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EXTENDED SUMMARY

Psychological factors related to the efficiency of a Neuroscience Motifs-Based Teacher Training program in the area of Special Education in Israel

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CHAPTER 1: LITERATURE REVIEW

The chapter summarizes a broad spectrum of literature which underpins the theories used for this research and the key concepts of the field. The theoretical review presented below pertains to four main issues that constitute the grounds for this research and which created the conceptual framework of the thesis. This chapter also reviews theories and models about the thesis subjects in general and in relation to special education. After presenting the main research field of Neuroeducation (NE), the review will continue to the theoretical foundation for this study, which is based on the constructs of Information Processing Theory, Social Cognitive Theory and Social Psychology.

1.1 Neuroeducation: definitions and development

Neuroeducation (NE) is defined as a growing interdisciplinary field based on the synergic connection between neuroscience, cognitive science, psychology and education in an effort to improve the theoretical and practical understanding of learning and education (Devonshire & Dommett, 2010; Nouri, 2013; Rodgers, 2015). This field draws attention to the potential practical implications of neuroscience research for educational contexts, and represents the intersection of education with neuroscience and the cognitive and developmental sciences, among other fields, in order to develop evidence-based recommendations for teaching and learning (Fischer, Goswami, & Geake, 2010; Macdonald, Germine, Anderson, Christodoulou, & McGrath, 2017). This emerging field has garnered growing interest (i.e., Carew and Magsamen, 2010; Sigman, Peña, Goldin, & Ribeiro, 2014), and its main purposes are: to obtain a better understanding of how we learn, to improve our theoretical understanding of learning and education, to develop teaching methods and programs for learning strategies, and to outline educational policies (Nouri, 2013). All these purposes, according to NE studies, must be scientifically based on empirical findings (Busso & Pollack, 2015; Hardiman, 2012b).

For many years, neuroscience and education proceeded on independent tracks. However, in the last few years it seems that there are attempts to connect these research streams. NE began as a cross-disciplinary venture between cognitive neuroscience and developmental psychology, and then it reached beyond these parameters to integrate education via educational psychology and educational neuroscience (Tokuhama-Espinosa, 2011). The potential of NE to succeed as a field according to Schwartz and Gerlach (2011) resides in its ability to generate new ways of understanding and solving educational problems by employing the perspectives of other disciplines such as genetics or neuroscience. Those neuroeducators who understand educational perspectives can design their own studies, regarding educational issues and challenges (Nouri, 2016). Despite being a relatively new domain, NE has already triggered important dialogues between teachers, pedagogy, parents and brain scientists, while examining the complex relationship between a combination of findings from neuroscience, education and pedagogy (Carew & Magsanam, 2010).

1.1.1 Neuroeducation and Special Education

Kosaraju, Gorman & Berry (2014) claim that research in neuroscience may have profound implications for individuals with disabilities in terms of addressing their functionality at multiple levels. Scientists are now investigating a biological basis for neurodevelopmental disabilities, such as autism, attention-deficit hyperactivity disorder (ADHD) and dyslexia. Training special education teachers in evidence-based practices has become highly important as the number of students diagnosed with special needs is increasing (Boomgard, 2013). Teachers of early elementary classrooms are more and more in need of strategies for children with special needs, and NE brings much hope to the field, creating growth-promoting classrooms that are language rich, emotionally rich and steeped in play (Hassinger-Das, Hirsch-Pasek, & Golinkoff, 2017).

1.1.2 Criticism on Neuroeducation

The field of NE was not always accepted with open arms. In 1997, Bruer published a paper called "A Bridge Too Far", in which he argued that at the time the paper was written, neuroscience was not able to guide educational practice and had little to offer teachers in terms of informing classroom practice. Along the years, several researchers supported this claim (Bowers 2016; De-Vos, 2015). The understanding of brain function acquired from the framework of neuroscience, and especially in the framework of cognitive neuroscience, can be assimilated into and useful to educational thinking. However, the adoption of this knowledge should be done carefully and be based on solid evidence, in order to avoid the creation of wrong concepts and neuro-myths.

1.1.3 Neuroeducation in Israel

There is a growing interest in the NE field in research and publications in Israel, mainly since 2006. The field of NE is rapidly growing in the last few years in teaching and research, and almost every university in Israel has courses related to that field directly or indirectly. However, few publications on this topic were seen in Hebrew. In 2016, a College of Education in Israel published its model for NE in a seminar and special publication (Achva Model of Neuropedagogy, 2016). The Achva College created a special center of neuropedagogy, in which its main purpose was to make the connection between neuroscience and education in teaching. So far, their program was tested on a few students in a master degree only or an elective course for in-service teachers. In other colleges of education, it is possible to find some elective courses and seminars on the topic of NE, but the topic is almost always presented in a set curriculum, and not implemented in other courses.

1.2 NE Theories and Models

Neuroeducational studies have gained significant advancements over the two last decades, however not much attention was dedicated to discussing the theoretical issues in the field. The theoretical foundation of NE has been borrowed from other disciplines such as psychology and cognitive sciences. However, there is no single theory dominating the field, and the application of a particular theory or theoretical approach to research perhaps depends upon the ontological and epistemological assumptions that reflect the researcher's interests and way of thinking. Therefore, a great deal of efforts and resources need to be dedicated to systematically define the nature of theory and theorizing in the field (Nouri, 2016).

1.2.1 Model of Levels of Development (Tommerdahl, 2010)

This model describes the connections between different fields included in the term *neuroeducation*, and tries to bridge the gap between neuroscience and education. In her article, Tommerdahl (2010) presents a model with five stages of knowledge (neurosciences, cognitive neurosciences, psychological mechanisms, educational theory and the classroom). Each stage, and the connection between the stages, has the potential to contribute to new teaching methodologies. The downward and upward connections between the levels might lead to greater communication between neuroscientists, educators and educational researchers, to achieve a common language to generate future research questions and translate research into educational practice.

1.2.2 A Middle Ground Neuroeducational Theory (Anderson, 2014)

Anderson (2014) referred to the lack of a neuroeducational theory and suggested that such a theory will be a coherent synthesis of current interdisciplinary scientific and socio-cognitive research findings generating into a strong theory that explains and predicts human learning, particularly meaningful learning as occurs in academic settings. The interdisciplinary sources that may contribute to a NE theory include neuroscientific knowledge of total brain/organismic level functions, socio-emotional-cognitive human functioning, and educational theory of best practices in various learning venues, including emerging digital learning environments.

1.2.3 The Neuroeducation Translational (NET) Research Model (Kosaraju, Gorman & Berry, 2014)

Kosaraju, Gorman & Berry (2014) suggested a re-conceptualized model of translational research for special education, specifically for neurodevelopmental disorders. It includes four phases to communicate

neuroscience research findings to educators for informing special education practice: (1) connecting knowledge gained from neuroscientific studies to intervention research; (2) developing pilot studies for educational settings based on intervention results; (3) expanding pilot studies to conduct larger cross-sectional, or longitudinal studies that bring neuroscience findings to teaching practice; and (4) integrating successful NE practices and foundational neuroscience knowledge to improve professional development, teacher preparation programs, and special education policies. The NET model involves multiple disciplines working collaboratively to undertake the common problem of translating neuroscientific research to enhance special education practices.

1.2.4 The Brain Targeted Teaching Model, BTT (Hardiman, 2012a, 2012b)

Hardiman (2012 a, b) focused on principles in the NE field with can be translated into classroom practice. The Brain – Targeted Teaching (BTT) Model is an instructional framework, aiming to assist educator in planning, implementing and assessing a program of instruction informed by research in neuro and cognitive sciences. The basis of the model is to bring relevant research from the brain sciences to educators through a pedagogical framework, and to provide teachers with a cohesive structure for interpreting research findings from the neuro and cognitive sciences and applying them to their own practice. Among the suggested issues in the BTT are: Establishing the emotional climate for learning; creating the physical learning environment and teaching for the extension and application of knowledge - creativity and innovation in education.

1.3 The Information Processing Theory

The Information Processing Theory (IPT) is actually not a single theory, but a framework characterizing a large number of research programs. Information processing investigators study the flow of information through the cognitive system. The main interest of this theory, thus, is in analyzing the operation of the processing system in particular situations while they occur. In order to describe these operations, several concepts and frames from computer sciences are being used. According to this theory, the student is like a computer, because he or she inputs information, saves it, and outputs the information (Miller, 2011). This theory can be connected to NE, since researchers from the information processing field look for the neural basis of information processing, executive functions and learning. They break down tasks or behaviors into their simple components, and then posit ways that children learn to integrate these skills into an organized, well- functioning system. Two main concepts related to this theory were chosen as core concepts for the NMTTP: Learning in context and metacognition.

1.4 Learning in context

Context is a setting in which a target (e.g. a learning material) is presented or found (Koens, Mann, Custers & Ten Cate, 2005). In an educational sense, the context can be conceived as the environment in which students are taught. In most real-life learning environments, what is learned has meaning for the learner, and is interpreted in terms of his/her accumulated prior knowledge and experience. According to Hardiman (2012b), we use prior knowledge to categorize stimuli and combine this prior knowledge with new knowledge to create patterns of thinking and learning. Koens et al (2005) in their model of "Dimensions of Context" explained this concept by saying that multiple associations increase the chance that a child can recall an item he learned. In this doctoral thesis, learning in context refers to the connection between prior knowledge of the learner and the new information in the context, which can be used to perform the learning task. The importance of learning in context is supported by recent neuroimaging research that provides biological support for many of the findings in information processing, in terms of memory consolidation for example. Information is thought to be stored in memory by the creation of knowledge structures called semantic networks (Bergman et al, 2015).

1.5 Metacognition in Learning and Teaching

Metacognition is defined as "thinking about thinking" or the process of considering and regulating one's own learning and thinking processes (Tokuhama- Espinosa, 2011; Young & Fry 2008). It refers to the ability of a person to rethink his thinking, steer his cognitive process in correspondence to his conclusions, and to monitor and control his cognitive processes (Goswami, 2008). In educational contexts, metacognition is used to explain the process by which students and teachers learn to understand their thinking, with the notion that regulating their thinking effectively will make them better learners (Jiang et al, 2016). Since the early days of studying metacognition, metacognitive training and instruction were shown to have positive effects on children's performance in diverse fields such as reading, mathematics and problem solving (Zohar & Barzilai, 2013). The metacognitive instructions are followed by metacognitive strategies, which include thinking about how to execute specific cognitive actions, such as planning, adjusting and evaluation. Within the concept of metacognitive strategies, the term "Metacognitive Reading Strategies" (MRS) refers to intentional and directed cognitive activities that readers can use to monitor, control, and evaluate meaning made in the reading process (Alexander & Jetton, 2000; in Bergey, Deacon, & Parrila, 2017; Chevalier, Parrila, Ritchie & Deacon, 2017).

1.5.1 NE and metacognition

Functional magnetic resonance imaging (f-MRI) and ERP are used in recent years to study higher level comprehension processes that provide evidence of comprehension monitoring. The use of metacognitive strategies elicits different neural activation patterns than the use of strategies involving less cognitive effort (Moss, Schunn, Schneider & McNamara, 2013). Baker, Zeliger- Kandasamy & DeWyngaert (2014) described neuroimaging evidences of comprehension monitoring in reading. Of particular interest in the imaging data were regions of the brain involved in executive control, associated with the application of the strategies, and regions involved in higher level comprehension processes. Apparently, two strategies, which require more cognitive effort (self-explanation and paraphrasing vs. only re-reading), were associated with greater activation of the control network (Baker, Zeliger-Kandasamy & DeWyngaert, 2014).

1.6 Social Learning Theory

This theory integrates behavioral and cognitive theories of learning in order to provide a comprehensive model that could account for the wide range of learning experiences that occur in the real world. The theory focuses on processes of change and the main characteristics of it, and according to Miller (2016), are the centrality of observational learning, a causal model that involves a triadic of environment – person - behavior system, which is a cognitive contribution to learning and self-efficacy. Bandura (1977) believes that learning from others is a key variable in an individual's growth process and that human behavior is an ongoing, reciprocal interaction between cognitive, behavioral, and environmental determinants.

1.6.1 Self- Efficacy and Teacher Self-Efficacy

Among the self-influence factors mentioned by Bandura, self-efficacy is a major component and refers to an individual's judgement of his capabilities to organize and execute courses of action required to achieve desired performances (Bandura, 1997, in Honicke & Broadbent, 2016). Another definition of self-efficacy is the individual's perception of his competence in dealing with his environment and exercising influence over events that affect his life (Bandura, 1977, *apud* Miller, 2011). It is a task-specific belief that regulates choice, effort, and persistence and is in concert with the emotional state of the individual (Bray-Clark & Bates, 2003). Self-efficacy has been demonstrated to be a strong predictor of both current behavior and the effects of treatments on behavior change (Ferreira, 2013). Social cognitive theory and self-efficacy theory are the underlying theoretical frameworks on which the study of teacher self-efficacy is based. The concept of "self-efficacy" can be expanded to "teacher self-efficacy" (TSE), which refers to teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teacher task in a particular context (Tschannen-Moran & Hoy, 2001). Within the context of teaching, self-efficacy and its influences are viewed as important factors on teacher performance and student learning, which establishes ways to connect and support teachers in various contexts of their work as well as in

professional learning environments (Boomgard, 2013). A vast amount of research points at the central role of TSE in teaching competence and teaching effectiveness (e.g., Tschannen-Moran & Hoy, 2001; Van-Dinther, Dochy & Segers, 2015). TSE has been also linked to use of innovative teaching strategies for teachers in general education classrooms (Tschannen-Moran & Woolfolk Hoy, 2001).

Hoy & Spero (2005) indicate that TSE may be most malleable during teacher preparation and during the first years of teaching. Thus, it is important to pay attention to the development of a strong sense of efficacy among novice teachers and PSTs. Bandura (1997) also referred to PSTs and stated that their self-efficacy is most pliable at an early stage of the learning process. Although there is evidence that teacher PSTs self-efficacy increases during standard teacher training programs (Hoy & Spero, 2005), it is still largely unclear if and how PSTs change their self-efficacy to implement motifs from a new field of knowledge after a training program.

1.6.2 Self- Efficacy and NE

According to Murphy (2017), research on self-efficacy has implications for the advancement of NE, because, as Holzberger, Philipp, and Kunter (2013) noted, there is a reciprocal relationship between teachers' self-efficacy and their instructional quality. Since teachers' self-efficacy impacts their motivation, planning, and competency, and in turn influences behavior (Bandura, 1977), it impacts teachers' performance (Tschannen-Moran & Hoy, 1998). In this case, it may have implications for the advancement of NE. Changing teachers' practices takes time and requires ongoing professional development and support (Tunks & Weller, 2009). According to Tunks and Weller (2009), implementation of an innovation increases significantly when accompanied by continuing, regular support. Thus, there is merit to the idea that adoption and diffusion of an innovation or practice is tied to self-efficacy.

Since NE is a relatively new discipline, there is a gap in the research between NE as a broader discipline and how it infiltrates the school setting, or specifically how motifs from the NE field are implemented in the classroom. Moreover, we consider that it is essential to explore how educators apply and assess the NE-grounded approaches they utilize in the classroom, and the role that self-efficacy plays in NE implementation.

1.6.3 TSE in Special Education

As a result of the "No Child Left Behind" policy in the United States and the inclusion policy in Israel, state schools are required to support almost all students, including students with disabilities or special needs (Cusick, 2014; Dorner, 2009). Special education and general education teachers not only need to understand that students with special needs are unique learners but also need to have the competency and confidence to implement appropriate learning strategies. In particular, special education teachers are often faced with challenging students with disabilities that influence student academic outcomes or their social-emotional development. Mastery of evidence-based practice or teaching, based on scientific evidences as the NE field suggests, might be helpful in this case, but it will also require new skills (Boomgard, 2013). Since self-efficacy is an accurate predictor of behavior as well as generating changes in behavior following an intervention, it is considered a tool that can accurately measure efficacy with regard to the desired behavioral change if necessary (Ferreira, 2013).

1.7 Social Psychology

Social psychology is a section in the psychology research field, that aims toward the understanding individual behavior in a social context (Murphy & Murphy, 1931). Baron, Byrne and Suls (1989) define social psychology as the scientific field that seeks to understand the nature and causes of individual behavior in social situations, therefore, it looks at human behavior as influenced by other people and the social context in which it occurs. Social psychologists therefore deal with the factors that lead individuals to behave in a given way in the presence of others, and look at the conditions under which certain

behavior/actions and feelings occur. One of the main topics in social psychology is represented by *attitudes*. Implementation of neuroscience in education demands the cooperation of teachers involved in this process, and usually requires a change in their current attitudes.

1.7.1 Attitude and Attitude change

Attitude is generally defined as a psychological construct, a mental and emotional entity that inheres in, or characterizes a person (Perloff, 2016, in Skiadas & Skiadas, 2018). Attitudes determine how people perceive situations, feel about them, and their tendency to behave accordingly (Ajzen, 1996; Fazio & Roskos-Ewoldsen, 2005). Generally speaking, it is considered that attitudes are relatively stable, not being prone to change, due to the elements of an affective and axiological nature which endow them with durability (Cook, 1992). However, despite the stability of attitudes, they are indeed subject to change (Lee, 2016). Attitude change may be defined as a process of transformation, alteration or reorientation of the general attitudes of an individual or a group, by modifying the elements or rapports that favored their original formation (Anghelache & Benţea, 2012). In this respect, Festinger (1957, in: Van der Linden et al, 2015) considered that both attitude formation and change originate in social comparison. It allows the check-up of one's vision of reality, and the situations commanding a strong consensus only reinforce the conviction that their thinking is right. Rogers (1995; 2003), in his model of diffusion of innovation, researched the adoption processes of technological innovation by farmers, and developed a model that describes steps in the adoption process. According to the model, diffusion of innovation is the process by which an innovation is communicated through certain channels over time among members of a social system. This model has been adapted to the field of education, and today is mentioned in most of the studies on educational innovation.

