group, and (3) the jigsaw instruction was highly beneficial to the low-performers, moderately beneficial to the medium-performers, and had a slightly negative effect on the previously high-performers.

Chapter 5

Discussion

5. 1   Introduction

Examining the multiple data sources used in this self-study helped me to explicitly

articulate the events and conditions that led to a gradual development in my teaching

career. Stated below are eight main themes that emerged from the analysis of those

sources: beliefs about subject matter knowledge, beliefs about teacher's role, beliefs

about teaching practice, beliefs about learning, beliefs about social interactions, beliefs

about assessment and cooperative learning, beliefs about reflective practice, and beliefs

about teacher education and professional development. Each of these themes is discussed

separately. The development of these beliefs was studied on the background of two

teaching methods, traditional and jigsaw. The impact of using the alternative jigsaw

method on student achievement, social interactions and attitudes toward science is

discussed integrally with references to changes in my teaching the obtained results imply.

At the heart of this self-study is not only my desire to be the best teacher possible but also

the passion for empowering my students' learning capacity and learning for

understanding. Being an effective reflective practitioner, I seek and frame problematic

situations where others may not see them and try to address those problems by actions

which hopefully will lead to their reframing and improving practice. From my

perspective, teaching, learning and researching are tightly connected and are necessary to

anyone who is committed to professional development and growth. Loughran (2006) put

forward for consideration the idea that teachers' explicit concern and personal

involvement in the development of knowledge through educational research lies in the fact that teachers are both users and generators of knowledge.

Undergoing a formal self-study is a risky inquiry into one's own practice as it involves exposure of defective or inadequate practice which makes the researcher vulnerable. "*This willingness to admit that we stumble in our teaching practice is a central part of work in self-study*" (Hamilton and Pinnegar, 1998, p. 243). Involving teachers in educational research, as subjects not objects of the study, addressing their real problems on the ground and finding solutions that have a direct impact on their practice became a new trend since the early 1990s. As described in the literature review in chapter 2, self-study became a very popular and recognized kind of educational research world-wide; nevertheless, we find a large absence of self-study research in Palestine. This may perhaps be attributed to the reluctance of teachers to point out their weaknesses publically, fear of criticism or even fear of losing their jobs in the large competition. Personally, I think that sharing our experiences, whether positive or negative ones, with colleagues brings fresh perspectives on situations we encounter in class and thus may only benefit us. Another reason may be that we are taught how to use the tools of self-study research, such as reflection, metacognition, action research or inquiry, during our university courses, but we hardly ever hear that these tools for improving one's practice could be used in a formal research. I am glad I have been given this opportunity because it provided me with not only the chance to study my practice deeply, articulate my problems explicitly and test my assumptions about teaching in the jigsaw experiment but also to study the history and methodology of self-study research as well as the self-studies of other educationalists. This was a great asset to my pedagogical knowledge

development, as many times I could have identified myself with the beginning teachers' difficulties and I was interested to see how did they solve the situations, while other times I looked up to the experience of teachers with long practical experience who are still willing to examine, frame and reframe their practice according to their developing perspectives on learning to teach and teaching (Freese, 2006; LaBoskey, 1997; LaBoskey, 2004; LaBoskey, 2005; Lougran, 2006; Loughran, Berry and Tudball, 2006; Loughran and Northfield, 1998; Russell, 1997; Russell, 2006; Russell and Munby, 1992). In summary, this self-study was a tremendous learning opportunity for me which helped me to take a new direction in my teaching.

5. 2   Discussion of the professional development themes

I have examined my changing professional beliefs about teaching science in elementary school on the background of a combined quantitative qualitative experiment with 120 sixth grade students. I compared between two teaching methods, traditional whole class lecturing which represented my older frame of work and cooperative small group jigsaw method which represented my new frame of work. Other major sources of reflection on my practice were my journals and teaching history narration, sets of questions about my beliefs about knowledge, science, pedagogy, learning and teaching, and finally video recordings of my lessons. After thorough examination of these multiple data sources, eight themes have emerged that characterize the main fields of my professional development on my journey of a novice teacher who initially embraced the school's

traditional teaching style and gradually grew to appreciate more innovative approach to teaching. I will discuss these themes in the light of literature review.

Beliefs about subject matter knowledge

The main idea in this theme was my changed belief about the sources of subject knowledge acquisition or rather the inclusion of students' knowledge as an additional and important source of knowledge. Ashman and Gillies (2003) suggested that the optimal level of learning is achieved when teachers share responsibility for learning with their students through involvement in knowledge acquisition and peer mediation. Thus I have changed from being the sole source of knowledge dissemination to being a partner in knowledge acquisition. Reviewing literature on cooperative learning, this is not a new idea in theory but it takes an effort and even courage to come as a new teacher to a school with more than sixty years of deeply rooted traditional teaching principles and challenge those principles in an attempt to improve the practice by radical innovations.

Beliefs about teacher's role

The idea found under this theme is related to all points of this investigation. A changed teacher's role in the classroom is fundamental to the shifting from lecturing to cooperative learning. The recognition of students' capability to learn provided they receive proper scaffolding as described by Vygotsky (1978) in chapter 1 necessitates a change in the teacher's role to that of facilitating learning and guidance of the learning

process. I ought to add here that in my opinion, it is also a genuine warm teacher-student

relationship that shows care, high expectations and belief in the individual students.

According to Cornelius-White and Harbaugh (2010), students respond positively to the

teacher's initiatives if they can recognize his/her genuine interest in 'walking the walk,'

not just 'talking the talk'. Unfortunately, research shows that it is mostly not the case

(e.g. a comparative study on teacher reflection and action by Marcos and Tillema (2006)

described in chapter 2). Cornelius-White and Harbaugh (2010) further emphasize the

capability of an accomplished teacher to support students in creating their own meaning

and completing their own learning endeavors rather than direct them to it. I believe that a

formation of such teacher-student alliance, based on genuine care for the students and

ongoing feedback about learners' knowledge, skills and dispositions, especially when

they are struggling to create meaning from new information, is highly motivating for the

students learning.

Beliefs about teaching practice

The main findings under this theme point to my recognition of committing the typical

mistake of the beginning teachers who concentrate all the focus on themselves and what

they want their teaching to look like instead of focusing on what would bring the best

students' learning outcomes. Reading through literature, for example the comparison of

eight self-studies of graduate teaching students describing their practicum experiences

conducted by Freese (2006), described in depth in chapter 2, helped me realize that

overconcentrating on my own actions is a normal first step in creating my teaching

identity. Upon careful evaluation of this rudimentary period and upon employment of

metacognitive and reflective strategies I took a new direction from a teacher-centered

instruction to a student-centered instruction, particularly the cooperative jigsaw method. I

came to believe that students need to be actively involved in the learning process in order

to find a true intrinsic motivation to learn. Cornelius-White and Harbaugh (2010) suggest

that intrinsic motivation and consequently the quality of learning may be enhanced by

provision of real life challenges to which students may rely and comprehend the purpose

of the challenges they are being confronted with. More generally, there is a transition by

teachers from focusing on themselves to focusing on student learning. In her in-depth

study of two student teachers LaBoskey (1991) identified the limiting effects of prior

knowledge and beliefs on the development of those two teachers. LaBoskey suggested

the need for continuous growth of student teachers from a "common sense thinker" with

focus on self and personal experiences to an "alert novice" and on to a "pedagogical

thinker" with focus on teaching and students' learning rather than oneself.

