

Lesson Studies from an Interdisciplinary Perspective: Consequences for Teaching Practices and Professional Identity

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Introduction

Currently there is an international panorama concerned with the levels of children and adolescents' learning achievement in educational systems in relation to the needs of the contemporary society, characterized as a society of knowledge.

Along with public policies that seek to respond to the demands of efficiency, quality and equity of educational systems, the focus of attention centers more intensely on teacher training. In this regard, emphasis has been placed on the mastery of contents that teachers should have and on the need for dialogue between education matters and those of learning sectors such as science, mathematics, communication and language, social science, etc. (Shulman, 2005). The same applies to the relationship between training institutions and centers for professional practice.

When studying the phenomenon of education, there is a consensus: it is a complex and multifaceted process. Phenomena of different natures are present in the micro-world of the classroom: neurological, psychological and sociological phenomena, learning strategies, teaching, coexistence, etc., all of them having a large impact on learning processes and on learners' development. The contributions of neuroscience, sociology of education, and multimodal didactics are clear examples of necessary current theoretical contri-

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butions for a better understanding of the complex phenomena occurring in the classroom.

It is important to acknowledge that different areas of knowledge have made important discoveries which have contributed to better understand this complex system. However, these findings have been over-generalized and have led to pedagogical tendencies that are eventually discarded because they simply do not work as expected or their solutions do not shed light on the educational phenomena. When displaced by new theories, these findings, which have been important for education, have also virtually disappeared from the scientific discussion on education and also from the educational theory and praxis. Today, with contributions from different areas of knowledge, it is possible to deal with a complex phenomenon from a complex perspective; that is, from an interdisciplinary perspective where each discovery coming from a given discipline or theoretical current is recognized as a contribution to the understanding of educational phenomena. Besides this, it is necessary to engage each of the findings in a theoretical – practical dialogue with the contributions from other theoretical currents and scientific disciplines, including those related to the learning sectors that contribute from their own epistemology.

Experiences with “critical” schools, analysis of teacher training curriculum in Chile (Ávalos, 2002) and our experience during the execution of project Conicyt Bicentennial SOC 15² verify that when teachers lack knowledge about educational-sociological issues they have difficulties understanding why socially underprivileged children do not achieve like more privileged students. They insist on working with an official program designed for an entire country with its stratified and culturally diverse population, and they do not consider the necessity to address school work so that the curriculum is based upon students’ experiences.

Like in many other countries, the area of neuroscience has not been included in the Chilean teacher training curriculum. The contribution of neuroscience would possibly give teachers a better understanding for the necessity of personalizing teaching even more by taking into consideration children’s emotions and culture as a basis for school work and as an additional support to the results that have emerged from didactics. In some cases, we have experienced that the inclusion of neuroscience has been resisted because it has been perceived as a new “fad” in education. This occurs despite the interest shown by researchers from this area in incorporating their knowledge and perspective to the teacher’s practices and training. In this discussion, and in the studies related with it, there seems to be a growing consensus. Besides public policies regarding management and financing of the system, both

² Project “Dialectic of learning and breaking the cycle of low learning in areas of high vulnerability” funded by CONICYT, Chilean National Commission for Scientific and Technological Research 2009 – 2001.

equity and quality of education require greater understanding of what happens in the classroom.

Moreover, Even though the education system of Chile provides unequal school conditions in terms of management and financial resources, some schools with poor conditions perform well. Consequently, our line of research proposes the creation of joint researcher centers from different scientific fields such as physiology, linguistic sociology, medicine, mathematics, natural sciences and didactics.

The theoretical approaches behind this proposal are based on the complex characteristics of the educational phenomenon under study, ranging from macro to micro perspectives, as well as on the interactions that arise from the different perspectives that take into account the teaching and learning relationship inside the classroom. Our purpose is also to study the impact of the interdisciplinary analysis on what happens in the classroom as well as on teachers' self-perception of their profession.

Disciplinary integration around the educational phenomenon

We have defined this project as an interdisciplinary work since it analyses, synthesizes and harmonizes links between disciplines within a coordinated and coherent whole, by using methods and insights of several established disciplines and traditional fields of study as an act of integrating knowledge, or as Mallon and Burnton stated as a “work having the faculty from different disciplines working together on the same project”. Mallon, W. T., & Burnton, S. (2005)

We have incorporated this vision since we are aware that the educational process requires contributions from various disciplines because a number of variables such as social, cultural, psychological, communicative and human interactions are involved. These variables at the same time have an ideological foundation. All of them are present in the didactic phenomena inside the classroom and must be incorporated to the teaching theory and praxis of the teacher.