1.7.2 Teachers attitudes toward change

Introducing and implementing pedagogical changes might involve great difficulties. However, existing research indicates that the ability of teachers to play an active role in the process of implementing changes is crucial for the implementation of radical and long-lasting changes and reforms throughout the entire educational system (Fullan, 2007; Mariage & Garmon, 2003). Studies reveal that the need to balance the desire to carry out changes with the necessity to maintain organizational stability is one of the main considerations that influence the processes of achieving efficiency in the workplace (Aypay & Kalayci, 2008, in Maskit, 2011). In many cases, describing a change in education might regard innovation in curriculum, teaching methods, technology etc. The essential role of teachers in implementing innovative pedagogical practices has been widely recognized by researchers and educators (Wu & Looi, 2015). At the same time, the characteristics of teachers, together with the characteristics of the innovation and features of environmental context, account for the outcome of diffusion of an innovation (Rogers, 2003). According to Wu and Looi (2015), teachers need to understand an innovation to reduce uncertainty about the advantages and disadvantages of an innovation. Sherry (2000) expanded Rogers' model, and focused on teachers in the context of technological innovation. Her study elaborates on the systemic process in which innovation in teaching develops, and the interplay between factors that influence the integration of innovation, such as technological, personal, organizational and pedagogical factors.

1.7.3 Teachers' Attitudes toward Neuroeducation

Based on the current literature, there is a paucity of research, a gap, on how teachers perceive professional development on the neuroscience of learning (Ansari, Coch, & De Smedt, 2011; Bana, 2018). Since teachers can play a crucial part in efficiently implementing this process (Fullan, 2007; Mariage & Garmon, 2003), exploring teacher perceptions and attitudes on this topic is an important part in providing meaning to perceived or actual connections between the fields of education and neuroscience. Only few researches reported on findings related to this specific context. Pickering & Howard-Jones (2007) reported educators' enthusiasm for NE from a sample of teachers attending neuroscience professional development courses. Following these promising results, Serpati & Loughan (2012) expanded the findings into a questionnaire to assess teachers' perceived importance of NE and reached similar results. Friedman et al (2019) suggested a Neuropedagogy Adaptation Project (NAP) and asked to unfold the usefulness and benefits gained from

their project, so attitudes were tested indirectly. In a thematic analysis of written reports, the participants raised their perceptions regarding the importance of neuroscience in education, the importance of neuroscience as providing evidence in support of the pedagogical methods that have long been in use by teachers, knowledge about construction of different teaching methods and acquiring understanding of how young people's brain functions direct teachers to change their approach to their students. Despite the findings from the literature above, there is still a gap regarding the effect of a training program that blends neuroscience and education on attitudes of the participants, using quantitative and qualitative tools. This doctoral study expands the literature findings, by exploring PSTs attitudes toward change in general and specifically toward NE, before and after a training program. Moreover, deep analysis of PSTs interviews may expand the quantitative results and shed light on the attitudes and perceptions of the PSTs from a personal wide point of view.

Justification of the doctoral research – Gap in knowledge

Few studies have examined the relationship between findings from the neuroscience field while implementing them into practical educational processes, despite the perception that science-based instruction is an advantage to the educational process (Busso & Pollack, 2015; Dubinsky et al, 2019). The areas in the field of NE which are not yet adequately treated in the existing literature are: 1) Valid and reliable NE curriculum/ intervention/ training programs for PSTs in general, and especially for PSTs in special education field; 2) Curriculum/ intervention/ training programs in the NE field which are implemented in other courses; 3) Examination of the effect of such intervention programs on psycho- social characteristics such as teacher self-efficacy and attitudes toward change; 4) Exploring the psychological factors related to the efficacy of NE programs, such as perceptions and attitudes of the lecturers who teach according to NE principles; 5) Exploring implementation of motifs learned in a neuroscience based program in practice.

Importance of the Research

In Israel, as in the world in general, there is a growing awareness of the benefits that can be derived from the connection between brain research and education. The NE field matches the approach of the need for innovative pedagogy, which aims to enhance interdisciplinary learning. Combining knowledge and findings from the neuroscience world with the needs and knowledge from the educational field may contribute to teaching and learning procedures, as well as choosing strategies and making decisions by teachers.
As the Ministry of Education in Israel seeks innovation in teaching and calls for improving teaching methods, it seems that NE has much to offer in this direction, and might pave the way to change teaching from an intuitive profession to evidence-based. Nevertheless, researches dealing with NE in Israel and around the world, referring to curriculum design, intervention program and especially implementation of such programs, are still scarce. As a consequence, many teachers still work and teach without having sufficient knowledge of how the brains of their students function and develop. Giving PSTs, the future teachers, the tools to teach in an evidence-based manner may lead to a better quality of teaching. This is especially important in the case of the special education area. The work of teachers, every single day, has the potential to change the brains of their students through learning. In special education, the teachers are required to diversify their teaching methods currently in order to help students with special needs in their learning. However, research indicates that introducing and implementing pedagogical changes involve great difficulties (Fullan, 2007). The ability of teachers to play an active role in the process of implementing changes is crucial for the implementation of radical and long-lasting reforms throughout the entire educational system (Fullan, 2007; Mariage & Garmon, 2003). Therefore, we consider that it is important to deeply understand the perceptions of those involved in changes, such as implementation of neuroscience in education. This doctoral thesis, which investigates the impact of an NE training program as an implemented part in training PSTs in special education on psycho- social characteristics and perceptions of the PSTs, has the potential of converting these ideas into practice, in Israel and around the world in general.

CHAPTER 2. METHODOLOGY

2.1. Research paradigm

In this doctoral thesis, a mixed methods research paradigm, combining quantitative and qualitative approaches was employed due to the expectation that it would yield more comprehensive and in-depth information regarding the individual psychological factors associated with the implementation of a NE program (Creswell, 2014; Tashakkori & Teddlie, 2003). The intent of the two-phase sequential mixed methods study is to learn about the process PSTs go through in implementing concepts from the neuroeducational field. The reason for following up with qualitative research in the second phase is to better understand and explain the quantitative results. In addition, a parallel qualitative research will explore the experienced lecturers' perceptions, attitudes and implementation of the NMTTP.

The quantitative approach was used in the thesis in two of its studies: study 2 - a pilot study and study 4 - a pre/post evaluation study of a series of psychological variables associated with the efficiency of the NE-based training program. The quantitative research is a means for testing objectives theories by examining the relationship among variables. These variables can be measured, so numbered data can be analysed using statistical procedures (Creswell, 2009).

The **qualitative approach** was used in the study 5 of this doctoral thesis. A qualitative research is a means for exploring and understanding the meanings individuals or groups ascribe to a social or human problem (Creswell, 2009). The qualitative research is derived from the social constructivist worldview, according to which individuals seek understanding of the world in which they live and work. In addition, individuals develop subjective meanings of their experiences which are directed toward certain objects or things (Guba, Lincoln, Denzin & Lincoln, 1998). In the case of the current study involving PSTs and lecturers, the purpose in choosing the qualitative tools was to explore the participants' perceptions, attitudes and feelings from their point of view.

2.2 Overview of the research design and of the five research studies

The research in this thesis was organized in five studies. The first study was a systematic review of literature on metacognitive reading strategies training programs in special education; the second was a quantitative pilot study validating the questionnaires developed for use in the main pre/post study; the third was a description of the NMTTP, the fourth study was a quantitative study assessing the impact of participating in the NMTTP on PST's self-efficacy and attitudes toward change; the fifth qualitative reflective study added depth to the data gained in the previous studies and related also to the lecturers' point of view. Merging the results of the five studies allowed a fuller picture to be gained on the importance, relevance and contribution of conducting designated training programs on NE for PSTs, and on the impact of one such training program, on the PSTs attitudes and self- efficacy.

2.3 The five research studies

Study 1: A systematic review of the literature regarding metacognitive reading strategies.

Study 2: A pilot study - Construction and validation of a package of questionnaires allowing the assessment of the psychological factors related to NE implementation, i.e., teacher self-efficacy and attitudes toward change (TSEATNE).

Study 3: Development and implementation of the NE teacher training program (NMTTP).

Study 4: Quantitative study - The impact of the NMTTP on PSTs' self- efficacy and attitudes regarding using concepts from NE in teaching.

Study 5: Qualitative study - Exploring the implementation of the NMTTP and the PSTs and lecturers' perceptions of the program

2.4 Research populations

Study 2 – Included 19 Israeli participants. The range of ages was between 23 to 67 years (mean 37.4, SD =12.9). Most participants (84%) were female, secular (73.7) and unmarried (63.1%). All the participants reside in the center of Israel. The majority of them studied in the two colleges in which the doctoral study was carried out (73.6%) and half of them (52.8%) were PSTs in special education, whereas 37% were studying towards an academic career change for special education teachers. Above two-thirds (68.4%) previously studied a neuroscience course in various fields (e.g., neuropsychology, developmental aspects of brain science, brain aspects of learning disabilities, etc.).

Study 4 –33 participants from the experimental group (out of 90) and 28 from the control group (out of 80) constituted the sample group of the study. The distribution of the participants' age in both groups is similar ($t_{(1,59)}$ = -.325, p = .746). On average, the mean age of the participants in the experimental group (n = 33) was 24.8 (SD = 6.20) and in the experiment group (n = 28) was 24.4 (SD = 2.18). The study was conducted during the 2017-18 academic year, October- June.

Study 5 - Included 11 PST's in their 2nd year of training, studying in an educational college in the center of Israel. The 11 PSTs had participated in a neuroscience motif- based teacher training program which was implemented in a reading course, during the academic year of 2017- 2018. In addition, the 3 experienced lecturers participated in teaching the training program were also included in this study. All the PSTs were involved with teaching students with learning disabilities. The demographic characteristics of the participants are summarized as: all of PSTs that participated in the interviews were females. Their ages ranged from the youngest (24 years old) to the oldest (29 years old). The mean age of the pre-service teachers was 25 years old, standard deviation 0.98. They were all training in the special education track.

2.5 Research Tools

Systematic literature review is a research method which summarizes empirical studies on a specific topic, offers conclusions on the actual scientific knowledge base and reveals unresolved aspects that need further investigation (Cooper, 1998). The study was written according to *Uman's eight stages of systematic review* (Uman, 2011):
1. Identifying and formulating the research questions. 2. Defining inclusion and exclusion criteria. 3. Developing search strategy and locating studies. 4. Selection of studies. 5. Adding extra data. 6. Assessing study quality. 7. Analysing and interpreting results. 8. Dissemination of the findings.
Literature search included the following databases: Proquest- Educational database, SAGE - Social Sciences and Humanities, ERIC, APA PsycNet and EBSCO. The literature search was based on the following keywords and combinations: *Metacognitive Strategies*, *Intervention Programs*, *Special Education and Reading Comprehension*. Based on a search of each of the keywords separately, hundreds of articles were found. The articles were then filtered according to further criteria.
The data collection was performed between November 2016 to February 2017.The information gained in the systematic review contributed to the implementation of metacognition as a core concept in the NMTTP.

The following questionnaires were used in the pilot study to validate the questionnaires. As will be explained, these questionnaires were then adapted for use in the pre/post study.

1. **Teacher Self-Efficacy Scale** (TSES, by Tscannen-Moran & Hoy, 2001). The questionnaire assesses efficacy for instructional strategies, efficacy for classroom management and efficacy for student engagement.
2. **Teacher Self-efficacy Questionnaire (Lazar, 2014) based on Soodak & Podell (1996)**. This questionnaire assesses personal efficacy of the teacher and efficacy of teaching. Six items were added to this questionnaire to describe teacher self-efficacy especially for using content from the

neuroscience field in teaching. The positive dimension (willing to make the change), the negative dimension (resistance to change) and the conflict experience related to the attitude.

3. **Attitudes toward Change Questionnaire**: This tool was based on the "*Attitudes toward Change*" questionnaire (Priester & Petty, 1996, in Zach, 2012). The questionnaire assesses the positive dimension (willing to make the change), the negative dimension (resistance to change) and the conflict experience related to the attitude. A change was implemented in this questionnaire, so that each time the word "change" appeared, it was replaced by "*combining knowledge from neuroscience in education*".
4. **Teacher Perception of Neuroeducation Questionnaire** (Serpati & Loughan, 2012, based on Pickering & Howard-Jones, 2007). The questionnaire assesses the importance of NE as perceived by teachers.
5. **A Questionnaire of Attitudes toward the Introduction of Changes in Teaching Methods** (Maskit, 1998, available in Hebrew language). The questionnaire assesses the cognitive, behavioral and affective aspects regarding attitudes toward change.

These reliable and valid pre-existing questionnaires were adapted for the purpose of this research. The questionnaire package was designed to examine the impact of the NMTTP for Israeli special education PSTs in order to assess their attitudes toward change- implementing neuroscience in education and their self- efficacy to implement this change. The questionnaires were adapted and changed to suit the study population and research content, based on the researcher's professional knowledge of the topic of NE and according to statistical and logical considerations. The pilot study was conducted to validate the five questionnaires that were adapted for use in the research.

The five questionnaires were included in a single package, i.e. **TSEATNE** (Teacher Self-Efficacy and Attitudes toward Change Regarding Neuroeducation Implementation Questionnaires).

The **TSEATNE** package was administered to control and experimental groups of PSTs in Israel. The control group were PSTs in a teacher training college who did not take part in the NMTTP. The experimental group took part in a novel training program, which implemented motifs from the neuroscience field in an existing reading course. Both groups answered the questionnaires at the same time, before and after the training program, even though the control group did not take part in the course.

The TSEATNE package of questionnaires included 102 items/survey statements and eight scales regarding self-efficacy, attitudes toward change and perception of the importance of knowledge from the field of neuroscience in education and teaching.

Qualitative analysis of the PST's exam answers, lesson plans and interviews was conducted, following their participation in the NMTTP. Also, interviews and stimulated recall interviews were conducted with the three lecturers participated in the NMTTP. The research goals were to investigate the perceptions of PSTs following their participation in the NMTTP toward implementation of NE in education and teaching. In addition, this research is interested in the experienced lecturers' point of view, after implementation of neuroscience motifs in their reading courses for the first time. Also, this study aimed to investigate the assimilation of motifs from neuroscience in planning lessons and teaching special education students. A deep analysis of the texts from the tools mentioned above lead to the discovery of themes and categories that reflect the complexity of introducing change into teaching.

2.6 Triangulation

Triangulation is the use of several data sources and methods to study the phenomenon (Jick, 1979, Wilson, 2014). By approaching the phenomenon from different observation points, using different methods and techniques, triangulation allows the researcher to identify aspects of a phenomenon more accurately. According to Shkedi (2011) triangulation enriches the quality of research and reinforces the claim to validity, reliability and qualitative inclusion. In this study, triangulation is reflected in multiple qualitative tools (semi structured interviews; document analysis of lesson plans; open ended question in a test), in different points of view of the same situation (PTS's perceptions and lecturers' perceptions regarding the implementation of the NMTTP) and also a common reference to the implementation process as reflected in quantitative and qualitative questions.

2.7 Ethical Considerations

The research was conducted in two colleges of education in the central region of Israel. In order to conduct this study according to the required procedures, the researcher gained permission to collect data at three levels: from each of the PSTs in the experimental group, to analyze their lesson plans, exam answers and interviews following the NMTTP, from each PSTs in both experimental and control groups to analyze their quantitative questionnaires, and from the college's research authority regarding the data collection. Every single participant was required to fill out a form of consent, with the participant's signature confirming his/her full understanding of that form. Since the researcher subjectivity might have influenced the research process and the possibility of interpretation and respresentation of data, this was taken into consideration, so the data analysis and the themes construct were built in peer learning.

2.8 Statistical Analysis of the data

Means and standard deviation were calculated for each group of statements in the attitudes and self-efficacy questionnaires. The reliability of the questionnaires was psychometrically assessed using Alpha-Cronbach reliability coefficients tests, including item-analyses. In the pilot study with a relatively small sample size, non-parametric Shapiro-Wilk tests were conducted to test whether the dependent variables were normally distributed. Differences between pre/post evaluations were calculated using paired samples t-tests and between groups t-tests. Multiple regression analysis was used for explaining the variance in PSTs' attitudes towards change (combining knowledge from neuroscience research in education).

CHAPTER THREE: ORIGINAL RESEARCH CONTRIBUTIONS

3.1. Study 1. Roles of Metacognitive Strategies in Reading Comprehension Tasks in Special Education Pupils: A Systematic Literature Review

3.1.1 Introduction and Research Goals

This study reviews the current academic literature on formal Metacognitive Reading Strategies (MRS) intervention programs for special needs students in a systematic manner. Metacognitive Strategies (MS) regulate students' cognition by activating relevant cognitive approaches and they include cognitive domains and learning contents, which qualify them as higher order strategies (Donker, De Boer, Kostons, van Ewijk, & Van der Werf, 2014). The term MRS refers to intentional and directed cognitive activities that readers can use to monitor, control, and evaluate meaning in the reading process (Alexander & Jetton, 2000; Bergey, Deacon, & Parrila, 2017). According to Zohar & David (2008), although using metacognition appears to be efficient for all the pupils, it can have major influences on those with low achievements. However, the application of MRS as an intervention program has attracted little attention in the field of special education, and most of the research is focused on poor readers. Since the literature indicates the importance of metacognitive strategies in reading, and yet few studies deal with metacognitive reading strategies in special education, a systematic review of the literature could shed light on this specific topic.

The study focuses on identifying the research questions, the aims, the tools that were used to assess MRS, the effects of MRS on academic achievements and the evaluation criteria of those intervention programs. The rationale of the study focuses on the need for improving teaching and learning strategies and methods, in order to enhance the ways pupils with special needs deal with reading and comprehension. This might help educators and policymakers in their decision making regarding teaching methods for special education students. It is important to mention that this review will present the concept under the acronym MS/MRS.