Beliefs about learning

The central idea in this theme was the turn towards perception of learning as a *process*, or

in other words, the belief that learning is the most effective if knowledge is constructed

by the learner. This perception of learning is grounded in the work of such educational

scholars as Piaget (1932), Dewey (1933) and Vygotsky (1978). According to Dewey,

teachers' should challenge students with problematic real-life situations, thus disturbing

the equilibrium of their previous understandings and forcing the students to adjust those

understandings to solve the problem. Reflection is an important part of this process. Vygotsky emphasized the social aspect of the learning process based on *"problem solving under adult guidance or in collaboration with more capable peers"* (p. 86). Piaget's cognitive conflict theory was explained in chapter 1. It seems logical that students should achieve a greater retention of the learned materials as well as increased ability to transfer the acquired knowledge into new areas when those were learned through a process, not through mere memorization. Nevertheless, to prove this statement would require a follow up study which would test for retention and transfer.

Beliefs about social interactions

> *Social interdependence to humans is like water to fish.*
>
> **(David W. and Roger T. Johnson, 1994)**

The pattern of this theme unfolded in two layers; social interactions among colleagues and social interactions among groups of students. Both of these layers share some common characteristics. Among them are the benefits of collective discourse, reflection on problematic situations and introduction of alternative views which no one person alone could think of. Furthermore, verbalizing one's intuitive ideas helps in organizing and reorganizing thoughts in more meaningful ways. Social interactions among teachers and their supervisors create an environment of openness, trust and collaboration. Articulation of problems and fresh views of colleagues may lead to a reframing of practice, teacher growth and change under the light of new understandings. Henderson (1996) praises the value of such professional relationships in which colleagues are

capable keeping their individuality while accepting constructive criticism and supporting

each others' diversity through collaboration. Similarly, peer interaction in cooperative

learning groups promotes contexts for purposeful talk leading to better understanding.

Most students feel safer and more free to express themselves or to ask for help in a small

group then in the whole class. Johnson and Johnson (1994) attribute cooperation to

human development and outcomes in education and life.

Beliefs about assessment and cooperative learning

The main idea in this theme was the positive interdependence among group members

with varying learning abilities and skills which, supported by shared grades and

individual accountability, intensified the helping behavior among peers. "*Group goals*

and individual accountability motivate students to give elaborated explanations and to

take one another's learning seriously, instead of simply giving answers" (Slavin, 2011, p.

348). According to Slavin, the greatest benefit students may get from learning is when

they explain the material to their peers. This forces them to organize their newly acquired

knowledge and construct a meaning out of it. He proposes achievement benefits for both

the high-performers and the low-performers, provided that the greatest beneficiaries of

cooperative learning are those who served as the explainers and second are those who

received the explanations. Even though I agree with Slavin on the effectiveness of

cognitive elaboration, my findings about who benefits from cooperative learning the

most, do not match his empirical evidence; in my experiment, the greatest beneficiaries

of cooperative learning were the previously low-performers and medium-performers

while high-performers have decreased slightly. A similar result was found in the study conducted by Yousef (1998) who examined 892 students from the Tulkarem Governorate. The second idea which I embodied into this theme was that students in small groups became more 'visible'. Firstly, they had a constant attention of their peers, and secondly, the class distribution into small groups allowed me to monitor individual students' progress more effectively while rotating between the groups. Cornelius-White and Harbaugh (2010) pointed out some the advantages of group assessment: (a) teacher may assign both individual and group grades within the group assignment, (b) teacher may intervene into the group's work if it will promote progress, and (c) teacher has an opportunity to assist to specific learning needs within the groups.

Beliefs about reflective practice

The leading idea under this theme was the need of using reflection and collegial collaboration to promote professional development and improved practice. During the conduction of this self-study I came to understand the idea central to Schön's (1987) work that we can learn from experience only if we reflect on it. Drago-Severson (2004), who investigated the effects of collegial inquiry, built on the concept of reflective practice, and found out that the greater awareness of personal beliefs and assumptions about teaching raised from collegial reflections resulted in greater professional development. The underlying reasons for this development were the emphasis on the value of learning from different perspectives, inclusion of others in leadership and management of change described in more details in chapter 2. Conle, Louden and Mildon

(1998) suggested that one of the favorable conditions for a joint academic inquiry is the dynamic in which the group members get to know each other closely which leads to a more intense interaction and mutual respect. References to lived experiences, discussions about and linking of those experiences creates new productive tensions that emerge from interpretative collegial inquiry.

Beliefs about teacher education and professional development

The main idea of this theme was that mastering one's subject is not sufficient for teaching this subject; therefore, teacher education should be a prerequisite to teaching. Furthermore, professional development, as the word development implies, should be a continuous process of in-service teachers' learning to improve instruction throughout their career. I suggested a way to support professional development in schools by the creation of a culture of collaboration to be built into the regular practice of teachers, such as observation of each other's lessons and group discussions of strategies that worked or did not work well and should be used and elaborated in the future or avoided respectively to facilitate the student learning process. I believe that explaining the advantages of collective reflective practice would allow the teachers to create a meaning of such professional social relationships that would lead to professional development rather than feeling of vulnerability or waste of time. At the moment, discussions among science teachers in my school concern rather the material that should be covered and one-sided criticism of the lessons by the supervisor rather than collegial collaboration. Teachers do not observe each other's lessons because of their overloaded schedules on one hand and

for fear of being seen as incompetent on the other. "*Sustainable professional growth requires development of trusting relationships in which the people involved are willing to take risks*" (Cooper and Boyd, 1998, p. 58).

5.2.1   Conclusion

I believe that a self-study undertaken with rigor leads to professional growth. Even though self-study concentrates on one's self, it is always done in relation to others, students, critical friends and literature, and with the aim of being publically scrutinized. This way self-study is both private and public. Conducting a self-study is a risky endeavor as it involves uncovering of one's problematic issues in professional practice but if met with a collaborative community, constructively critical and supporting, it might lead to professional development and improved practice. A central idea of educational self-study is framing one's beliefs and assumptions about teaching, finding and articulating potential problems, preferably collaborative reflection on the issue and taking an action that will ideally result in reframed thinking. Self-study is a relatively new but rapidly developing genre of educational research. Brody and Davidson (1998), LaBoskey (2004), Loughran (2006), Zeichner (1999) and other educational scholars have been increasingly interested in teachers' biographies, the processes of how they grew to become the practitioners they are, and the conditions that led them to adapt innovations through their developing perspectives on teaching.

5.3 Discussion of the jigsaw experiment findings

5.3.1 Introduction

The nodal points of my professional developments described above are coupled with the cogitations of cooperative learning and concentration on the student learning process. The shift to cooperative learning requires both the teacher and the students to change significantly how they approach learning, perceive others, and the expectations they have for learning outcomes.

5.3.2 Discussion of the impact of the jigsaw method on student achievement, social interactions and attitude toward science

Even though the jigsaw method did not produce significant differences in the students' achievement in science, strong positive attitude was found that implies an increased interest and intrinsic motivation toward learning science as well as improved social skills among groups of students.

The experimental jigsaw group and the control group did not show significant differences in neither the total test results nor in the individual subgroups of knowledge, comprehension, application and higher order thinking skills. When interpreting these findings, one must bear in mind that these students have never been exposed to teaching strategies that require independence, group work or analysis, synthesis and evaluation; quite contrary, the traditional character of the school, perhaps unintentionally, supports

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the "recall" kind of learning that I was trying to reduce and replace in the course of this experiment. It is actually required that test questions were close-ended with a single possible answer. I consider it a step forward that I was allowed to include open-ended tasks during the jigsaw experiment as well as open-ended test questions that required higher order thinking skills. The fact that no significant differences were found between the experimental and the control groups in the written exam could be attributed to the relatively short (three months) duration of the experiment. I believe, and the students' reflections support my belief, that continuing to include open-ended challenging problems into the instruction and testing that require habituating of the use of higher order thinking skills will have a positive effect on the jigsaw students' capability to understand the material in meaningful ways which will allow them to utilize the acquired knowledge in analysis, synthesis and evaluation and its transfer into new situations. On the other hand, mere memorizing of study materials to which the students are traditionally accustomed and which does not require much effort on behalf of the students, will not develop those higher order thinking skills. It is worthwhile to bring to attention that many jigsaw students reported less preparation for the final test claiming that they understood and remembered the material from school. Both groups have done well on the post-test but only the jigsaw students grew to appreciate the *process* of searching for information and peer discussions that helped them make sense out of the new information, deeper understanding and creation of links between chunks of knowledge. It would be extremely interesting to follow up on this and retest the students after a period of time to study the effects of the learning process on retention.

The positive effect of cooperative learning on student achievement was shown and is generally agreed on in literature (Ahles and Contento, 2006; Bandiera and Bruno, 2006; Doymus, 2008; Doymus, Karacop, and Simsek, 2010; Johnson and Johnson, 2003; Köse, Şahin, Ergű, and Gezer, 2010; Shachar, 2003; Sharan, 2003; Souvignier and Kronenberger, 2007; Walker and Crogan, 1998). The reason for the neutral results found in this study may be attributed to (1) the short duration of the experiment, (2) the need to learn how to utilize the external resources by the students more effectively, and (3) the need to plan for instruction that would accommodate the students' requirement of active participation on the process of learning on regular basis. If I was to repeat this experiment, I would try to decrease the time pressure the method imposes on the students (searching for materials, preparing documents, etc.), as a significant amount of their work was carried out outside of the classroom, and cooperate with other subjects' teachers on this project. For example, the information technology (IT) teacher could explain about internet search engines to help students find relevant information, both IT and art teachers could help with graphic design, English teacher could introduce part of the vocabulary (English is a foreign language) or related articles and so on. This way a part of the pressure would be taken of the students who are already under a lot of pressure from other subjects' assignments.

Regardless of the pressure imposed on the jigsaw students, the five themes extrapolated from students' reflections on the jigsaw experience in learning science had largely positive character. The characteristic of cooperative learning valued the highest by the students was responsibility for learning and independence. The conclusion I derive from

this point is that students are indeed truly motivated by their involvement in the process of learning, negotiating their views and feeling proud of their hard work. The aspect of 'I did it myself, I don't need any help', characteristic of children entering puberty, the sixth grade, seems to be a strong impetus for learning, interest in the subject and growing self-esteem. High values attributed to the social aspects point back to the underlying theories about cooperative learning. Vygotsky's (1978) idea that learning should be a social activity in which students discuss issues and work together immediately springs to mind. Many students mentioned friendship and helping behavior as one of the group work characteristics. Johnson and Johnson (2003) categorize mutual help, assistance and trust under a promotive interdependence interaction which is highly motivating for a group of students sharing a common goal. Moreover some students who may for various reasons be unpopular among their classmates are included into the collective naturally when learning in small groups. One of my students told me: "*Teacher, I love jigsaw, finally the girls accept me and talk to me.*" Palmer, Peters and Streetman (2004) point out the increased diversity awareness among students during small group instruction because students are assigned to heterogeneous groups by the teacher and thus 'forced' to interact with other students than might be their natural choice which gives them the opportunity to explain and defend their reasoning. Assigning challenging but achievable problems addresses the students need for active participation and creativity. Construction of artifacts, opportunity to speak and being listened to gives the students feeling of being important and increases their self-confidence. This is then reinforced by the opportunity of teaching others. A considerable number of students mentioned anticipated higher achievement. Based on the analysis of research question three about the interaction

between the teaching and prior achievement, they were probably the previously lower-achieving students who gain greater benefits from the group work and shared assignments than they would be able to achieve individually. Examination of the trends of student prior and present achievement showed increased achievement of the previously lower and medium-performers while the higher-performing students decreased slightly. Similar result was found in the Stockdale and Williams (2004) study. A possible explanation for this result may be linked back to the Piaget's socio-cognitive conflict theory. It is possible that the high performers spent a lot of time clarifying misconceptions and explaining the concepts, they have already understood, to their peers but they did not receive the same chance of cognitive conflict themselves. This could also explain the negative student reflections, when two students mentioned overdependence of the group members on the strong student and four students claimed that the teacher explains better. Finally, all but one student expressed the desire to learn through jigsaw in the future. This attitude sums up all the previously discussed advantages of the cooperative learning mentioned by the students; this includes innovative approach, avoiding boredom – "doing something different" as one of the students put it, strengthening of friendships, independence in learning, open opportunities in search for information, and greater retention of the new knowledge as it is organized in a meaningful way by peer scaffolding. Some students mentioned that jigsaw learning requires more efforts and time on their behalf but they would still prefer this method in the future. This is a strong indicator for me as a teacher that I should continue to include jigsaw method, or some of its components, into my teaching repertoire in the future whenever the character of the unit / lesson allows it. Students' will to choose the harder

way of acquiring knowledge because they feel it brings them more satisfaction and better results is the real achievement here.

Most of the negative comments were, not surprisingly, made by some of the usually higher-achieving students. Support for this finding may be found in Shachar's (2003) review of eight studies on cooperative learning; the data from Singapore and Israel showed the dislike of the high-achieving students for cooperative learning, which was explained by the high-achieving students' comfort in the traditional whole class instruction to which they are adjusted and in which they are successful and thus resistant to change to the unknown.

Reviewing the results obtained from students' reflections on the jigsaw experience, it is easy to deduce the predominant positive attitude toward cooperative ways of learning science. The responsibility for learning, and independence of the teacher, replaced by interdependence among the group members, are the highest-valued factors by the students that motivate them to learn science in the future.

As I have mentioned above, the experiment did not bring any significant difference in the test scores between the two groups. Nevertheless, the results gained by examination of pamphlets created by small groups of students from both traditional and jigsaw sections showed that even a short experience (three months) in jigsaw learning had highly

increased the students' capability to cooperate productively and successfully with their peers on a joint project. Their organizational skills had been improved. The capacity to seek, recognize, understand and utilize new information was also increased. Moreover, the skill of designing computer-based artifacts, gained in the jigsaw project where it was compulsory, translated into its usage in pamphlet designs where the tools were not specified. It can be concluded from these findings that the jigsaw group students possess improved learning and social skills which can be attributed to the jigsaw instruction experience.

5.3.3   Summary and Conclusion

The overall results found in the examination of the jigsaw learning method studied in this experiment showed positive effects on students' attitudes towards learning science and increased employment of learning and social skills during the learning process. Studying the achievement trends showed improved achievement of lower and medium-performing students which can be attributed to the employment of constructivist and social aspects of cooperative learning. Higher-performing students were affected slightly negatively on the group assignments and imponderably on the individual post test results.. This may partly explain their reluctance toward peer-based learning as they were the authors of the negative comments on jigsaw instruction in their reflections. The results of this study should be considered tentative as the duration of the experiment and the small number of participants does not consent generalizations. The fact that the jigsaw students performed equally well on the post-test as the control group can be considered a good result

considering the fact that these twelve-year olds were exposed to small group learning with high level of independence of the teacher and interdependence among the group members for the first time in their lives. It should also be considered that the jigsaw method required of the students a significant load of work in after school hours, visiting group members at home to collaborate in creation of materials, for many students it was the first experience creating printed documents and communicating with the teacher via emails. Dividing the students into heterogeneous groups was a good strategy which brought advantages and higher achievement to most of the students, increased self-esteem of faster learners who provided help to their peers who appreciated the increased attention to their needs compared to the whole-class instruction. Taking into consideration the students' reflections, I will have to pay more attention to the division of responsibilities in preparation of the printed materials (outside of the school) when using the jigsaw the next time. I understood that some students took an advantage of their more diligent peers in this matter. Considering the students' enthusiasm towards learning science through the jigsaw method, during and after the experiment, there is no question in my mind I will include this teaching strategy in my science instruction in the future.