3.1.2. Methodology

In order to answer the research questions, the method chosen was the *systematic literature review*, which summarizes empirical studies on a specific topic, offers conclusions on the actual scientific knowledge base and reveals unresolved aspects that need further investigation (Cooper, 1998).

The following research questions have guided the systematic literature analysis.
1) What are the aims of the researches studied on MS/MRS and reading comprehension with special education students?
2) What types of MS/MRS were used for special education students?
3) Which dimensions of MS/MRS are found to be significant for academic achievements or improving reading comprehension?
4) What dimensions of academic achievements were influenced by MS/MRS?

Literature search included the following databases: Proquest-Educational database, SAGE- Social Sciences and Humanities, ERIC, APA PsycNet and EBSCO. The literature search was based on the following *keywords* and combinations: Metacognitive Strategies, Intervention Programs, Special Education and Reading Comprehension. Based on a search of each of the keywords separately, hundreds of articles were found. The data collection was performed between November 2016 to February 2017. The combination of all the key words together revealed dozens of articles, which were filtered according to the following inclusion criteria: Studies had to be published in *English*; Studies had to be published between 2007 and 2017 in peer review journals; Studies had to allow full text access.

3.1.3. Findings

This section includes the results on the distribution of studies by authors, year of publication, study population, ages covered, number of participants and the country of origin. A complete list and descriptors of the studies included in the systematic review is presented in Table 3.1.1. All the reviewed studies addressed special education pupils or students, but they differed in the specific population chosen for the research, as well as on the ages of the participants.

Table 3.1.1. The complete list of the studies analysed in the systematic review.

Research Title	Authors	Year	Research Population	Age/ Grade of the Participants	Number of Participants	Country
The impact of a strategy-based intervention on the comprehension and strategy use of struggling adolescent readers.	Cantrell, Almasi, Carter, Rintamaa, & Madden.	2010	Struggling readers	6th and 9th grades	6th grade: 192 9th grade: 254	U.S.A
Ameliorating children's reading-comprehension difficulties a randomized controlled trial	Clarke, Snowling, Truelove, & Hulme.	2010	Children with specific reading comprehension difficulties	4th grade	84	England
The role of metacognitive reading strategies, metacognitive study and learning strategies, and behavioral study and learning strategies in predicting academic success in students with	Chevalier, Parrila, Ritchie, & Deacon.	2017	Self-reported history of reading disabilities	1st year university students	79 experimental group	U.S.A

and without a history of reading difficulties						
Metacognitive strategies: A foundation for early word spelling and reading in kindergartners with SLI.	Schiff, Nuri Ben-Shushan, & Ben-Artzi.	2017	SLI (Specific Language Impairment)	Average age: 5.8	295 control group	Israel
Combined modality intervention for ADHD with comorbid reading disorders: proof of concept study	Tannock, Frijters, Martinussen, White, Ickowicz, Benson, & Lovett.	2016	ADHD and comorbid reading disorder	7-11 years age	67	U. S. A

Research question 1: *What are the aims of the research studied on MS/MRS and reading comprehension with special education students*

Generally, all the studies included in the systematic review aimed to investigate the influence of MS/MRS on academic performance of students. While most of the studies (Cantrell et al., 2010; Clarke et al., 2010; Sciff, Ben- Shushan & Ben Artzi, 2017; Tannock et al., 2016) compared different intervention programs through experimental design studies, including MS/MRS intervention, Chevalier et al. (2017) used a self-report study in order to understand the influence of MS/MRS on academic performance.

Research question 2*: What types of MS/MRS were used for special education students?*

Most of the studies presented and mentioned specific aspects of metacognitive strategies. Hence, Chevalier et al. (2017) presented a self-report study which asked students with a history of reading disabilities about their use of metacognitive strategies such as information processing, selecting main ideas, self- testing, study aids, test strategies and time management. Cantrell et al. (2010) also used a self-report measure as a part of an intervention program and in their MARSI measure they used items related to global reading, problem solving and support strategies. Clarke et al. (2010) mentioned other components in their Text Comprehension program (reread, look-back, visualize, think aloud and self-explanation). Schiff, Ben-Shushan & Ben Artzi (2017) investigated a group of children with SLI who received metalinguistic instructions that integrates metacognitive strategies, including goal definition, planning, process monitoring during performance and product evaluation after performance. One study did not elaborate on the components of the MS/MRS intervention program, but it only mentioned that its purpose was to train children to use and monitor the application of MS/MRS for both academic (mathematics, organizational skills and reasoning) and social settings (Tannock et al., 2016).

Research question 3*: Which dimensions of metacognitive strategies are found to be significant for academic achievements/ improving reading comprehension?*

The analysis reveals that most of the studies included in the literature review (Clarke et al., 2010; Schiff, Ben- Shushan & Ben Artzi, 2017, Tannock et al., 2016) did not elaborate on the results of specific items or dimensions of MS/MRS, but rather treated the general influence of MS/MRS on academic achievements. One study identified the problem- solving strategy as an MS/MRS dimension influencing academic achievements (Cantrell et al., 2010) and one study identified the selection of a main idea as influencing academic achievements (Chevalier et al, 2017). The dimensions of MS/MRS, which were found significant for academic achievements are presented in Table 3.1.2

Table 3.1.2 Identified dimensions of MS/MRS significant for academic achievements in the five studies included in the systematic review.

Dimensions of MS/MRS	Number of studies
• Metacognitive strategies in general	3
• Selecting main ideas	1
• Improvement in use of problem- solving strategies (visualization, rereading, adjusting speed and guessing the meanings of unknown words)	1

Research question 4*: Which dimensions of academic achievements were influenced by MS/MRS?*

This research question focuses on the other side of research question 3, asking about the different academic achievements that were influenced by MS/MRS intervention programs. Also, this question functions as a way to evaluate the influence of MS/MRS intervention programs in relation to the academic achievements of the students. According to Chevalier et al. (2017), who did not use an intervention program, students with a history of reading disabilities had lower overall GPAs (Grade Point Average) and they used fewer metacognitive reading strategies than students with no history of reading difficulties. Tannock et al. (2016) and Clarke et al (2010) reported improvement in reading outcomes after the MS/MRS intervention programs, which lasted 10 weeks or 20 weeks, respectively. Cantrell et al (2010) reported improvement in reading comprehension, and Schiff, Ben- Shushan & Ben Artzi (2017) reported the influence of an MS/MRS intervention program on spelling accuracy as an important step toward reading.

3.1.4 Discussions, conclusions and limits

The results of the review refer to the research aims and questions, to the type of tools that were used to assess MS/MRS and describe the dimensions of MS/MRS related to academic performance, as well as the way they were evaluated. Studies were generally aimed to compare several intervention programs and inspect the relations between those programs and academic achievements of the students. Most of the studies suggested a significant association between MS/MRS intervention programs and success or improvement in reading or reading comprehension. However, in two studies, the effect of an MS/MRS intervention program was reported as being lower than a reading intervention program (Clarke et al, 2010; Tannock et al, 2016), or relevant to sixth grade students but not for ninth- grade students (Cantrell et al, 2010).

The results of this systematic review could be further valued in designing MS/MRS intervention programs in schools, kindergartens and even higher education, since the investigated literature reveals an ongoing process of implementation of MS/MRS programs and its advantages. Applying metacognitive strategies during learning can serve as an effective platform for developing children's reading comprehension. Furthermore, the relationship between using metacognitive strategies in students with learning disabilities and their academic achievements suggests that a proactive use of early intervention programs which emphasize metacognitive awareness is important. Specifically, having a better understanding of which strategies are associated with academic success can help academic support service providers build specific intervention plans for schools.

The current study also presents some potential methodological and conceptual challenges. The fact that only few studies were found after using the inclusion criteria might indicate a relative lack of the evidence-based research in the field of MS/MRS intervention programs, but it also might be explained by the heterogeneity of the concepts and its dimensions. Hence, some researches use different concepts with similar meanings, such as Metacognitive Strategies, Metacognitive Reading Strategies, Metacognitive Awareness, etc. Some articles refer to only one dimension of Metacognition, such as self-regulation. A larger number of studies might have been revealed if other concepts would have been chosen for this review.

3.2 Study 2. Development and Validation of a Package of Questionnaires for the assessment of psychological factors related to NE implementation: Teacher Self-Efficacy and Attitudes Toward Change – Pilot Study

3.2.1 Introduction

Implementation of neuroscience in education might be considered as change or innovation in curriculum as well as teaching methods. People with positive attitudes are more likely to conform to the demands that a change entails (Zala-Mezö, Raeder, & Strauss, 2019) Although teachers' attitudes were researched widely and in different contexts, only few studies examined teachers' attitudes regarding NE. In addition, one of the means of assessing the ability of integrating NE knowledge in teaching methods is by examining the PSTs' self-efficacy. As the PSTs begin their in-service training from the start of their first year of studies, the concept chosen for this research is teacher self-efficacy (TSE). TSE refers to teachers' beliefs in how to organize and execute actions to accomplish specific tasks of teaching, or the judgment of their capabilities to bring about desired outcomes of pupils' engagement and learning, even among those pupils who may be difficult or unmotivated (Ferreira, 2013). Tschannen-Moran & Hoy (2001) developed the TSE Scale (TSES), which has been widely used in teacher education research (e.g. Klassen, Usher, & Bong, 2010; Yoo, 2016). Nevertheless, no valid translation of this questionnaire into Hebrew was found. Several valid TSE questionnaires were found in the Hebrew language, such as the TSE questionnaire by Lazar (2014), which was also chosen to be included in this pilot study. One of the main goals of the study is to evaluate specific TSE to integrate concepts from neuroscience to education, and since no specific questionnaire on that topic was found in English or in Hebrew, some items related to NE were added to Lazar's questionnaire (2014).

There is a lack of research questionnaires addressing NE in general, thus the need to develop a package of questionnaires related to self-efficacy and to attitudes toward implementation of motifs from the NE field was identified. Investigation of these variables in PSTs in Israel led to the analysis of the Hebrew versions of the questionnaires for their psychometric properties.

The goal of the pilot study was to construct the research tool for Study 4, by creating a reliable package of questionnaires (TSEATNE- Teacher Self-Efficacy and Attitudes toward Change Regarding Neuroeducation Implementation Questionnaires) with an optimal level of comprehension in the Hebrew language. More specifically, the pilot study intended to provide a tool package to evaluate specific psychological dimensions related to inclusion of NE in the educational practices in Israel, such as teacher self- efficacy and attitudes toward integrating concepts from neuroscience to education.

3.2.2 Methodology

The methodology used in the study in order to construct and validate the TSEATNE questionnaire included a pilot study, and a reconstruction of the questionnaire, according to findings of the validation process.

Research Population

This pilot study included 19 Israeli participants with a range of ages between 23 to 67 years (mean 37.4, SD =12.9). Most participants (84%) were female, secular (73.7) and unmarried (63.1%). All the participants reside in the center of Israel. The majority of them studied in the two colleges in which the doctoral study was conducted (73.6%) and half of them (52.8%) were PSTs in special education. 37% of the participants were studying towards an academic career change for special education teachers. Above two-thirds (68.4%) previously studied a neuroscience course in various fields (e.g., neuropsychology, developmental aspects of brain science, brain aspects of learning disabilities, etc.).

Adjustment, Validation and Reliability of the Questionnaires

Adjustments in the questionnaires were performed following logical and statistical considerations. In addition, changes such elimination of questions and amendment of wording were conducted after the pilot study. The TSEATNE includes five questionnaires: 1) ***Teacher Self Efficacy Scale (TSES,*** based on Tschannen-Moran & Hoy, 2001): The overall reliability of the scale is very high (α= .97). All items are sufficiently correlated (above .40) with the other items of the scale. No changes were made in the questionnaire. 2) ***Teacher Self-Efficacy*** (based on Lazar, 2014, in the Hebrew language): The overall reliability of the scale was high (α = .89). 6 items that relate to self-efficacy regarding combining NS in education were added to the original scales and their reliability was tested separately. General SE in

teaching had a value of α=.85, and SE in combining neuroscience (NS) in teaching and learning had a value of α=.80. 3) ***Attitudes Toward Change Questionnaire***" (based on *Attitudes Toward Change Questionnaire*" of Priester & Petty, 1996, in: Zach, 2012, in the Hebrew language). The overall reliability of the scale is acceptable (α = .763). All items (except #3) are sufficiently correlated (above .40) with the other items of the scale. A change was implemented in this questionnaire, so that each time the word "change" appeared, it was replaced by "combining knowledge from neuroscience in education". 4) ***Teacher Perception of NE Questionnaire*** (Serpati & Loughan, 2012, based on Pickering & Howard- Jones, 2007): This questionnaire was translated into Hebrew by two independent professional translators. After the translation, it was decided to divide the questionnaire into three parts (note: 7 items with specific content related to NMTTP were added to the original form): 10 items referring to the importance of understanding scientific content from the neuroscience field in education and teaching, 5 items referring to the importance of combining neuroscience in education and 5 items about teachers' roles regarding combining neuroscience in education. In order to validate these changes, consultations were held with four NE and methodology experts separately. In all the sub- scales, the overall reliability was above α = .73 and most items were sufficiently correlated (above .40). 5) **A Questionnaire of Attitudes toward the Introduction of Changes in Teaching Methods** (Maskit, 1998, in the Hebrew language). Four sub-scales were identified in this questionnaire, as originally appeared in the original questionnaire. The overall reliability of all the sub-scale was acceptable (α Cronbach = .77 and higher), and in most of the sub- scales, the items were sufficiently correlated (above .40).

3.2.3 Findings

Table 3.2.1 summarizes the final form of the package of questionnaires TSEATNE, after the validation and reliability processes. The term NS in the table refers to "neuroscience".

- **Table 3.2.1**. List of the final form of the package of questionnaires TSEATNE (Teacher Self-Efficacy and Attitudes Toward Change Regarding Neuroeducation Implementation Questionnaires).

	Scale Name	# of Items	Cronbach's α	Range of Measurement Scale
1	Attitude towards Change – Combining Knowledge from NS Research in Education	6	.763	1=strongly disagree, 5=strongly agree
2	Teachers' Perception of the Importance of Knowledge from the Field of NS in Education and Teaching			
2.1	Understanding scientific contents from NS field is important to the following topics	10	.80	1=not important at all, 5=very important
2.2	The Importance of Combining NS in Education	5	.73	1=not important at all, 5=very important
2.3	Teachers' Roles Regarding Combining NS in Education	5	.857	1=strongly disagree, 5=strongly agree
3	Teachers' Self Efficacy	19	.89	1=strongly disagree, 5=strongly agree
4	Attitudes towards Introducing Change in Teaching Methods	9	.85	1=strongly disagree, 5=strongly agree
5	The Amount of Time Teachers are Willing to Invest in Introduction of Changes in their Teaching Methods	10	.79	1 = not willing at all, 2 = willing a little (1-2 hours a week), 3 = willing to a certain extent (3-4 hours a week),

				4 = willing to a high extent (more than 4 hours a week) 5 = very willing (all the time)
6	Factors that may Assist in Introduction of Change Processes	9	.763	1=does not assist at all, 5=assists very much
7	Teachers' Perception of Teaching as Evidence based	5	.72	1=strongly disagree, 5=high ability / competence
8	Teachers' Beliefs about their Abilities and Competences	24	.763	1=strongly disagree, 5=high ability / competence

3.2.4 Discussion, conclusion and limits

All the scales and the sub-scales included in the final tool package had acceptable to excellent internal consistency values ranging from α =.723 to α =.970. Based on the preliminary data gathered through this pilot study, it can be concluded that a valid and reliable package of questionnaires with optimal level of comprehension (in the Hebrew language) was developed for the doctoral research and for the Israeli academic community. The decision to adjust and add questions/items was grounded on logical and statistical considerations, followed by consultation with expert researchers to strengthen the validity of the study. The preliminary results indicate that the Hebrew versions of the questionnaires are reliable and valid. The findings from this pilot research paved the way for use of a reliable package of questionnaires in the quantitative study (Study 4) and enables comparison of teacher self- efficacy and attitudes toward change between the experimental group and the control group, before and after the intervention. Thus, this tool package can be further considered as one of the possible contributions of this study in enabling the academic community in Israel access to valid instruments for the assessment of variables related to the teaching process and implementation of NE programs.

3.3 Study 3: Development of a Neuroscience Motifs-based Teacher Training Program (NMTTP)

3.3.1 Introduction

The third study of the doctoral thesis focuses on describing a teacher training program and a suggested curriculum, which would allow the implementation of motifs from neuroscience in a reading class for PSTs in the field of Special Education. This study follows curriculum design principles for developing modules in education suggested by Remesh (2017). Although NE has gained importance in recent years, there is a lack of information on how it is implemented in the classroom (Murphy, 2017). In recent years, interest has been shown in seeking to implement neuroscience knowledge and research findings into pedagogy and classroom teaching for advancing teaching and learning (Friedman, Grobgeld & Teichman- Weinberg, 2019). It seems there is a gap between the declarative statements about the importance of implementation of neuroscience in education (Clement & Lovat, 2012; Curtis & Fallin, 2014; Gabrieli, 2016; Stern, Grabner, & Schumacher, 2016) and the small number of suggested programs which actually present an implementation in practice (BrainU, in: Dubinsky et al, 2019; NAP, in: Friedman et al 2019). From the existing programs, it seems there are positive results and enthusiasm from the participants regarding the induction of neuroscience into their work. However, it also seems that there is still not one specific curriculum to guide this implementation.

Research objective: The main objective of Study 2 was to develop a neuroscience motifs- based teacher training program (NMTTP) for PSTs of Special Education, which will be further implemented and tested in the next quantitative study of the doctoral research, in terms of its impact on several psychological variables, such as teachers' self-efficacy and attitudes regarding the implementation of neuroscience motifs in their pedagogical practice.