5.4   Recommendations

Based on the outcomes and findings of this study which interrelated teacher professional development and student cooperative learning, several recommendations can be made:

(1) Teachers committed to understanding the nature of teaching and learning should employ themselves in reflective practices, action research or self-studies.

(2) School administrators may encourage professional development by creating cultures of collaboration in their schools.

(3) Teacher training should include reflective, metacognitive, and teaching strategies as well as action research and self-studies to promote professional growth.

(4) Self-study research may serve as a tool in teacher education.

(5) Considering the generally positive outcomes of cooperative learning, teachers should consider including small group learning like jigsaw in their instructional repertoire.

(6) A follow up study to explore the effects of a learning process versus material memorization on retention would be interesting.

(7) Replication of the jigsaw experiment is advisable to compare the results.

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Worker Bees

- *The worker bees do all the work around the hive .*
- **Nurses** *take care of babies ,***foragers** *look for food ,***scouts** *they look for place for a new hive ,***guards** *protect the entrance , finally the* **undertakers** *remove the dead ones.*
- *They are* **all female***.*
- *Worker bees have (3)three life stages :***youth *,* middle age** *and* **old age** *.they have specific jobs.*

- *Young workers*

A)forgers

Gather nectar and pollen as food *for members of the colony , sucks up the nectar with its tongue and desposits the nectar into a* **special honey** *stomach inside its abdomen. When the stomach and* **pollen baskets** *are full , the worker bees flies back to the hive to share its bounty with the other members of the colony . the young honey bee regurgitates the nectar passes it ,to the middle aged workers .*

B)Guards

Use their **stingers to protect the hive** *,when threatened, a bee will sting its intruder by pushing the tip of stinger and pumping* **venom** *from its venom pouch. When the bee pulls itself away , it leaves the venom pouch and stinger inside the invader .The bee soon dies because of the rupture of its abdomen.*

C)Nurses

Tend to the queen *,feeding and taking care of her life , cleaning the cells and feeding the larvae.*

Middle age workers

A) *Distribute the nectar ,* ***convert it into honey*** *and store it for further use.*
B) *They are responsible for* **building the honeycomb** *from* ***wax*** *secreted from their abdomens.*

Old workers

Supply some of nectar ,provide the enzymes for converting it to honey , ***help*** *the other honey bees store the nectar and pollen and* ***ventilate*** *the hive.*

Nectar: a sweet liquid inside the flower

Example of student's worksheet

Science Worksheet

Name: _____   Date: _____

Part 1: Queen Bee

Q1: Fill in the blanks:

1) The royal jelly is full of _____ and _____ .

2) The queen only has to _____ the eggs, _____ per day.

3) When the queen lays the eggs she puts a _____ in each cell.

Q2: True or False:

1) The new queen makes several mating fights. _____

2) The queen stores a mixture of sperm on her leg like the worker bees. _____

3) Some of the larvae develop in the peanut-shaped cells._____

Q3: Explain.

 In the colony all the bees have the same mother but various fathers.

_____

If the queen runs out of eggs, a new queen will be produced by the workers.

_____

Q4: Circle the correct answer:

1. The colony may have: 2. A queen lives for:

   a) One queen   a) 6 years

   b) Three queens   b) 5-7 years

   c) Thousand queens   c) none of these, it is _____

Part 2: Bees' dance

Q1: Draw a map in which the flower is on the right side from the Sun and explain:

Q2: Answer:

What are the main parts of a map?

_____

What does a worker bee do when there is plenty of food and what does it do if there is only a bit?

   _____

   _____

_____

Pre-test

Rosary Sisters School

6th grade Science test – **Honeybees** (45 marks)

Teacher: Ms. Vera Taha

Name: _____ Section: A, B, C, D

Date: _____

1. **Fill in the blanks: (8 marks)**

   1. Insects that live & work together are called "_____ insects".

   2. A group of bees is called _____ .

   3. A food fed to a queen bee is called _____ .

   4. A queen lays _____ eggs a day.

   5. A bee's life span is about _____ days.

   6. The shape of the cells in a honeycomb is _____ .

   7. Bees communicate by _____ .

   8. The fight between new queens is known as _____ .

2. **Label the part of a bee which is used for:** #1: protection

   (6 marks) #2: collection of pollen

   #3: sipping nectar
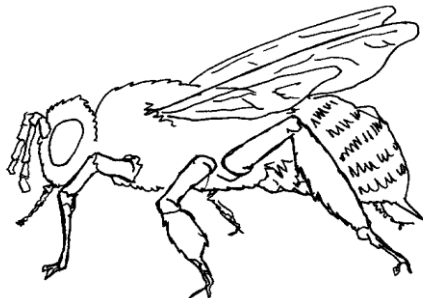
3. **Match the bee type with its job: (5 marks)**

The queen	ventilating the hive
Drone	laying eggs
Young worker	producing honey
Middle-aged worker	mating
Old worker	foraging

4. **Describe the jobs of: (3 marks)**
   a) An undertaker _____
   b) A guard _____
   c) A nurse _____

5. **Number the following statements according to their importance for humans: (3 marks)**
   _____ Bees make honey and wax.
   _____ Bees pollinate our crops.
   _____ Bees live inside a hive.

6. **Name the four stages of a honeybee's life cycle in the correct order: (4 marks)**
   1. _____
   2. _____
   3. _____
   4. _____

7. <u>Give two ways the bees can use to cool the hive down on a hot day:</u>

(2 marks)

1. _____

2. _____

8. <u>What two things attract the bees to the flowers:</u> (2 marks)

1. _____

2. _____

9. <u>Explain:</u> (6 marks)
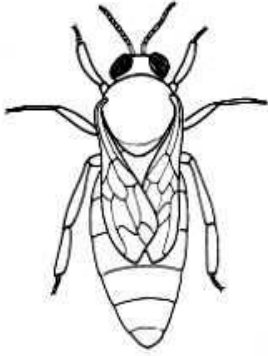
1. Why drones cannot feed themselves?

_____

2. Why worker bees force the drones out of the hive when there isn't enough food?

_____

_____

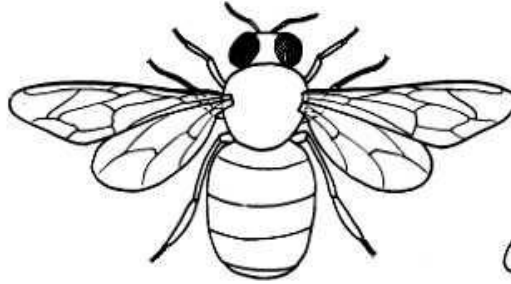3. Why bees can use their stinger only once?

_____

_____

10. **Compare and explain:** **(6 marks)**

Observe closely the eyes, wings and abdomens of the three types of bees.