3.3.2 Methods

The topics chosen for the NMTTP were based on the guidelines of the *Brain Targeted Teaching Model* (BTT) by Hardiman (2012), the ideas of Tokuhama- Espinosa (2011) in her guide to brain-based teaching and original lessons developed by the researcher Before starting the academic year (October, 2017), the Israeli lecturers received a booklet with information about NE research, the purpose and rational of the study and some proposed changes in the original course. They gave their written agreement to participate and cooperate in the study. The lesson plans were presented in advance, with an opportunity to respond and be flexible with suggestions, although the main ideas of the intervention plan were kept.

The NMTTP was spread over the academic year of 2017-2018 (two semesters). It was incorporated into **10 major lessons** (each lesson had a total duration of 90 minutes, including the reading lesson content) during the academic year which are presented in brief in table 3.3.1

Table 3.3.1. An overview of the NMTTP lessons.

Lesson	Purpose	Key Concepts	Teaching Methods	Materials Needed or other Variables
1	Presenting the purpose of the doctoral research	NE	Discussion	
2	Emphasizing the importance of learning in context	• Synaptic networks • Learning in context • Hebb's law	• Metacognitive discussion • presentation	Synaptic network presentation
3	Emphasis of the brain plasticity.	Neuroplasticity	• Multi-sensory use in teaching. • Combining movies in teaching	Plasticine Youtube movies on the topic of Neuroplasticity Quiz game
4	Acquaintance with the concept of neuromyths and discussing the importance of evidence-based teaching	Neuromyths	Casting votes on phrases relating to the brain and confrontation about them	Signs similar to traffic lights for "True" or: "False"
5	A brief introduction to recent literature about the connection between brain and reading	Imaging devices	• Critical discussion: Ethics • Presentation	Presentation
6	A general introduction to metacognition and the brain	• Metacognition • Metacognitive questions • Metacognitive strategies and reading strategies	• Role play • Creating a conceptual map	• Memo notes • Cognitive/ Metacognitive questions
7	Acquaintance with the concept of Mirror Neurons and learning by imitation	• Mirror Neurons	• Modeling • Demonstration	• Reading diagnostic kit
8	Expanding the understanding of the concept "Working Memory" and its connection to the brain by a physical- cognitive experiment	• Working Memory • Physical activity and the brain	• Active physical learning • An experiment	• The Jellyfish Game
9	Providing systematic exposure to metacognition and metacognitive strategies in relation to the brain	• Metacognition • Metacognitive skills • Metacognitive knowledge	• Presentation • Demonstration by dealing with pre-reading strategies	• The Japanese exercise

		• Metacognitive strategies		
10	Acquaintance with spaced learning and metacognitive- critical thinking about it	Spaced learning and its benefits according to evidences from the brain	Experience in the classroom combined with spaced learning	A ball

The assessment of the NMTTP was reflected in several ways. First, semi- structured interviews with PSTs from the three classes participating in the study, describing the process of implementation as perceived by them. Second, tracking and locating the motifs and methods of the NMTTP in the PSTs' lesson plans for special education pupils. Third, open-ended question tracked the concepts from the NE field and the perceived importance of NE in a mid-term and final exam of the students in the reading course. Fourth, through questionnaires, tracking the changes in attitudes toward the assimilation of change in teaching methods, the change in general teacher self-efficacy and teacher self-efficacy to implement motifs from NE in class.

3.3.3 Discussion, Conclusions and limitations

Reviewing the current literature dealing with NE reveals that, although many of the studies emphasize the importance of NE as an innovative teaching content and method (e.g Ansari, de Smedt & Grabner, 2012; Murphy, 2017), only few studies describe implementation of NE in practice. Within these programs, particular features of the NMTTP can be found, as detailed below: **Implementation in an Existing Syllabus:** Among the few curricula or syllabuses discussing NE, it seems that the prominent ones are studied separately from other courses, and not from an interdisciplinary or integrative point of view. Unlike other programs which focus on teaching students neuroscience or NE in a separate course or program, the NMTTP intervention program insisted on implementation of motifs from the neuroscience field in an existing reading course, from a point of view that the best transfer and implementation will occur when content is part of a current lesson. **NMTTP Chosen Topics and Concepts:** Although the topics for the NMTTP were based on the guidelines of the Brain Targeted Teaching Model (BTT) by Hardiman (2012), and the ideas of Tokuhama- Espinosa (2011), the NMTTP was reflected in an original, special implemented module in the curriculum of the reading course, and the principles of it can be integrated in many other courses as well. **Implementation in a Teacher Training Program:** The few programs dealing with implementation of NE are directed to in- service teachers. The NMTTP, however, is aimed to PSTs in their first degree, based on the idea that implementation of NE during the training period might have a beneficial effect as their professional identity develops in this stage. PSTs who practice NE might, hopefully, implement it into their lesson planning, and thinking and teaching methods more easily than in- service teachers who already have specific habits of teaching. **Implementation of a Program for Special Education Teachers:** Although different researchers talked about the importance of NE to achieve a better understanding of special education in general and learning disabilities in particular (Hardiman, 2012a; Kosaraju, Gorman & Berry, 2014; Stern, Grabner, & Schumacher, 2016), few studies have made the connection between these fields in practice. However, the NMTTP took place in a special education track course, and was aimed to consider the different needs of pupils with reading difficulties regarding concepts and methods from the neuroscience field. Since children with learning disabilities have difficulties in embracing learning strategies on their own, there is a possible contribution of a program focusing on evidence- based methods to improve teaching and learning in this population. One possible limitation deals a gap between the knowledge of the researcher who is also a lecturer, and the knowledge of the two other lecturers.

3.4 Study 4: A quantitative investigation of the effects of participating in SHE training on the attitudes, knowledge and willingness to teach SHE of PSTs in Israel

3.4.1 Introduction

Changing teachers' practices by including elements of NE often requires ongoing professional development and support, and the psycho-social characteristics of the PSTs, such as attitudes and self-efficacy, may have a mediating role between what they acquired in the training intervention program and the implementation of the acquired knowledge in the lessons. Thus, it's possible that adoption and diffusion of an innovation or practice is tied to self-efficacy and more specifically, to teacher self- efficacy (TSE). Since NE is a relatively new discipline, it is essential to explore how PSTs, who are about to be teachers, apply and assess the NE-grounded approaches they utilize in the classroom, and the role that self-efficacy plays.

Only a few researches examined teachers' attitudes regarding NE (Friedman et al, 2019; Pickering & Howard-Jones (2007); Serpati and Loughan, 2012). While Serpati and Loughan (2012) assessed the importance of understanding scientific contents from the neuroscience field in education and teaching and the importance of combining neuroscience in education and teaching in their questionnaire, there was no reference to the issue of teachers' roles regarding combining neuroscience in education. According to Phillippo and Stones (2013), teachers' roles, implying what is expected from them as professional teachers, have tended to focus on the curricular instruction within classrooms, but may have wider implications and are critical to teacher characteristics related to their ultimate practice. Therefore, teachers' roles regarding combining neuroscience in education, teaching and learning might be an important concept when investigating the attitudes of teachers or PSTs. Readiness for change equates to a preparation stage, whereby individuals have positive attitudes toward a change and indicate an inclination to act in the immediate future. Thus, one crucial element of the readiness to make such changes is the attitude of individual administrators and teachers regarding the change (Maskit, 2011). Moreover, readiness for change requires the willingness to change (Holt & Vardaman, 2013). The importance of these psycho- social variables, teacher self-efficacy and attitudes toward change, led to the decision of investigating their change, following the NMTTP.

The main aims of this research were 1) To examine PSTs' *self-efficacy* in implementing the neuroscience motifs-based teacher training program. 2) To examine PSTs' *attitudes* toward implementing the neuroscience motifs-based teacher training program.3) To explore which variables can explain the variance in PSTs' *attitudes* towards using concepts from NE in teaching. 4) To explore which variables can explain PSTs' *self-efficacy* relating to using NE motifs in teaching.

3.4.2 Research Methodology

Participants: the participants were PSTs in their 2nd year of studies in Special Education, from two teacher training colleges in the center of Israel. Two groups participated in the research: a research group and a control group. The research group included 90 PSTs who participated in the NE Intervention Program (NMTTP) during a reading course in the academic year of 2017-2018 (October- June). The control group included PSTs who participated in a similar course in another teacher training college, without the intervention program. The participants were requested to complete the online package questionnaire validated in Study 2 at two time points: before and after the training program.

Before Intervention - Experimental group: n=53, Control group: n=28. *After Intervention* – Experimental group: n=33, Control group: n=28. The overall response rate was 42%.

Instruments - TSEATNE (Teacher Self- Efficacy and Attitudes Toward Change Regarding Neuroeducation Implementation) questionnaires were distributed to the PSTs.

3.4.3 Research Findings

Demographic variables of the two groups:

The findings below relate to the demographic characteristics of both the control and experimental groups. Table 3.4.1 summarizes the personal demographic characteristics: age and gender, and relevant academic characteristics, such as a secondary field in addition to special education and previously studied a Neuroscience Course. no significant differences were found in PSTs' age by group, the majority of the

participants were women. The majority of the PSTs in the Control group have a secondary field in addition to special education, but in the Experimental group – less than half of the students have a secondary field in addition to special education. In the measurement before the intervention, no significant difference was found in the percent of PSTs who previously studied a Neuroscience Course by group.

Table 3.4.1 Frequency (%) of the demographic characteristics of the participants to the two groups

Demographic Characteristics	Values	Control (n = 28)	Experimental (n = 33)	$\chi 2$	p
Gender	Female	94.4%	97.7%	.971	.324
	Male	5.6%	2.3%		
Marital status	Divorced	0.0%	1.2%	.993	.609
	Married	11.1%	11.6%		
	Single	88.9%	87.2%		
Religion	Atheist	1.9%	0.0%	6.40	.170
	Secular	68.5%	54.7%		
	Traditional	25.9%	34.9%		
	Religious	3.7%	9.3%		
	Orthodox	0.0%	1.2%		
Has a secondary field?	No	9.3%	57.0%	35.8	.000
	Yes	90.7%	43.0%		
Studied a Previous Neuroscience Course?	No	75.9%	95.3%	11.56	.001
	Yes	24.1%	4.7%		

The distribution of the participants' age in both groups was similar ($t_{(1,59)}$ = -.325, p = .746). On average, the mean age of the participants in the experimental group (n = 33) was 24.8 (SD = 6.20) and in the control group (n = 28) was 24.4 (SD = 2.18).

3.4.3.1 Preliminary Analyses – Differences between Groups Before and After the Intervention groups

Matched-questionnaires Analyses – Differences between before and after the intervention in each group

Due to the small number of participants whose questionnaires could be matched (i.e., responded to both measurements, before and after the intervention), related-samples Wilcoxon Signed Rank Test was used to examine the differences between before and after the intervention in each group. In addition, Mann-Whitney U Test was used to compare the Control group and the Experimental group in each measurement (before / after).

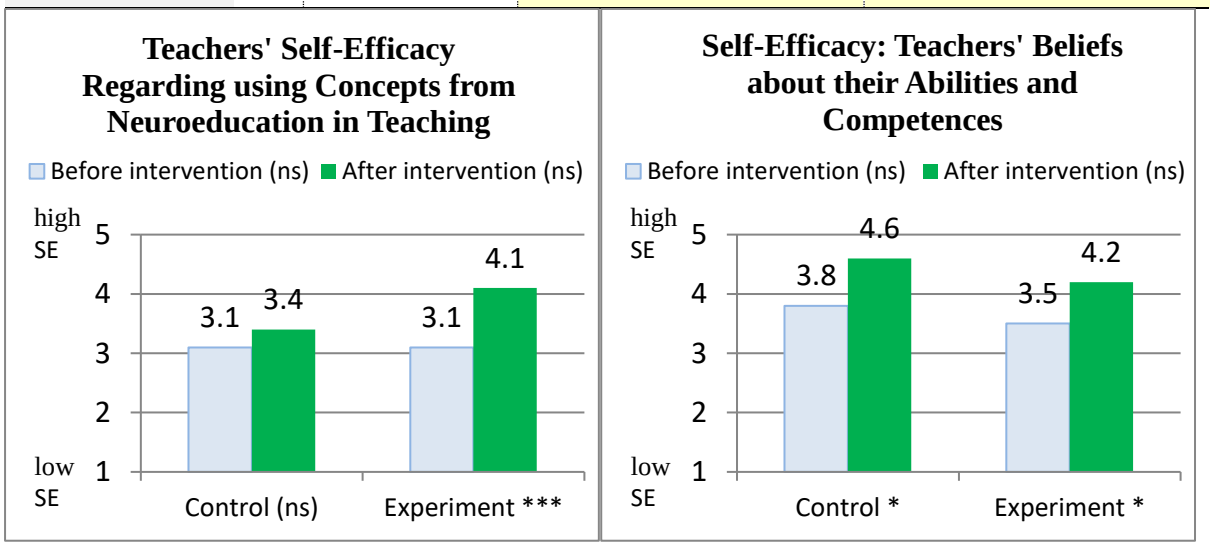
Self-Efficacy Regarding the use of NE Knowledge in Teaching

The findings are presented in table 3.4.2 and refer to two indices: PSTs' Self Efficacy-neuroscience knowledge and PSTs' beliefs about their abilities and competences.

Table 3.4.2 Differences in level of **self-efficacy** before and after intervention in each group (Control / Experimental)

*"NS" inside the tables is a shortcut for "neuroscience"

Index	Control - Experiment **Mann-Whitney U test** (sig.)		**Control (N=7)**			**Experimental (N-15)**		
			Mean	SD	Before-after **Wilcoxon Signed Rank Test** (sig.)	**Mean**	SD	Before-after **Wilcoxon Signed Rank Test** (sig.)
(3) PSTs' Self Efficacy-NS knowledge	before	1.000	**3.1**	0.49	**.345**	**3.1**	0.67	**.001**
	after	.361	**3.4**	0.59		**4.1**	0.46	
(8) PSTs' Beliefs about their Abilities and Competences (SE)	before	1.000	**3.8**	0.83	**.028**	**3.5**	0.74	**.027**
	after	.630	**4.6**	0.35		**4.2**	0.66	



* $p < .05$, *** $p \leq .001$, ns = nonsignificant

Figure 3.4.1 Differences before and after intervention in each group in: PSTs' beliefs about abilities and competences and their self-efficacy regarding using concepts from NE in teaching

Table 3.4.2 and figure 3.4.1 indicate, that following the training program, PSTs' self-efficacy regarding using concepts from NE in teaching was significantly higher among the Experimental group ($M = 4.1$) than before the intervention ($M = 3.1$), and the Control group after the intervention ($M = 3.4$).

This finding supports hypothesis 1.

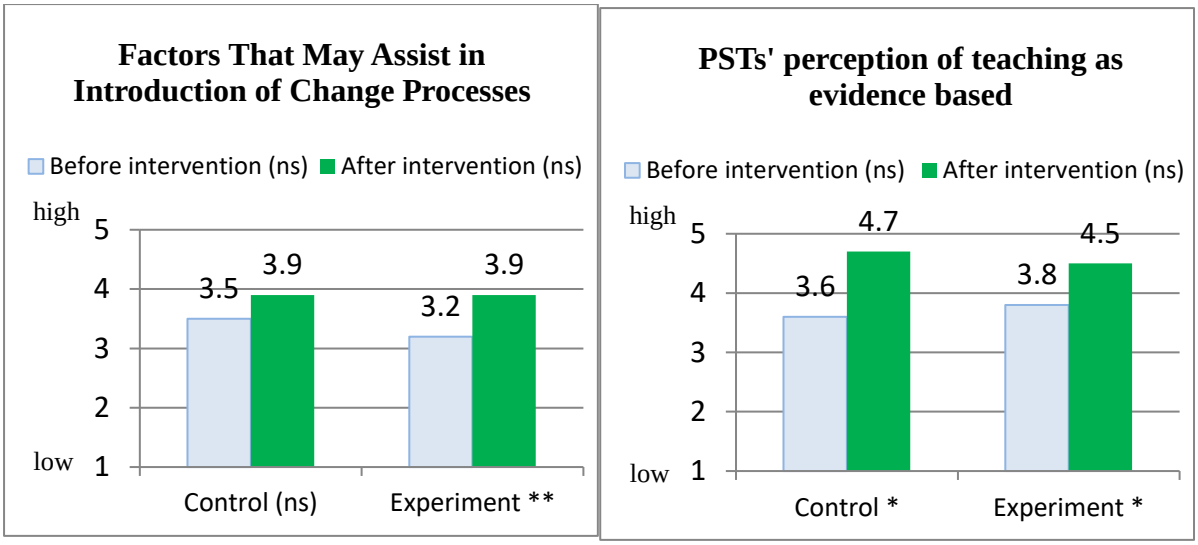
Research Question 2 and Hypothesis 2:

The second research question was: **Is there an impact of the NMTTP on the PSTs attitudes towards using NE motifs in teaching, following the NE training program?**

According to hypothesis 2, the level of favorability of the *attitudes* toward using NE knowledge will be similar before the training program in the Experimental and Control groups, but higher in the Experimental group after the training program.

Table 3.4.3 Differences in **attitudes** before and after intervention in each group (Control / Experimental).