Find three differences in their body structures. Explain why they differ.

| a queen | a drone | a worker |

_____

_____

_____
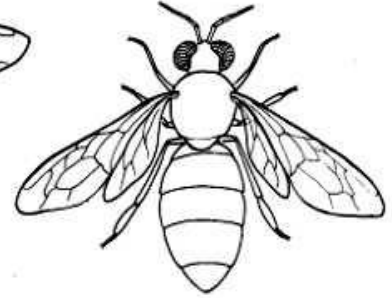
GOOD   LUCK !

Appendix 4

Post-test

Rosary Sisters School

6th grade Science test – **Honeybees** (50 marks)

Teacher: Ms. Vera Taha

Name: _____ Section: A, B, C, D

Date: _____

11. Fill in the blanks: (8 marks)

9. Insects that live & work together are called "_____ insects".

10. A group of bees is called _____ .

11. A food fed to a queen bee is called _____ .

12. A queen lays _____ eggs a day.

13. A bee's life span is about _____ days.

14. The shape of the cells in a honeycomb is _____ .

15. The fight between new queens is known as _____ .

16. A beekeeper should wear _____ .

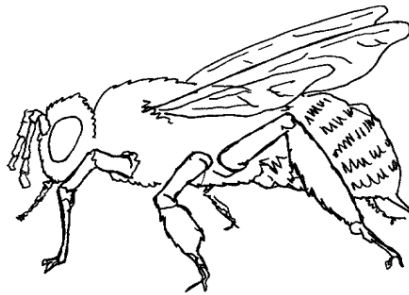**12. Identify the part of a bee which is used for: #1: protection**

(6 marks)   **#2: collection of pollen**

                                                          #3: sipping nectar

& label it using the part's name.

13. <u>Match the bee type with its job:</u> (5 marks)

The queen	ventilating the hive
Drone	laying eggs
Young worker	producing honey
Middle-aged worker	mating
Old worker	foraging

14. <u>Describe the jobs of:</u> (3 marks)

d) An undertaker _____

e) A guard _____

f) A nurse _____

15. <u>Number the following statements according to their importance for humans:</u> (3 marks)

_____ Bees make honey and wax.

_____ Bees pollinate our crops.

_____ Bees live inside a hive.

16. <u>Give two ways the bees can use to cool the hive down on a hot day:</u>

(2 marks)

1. _____

2. _____

17. <u>Think about it:</u> (7 marks)

a) Explain why each flower has a different smell.

_____

b) Discuss why insects tend to sit on you more if you wear a bright color t-shirt than if you wear a dark t-shirt.

_____

c) Predict what would have changed if there were no bees in the world.

_____

d) Every year the number of bee colonies is decreasing. Suggest a plan to increase the bee population.

_____

e) Guess what would the bees do if their queen ran out of eggs._____

f) Try to explain why it is wiser to have the hive's entrance on the bottom and not at the top.

_____

g) Imagine what changes would happen in the worker's body if it was fed a "royal jelly" instead of "bee bread".

_____

18. **Explain:** (3 marks)

1. Why drones cannot feed themselves?

_____

2. Why worker bees force the drones out of the hive when there isn't enough food?

_____

3. Why bees can use their stinger only once?

_____

19. **Calculate:** (1 mark)

In one day a bee will visit an average of 10 000 flowers. Calculate how many flowers a bee visits in her entire life.

_____

Note: This is enough to make 1/12 of a teaspoon of honey.

20. **Describe in steps what should you do in order to take a frame full of honey out of a hive.** (1 mark)

_____

_____

21. Draw a worker bee's lifecycle (1 mark)

22. A worker bee has returned from a location 100m away from the hive where she found a lot of nectar-bearing flowers. **How will she communicate this information to her sisters? Draw and explain. (4 marks)**
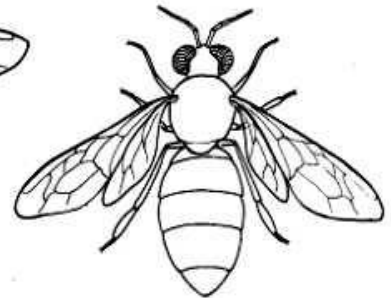
23. Compare and explain: (6 marks)

Observe closely the eyes, wings and abdomens of the three types of bees. Find three differences in their body structures. Explain why they differ.

a queen   a drone   a worker

_____

_____

_____
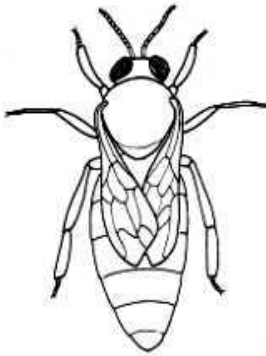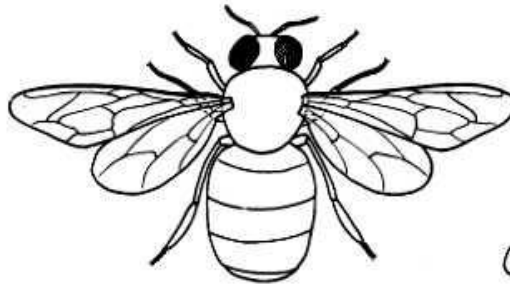
GOOD LUCK !

Appendix 5

My Journal (short version)

When I have started teaching five years ago, I have been very self-centered. I had a mentor-teacher whose lessons whose lessons I had been observing for about three months before I started teaching myself and I guess I tried to follow the same pattern of her teaching.

My primary concern was to have the class under control, regulate the activities and the pace of the lesson, give everyone a chance to participate, explain the lesson in an easily digestible way, ask good questions to check for understanding, underline the important parts of the textbook, … it was all about me and what I do in the lesson.

I had to do a lot of preparation and lesson planning. I did not know the book, so I had to read it and study it ahead of the students. When I taught from the same book next year I have started to expand more and do additional readings on the topics and deepen the information given to the students …. It was still about me and my preparations for the lesson (of course with the best intention to be a good, responsible and resourceful teacher).

With that same intention, self-improvement as a professional, I entered my master studies during my third year of practice.

Perhaps influenced by experience, but probably more due to my extended studies on new methods and methodology of teaching science, I started to question myself. Are the lessons about me or about my students' learning? My vanity was touched. Of course I have to perform well, but different. I have to strengthen the position of the students. I

have to give them more space … to think, to ask, to inquire. Even the chance to be wrong according to the saying: A person learns by her own mistakes. But most of all to be active. I thought, why should I , the teacher, do all the work, research and thinking and then serve it ready on a plate to the students? It is not me who should learn and seek information here, it is the students' turn (with help, of course).

This is the point where I have begun to reframe my idea of good teaching. I have to involve them as much as I can.

1. You learn much more if you do it yourself (i.e. with a friend in the same situation).
2. If you have to explain a new thing to somebody, you really have to understand it yourself first.
3. If you search for it and explain it to others, you won't forget it.

The shift of responsibility for learning and teaching from the teacher, me, to the students became my new line of thinking. Here had started the idea of jigsaw.

During my fourth year of teaching I started to use the jigsaw method. It was very exciting! For both my students and me.

As for students:

1. They welcomed the change and the challenge. It was like a game for them.
2. They liked the special seating in science lessons (in small circles of 5).
3. They didn't have to listen to me all the time but the task was up to them.
   (I also think they cared very much to impress me with their work. I tend to be friendly with my students and I guess they tried hard not to disappoint me.)

4. They felt proud of themselves seeing the outcome of their work in form of printed notes and worksheets will actually be used for teaching others and study materials for the final exam.

   (I think they were amazed and surprised at what they are capable of doing.)

   (I have often heard them saying: "Please, teacher, just give us a few more minutes to finish this", when the lesson was over.)

5. The students that learn and understand a new thing quickly, enjoyed the responsibility, and possibly the show off while explaining the material to their peers in the expert group.

And later everyone enjoyed being an expert on their topic in the home group. They all loved the attention they got while taking the whole lesson explaining their topic to peers who heard the things for the first time and had a lot of questions.

As a teacher:

1. I was busy moving around the expert groups, giving advice or a little explanation here and there (not to be forgotten English is a foreign language for my students and all the materials we use are in English), checking the progress, involvement of all members, patience and friendly approach to each other.

2. I helped to check the final products (notes, worksheets) for completeness, correct grammar and organization before printing and distribution.

3. I was responsible for correction of the worksheets (after each lesson) – a lot of work, but it had shown in the exam. It is good to check for comprehension after each lesson.

4. During the home groups' stage – experts explaining, I have just moved around to listen randomly to each group to see all went on smoothly.

5. Students had some collective grades (for cooperation, notes and worksheet preparation) and some individual (explaining, filling in the worksheets and final exam).

Conclusion:

1. Everybody, even the shy and inactive students, participated in the expert group and most of all had a full attention in the home group during their explanations.
2. Lower-achieving students received a great push-up by their peers on the team work and gained higher self-esteem by their work in the home group which was reflected in their higher grades in that semester, plus no one failed in science during jigsaw, presumably due to the shared grades push.
3. Some of the usually higher-achieving students have complained that they have been pulled down by the group and that they had to spent a lot of effort teaching some of their peers. *The change in grades was minimal. *the effort was "healthy" for them ☺
4. Many of my colleagues, seeing the excitement of my students, have asked me what was it that we were doing in science, and have expressed interest in trying the method in other subjects too.

I felt like a winner! – Students doing better in science. – Colleagues being interested and excited. – Me having my lessons going on even when I was absent and nobody missed me!

They did it!! (Not me!)   Goal achieved!

My fifth year of teaching and final year of my studying, I decided to use the jigsaw experience as a topic of my thesis. I want to let people know how have I reached there and what difference has it made for my students.

My school is very traditional in every way. Things have their way of how they're done, the way they have always been done. Teachers are traditional too. They are very responsible and take their work seriously. The book has to be covered from cover to cover and regular written examination has to be done. My colleagues are always stressed, especially the last two years when our working load had been increased to the top of our capacity (30 lessons a week). We are all tired. I have an advantage that my subject is extracurricular and it is not one of my objectives to cover the whole book. In the beginning of my teaching I have always cared that my students understood all that was written in the book before I moved to the next unit. But for the last two years I actually take the book kind of as a guide for the topics that we should explore in the class and care more if the students understood the main concepts. Maybe this had started from my boredom of teaching for the fourth and fifth time the same thing (the book hasn't changed) but it became very interesting for various reasons. When using different sources of information (encyclopedias, computer educational programs, movies, internet) and different strategies (inquiry, games, small groups, art) not only the lessons become more interesting for both me and my students but also I learn more myself, my students are excited about science lessons considering them kind of a game and welcomed change to their routine. I like to address multiple aspects of my students' work (different projects, making posters, reports, presentations, lab work, activities). Nevertheless, the school is pushing me to give exams at regular intervals as if only this written examination

based on specific pages in the book counted as data to evaluate students' achievement. Sometime I tell them (the management and my supervisor) that hat we are in the middle of a project and that I have enough grades at the moment but they insist we have to have an exam too. Sometimes it seems to me that my projects and ideas are tolerated simply for the fact that I am the only foreign teacher in the school so I am perceived differently/weird. Weird in a way that I bother with activities that take a lot of preparation and extra time and extra nerves (kids are not used to it and need a lot of organizing to e.g. rearrange seating in the class or work with a microscope) and at the end what the school looks at is the exam only. My colleagues often tell me: "Good for you that you can do it" or "How come you are always in a good mood? What's there to be happy about?" or "You're crazy you gave the students your email address, they won't leave you alone now." It feels as if students were some kind of nuisance or enemies. The truth is that ones you get to know them better, they are just fine and interesting. How come you don't look that way at friends' or neighbors' or your own children? The difference is that you know them better. I teach 450 students and I am often frustrated that having them for just two lessons a week I do not have the chance to know them as well as I would like to. I have discovered that the jigsaw is perfect for me as a teacher (apart from the benefits for the students) because I can rotate among small groups of students which gives me a much better picture of who they are among their friends, feeling free to talk, someone the leader, someone the negotiator in arguments, someone the artist, someone the joker making a god atmosphere, other always unsatisfied – ready to make trouble. In the whole class (30 students) it is sometimes easy to overlook students who do not want to be seen. Some kids participate actively and enjoy being the center of attention or even show off. Some know the answer to what I am asking but don't want to talk in front of

everybody. Some don't know and want to act invisible so that I wouldn't ask them. Even though I always encourage questions from students, sometimes kids get laughed at from others if their question seems silly at first. It is much different in small groups. Groups are more intimate and it feels better for the girls to ask anything. It might be also because I am out of picture so they don't feel authority and judgment.

Sometimes I feel that I am fighting against too much. Most of my students have been in this school since kindergarten and are much used to the system of learning by memorizing and working hard just to get good grades. Once I asked in a class: "Why do you study?" Only two girls said to learn something new. All answered to get high grades in an exam. Last year I tried an experiment in the 6th grade. I gave them a pop-exam from a unit we finished three months ago. Out of 120 students, all but 8 got a grade below 60/100. It was a shock for me and I felt a failure. I was almost ready to quit my job. I didn't teach them anything. Nothing that sticks! It was an eye-opener for me. This is when I started with jigsaw. They have to be involved! They have to reach the knowledge they have as a process they go through, not as information I give them and soon they forget it. In order to remember what they learn, they have to discover it – search internet, ask friends, consult with peers, explain to others, reassure each other of the correctness of their findings in a group discussion. They have to be involved!

Actually, it would be interesting to find out what does the last year's jigsaw group remember about honeybees. ☺

Appendix 6

Questions about teacher's beliefs prior to the experiment

Guidelines for writing case study
Description of knowledge and beliefs

A) The aims of education and the role of teacher

I want my students to find interest in science. I want to reach a point where we can discuss issues and concepts, for now I think very few of my students learn with understanding, their main motivation are their grades. I am looking for ways to change that.

2. What is the most important second goal for you?

I would like to find a strategy which would enable me to pay more attention to the less active or shy students which is very difficult in the large number of students I teach. I want to know the students better (their skills, interests) to accommodate their individual needs better.

3. Are there other important goals?

I would like to extend the book material (the subject matter) to connect it more to our everyday lives and also make a step further as compared to the previous years – not just to teach the *what* contained in our science book but also the *how* and *why* which are often missing and I think would promote thinking and deeper understanding.

4. Do you feel you're meeting these goals? Why? What do you need to achieve it?

I think that I am doing a good job increasing my students' interest in science by bringing interesting questions to start discussions, and challenges, usually in a form of bonuses and external searches (internet, encyclopedias) or science projects combined with art (e.g. posters) but I still feel that the main motivation are the exam grades, and short term recall kind of memory rather than understanding is characteristic of most of the students. I need for the students to gain their knowledge through a process which will be "unforgettable" for them because they will have to work hard for it. And I need to work with smaller groups of students so no one is overlooked.

5. Are there other important goals but you did not mention because you do not work to

achieve them? What are they? Why do you find them difficult? What do you need to achieve them?