Index	Control - Experiment **Mann-Whitney U Test** (sig.)		**Control (N=7)**			**Experiment (N-15)**		
			Mean	SD	Before-after **Wilcoxon Signed Rank Test** (sig.)	**Mean**	SD	Before-after **Wilcoxon Signed Rank Test** (sig.)
(1) Attitudes towards Change – Combining Knowledge from NS Research in Education	before	.376	**4.6**	0.37	**.068**	**4.2**	0.46	**.410**
	after	.334	**4.3**	0.71		**4.0**	0.85	
(2.1) Understanding Scientific Contents from NS Field is Important to the Following Topics	before	.172	**4.4**	0.36	**.400**	**4.1**	0.42	**.887**
	after	1.000	**4.2**	0.43		**4.0**	0.82	
(2.2) The Importance of Combining NS in Education	before	.361	**4.3**	0.49	**.063**	**3.8**	0.50	**.820**
	after	1.000	**3.7**	0.59		**3.6**	0.64	
(2.3) PSTs' Roles regarding Combining NS in Education	before	.001	**4.5**	0.28	**.018**	**3.7**	0.65	**.977**
	after	1.000	**3.8**	0.56		**3.7**	0.65	
(4) Attitudes towards Introducing Change in Teaching Methods	before	.652	**4.1**	0.53	**.496**	**3.7**	0.34	**.210**
	after	.361	**3.9**	0.67		**3.5**	0.85	
(5) The Amount of Time PSTs are Willing to Invest in Introduction of Changes in their Teaching Methods	before	.652	**4.3**	0.54	**.041**	**3.8**	0.54	**.637**
	after	.648	**3.5**	0.89		**3.9**	0.69	
(6) Factors That May Assist in Introduction of Change Processes	before	.652	**3.5**	0.54	**.150**	**3.2**	0.65	**.003**
	after	1.000	**3.9**	0.67		**3.9**	0.61	
(7) PSTs' perception of teaching as evidence based	before	.630	**3.6**	0.73	**.028**	**3.8**	0.55	**.012**
	after	.052	**4.7**	0.55		**4.5**	0.42	



* $p < .05$, ** $p \leq .01$, ns = nonsignificant

Figure 3.3.1 Differences before and after intervention in each group in PSTs' perceptions of: factors that may assist in introduction of change processes, and teaching as evidence based.

According to table 3.4.3, no significant differences were found in PSTs attitudes towards change – combining knowledge from NS research in education after the intervention as compared to before it, in both research groups.

This finding refutes hypothesis 2.

It should be noted that in both research groups, the means of this variable before the intervention were high (above 4 on a scale of 1 to 5).

Nevertheless, as presented in figure 3.3.1 – PSTs in the experimental group after the intervention ranked significantly higher in factors that may assist in introduction of change processes (M = 3.9) than before the intervention (M = 3.2). In the control group, this change is nonsignificant. It should be noted that although a parametric statistical analyses was conducted – the number of matched participants is small and therefore these findings point to a tendency rather than drawing a credible picture.

In both groups, after the intervention, at the end of the school year, PSTs' perceptions of teaching as evidence based were significantly higher (Experimental – M = 4.5, control – M = 4.7) than at the beginning of the year, before the intervention (Experimental – M = 3.85, control – M = 3.6).

In order to answer research questions 3 and 4 two statistical analyses were carried out: (a) correlation coefficients (Pearson) among research variables; (b) Multiple regression analyses for explaining the variance in *PSTs' self-efficacy regarding the use of NE knowledge in teaching and* their *attitudes towards using NE motifs in teaching.* These analyses were conducted among the Experimental group participants who completed the questionnaire after the intervention (N = 33).

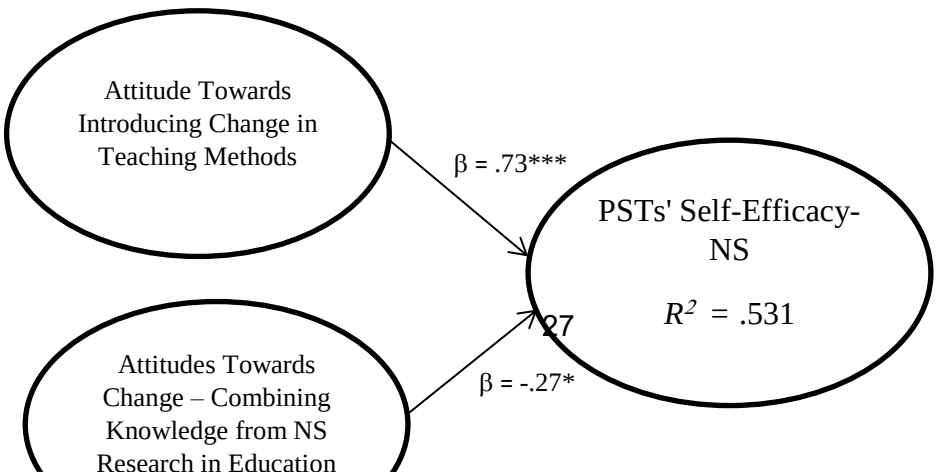


Figure 3.3.2. Multiple regression analyses for explaining the variance in PSTs self-efficacy regarding the use of concepts from NE in teaching practice.

According to figure 3.3.2, 53.1% of the variance in *PSTs' self-efficacy regarding the use of concepts from NE in teaching* is significantly explained by their attitudes towards introducing change in teaching methods (β = .73, *p* = .000) and their attitudes towards change – combining knowledge from NS research in education (β = -.27, p = .042); The **higher** the level of favorability of the attitudes toward introducing change in teaching methods, and the **lower** the level of favorability of the attitudes towards change – combining knowledge from NS research in education – the PSTs' self-efficacy in teaching is **stronger**.

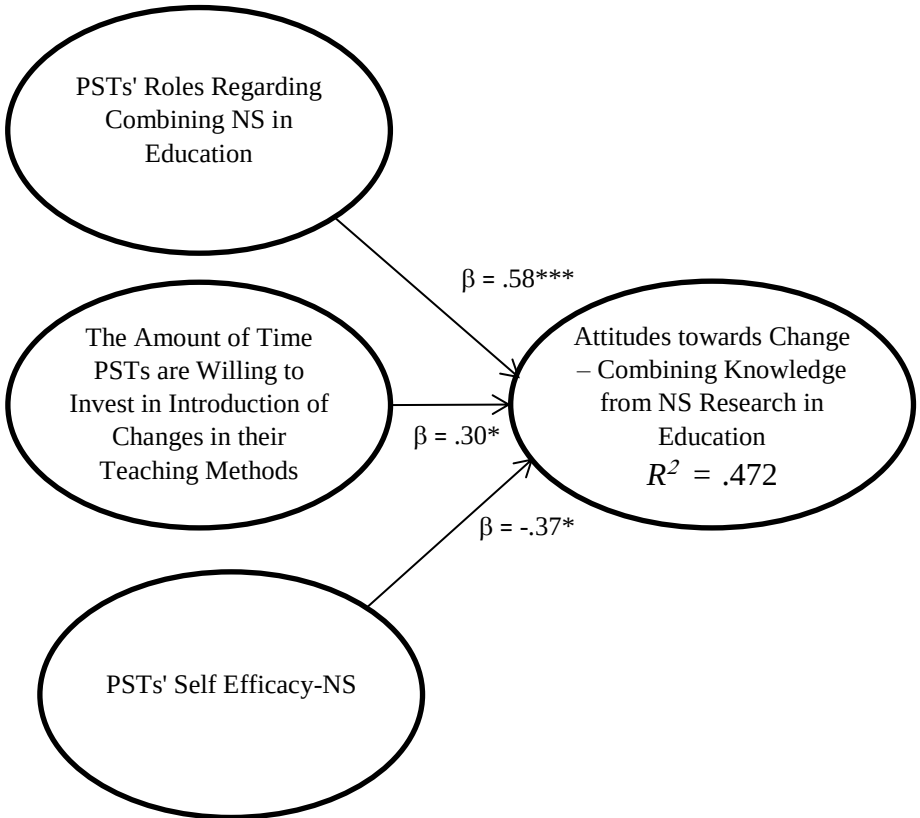


Figure 3.3.3. Multiple regression analyses for explaining the variance in PSTs' attitudes towards ng.

**** p < .05, *** p < .001***

According to figure 3.3.3, 47.2% of the variance in *PSTs' attitudes towards combining concepts from NE in teaching* is significantly explained by their perceptions of PSTs' roles regarding combining NS in education (β = .58, *p* = .001), the amount of time PSTs are willing to invest in the introduction of changes in their teaching (β = .30, *p* = .042) and PSTs' self-efficacy regarding using concepts from NE in teaching (β = -.37, *p* = .017); The **more** the PSTs agreed with their roles regarding combining NS in education, the **more** time they are willing to invest in the introduction of changes in their teaching, and the **less stronger**

is their self-efficacy regarding the use of concepts from NE in teaching – the level of favorability of the attitudes towards change – combining knowledge from NS research in education is **higher**.

3.3.5 Discussion, conclusions and limitations

The research findings indicate that the PSTs' self-efficacy regarding the use of concepts from NE in teaching is significantly higher among the Experimental group than before the intervention and the Comparison group after the intervention. These findings contribute to knowledge about the correlation between participating in a neuroscience training program and TSE, since research on this correlation are scarce. The findings contribute to the general knowledge regarding the effect of training programs to self-efficacy, and specifically to the importance of the NMTTP to raising the PSTs self- efficacy to use NE motifs in their teaching practice. When efficacy for teaching is high, teachers tend to utilize a variety of instructional strategies that are autonomy-supportive and positive for student engagement and achievement outcomes, even when faced with challenging situations (Duffin, French, & Patrick, 2012). Therefore, TSE is a variable which should be considered during PSTs' training. The TSE is shaped in the teacher-training phase, although it changes over time.

The findings from the second research question indicate that no significant differences were found in PSTs attitudes towards change – combining knowledge from neuroscience research in education after the intervention as compared to before it, in both research groups. One possible explanation for this finding might be due to the fact that both groups had positive attitudes toward combining neuroscience in education from the first place, and they both scored a mean of over 4 points (out of maximum 5 in a Likert scale) in the Before intervention phase. Similar findings are reflected in the literature (Şener, 2015). Another explanation of the findings might be due to the content knowledge of the experimental and control group. The descriptive statistics revealed that in the control group, about a quarter of the PSTs studied a previous neuroscience course, while in the experimental group only 4.7% studied a similar course. Since content knowledge may influence attitudes, it's a possible explanation for the similarity between the research and the control group (Smit, Weitzel, Blank, Rietz, Tardent, & Robin, 2017).

The multiple regression analyses for explaining the variance in PSTs' self-efficacy and attitudes revealed some interesting findings. Hence, 53.1% of the variance in PSTs' self-efficacy regarding the use of concepts from NE in teaching was significantly explained by their attitude towards introducing change in teaching methods and their attitudes towards change – combining knowledge from neuroscience research in education. Thus, the higher the level of favorability of the attitudes towards introducing change in teaching methods, and the lower the level of favorability of the attitudes towards change – combining knowledge from neuroscience research in education, the PSTs' self-efficacy in teaching is found stronger. These findings are interesting, since they present a gap between types of attitudes. A possible explanation may be grounded in Festinger Cognitive Dissonance Theory (1957) so the gap between what the PSTs wanted to present in the self- efficacy questionnaire might have been in dissonance with their beliefs about actual implementation of it, perhaps because they didn't have the feeling of confidence about their knowledge regarding neuroscience. In order to calm the dissonance, the PSTs might have declared a negative attitude toward the implementation.

The regression analysis also found that the more the PSTs agreed with their roles regarding combining neuroscience in education, the more time they are willing to invest in the introduction of changes in their teaching, and the less stronger is their self-efficacy regarding the use of concepts from NE in teaching – the level of favorability of the attitudes towards change – combining knowledge from neuroscience research in education is higher. While the first two components were positively associated with the attitude toward change in implementing neuroscience in education, the TSE component was associated in a negative connection. This finding was surprising in regard to previous studies found in the literature (Savolainen, Engelbrecht, Nel, & Malinen, 2012; Weisel & Dror, 2006; Yada & Savolainen 2017). However, contradictory findings can also be found in the literature. Lee, Cawthon, and Dawson (2013) posed the question: How does high TSE relate to pedagogical conceptual change? Results indicated that self-efficacy

was not necessarily predictive of greater integration of a suggested change in teaching methods. Rather, some teachers with high self-efficacy were found to implement at higher levels while others were not. The authors suggested that an explanation of this finding is due to personal stressful events, such as getting married or leaving home, which might influence TSE at specific time periods. This might also be a possible explanation for the finding in this study, since the PSTs in their second year of studies sometimes experience significant life events.

In terms of applied values, the research results may contribute to constructing training programs dealing with NE in other countries and cultures. Such programs should not only promote the importance of evidence-based teaching which will change teaching methods but will also pay attention to psycho-social characteristics of the people involved in the implementation of such a change. Moreover, longitudinal studies, which involve more support to teachers implementing change and perhaps more detailed observations should be conducted in order to better understand the impact of innovative teacher training programs on attitudes toward change and TSE concepts.

3.5. Study 5. Exploring the Individual Perceptions of the Implementation of the NMTTP: A Qualitative Study

3.5.1 Introduction

NE, as an innovation, demands changes in perceptions, teaching methods, curriculum, and attitudes. The essential role of teachers in implementing innovative pedagogical practices has been widely recognized by researchers and educators (Wu & Lui, 2015). At the same time, the characteristics of teachers, together with the characteristics of the innovation and features of environmental context, account for the outcome of diffusion of an innovation (Rogers, 2003; Shery, 2000). According to Wu and Lui (2015), teachers need to understand the innovation and reduce uncertainty about their advantages and disadvantages. Therefore, there is a great importance to explore the perceptions of those who are involved in the implementation of innovation, and observe the process from their points of view. While the previous study focused on the PSTs' self-efficacy and attitudes toward implementation of neuroscience in education, the purpose of this study (Study 5) was to explore the processes and perceptions of the PSTs and lecturers throughout the implementation of the NMPPT, as well as the implementation of neuroscience motifs in practice.

The **main goal** of this research is to investigate the perceptions of PSTs following their participation in the NMTTP in Israeli colleges directed to prepare PSTs to work in schools for students with special needs. In addition, this research is interested in the experienced lecturers' point of view, after implementation of neuroscience motifs in their reading courses for the first time. The research aims are reflected in the following research questions: 1) What are the perceptions of the PSTs and lecturers regarding the implementation of motifs from neuroscience in education and teaching? 2) How do PSTs assimilate motifs from neuroscience in planning lessons and teaching special education students?

3.5.2 Methodology

In this study, a qualitative research approach was used to collect data about the perceptions of PSTs and lecturers the NE and the NMTTP after participating in the training program in the reading course for special education PSTs. A deep analysis of the personal point of view from multiple tools texts can lead to thematic composition and categorization into themes, to deepen the understanding of the implementation process.

Participants

The research includes 2 groups of participants: The PSTs group and the lecturers group. The PSTs group included 11 PSTs studying in an educational college in the centre of Israel, from the experimental group which participated in the NMTTP. In the lecturers' group, the 3 lecturers who participated in the NMTTP were interviewed in the middle of the academic year (2017-2018) and at the end of it. Y is 60 years old, a very experienced lecturer with 25 years of teaching experience. D is 40 years old, and has experience of 5 years in teaching in higher education. She has training and experience as a didactic diagnostician. E is the researcher of this study. She's 40 years old and has 7 years of experience in teaching in higher education as well as working as a pedagogic instructor. She is also a trained and experienced didactic diagnostician. She was the only of the lecturers who held these two positions throughout the period of the research.

Research tools and data analysis

Several tools have been used in the qualitative research: **Semi-structured interviews** at the end of the academic year 2017 -2018 (June to July, 2018) with 11 PSTs from the research group. In addition, in the middle of the academic year and at the end of it interviews took place with the 3 lecturers involved in the study. **Stimulated recall interviews:** In this study, stimulated recall interview was performed with the lecturers as research participants. After all the interviews with the lecturers were conducted and analyzed, the three lecturers met with a secondary researcher for reflection on some parts of the interviews and they were asked to relate to suggested themes identified after the analysis process. **Document analysis:** In this study submitted lesson plans were part of the PSTs obligations. The lesson plan analysis was conducted with the aim of identifying and characterizing neuroscience motifs that appear in the rationale for a lesson or a course description, if found, so the initiation point is etic- from the theory to the field. **Open-ended question**: In this research, open- ended questions were presented to the PSTs in the research group as non-mandatory questions in a mid-year and final-year home test.

In this study, the **content analysis method** is applied, in which there is usage of text segments which lead to theme categories (Shkedi, 2011). Also, a **systematic content analysis** of the lesson plans was according to the main concepts that were identified in the literature review, meaning it was focused on the criteria (etic). According to Shkedi (2011) in the methodological pattern that focuses on criteria, the categories come directly from the theoretical framework of the study, are determined at early stages of the study and remain stable throughout the study.

3.5.3 Findings

Research findings regarding the 1st Research Question:

With regard to the research question, the **categories** that emerged from the qualitative analysis of the PSTs' interviews were: attitudes toward NE (NE importance, relevance and contribution attitudes toward the structure of the NMTTP and the affective component of attitudes as reflected in fear and stress) and the NMTTP and knowledge (Fig. 3.5.1).