6. The following table shows some of the goals in science education. Select the most important 3-5 goals as you think and arrange them as priority.

1. Knowledge of ideas and important concepts in science.

2. The development of scientific thinking skills (observation, measuring, formulating hypotheses and testing, etc.).

3. Develop critical thinking skills and creativity.

Goals of Science Education

• Knowledge of ideas and important concepts in science.
• The development of scientific thinking skills (observation, measuring, formulating hypotheses and testing, etc.).
• The application of science and uses in scientific fields and in life.
• The development of manual skills / technical-related science and technology.
• Show positive attitudes towards science and scientists.
• The adoption of scientific attitudes (the secretariat for the intellectual, rational, objective, etc.).
• The development of tendencies toward the practice of scientific activities or exercise science-related career.
• Understand the nature of knowledge and scientific research.
• Understand relations between science, technology and society.
• Develop critical thinking skills and creativity.
• To develop skills and healthy habits.
• The development of trends for the preservation of the environment.
• The development of social awareness (use of science for the benefit of society and human service, develop a sense of belonging to society and the development of the tendency to participate in community development, etc.).
• Develop the ability to make decisions.
• Develop the ability of self-learning.

7. What is your role as a teacher? Explain.

I plan the lessons and activities, I explain, I ask questions to get students to think of things differently, I address misconceptions, I encourage students to participate and ask a lot of questions even if they think

they might sound silly, I treat students with dignity and respect.

B) **Beliefs about learning**

1. When teaching a new idea or concept to students, what do you do to help students absorb the new concept? Give examples.

I try to relate it to something they already know, perhaps by the use of metaphors. For example, when we learn that diffusion is the movement of materials from a place with higher concentration to a place with lower concentration, as is the case of nutrients moving from the blood stream to the cells across the cell membranes after we eat, I could say something like: "Imagine Jana has five shekels and Jana's father has five thousand shekels. Who is going to give money to whom?" They laugh and say: "Father gives to Jana". And I say: "Yes – from a high concentration of money to a low concentration of money just like the nutrients move from high concentration in the blood to a low concentration in cells". It helps the students to remember, because they understand the concept. Or experiments and observation, e.g. when we were learn about parachutes, I might initiate the lesson by taking students to the terrace and throw some plastic figures down. First one without a parachute, second with a parachute, then the two simultaneously, and have the students observe the falls and describe and try to explain what they see.

2. To what extent you use models, analogies, examples, activities. Why?

I use models if I have them. I use analogies and examples frequently because I think it helps the students to relate to what they already know. I do hands-on activities more with the younger children (third and fourth grades) and I tend to do more lecturing with the older students (fifth and sixth grades). The older students' activities may be in form of presenting new, extra information they have found on the internet or sometimes laboratory work.

3. Why is it important to know what students know about the subject? Why?

To address misconceptions and build on what they know rather speaking of something that confuses them. And also not to bore them in case they know more than expected.

4. How do you know what they know? How does this affect your learning?

I don't know until I ask them. Sometimes they might become so curious and come up with such fascinating questions; I might not know the answers. Then I suggest we both look for the answers

and continue the discussion next time. While looking for the answers, I usually browse into other interesting information and learn a lot of new things. I often learn from the information the students bring in. They often employ their parents too. I have learned that students may be a great source of information.

5. Do you sometimes find that you are compelled to change the ideas of students about a particular subject? How do you do it? Give examples.

First of all, I never want my students to feel embarrassed about their ideas. I might try to ask them a question which they cannot answer and either they realize their mistake or I can ask prompting questions and lead them to see the problem from a new angle.

6. When explaining something students do not understand exactly what you want, what in your opinion you think the reason is? What happens in the minds of these students?

Either they cannot link it to anything they know, so they don't understand, or I am not explaining myself clearly, or their language capacity is inadequate (they learn in a foreign language). Some might work hard with me to understand and start to ask a lot of questions and most probably lose interest in the lesson.

C) Beliefs about knowledge

1. What is knowledge in your opinion? What is the goal of scientific activity?

The repertoire of things we know and are able to transfer into new situations. The goal of scientific activity is to find new discoveries to improve the quality of our lives.

2. How do you define your specialty?

My interest has always been in the living creatures (their structure and function, and comparison – similarities and differences) and their relationship to the environment. I am also deeply interested in ecological concepts and interactions.

3. What does the content of scientific knowledge contain from?

Tentative theories.

4. What is the scientific research method formed of?

Formulation of hypothesis, prediction, observation, testing hypothesis, and formulating theories.

5. To what degree the scientific knowledge is objective? Explain.

It is objective until somebody can prove it is not. E.g. it was generally accepted that, according to Einstein, the highest speed was the speed of light, until recently it was proven that some part of an atom is faster.

6. How is the scientific knowledge developed?

Some scientists may intentionally search for a specific thing, e.g. a cure for cancer, and sometimes new discoveries may be done "accidentally".

7. To what degree is the scientific knowledge stabled?

Until it can be proven wrong.

8. To what degree is the scientific knowledge changeable?

Until new discoveries are made that bring a better but altered understanding of the phenomena.

D) Pedagogical / Knowledge

1. How will you teach this subject? (honeybees)

I will take my students to a Natural History museum where they have an extended exhibition about bees with a guide and hands-on activities. This will serve as an introduction to the topic. Then I will use two teaching methods, the jigsaw and traditional lecturing, to explore which one will bring better outcomes.

2. Do you expect to face difficulties in teaching this subject? Explain

Students are not used to hold responsibility for acquiring new information by themselves nor working in small groups. It may take some time for them to constructively divide forces among themselves in the jigsaw groups and cooperate successfully.

3. What are the examples and the extent of the activities that can be used? Explain

In jigsaw, students study the material, search for additional information, teach each other within the group, prepare a report and a worksheet, and after the switch, each student gets the chance to explain his part. Graphical design of the written parts, correctness and completeness of the information are also a part of the project.

4. What do you expect students to know about it?

At minimum, they should know that bees are a social insect living in colonies; they pollinate flowers and make honey.

5. Do you expect them to carry concepts or ideas that are not accurate or wrong on the subject? Explain

I suspect the students think that pollination is only important to the flowers, and do not realize that people also depend greatly for their nutrition on bees.

6. What are the purposes or objectives that this subject can serve?

We can study bees as for their body structure and function. From the biological point of view they are social insects living in well organized groups with well developed communication and survival skills. From an ecological point of view, we have seen a great depopulation of bees probably due to extensive use of pesticides and cutting of forested areas. From a nutritional point of view, about one third of food we eat needs insect pollinators. Finally, from an economical point of view, beekeeping plays an important role in agriculture.

Students should realize the connections between seemingly unimportant insects that may bother them when playing on the grass and the importance of all the above mentioned points for human life.

Students should think ecologically in terms of making decisions about things like eating fruits which are not perfect but organic over extensive usage of pesticides, or deciding what kinds of plants to grow in their gardens (bee-friendly flowering plants over polished lawns with no flowers).

Appendix 7

Questions about teacher's beliefs after the experiment

Guidelines for writing case study
Description of knowledge and beliefs

A) The aims of education and the role of teacher

1. What is the most important goal for you as a science teacher?

Probably to show my students that science is interesting, it is fun and it is a part of our everyday life which they sometimes do not realize. My goal is to awake my students' curiosity about the world around us, look for how things are related, and realize how we too are a small part, even though with a large influence, of this great apparatus.

2. What is the most important second goal for you?

My second goal is to teach with understanding. I do not mind sometimes to change my plans for the lesson, or even not to complete all the units in the book, when students' interests and constructive questions sway us in a different direction, or make us look into a problem of the students' interest deeper, using more resources and time.