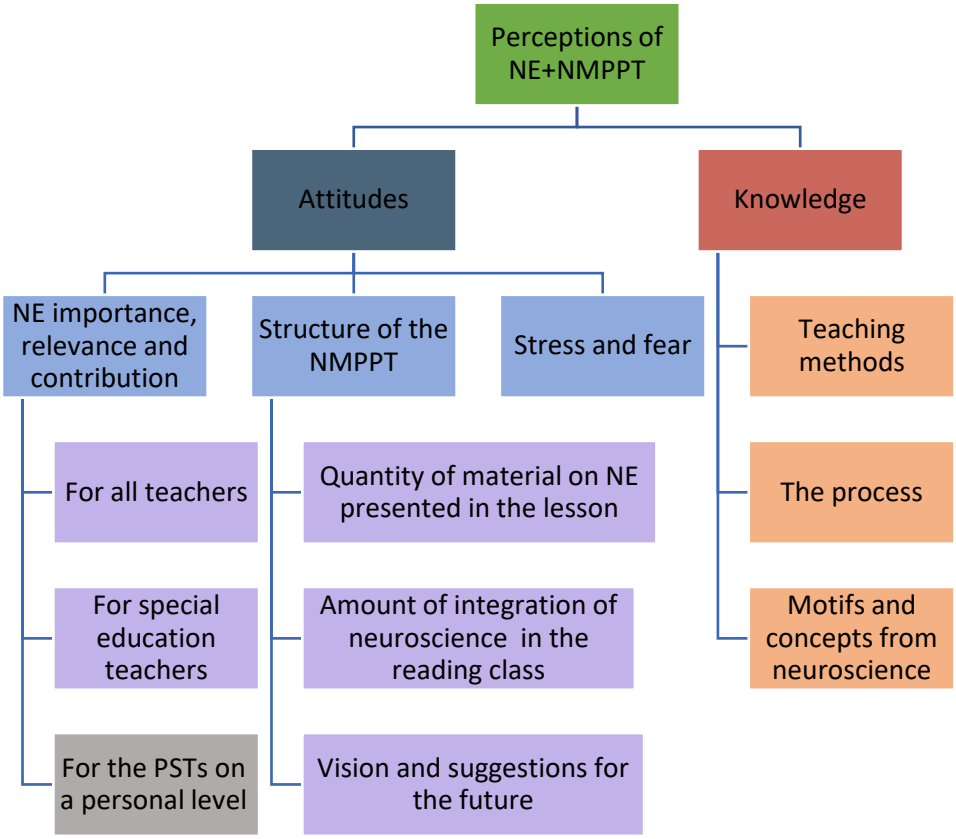


Fig. 3.5.1 Categorization of the findings from the interviews with the PSTs (qualitative study).

Within each of the two categories, several themes emerged from the study of the PST's perceptions of NE+NMTTP. Figure 3.5.1 illustrates the relationship between the categories and the themes that emerged from the PST's interviews and open- ended questions in the exam and that will be expanded upon in this section.

Category PSTs Attitudes toward NE importance, relevance and contribution

Generally, the PSTs presented positive attitudes toward NE, as reflected in the presentation of its importance, relevance and contribution to all teachers, special education teachers and positive attitudes of the PSTs toward NE relating to themselves.

Category Structure of the NMPPT

The PSTs were interested in the quantity of neuroscience in the reading class. Their answers reflected a variety of attitudes, but mostly they express their attitudes toward the part of neuroscience in the lesson as being too short, due to pressure of time. Regarding the amount of integration between NE and the reading course, the answers reflect attitudes with a general positive direction toward the integration of neuroscience in the reading course, and it seems the general experience was that of a good integration between neuroscience and reading throughout the course, thought other voices reflecting sense of non- integration were sounded as well.

Fear and stress

This theme reflects the affective component of the attitudes. It reflects the inconvenience, stress and fear especially in the beginning of the course, when a lot was unknown. Sometimes, they present doubts in the PSTs perceived ability to succeed in learning neuroscience motifs.

Category Knowledge of PSTs after Participating in the NMTTP

The themes developing from the "Knowledge" category reflect understanding of the concepts presented in class and their connection to different teaching methods. This connection was also reflected in what the PSTs had to say about the process in general, and the thinking paths after the NMTTP as being a part of them.

Quantification of the findings of the qualitative analysis yielded a frequency table of the neuroscience concepts raised from the PSTs' answers. The answers were content-analyzed in order to produce neuroscience terms related to teaching and learning. The distribution of the terms and their categorization is presented in Table 3.5.1 and Figure 3.5.2:

Table 3.5.1: Frequency (number and percentage of occurrences) of the neuroscience terms in the PSTs' home tests.

Concepts	Frequency (Number of occurrences)	Category percent of total	Percent of category
Total	140	100%	
Physiological terms	80	57%	100%
Neuroplasticity	27		34%
Synaptic connections	20		25%
Neuron	14		18%
Synapse	9		11%
Mirror neurons	4		5%
Gray matter	4		5%
Hemispheres	2		3%
Teaching/learning processes	26	19%	100%
Learning in context	9		35%
Spaced learning	7		27%
Rehearsals in teaching	4		15%
Diverse teaching methods and neuronal activity	4		15%
Attention and the brain	2		7%
Combined - Physiological terms and Teaching/learning processes	23	16%	100%
Neuromyths	7		30%
Neurological deficit and dyslexia	5		22%
The limbic system and learning	3		13%
Imaging studies	4		17%

Neuropsychology	2		9%
NE	2		9%
Cognitive physiological/ psychological processes	11	8%	100%
Metacognition	5		45%
Memory	3		27%
Physical activity and the brain	1		9%
Information processing	1		9%
Morphological changes	1		9%

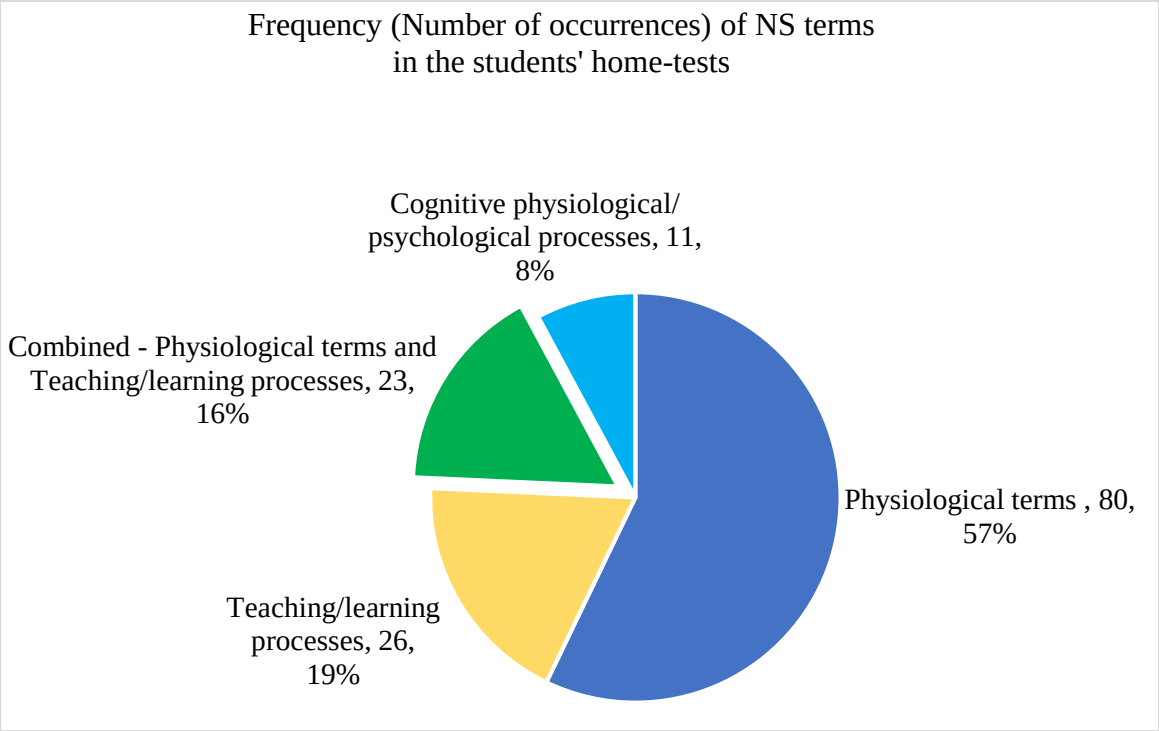


Figure 3.5.2. Frequency (number and percentage of occurrences) of the NS terms in the PSTs' home tests by category.

The frequency table and figure reflect the diversity of answers raised from the PSTs, which reflect the vast range of concepts they were exposed to. Some concepts were only mentioned once, but it seems they left great impression, such as Mirror Neurons or Neuromyths.

In the explanations of the concepts, there was an emphasis of the importance of neuroscience in teaching and its implementation in applying teaching methods

Qualitative analysis of the lecturers' perceptions

Following the content analysis, three main themes emerged from the interviews with the lecturers, all dealing with the lecturers' attitudes:

1. Attitudes toward methods (the different teaching methods used in the NMTTP, the way the course was taught);
2. Attitudes toward content (the different motifs from neuroscience in the course and the integration with the reading course);
3. Attitudes toward relationships and communication (the relations between the lecturers and especially with the leading lecturer).

Generally, the findings present the attitudes of the lecturers as complex and ambivalence, with major differences between the different lecturers. The themes present the complexity of the gap between being a full partner in an innovative program vs. being a partner who joins an existing idea.

Research Findings Regarding the 2nd Research Question

The findings from the document analysis of the lesson plans raised several evidences for implementation of neuroscience in the lesson plans for students with learning disabilities. The main themes emerging from the analysis regarded four main topics which were recurring between different lessons of the PSTs: 1) The importance of learning in context and synaptic connections, especially in the beginning of the lesson; 2) Multi-Sensory Activities for presenting and rehearsing learnt material; 3) Active Learning of the students during the lesson; and 4) Metacognition in learning.

3.5.4 Discussion and Conclusions

Generally, the PSTs agreed that introducing neuroscience into education and teaching is important, relevant and contributes to decision making in class as well as in choosing teaching methods. Based on examination of their interviews and test- answers, some of the PSTs presented this knowledge as crucial for their learning and professional development. For example, M.S.B said: *"I believe with all my heart that neuroscience and education are interdependent. What I don't understand is how something so obvious was not part of my knowledge until this course"*.

Attitudes of PSTs and lecturers to the NMTTP and NE

i. Importance, Relevance and Contribution of NE and the NMTTP

The positive attitudes toward NE and the NMTTP as reflected from the PSTs answers fitted in many ways with previous findings in the literature that report on teachers' enthusiasm for NE (Pickering & Howard-Jones, 2007; Serpati & Loughan, 2012). This importance of neuroscience knowledge was also reflected in an overlapping theme which regarded the emphasis of PSTs on ***teachers' obligations***. The PSTs thought that not only is NE is important and relevant, but they believed it is the teacher's obligation to learn about the brain. This research expands the current literature on two additional points. It emphasizes the NE importance, relevance and contribution for *special education teachers* in particular, and also sheds light on an interesting and unexpected point of the importance, relevance and contribution to the *PSTs on a personal level*, as perceived in their attitudes. Regarding the relevance and contribution for special education teachers in particular, the qualitative analysis reflects researches that support the possible contribution of NE to special education, considering that neuroscience may have profound implications for individuals with disabilities, research from the neuro- and cognitive sciences have the potential to improve pedagogical practices and develop creative problem-solving abilities (Boomgard, 2013; Carew & Magsmen, 2010; Hassinger-Das, Hirsh-Pasek, & Golinkoff, 2017; Kosaraju, Gorman & Berry, 2014). As to the relevance and contribution on a personal level, it seems that the exposure to the way the brain learns and remembers influenced the PSTs.

In the investigation of the perceptions of the **lecturers**, the presentation of attitudes toward the NMTTP and NE was much more complex. Throughout the interviews, the attitudes toward the NMTTP in particular and NE in general were often presented in an ambiguous and ambivalent way, especially from the two lecturers who joined the training program. This ambivalence might reflect the gap between the professional/ personal state of the lecturers and the innovative change that NE requires of them. It might also reflect the gap between the leader of change or innovation, and those who are expected to join him/ her. While the leader lecturer of the NMTTP, E, presented strong positive attitudes supporting NE, the other lecturers, D and Y were more ambivalent. The lecturers in teacher training colleges function as teacher of teachers. According

to the scientific-professional view, educators and teacher educators are required to learn and develop, to stay professional and to keep abreast of innovations on a regular basis (Darling- Hammond, 2005). The current research suggests some difficulties of the lecturers in implementation of the NE in their courses. One explanation might be connected to their willingness. Although the two teachers who joined the training program presented their willingness and support, it seems that their motive was external in helping the leading lecturer, and not internal, from an inner belief in the importance and contribution of the field.

ii . Structure of the NMTTP

The interviews revealed that the PSTs had general positive attitudes toward the structure of the NMTTP, though some claimed that the amount of time specified for it in the lesson was too short or non-significant. The implementation of the NMTTP in the reading course was due to the researchers' experience, consideration and will to implement the neuroscience motifs in a context of a specific content, in order to ease the transition and use of the concepts from neuroscience into practice. That decision made the course interdisciplinary in a way, in contrast to other NE courses, which are taught separately from a specific content (e.g. Blake & Gardner, 2007; Warner & Tempelton, 2010). Required interdisciplinary courses have become an increasingly standard curriculum feature at many colleges and universities (Rhoten, Mansilla, Chun & Klein, 2006). However, interdisciplinary courses also have their difficulties and disadvantages (Goodman & Huckfeldt, 2014). The lecturers also presented a mixed/ ambivalent picture regarding the integration of neuroscience in a reading course. The gap between the lecturers regarding the integration theme might be explained by gaps in knowledge, as will be explained ahead in the "knowledge" theme.

iii. Affective component of attitudes

Some of the PSTs reports on feelings of stress and fear, especially in the beginning of the year and in relation to the NMTTP. The concepts from the neuroscience field, seemed long, irrelevant and frightening, according to the qualitative analysis. On the personal level, changes elicit both skeptical and enthusiastic responses: people who describe change processes use expressions of anxiety and fear, danger, loss and panic, along with expressions that indicate high energies, transcendence, risk-taking and great excitement (Fullan, 2007). Studies show that general education PSTs have concerns related to limited knowledge and preparation in many areas (Tillery, Varjas, Meyers & Collins, 2010). Sandholtz (2011) found that PSTs are concerned about teaching strategies, planning and organization, behavior management, collaboration, and working with diverse students and families. Despite the expression of fear, stress and concerns regarding NE, one possible contribution of the NMTTP might be in reduction of these feelings of stress and fear, since they were reported in a retrospective meaning.

Category Knowledge of PSTs after Participating in the NMTTP

The qualitative finding concerning the PSTs and lecturers interviews and test- answers regarding knowledge after participating in the NMTTP show that the PSTs considered their participation in the NMTTP had increased their knowledge in three areas: (1) knowledge related to teaching methods, (2) knowledge related to the process of implementation of NE in teaching and education and (3) knowledge related to motifs and concepts from neuroscience. These findings are in line with the literature, for example Coch (2018) claimed that knowledge about student's learning and learning environments might be included in pedagogical content relating to two components of the pedagogical content knowledge in PSTs: (1) knowledge about subject matter; (2) knowledge about students and learning. Some of the PSTs related the process of learning about neuroscience as experiencing an entrance to a new world, that once you entered, it becomes a part of the way you think; some even described it as an experience on an unconscious level.

In general, it has been shown that PSTs who participated in the NMTTP demonstrated a variety of concepts acquired in the training program, and they also knew how to explain them and their applications in teaching. Apparently, it seems that there is a great importance of acquiring knowledge on the shaping of the PSTs attitudes toward NE and the NMTTP. Van der Linden et al (2015) concluded that it appeared possible to positively change PSTs' beliefs and attitudes toward research, while developing their research knowledge in the second year of their education. Also, according to Friedman et al (2019), it is important that teachers and educators be equipped with basic knowledge of neuroscience and familiarity with brain structure and

function, abilities and limitations. This is so that they can understand, appreciate and apply the principles of learning and its methods.

The theme of knowledge was also reflected in the lecturers' points of view, and might be one of the most important explanations for the gap between the lecturers regarding their attitudes toward NE and the NMTTP. The themes of content and methods from the lecturers' study, both from the internal and external points of view, emphasize the sense of lack of knowledge and its impact, and may express the confusion and sense of unfamiliarity the lecturers who joined the study felt. According to Rogers (1995, 2003) diffusion of innovation starts from knowledge, when an individual becomes aware of the innovation by being exposed to it. However, in the beginning, there is insufficient information. Only after, the novelty becomes interesting and intriguing to the individual, but he has not yet examined its effectiveness and contribution to the concepts of his personal needs. At this point, the individual's conscious component is involved. The lack of knowledge on neuroscience might have caused the two lecturers to skip to the phase where the NE as a novelty is interesting enough to learn more about it.

Implementation of NE in practice

The findings outline the PSTs' experiences of implementation and their explanations for their choices, as reflected from the qualitative analysis of the interviews and the document analysis of the lesson plans for students with special needs. The findings point out to a partial success of implementation of motifs from neuroscience in teaching. The PSTs related to implementation of motifs from the neuroscience field, in an entire classroom setting or working with an individual student. Beyond mentioning the specific use of a concept or teaching tool or method, what matters is the emphasis of an established rationale the PSTs gave to their choices. Four main issues were rehearsed throughout the samples of the lesson plans': the importance of learning in context and synaptic connections, especially regarding the beginning of a lesson; multi- sensory activities in learning; active learning; and metacognition in learning. Learning in context, which was mentioned due to its importance in developing synaptic connections while learning and neuroplasticity, is one of the core motifs of the NMTTP. The relatively high number of references of it indicated its importance from the PSTs' point of view and success of its implementation. Active learning and learning through multiple senses were studied in the course theoretically as well as in practice with modeling and experience.

For more than a decade, researchers and experts from the NE field claimed that there is sufficient research with direct relevance to educational practice. These experts worked to bring this knowledge to teachers and educators, including working methods and directions based on brain research, and suggested ways to apply them in teaching and learning (Ansari, De-Smedt, & Grabner, 2012; Blakemore & Frith, 2005). Neurological insights from the field of brain research may have a potential contribution to promoting teacher work and improving student learning. This research, which took the challenge of presenting implementation of NE in practice, may in some way refute the arguments voiced about the lack of need or the futility of applying brain research findings to teacher work (e.g Bruer, 1997). Yet, it's important to remember that overgeneralization with respect to classroom application of both behavioral and neuroscientific laboratory findings, without appropriate translation, is not right. One must notice that a causal chain of reasoning from a basic neuroscience fact to a teaching method is often weak, because of the variance between peoples' brains (Coch, 2018).

The psycho-social characteristics of the participants, such as their attitudes in the PSTs study, or the sense of knowledge and control from the lecturers' point, seem to have a significant and crucial importance in the integration process of the NMTTP and the specific motifs in the core of it. The context of the environment of the participants must be taken into consideration in implementation of such training programs.

The qualitative paradigm has its limitations as for the analysis and sample population of the study. Eleven PSTs and three lecturers were included in the interview group as a sample of the research population following the NMTTP. As such, the limitations of the analysis are based on the findings from the interviews were of specified PSTs who had participated in the NMTTP. Nevertheless, the research population can be considered as adequately representing the research phenomenon of PSTs in their second year of studies in the special education track, and providing reading lessons for students with learning disabilities, even though the sample population may not reflect the general population. Regarding the lecturers, the research

dealt with only three lecturers, including this thesis writer. Since the psycho-social characteristics of the participants have much impact on implementation of processes, other researches should examine the teachers of teachers' point of view in other contexts. Only few intervention programs concerning NE exists in Israel, and a major factor that is currently lacking in most NE programs is exploring the attitudes, self-efficacy, knowledge and implementation in practice. The contradictions found in this research between attitudes and actual practice emphasize the need for a clear explanation of PSTs perceptions, as these are a significant factor in implementing the change. Also, the attitudes of the lecturers/ teachers of teachers may have much impact on the PSTs' approach to NE.

3.6 Triangulation of the qualitative and quantitative data

Triangulation refers to using more than one particular approach when doing research in order to get richer, fuller data and/or to help confirm the results of the research (Wilson, 2014). Denzin (1978, in Flick, 2002) defined methodological triangulation as a combination of multiple methods to study the same social phenomenon, and Jick (1979) referred to it as "across methods triangulation" which involves quantitative and qualitative approaches which complement each other. When using mixed methods, as in this study, the data is first collected and consequently analyzed separately, comparing the results at a later stage. In this thesis, the triangulation is presented in relation to the applied questions of the main quantitative and qualitative researches: Research 4 and Research 5.

The research questions of Study 4 were (1) Is there an impact of the NMTTP on the PSTs' *self-efficacy* and *attitudes* relating to using NE motifs in teaching, following an NE training program? And (2) Which variables can significantly explain the variance in PSTs' *self-efficacy* and *attitudes* regarding using NE knowledge in teaching?

The quantitative study produced data on the impact of the training program. The level of self-efficacy regarding the use of concepts from NE in teaching was significantly higher among the participants of the Experimental group before the intervention and the Comparison group after the intervention. The qualitative study supports these findings, as reflected in the theme of the importance of NE and its contribution and relevance to the PSTs on a personal level. In this theme, there was a reflection of the contribution of the NMTTP to the sense of capability the PSTs reported in planning their lessons that included motifs from neuroscience for special education pupils, and also contributed to the PSTs themselves as learners.

When analyzing the variables that explained the variance of the quantitative findings, it suggested that the higher the level of favorability of the attitudes towards introducing change in teaching methods, and the lower the level of favorability of the attitudes towards change – combining knowledge from neuroscience research in education - the PSTs' self-efficacy in teaching is found stronger. One explanation was grounded in the possible anxiety and low self- confidence of the PSTs regarding their knowledge in neuroscience. The interviews from the qualitative study shed light on this point, as presented in the theme dealing with the affective component of the attitude, or specifically in this study, stress and fear. The quotes of the participants present the inconvenience, stress and fear especially at the beginning of the course, when the unknown was prevalent. At times, they presented doubts in the PSTs perceived ability to succeed in learning neuroscience motifs.

Regarding the PSTs attitudes, the qualitative research findings indicate that no significant differences were found in PSTs attitudes towards change – combining knowledge from neuroscience research in education - after the intervention as compared to before it, in both research groups. One possible explanation for this finding was grounded in the favorability of the attitudes found in the initiation point of this study. The enthusiasm toward implementation of neuroscience in education was reflected also in the qualitative study, in the different categories reflecting the importance of NE and its relevance and contribution as perceived in the PSTs quotes. Also, at the end of the academic year, PSTs' perceptions of teaching as evidence based were significantly higher than at the beginning of the year, before the intervention, in both groups. This finding may indicate professional growth of the PSTs during their 2nd year of studies and was reflected in the qualitative study as well during which the PSTs constantly reminded about the importance of evidence- based knowledge for rational based decision- making in planning and teaching.

In analyzing the variables that significantly explain the variance related to the attitudes, it is suggested that one of the factors explaining this variance is that PSTs' agree with their roles regarding combining neuroscience in education. This issue was very dominant in the qualitative study. Besides the mentioned categories of NE importance, relevance and contribution, the PSTs emphasized the obligations of teachers to learn about the brain and its function, as part as his/her professional growth, implying both the importance of the personal role of NE implementation and a more general view on teachers' roles.

Using a mixed methods study including qualitative as well as quantitative methods yielded deeper insights into the impact of the training program.

The research questions of Study 5 were: (1) What are the perceptions of the PSTs and lecturers regarding the implementation of motifs from neuroscience in education and teaching? (2) How do PSTs assimilate motifs from neuroscience in planning lessons for special education students?

The general positive attitude toward implementation of neuroscience in education from the PSTs perspective as reflected in the quantitative and qualitative studies was discussed above, and may indicate that acquiring information on brain research and education contributes to a sense of security and professional control and a sense of perspective, patience, and empathy towards challenging students who do not cooperate or who may interfere, as suggested by Hook & Farah (2013). These findings are especially important in the context of special education, because the unique qualities of each student are crucial for adaptive teaching and learning. Nevertheless, the quantitative study presents complex relations between self-efficacy and attitudes, which did not always follow the expected correlation as presented in the literature. This complexity was also reflected in the qualitative study, whereas despite the general positive attitudes toward NE, some inconvenience, doubts and hesitations were reflected, especially regarding the structure of the NMTTP. It is possible that these feelings and doubts also influence the complex relation between the PSTs' self- efficacy and attitudes as mentioned above. The lecturers' study, which used only the qualitative methodology, also shed light on the complexity of attitudes toward NE and the NMTTP, as reflected in their ambivalent attitudes and ambiguousness, especially due to the absence of sufficient knowledge in the NE field. The joined findings dealing with the PSTs' and lecturers' perceptions indicate once again the importance of the psycho- social aspects of those involved in the process of implementation.

An interesting issue raised while exploring the PSTs' perceptions which related to high order thinking and metacognition. The PSTs presented their perceptions of NE as a facilitator for high order thinking specifically with reference to metacognitive thinking. In practically implementing NE in their lessons, the topic of metacognition recurred, although with a relatively low number of demonstrations. The importance of metacognition was reflected through emphasis in the NMTTP, nevertheless showing the complexity and difficulty in implementation as reflected in Study 1.

The systematic literature review presented the importance of metacognitive reading strategies for students' achievements in special education, but also presented the lack of studies in this field. One proposed explanation is because of the complexity of different sub- concepts in the field of metacognition, un-unified assessment tools and a variety of suggested metacognitive strategies. The importance of metacognition was reflected both in the systematic literature review and the PSTs' perceptions, however the "fuzziness" of the metacognition concept might be reflective of some of the difficulties of implementing it in practice.

CHAPTER IV: DISCUSSION AND GENERAL CONCLUSION

4.1 Discussion of the findings from the research thesis

The purpose of this doctoral thesis was to develop a neuroscience motif-based teacher training program, and to investigate the psycho-social aspects associated to the implementation of the program for special education pre-service teachers. Also, the doctoral thesis aimed to investigate the implementation of the training program in practice, and to explore the attitudes of the experienced lecturers' participating in the process toward the program and toward neuroeducation from their point of view.
The findings of the study can be summarized as follows:

- The findings of the systematic review show the diversity of metacognitive strategies (MRS), tools and ways of assessment, and despite the variance among the studies, it can be concluded that MRS intervention programs contribute to special education students' achievements. The findings also indicate that there is a need for formal MRS programs for students with special needs, and that the concepts in the field of metacognition are "fuzzy" and sometimes incoherent. The research findings inspired the choice and centrality of one of the two main motifs included in the design of the NMTTP, which is metacognition to which learning in context was added.
- The TSEATNE package of questionnaires (Teacher Self-Efficacy and Attitudes Toward Change Regarding Neuroeducation Implementation Questionnaires) was developed and found to be a valid and comprehensive package of questionnaires, which could be further used to explore the understanding of PSTs' attitudes toward change and self-efficacy in implementing neuroscience in teaching, in the context of special education in Israel but also in other cultures throughout the world.
- The quantitative study indicates that participation in the NMTTP clearly affects the PSTs' self-efficacy to use concepts from neuroscience in education practices. In addition, the findings shed light on the different connections between PSTs' self-efficacy and attitudes toward change. The results indicated significantly positive relations between participation in the NMTTP and the impact on PSTs' self- efficacy to implement neuroscience in education. The expected difference between attitudes before and after the training program was not found, and the different factors explaining the variance were discussed.
- The qualitative study expanded the findings from the quantitative study by relating to the attitudes theme in detail. Most of the attitudes toward NE and the NMTTP relating to importance, relevance and contribution in general and in the context of special education were positive and may indicate a high commitment to the process of assimilation with emphasis on its importance. Participation in the course was shown to change attitudes to the PSTs' own capabilities as well as their attitudes to their students. Participation in the NMTTP or similar training programs may therefore impact upon teachers' willingness and abilities to teach according to NE principles. However, a variance in the PSTs answers regarding the structure of the NMTTP and the affective component of stress and fear may have influenced the complexity of the general attitude toward change and implementation of NE as reflected in the quantitative study.
- The qualitative study indicated that participation in the NMTTP led to increased knowledge on NE topics. The concepts that were learnt and retrieved created a new way of thinking and phrasing, and therefore it is strongly recommended that courses from different fields designed to increase knowledge of teaching methods and interdisciplinary topics should be incorporated into all teacher training programs in colleges. The findings presented implementation of knowledge from the NMTTP, regarding the core motifs (learning in context and metacognition) among many others. It seemed that although some concepts were only exposed once, they left a great impression. However, the implementation of the concepts in practice was partial, and it seems there is a need for more time for diffusion. The implementation was reflected through specific use of a concept or teaching tool or method as well as emphasis of an established rationale the PSTs gave to their choices. The findings from the lecturers' study presented an ambiguous, ambivalent and complex picture of attitudes toward NE and the NMTTP, and the gap between the perceptions of the different lecturers may indicate the complexity of diffusion of innovation in the teacher of teachers' context.

The qualitative study revealed the deeper psycho-social aspects of participation in the NMTTP, highlighting the positive perceptions of the PSTs involved in the study which also reflected their stress and fear as inhibitors. The analysis of the interviews and exam-answers revealed that the PSTs considered NE as important, relevant and with different contributions to all teachers, to special education teachers specifically

and also to the PSTs on a personal level, and they were empowered on a personal and professional level after participating in the NMTTP. The affective component of attitudes of the PSTs reflected stress and fear retrospectively at the beginning of the year which was replaced by positive attitudes, a sense of obligation and commitment as well as partial implementation in practice. They also felt that they had received important teaching methods and a rationale to use them, thus improving their ability to choose wisely in their decisions relating to lesson plans and teaching.

The reflections of the qualitative study emphasized the importance of the psycho-social aspects of participation in the NMTTP designated for PSTs in the special education track and in general tracks. On the one hand, the PSTs presented positive attitudes toward the implementation of neuroscience to teaching and education and even considered it as valuable knowledge that should be obligatory for every teacher to be able to follow its principles. On the other hand, the implementation in practice was partial, perhaps since the diffusion of changes takes time and calls for a higher self- efficacy of the PSTs.

In addition, although the PSTs presented knowledge acquired in the training program directly and indirectly, it still may be considered that a lack of knowledge might have influenced the implementation in practice. Therefore, it is concluded and strongly suggested that further development of curricula for teaching NE in general and special education in particular, should always be accompanied by programs which consider the psycho- social characteristics of their participants such as attitudes and self- efficacy, as well as cognitive components such as their former knowledge. This component was also mentioned constantly in the lecturers' study, relating to the gap in the knowledge between the leading lecturer who designed the training program and the two additional lecturer who joined it. An important conclusion points to the importance of training the staff to deliver these programs, and also to closely examine their attitudes toward the innovation or change, as these influence their willingness to be full partners in implementing it.

4.2. Theoretical Implications and Findings according to the research questions

Study 1: *What is the current state of knowledge regarding metacognitive reading intervention programs for special education students?*

The initial literature review revealed that despite the assumed importance of metacognitive reading strategies (MRS) for children with special needs, the application of MRS as an intervention program has attracted little attention in the field of special education, and most of the research was focused on poor readers. In general, good learners employ strategies more consciously, more purposefully, more appropriately, and more frequently than do poor learners (Oxford & Nyikos, 1989; in: Pammu, et al, 2014; Tokuhama-Espinosa, 2010). According to Zohar & David (2008), although using metacognition appears to be efficient for all pupils, it can have major influences on those with low achievements. Therefore, students with low achievements and/or special needs may benefit greatly from intervention programs focused on teaching metacognitive knowledge, and improving teaching and learning strategies and methods, in order to enhance the ways pupils with special needs deal with reading and comprehension. The findings from the review inspired choosing the *Metacognition* concept as a core concept of the NMTTP, aimed for PSTs in special education.

The systematic review also revealed a diversity of the participants' age, the specific population chosen for each study, and diversity in the chosen tools and ways of assessments, although all were aimed for assessing academic performance of students. Also, the systematic review raised an open question regarding the possible influence of the diversity of the origin countries where the reviewed studies were conducted on the use of different metacognitive strategies in different cultures as a result of the socialization processes since school institutions, parents, teachers, and peers may play different roles in this socialization process in different cultures (Wiley & Güss, 2007). However, the review showed a gap in knowledge on this point, since researches of cross- cultural MRS programs or comparative researches between different countries are scarce.

The study presented a methodological and theoretical challenge, since only few studies were found after using the inclusion criteria. This might indicate a relative lack of the evidence-based research in the field of MRS intervention programs, but it also might be explained by the heterogeneity of the concepts and its dimensions, and a larger number of studies might have been revealed if other concepts would have been

chosen for this review. The term "metacognition" and "metacognitive strategies" was presented in the NMTTP in relation to specific brain- imaging studies (Baker et al, 2014; Moss et al, 2013) and also as an effective teaching method, but it wasn't retrieved as expected in lesson plans. One possible explanation of it was the "fuzziness" of the concept, as reflected in this study.

Study 2: *What are the psychometric properties, i.e. validity and reliability, of the questionnaires which will be used as the tool package in Study 4**?***

The second study was dedicated to developing validation and reliability tests of a tool package of questionnaires, i.e. TSEATNE (Teacher Self-Efficacy and Attitudes Toward Change Regarding Neuroeducation Implementation Questionnaires), intended to expose differences in PSTs' self-efficacy and attitudes toward change, regarding implementation of neuroscience in education, between an experimental and a control group. The only few studies which dealt directly with teachers' attitudes toward NE revealed enthusiasm to the field (Pickering & Howard- Jones, 2007; Serpati & Loughan, 2012). The mentioned authors suggested the Teacher Perception of Neuroeducation Questionnaire, which its version was used in this study. Yet, a wider view of PSTs' attitudes toward NE as a change or innovation was missing, despite the crucial role of attitudes in implementation processes and the difficulties in embracing changes (Fullan, 2007; Mariage & Garmon, 2003; Maskit, 1998; Maskit, 2011). In addition, a Hebrew version, with specific reference to NE, was needed.

Statistical measures of the TSEATNE questionnaires that indicated good psychometric characteristics of the sub-scales and of the global scale, i.e. Cronbach's Alpha values above 0.72, thus positioning the questionnaire as an appropriate measure tool for examining the psycho- social differences between the experimental and control groups.

The theoretical implications of Study 2 is aimed at expanding the tool packages relating to attitudes and self- efficacy regarding a wider diversity of variables than was presented so far in the literature in the context of NE. The tools allow examining the impact of innovative teaching methods, thereby making a valuable methodological contribution to the examination of the impact of these innovative teaching methods on cognitive, emotional and behavioral variables such as attitudes and self-efficacy. Korthagen & Vasalos (2005) claimed that it is very difficult to change the preconceptions, images and assumptions that PSTs bring with them. However, others argue that they can be changed through the process by which PSTs are directed toward establishing the professional knowledge of teaching. This is done through the training process that avoids forcing attitudes but aims to develop a professional identify and reveal preconceptions while focusing on reflective discourse to examine them (Yayli, 2007).

Study 3: This study described the development and implementation of the Neuroscience Teacher Training Program (NMTTP). The literature in the field of NE reflects a gap in searching for a single theory dominating the field, and a great deal of effort and resources was dedicated to systematically define the nature of theory and theorizing in the field (Nouri, 2016). The NMTTP relied on existing models that describe the relations between neuroscience and education (Anderson, 2014; Hardiman, 2012a; Kosaraju et al, 2014; Tommerdahl, 2010) Thus, the NMTTP relied on the existing models in the literature in creating an original curriculum training program for PSTs in the special education track.