3. Are there other important goals?

I do my best to include all students in the lesson. I have no illusions that everyone loves science but I believe that there is a way to reach all students to participate in some way.

4. Do you feel you're meeting these goals? Why? What do you need to achieve it?

I find the easiest way to make my students curious is to relate to something they already know and then bring some new aspect to it, something they haven't realized before. Students with interest in science often like challenges, things they have to search for, feel that they have achieved it. Some students find language barrier, I teach science in English to Arab students, some need more visual aid (posters, movies), some more practical exercises (labs, guided museum visits), some need arts (drawing).

The hardest goal to achieve is understanding. The jigsaw is more time-consuming but it accommodates the goal of learning with understanding. My students like to memorize, which may be good for facts acquisition but not for e.g. analyzing, comparing, or concluding. I find the best way to help them understand and ask the right questions that will help understanding is to leave

part of the responsibility learning on them, or even to have them teach a part of the subject matter to others.

5. Are there other important goals but you did not mention because you do not work to achieve them? What are they? Why do you find them difficult? What do you need to achieve them?
6. The following table shows some of the goals in science education. Select the most important

3-5 goals as you think and arrange them as priority.

1. Knowledge of ideas and important concepts in science.
2. The adoption of scientific attitudes (the secretariat for the intellectual, rational, objective, etc.).
3. Develop the ability of self-learning.
4. Show positive attitudes towards science and scientists.
5. The development of trends for the preservation of the environment.

Goals of Science Education

• Knowledge of ideas and important concepts in science.
• The development of scientific thinking skills (observation, measuring, formulating hypotheses and testing, etc.).
• The application of science and uses in scientific fields and in life.
• The development of manual skills / technical-related science and technology.
• Show positive attitudes towards science and scientists.
• The adoption of scientific attitudes (the secretariat for the intellectual, rational, objective, etc.).
• The development of tendencies toward the practice of scientific activities or exercise science-related career.
• Understand the nature of knowledge and scientific research.
• Understand relations between science, technology and society.
• Develop critical thinking skills and creativity.
• To develop skills and healthy habits.
• The development of trends for the preservation of the environment.
• The development of social awareness (use of science for the benefit of society and human service, develop a sense of belonging to society and the development of the tendency to participate in community development, etc.).
• Develop the ability to make decisions.
• Develop the ability of self-learning.

7. What is your role as a teacher? Explain.

I would like to offer my students some of my knowledge and enthusiasm for science to serve as an opening gate for their further study, awaken interest in the world around us, observation of the interactions and relationships between living and non-living things, and perhaps making science their future occupation. I would like to provide my students with positive attitudes and useful tools for their further successful studying. After the jigsaw experience, I also believe that students are highly capable of learning by themselves, discovering knowledge with their peers, if they are guided properly and their progress is monitored and feedback provided. So this should be my new role as a teacher; give students more independence to make their learning a process in which I am an advisor or a guide.

B) Beliefs about learning

1. When teaching a new idea or concept to students, what do you do to help students absorb the new concept? Give examples.

I usually try to relate to something they know, or are capable of imagining.

E.g. When learning about the idea of non-renewable sources of energy being exhausted in the next couple of decades … I let students imagine and describe how would our life look like if we had no petrol, no electricity, etc. They usually say things like we would go back to horses and carriages, use candle sticks for light, etc. and then they realize there would be no computer, no TV, no MP3, and become uncomfortable with the idea. At this moment I bring up the idea of renewable sources of energy, or alternative sources of energy being developed, since we already know our main sources of energy used today are limited. Students then draw and explain their inventions of solar and other machines based on alternative power sources. Students realize that in a limited way we already use sun to heat water, dams and wind turbines to make electricity, etc. Only the next lesson we start to read from the book, explain, look at pictures.

2. To what extent you use models, analogies, examples, activities. Why?

I use examples and analogies all the time. I find them the easiest to relate to students and help them understand. I use models when available. I try to use a lot of activities (lab work, group work, field trips, movies, research, presentations, drawing, computer activities, collecting recyclables, etc.) but often those activities are disrupted by low discipline and high number of students in class/group.

I am often being laughed at by my colleagues as being young and enthusiastic if I bother with extra activities, but I believe that those practical experiences will help my students to understand and be willing to learn more.

3. Why is it important to know what students know about the subject? Why?

Because it is easier to build if you know what the basis you are building on are.

4. How do you know what they know? How does this affect your learning?

I usually try to start each new chapter with a discussion or open-ended question to find out what my students already may know about the topic before I explain anything. I encourage students to talk even if they may be wrong. We are learning, it is not a shame to be mistaken.

Sometimes I found out that their knowledge is higher than I have expected, so we may pass some parts faster, sometimes I found out they have misconceptions about the topic, and sometimes they ask a question I do not have an immediate answer for and I have to look for it in books or other resources.

5. Do you sometimes find that you are compelled to change the ideas of students about a particular subject? How do you do it? Give examples.

I teach young students who do not often have strongly formed ideas about science. But for example, in the 4th grade we spend an entire semester talking about invertebrates which many of the students find disgusting and useless, so I try to expand the book which teaches mainly about the form and function of insects, for example, and expend it by teaching about the purpose and importance of insects for humans, atmosphere, food chains, etc.

Some other times, I do not try to change students' ideas about a particular topic but rather offer a different point of view. E.g. in teaching about evolution, 6th grade. It is impossible to decide whether religious or scientific point of view is correct, so we just see what each one has to say and everyone can decide for himself what he believes without judgment.

6. When explaining something students do not understand exactly what you want, why in your opinion you think the reason is? What happens in the minds of these students?

Different reasons; not enough bases to built on, time pressure and taking the subject too fast, not using aids to reach students using different senses, little practice, use of higher level language than they can comprehend, …

Some students then probably become uninvolved and bored, others panicked and nervous.

C) Beliefs about knowledge

1. What is knowledge in your opinion? What is the goal of scientific activity?

General knowledge is the sum of all proven discoveries the mankind had made which is subject to change over time if new discoveries are made.

Individual knowledge is the repertoire of information and experience a person possesses and is capable of using.

The goal of scientific activity should be a discovery.

2. How do you define your specialty?

My field of interest is biology. Biology studies the function, relationships and interactions of living thing within themselves and with their environment.

3. What does the content of scientific knowledge contain from?

Scientific knowledge should contain facts, ability to analyze, compare, prove, disprove, hypothesize, synthesize, and conclude.

4. What is the scientific research methods formed of?

Scientific research methods are formed of a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. It is a method of procedure consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.

5. To what degree the scientific knowledge is objective? Explain.

As long as nobody can prove it wrong, it is objective.

6. How is the scientific knowledge developed?

Over a period of time, scientific knowledge develops due to the use of new technology (instruments, media) and discovery of new evidence (e.g. the 10th planet).

7. To what degree is the scientific knowledge stabled?

Perhaps facts like determining the range of age of our planet or Newton's laws can be considered stable but most subjects are opened. What was considered crystal clear a hundred years ago is a history today. There were times people could not imagine driving or flying or talking on the phone, sending emails or using the internet or even using antibiotics which seems normal to every little child today as well as we cannot imagine telepathic communication or translocation today which may be normal for the next generations. We do not even know what three quarters of our own brains serve for.

8. To what degree is the scientific knowledge changeable?
Scientific knowledge is true until new evidence emerges that proves it wrong or incomplete.

Appendix 8

DVD disc containing selected video recorded scenes of the lessons