The decision to construct the training program was based on a need presented in the literature that reflected an attempt to implement neuroscience knowledge and research findings into pedagogy and classroom teaching for advancing teaching and learning (Friedman, Grobgeld & Teichman- Weinberg, 2019; Murphy, 2017). Furthermore, the NMTTP was in line with the literature claiming that there is a growing sense among educators that neuroscience can serve as an important turning point in initiating evidence-based pedagogical and educational practices, which in turn will serve to empower teachers' professional performance, in general and special education (Ergaz et al, 2018; Hardiman, 2012a; Kosaraju et al, 2014). The NMTTP also tried to give answers to doubts presented in the literature regarding the general connection between neuroscience and education, and specifically neuroeducational curriculum (Bruer, 1997; Clement & Lovat, 2012; Crifaci et al, 2015; De-Vos, 2015). The NMTTP contributed on the theoretical level by reviewing the current training programs in the NE field, expanding them in particular aspects and strengthening the claim that bridging between neuroscience and education is possible. The NMTTP suggested an organized evidence-based program with a rationale and suggested teaching methods, that have particular adjustments

for students with special needs, and might be useful for PSTs who are entering the teaching field. In addition, the NMTTP presented an interdisciplinary perception, and encouraged high order thinking and critique which may prevent connecting neuroscience and education directly without carefully using judgement in decisions used in the educational processes. (Blakemore and Frith, 2005; Tokuhama-Espinosa, 2010).

Study 4: *(1) Is there an impact of the NMTTP on the PSTs' self-efficacy and attitudes relating to using NE motifs in teaching, following an NE training program? (2) Which variables can significantly explain the variance in PSTs' self-efficacy and attitudes regarding using NE knowledge in teaching?*

The quantitative and qualitative studies in this research explored the impact of participating in a specially designed NE training program for PSTs in a special education track. The experimental group of PSTs in the study were found to have significantly higher self-efficacy regarding the use of concepts from NE in teaching before the intervention as well as compared to the control group after the intervention. These findings contribute to knowledge about the correlation between participating in a neuroscience training program and PSTs' self- efficacy, since researches on this correlation are scarce. In addition, there was an increase in the PSTs' self-efficacy about their abilities and competences in both groups, which demonstrated the personal growth after completing a full year of general studies in teacher training. In an attempt to investigate the variables explaining the variance in the PSTs' self- efficacy, the analysis showed that the higher the level of favorability of the attitudes towards introducing change in teaching methods, and the lower the level of favorability of the attitudes towards change – combining knowledge from neuroscience research in education, the PSTs' self-efficacy in teaching is found stronger. The contradictions in the findings were explained in light of the Cognitive Dissonance Theory by Festinger (Festinger, 1957, in Anghelache & Benţea, 2012), so there might be dissonance between what the PSTs wanted to present in the self- efficacy questionnaire and their beliefs about the actual implementation of it. Perhaps because they didn't have the feeling of confidence about their knowledge regarding neuroscience, a negative attitude in presented. This interesting gap needs further investigation, but might relate to the different stages in the process of diffusion of innovation (Rogers, 1995, Sherry, 2000) or the domain specificity of both attitudes and self-efficacy measures (Scherer et al, 2018).

Participation in the training program did not impact attitudes in the expected direction, so no difference was found between the experimental and control group relating to attitudes toward implementation of neuroscience in education. One possible explanation discussed was the initial high level of attitudes toward the NE field at the beginning point, as reported in other researches reporting on teachers' enthusiasm toward it (Pickering & Howard- Jones, 2007; Murphy, 2017; Serpati & Loughan, 2012). The different findings related to PSTs' self- efficacy and attitudes present a lack of knowledge on the psycho- social aspects relating to implementation of NE training programs, but on the other hand demonstrate how participation in a specially designed training program can significantly change levels of self- efficacy. In an attempt to understand the variables that significantly explain the variance in attitudes, it was found that the more the PSTs agreed with their roles regarding combining neuroscience in education, the more time they are willing to invest in the introduction of changes in their teaching, and the less stronger is their self-efficacy regarding the use of concepts from NE in teaching - the level of favorability of the attitudes towards change in combining knowledge from neuroscience research in education is higher. The findings again shed light on the complexity between attitudes and self-efficacy, but also contribute to understanding the importance of willingness and role perception in the process of implementation a change (Maskit, 1998, 2011).

A future neuroscience teacher training program should take these finding into consideration in the planning stage. A possible implication of this might be for the education decision-makers and policymakers. The findings support the idea that it is important to allocate time for teachers to examine practices in introducing changes in their teaching and allow them the space and time resources.

Study 5: *(1) What are the perceptions of the PSTs and lecturers regarding the implementation of motifs from neuroscience in education and teaching? (2) How do PSTs assimilate motifs from neuroscience in planning lessons for special education students?*

The fifth study aimed to gain a deeper understanding of the perceptions of PSTs and lecturers relating to the idea and process of implementation of neuroscience in education and teaching. Results of the study

confirm and explain the findings from the quantitative study, but gave a deeper understanding on the complexity of the implementation process, on the perceptual level as well as implementation in practice. The findings from the PSTs qualitative study present the importance of a wide range attitudes and the sense of knowledge as important factors in the perception of NE and the NMTTP, but it may be generalized to implementation of change or innovation in education.

The PSTs perceived NE and the NMTTP as important and relevant which contribute to teachers in general, to teachers of special education and to the PSTs themselves on a personal level. Their attitudes regarding the structure of the NMTTP were mostly positive, even though this research questions the manner in which the integration with the reading course occurred. The findings strengthen the literature claiming the wide benefits that neuroscience has to grant to education in general and special education in particular (Ansari, Coch & De Smedt, 2011; Coch, 2018; Howard- Jones, 2014; Nouri, 2016; Sigman, Peña, et al, 2014; Thul, 2019). Besides the theoretical argument about the role and contribution of NE in obtaining a better understanding of how we learn and suggesting teaching methods and programs for learning strategies, the findings demonstrate NE as allowing better understanding of students with special needs. The findings from this study were in line with the literature, suggesting that knowledge of the neural basis of learning gives teachers a sense of perspective, patience and empathy toward challenging students, by understanding some of the unique processes in their students' brains (Baker et al, 2014; Fara and Hook, 2013; Kosaraju et al, 2014).

The findings from the qualitative lecturers' study present a more complex view. The attitudes of the lecturers toward NE and the NMTTP were varied, and in many cases ambivalent. This ambivalence might reflect the gap between the professional/ personal state of the lecturers and the innovative change that NE requires of them. The findings of this part of the study is significant generally when a change is planned in education, because of the crucial function the lecturers, as facilitators of change have in implementing them. The lecturers in teacher training colleges function as teacher of teachers. The scientific-professional view states that educators and teacher educators are required to learn and develop, to stay professional and to keep abreast of innovations on a regular basis (Darling- Hammond, 2005). Nevertheless, in many cases teachers of teachers are required to embrace changes and present them to PSTs as innovations, when their own state and attitudes are not considered substantially.

One of the components that might have influenced the ambivalence of the lecturers who joined the study was their lack of knowledge in neuroscience. This component of knowledge regarding the innovation/ change seems to be crucial in the case of teachers of teachers. According to Rogers (1995, 2003) diffusion of innovation starts from knowledge, when an individual becomes aware of the innovation by being exposed to it. Despite the feeling of lack of knowledge from the lecturers' point of view, the PSTs presented knowledge in a more positive way. In general, it has been shown that PSTs who participated in the NMTTP demonstrated a variety of concepts acquired in the training program, and they also knew how to explain them and their applications in teaching. The topic of assimilation in practice presented the PSTs ability to implement motifs from the neuroscience field, in an entire classroom setting or while working with an individual student. Beyond mentioning the specific use of a concept or teaching tool or method, they presented an established rationale for their choices. Although the relative number of references and variety of concepts presented in the lesson plans wasn't always as expected, the evidences of assimilation contribute to a theoretical implication, suggesting that neurological insights from the field of brain research may have a potential contribution to promoting teacher work and improving student learning.

4.3. Practical implications of the doctoral research

The data collected in the five studies included in this doctoral research contributed to a gradual extended understanding of the implications of PSTs' participation in an NE training program for special education PSTs. The studies investigated the effects of the NMTTP on the Israeli PSTs' attitudes and self- efficacy to implement NE in their teaching, and the implementation of motifs from neuroscience in practice. The results of the study demonstrated the lack of practical NE studies, and also the lack of research dealing with the psycho- social aspects of the implementation of NE as an innovation.

Study 1. A Systematic Literature Review - Roles of metacognitive strategies in reading comprehension tasks in special education pupils. The literature reviewed in this study shows that most of the studies

suggested a significant association between MRS intervention programs and success or improvement in reading or reading comprehension, so a proactive use of early intervention programs which emphasize metacognitive awareness is important. However, the role that MRS interventions received in some studies in comparison to central intervention programs is marginal. The practical implications of the study include a suggestion for implementing MRS intervention programs in schools, kindergartens and even higher education, since the investigated literature reveals an ongoing process of implementation of MRS programs and its advantages.

***Study 2*:** Pilot Study – Quantitative Study. This study provided a tool for the examination of factors related to the effect of the NMTTP on the Israeli PSTs' attitudes toward change and self- efficacy. The package of questionnaires compiled as a result of the study was termed the TSEATNE questionnaire (Teacher Self-Efficacy and Attitudes Toward Change Regarding Neuroeducation Implementation Questionnaires). the TSEATNE questionnaires may be used in the future to further contribute to a wider understanding of PSTs' attitudes and self- efficacy to implement motifs from NE in special education settings or in general education programs.

***Study 3*:** Development and implementation of the neuroscience teacher training program (NMTTP). The study reviewed the current training programs in Israel and around the world, and suggested particular features of the NMTTP, which are as follows: implementation in an existing syllabus and not separately; unique topics and concepts chosen for the NMTTP; implementation in a teacher training program, and more specifically in a program for special education teachers; and consideration of the assessment of PSTs self-efficacy and attitudes toward change as part of the program. The suggested curriculum with its special features may contribute to construction of similar training programs with practical orientation of implementation in Israel and around the world.

***Study 4*:** Pre/Post assessment of the psycho-social impact of the NMPPT on PSTs. The findings contribute to the general knowledge regarding the effect of training programs to self-efficacy, and specifically to the importance of the NMTTP in promoting the PSTs self- efficacy to use NE motifs in their teaching practice, in the context of special education. The study also highlighted the findings highlighted the different connections between PSTs' self-efficacy and attitudes toward change. Other findings from the study relating to the relation and attitudes to evidence- based teaching shed light on the general professional development and personal identity development of PSTs. The findings of this study are relevant not only for training programs relating to NE, but also to how courses and training programs dealing with implementation of innovation or change in current teaching methods or ways of thinking should be planned. The psycho- social characteristics of the participants were found to be a major component in the implementation process besides the content to be learned. Further, the knowledge the participants have in advance relating to the change is also crucial for the success of the implementation process.

Study 5: The data collected from the different research tools and participants (PSTs and lecturers) added greater insights to understanding the complexity of implementation of neuroscience in teaching specifically, and implementation of innovation or change generally. The summary of data reflected the importance of attitudes, knowledge and implementation in practice as major components in an implementation process. Also, the answers of the PSTs added greater insights into how they benefitted from participating in the NMTTP. The findings indicate that the training program contributed significantly to PSTs' knowledge on innovative teaching methods in the context of evidence- based teaching and the brain. In addition to imparting tools and knowledge training, developers of NE training programs must also be aware of attitudes and self- efficacy in order to empower PSTs to use the knowledge they learned and implement it. This note may contribute to the decision making of professionals in the field of teaching, administrators of teacher training colleges and schools and also policymakers who decide to make changes. Specifically, they should take into account the psycho-social variables of all populations involved in the change implementation: teachers of teachers, in- service teachers, PSTs etc.

4.4. General conclusions of the doctoral research and recommendations

From the findings of the thesis it can be concluded and interpreted that:

1) Integrating neuroscience into teacher education programs provided another perspective on learning and teaching, and played a modest but important role in building an evidence- based learning education culture. The NE has contributed knowledge and teaching methods that served as a rationale and informed decision-making tool for PSTs in special education while planning lessons for students with special needs. The contribution was perceived as important to an extent that some of the PSTs declared the teachers' obligation to know NE principles.
2) The NMTTP contributed to the PSTs self-efficacy to implement knowledge from neuroscience in education and teaching and to shape their attitudes toward the implementation process. While positive attitudes toward NE were presented in the beginning of the training program, the qualitative study revealed the variety of sub- attitudes relating to NE, and the different layers which might influence the relationship between teacher self- efficacy and attitudes toward change. Also, the willingness to invest time in assimilating the change and the perceptions of PSTs' roles regarding the implementation process are crucial factors in the process.
3) Study 5 investigated the applied value of NE principles and neuroscience motifs learned in the training program in practice. The implementation was reflected in four main topics: The importance of learning in context and synaptic connections; Multi-sensory activities; Active learning and Metacognition in learning. The implications of this implementation are by changing the way PSTs plan their lessons from the very beginning, through choosing specific teaching methods and activities adjusted for their specific students, with a coherent rationale based on knowledge relating to how learning occurs in the brain.
4) Two main motifs were chosen for the NMTTP: learning in context and metacognition. While the first one was implemented and retrieved relatively smoothly, the term of metacognition wasn't retrieved and used constantly. Future studies should consider the complexity of this concept and suggest ways of encouraging high order thinking and metacognition, despite its complexity.
5) The gaps raised in the quantitative and qualitative studies relating to attitudes toward NE reflect the complexity of change implementations. The psychosocial aspects of all the participants involved have a major function in implementing change.
6) The interdisciplinary structure of the NMTTP allowed practical implication of NE principles in teaching reading. However, it also had its disadvantages such as stress of time, and further research and planning of the courses should be considered as to an efficient way of implementation in existing courses.
7) In terms of recommendations, the doctoral thesis support the idea that the studies dealing with innovation/change in teacher training colleges, the lecturers who serve as teachers of teachers have a crucial role in the implementation process, and they should be considered as essential mediators of the training programs to PSTs. Colleges should consider separate training programs to base the knowledge of the lecturers in NE or other fields, while also considering the current state and attitudes of the participating lecturers.
8)

4.5. Research limitations and future research directions

In terms of limitations, this part relates to the research population, research tools, structure of the NMTTP and the involvement of the researcher.

Research Population: In all the studies in which participants were involved (2, 4 and 5) the number of respondents was relatively low. Thus, in Study 2, the convenience sampling did not produce a large enough number of respondents to the questionnaire which might have contributed to more established results. In Study 4, although a parametric statistical analysis was conducted, due to this small number of matched participants the findings point to a tendency rather than a credible picture. In Study 5 only eleven PSTs and three lecturers were included in the interview group as a sample of the research population following the NMTTP. As such, the limitations of the analysis are based on the findings from the interviews were of specified PSTs who had participated in the NMTTP. Nevertheless, the research population can be considered as adequately representing the research phenomenon of PSTs in their second year of studies in

the special education track, and providing reading lessons for students with learning disabilities, even though the sample population may not reflect the general population. Future studies should try and reach larger populations for more valid generalization.

Research Tools: (1) Since there was a lack of questionnaires specified for PSTs and relating to the specific chosen research questions, the thesis was based on questionnaires for teachers. This decision may have an impact on the participants' responses, as some of the questions are directed for in-service teachers. However, attempts have been made to generate maximum adjustments for the PSTs. (2) Using interviews in the qualitative study might be followed by social desirability, and won't necessarily reflect the wide attitudes of the participants. In order to overcome this, a second interviewer, who was not involved in the NMTTP conducted the interviews. Future studies should consider using more interviews following the process of implementation, for example at the beginning of the year, in the middle and in the end of it. In addition, other tools such as observation, might shed light on the implementation process in practice.

The structure of the NMTTP (1) The NMPPT was designed as an original training program for Israeli PSTs in the field of special education, and it was implemented in an existing course. Since the syllabus of the reading course already existed as a whole, it was sometimes difficult to implement the motifs from the neuroscience/NE field, since there was pressure to teach the original material of the course. Future studies may better formulate the correct form for embedding content into an existing course. (2) The gap between the knowledge of the researcher who is also a lecturer, and the knowledge of the two other lecturers created a diversity of ambivalence attitudes. Future researches may suggest improved support for the lecturers, or accept flexibility and variance among those involved in the process of implementing innovations. A possible future research might suggest a preparation phase for lecturers, which will give them a better sense of knowledge that was suggested in this study.

Researcher Role: The researcher of this thesis is also one of the lecturers in the study, responsible for a group of PSTs and a member of the reading course team in the special education track, with the two other lecturers. The involvement of the researcher in almost every step of conducting and evaluating the program night have had its influence on the findings, although maximal effort was done to overcome this limitation.

In terms of further investigations, there are several possibilities for future research directions as stated below:

- Future studies could shed light on additional aspects related to infusion of neuroeducation in the context of special education and in the general education as well. One such offer might be a longitudinal study, which will investigate the use of the motifs learned in the program as part of the process of teaching reading, five years after participating in the NMTTP, or exploring their current teacher self- efficacy and attitudes in a retrospective overview.

- Future studies might explore the possible connection between the attitudes of the different lecturers and their matched PSTs', since the attitudes of the lecturers/ teachers of teachers may have much impact on the PSTs' approach to NE. Hence, the differences between PSTs' attitudes toward the specific change could be explored: those who studied the course with the lecturer who lead the change, and PSTs who studied with lecturers who joined the process from intrinsic or extrinsic motives.

- The ambivalence reflected within the lecturers' points of view regarding NE might indicate a general difficulty of the system in embracing NE in teaching. A future study might investigate the entrance of PSTs in their final stages of training or beginner in- service teachers with NE knowledge to the education system. The encounter with schools and teachers with no knowledge on NE as accepted or rejected and its implications for future implementation are interesting topics for future research.

- Future research may extend the NMTTP to a broader training program with more lessons on other issues that were not included in the original plan, such as basic physiology of the brain, attention, the limbic system and the brain, the influence of the classroom environment and design on learning, the importance of arousing innovation to the learning brain etc. In addition, the NMTTP may be

expanded to other existing courses from different fields such as Math, Arts and Sciences, or specifically implemented into the mentoring course which accompanies the PSTs' practice teaching. All these suggestions should be accompanied with research and assessment.

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