Theories of social reproduction that explain why and how the school contributes to social reproduction are examples of how scientific knowledge from different educational areas can be integrated to didactic theory and praxis. Schools do this through a curriculum that presents a particular dominating culture. The curriculum, in educational theory, corresponds to a dimension called the contextual framework of the educational process (Dahllöf, 1990).

The contributions of neuroscience, sociology of education and the development of education as a discipline, for example, do not only reveal a scien-

tific reality reflected in the different approaches to educational phenomena but also a deep need to move towards knowledge integration and theories that explain and generate interesting perspectives about one of the most important purposes of education: the phenomenon of learning, the development of the mind from different areas of culture.

The need to systematize and generate theoretical coherence between different levels and dimensions of the educational process is consistent with the views expressed by Swedish and English researchers Selander and Kress in the text "Design för lärande: ett multimodalt perspektiv" (2010) with reference to, for example, the necessity of didactic designs adequate for the needs of the classroom. It is also consistent with the Swedish educational tradition, which states that education as a whole must be based on scientific perspectives and proven experience (Björklund, 1991). If done like this, teachers would make a difference, but this would be sustainable to the extent that their practices are based on scientific theories and on the development of an epistemology of the praxis (Tardif, 2004) which encompasses practice, science and the life inside the classroom.

To do this, the teacher must have training oriented towards achieving that goal. Hence, the teaching profession should also be approached from that perspective, especially because the knowledge building of teachers is experiential, plural, historical, biographical and socio cultural, (Butt, Raymond, and Yamagishi, 1988; Zeichner, 1993; Montero, 2001; Mercado, 2002; Tardif, 2004; Moreno and Mendoza, 2005; Imbernon, 2006, among others) and this would depend on the conditions under which they do their work, their training and their professional experience.

Our starting point of view: Humanism

In spite of humanism not being considered a theory but an ethical position, we consider that the humanistic perspective is central to this project. First, because our analysis is related to one of the most unique qualities of the human being: the mind in contexts of social relations determining its development. Nowadays, we understand that this approach has its support in theories that we here call artificially micro, like neuroscience, which shows that those children who are stimulated and treated with consideration have a larger development and socio-affective capacity.

Another relevant theoretical perspective that illuminates the "teacher-student" dimension is Freire's (1996, 2000), and Max van Manen's (2010) which we will now call 'pedagogy of autonomy'. The option, according to Freire, is between education for students as objects and education for students as subjects. According to Freire and van Manen, the educator must develop independent thinking, reflective capacity, critical and creative power to go beyond the dominant education. In a converging humanistic line we

find Taylor's (1999) and Maturana's (1992) theoretical developments which aim to highlight the central importance of coexistence in educational processes and the recognition of cultural diversity, and from this, the recognition of the "legitimate other".

The studies of Maturana show cases of interdisciplinary and theoretical dialogue. As a biologist he attempts to describe the learning conditions that allow people's development as coming from themselves and not as an external obligation. In this way he establishes a guiding thread between biology and educational humanism. This way of reasoning provides a base to think that there can also be a guiding thread between theories related to neuroscience, psychology and sociology and the humanistic point of view for the development of students. This guiding thread helps to better understand how education becomes an instrument that generates conditions for the development of society and individuals and at the same time works as an instrument for domination and social enclosure determined by economic and social structures.

Macro theories

The macro-social perspective conceives education as a factor of social and individual development, and especially as a factor of social promotion. Empirical evidence, based on studies inspired by human-capital theory, indicates that there is, effectively, a relationship between education levels and individual and social income. The countries with higher average of education levels have higher levels of income distribution per capita. Therefore, education generates skills that increase efficiency in a person's performance in the work market (Blaug, 1987; Boström, 2003; Björklund & Lindahl, 2005).

Although the studies carried out in the framework of the human-capital theory provide evidence of the real impact of education on the individual and also on the social level, there is evidence of how investments in education do not favor all sectors of the population equally. The studies of Coleman (1966) on the differentiation in students' learning in the United States revealed that learning is strongly associated with the students' characteristics, their access to a library at home, and their level of aspiration. At the same time, Coleman indicates that the children of ethnic minorities have deficiencies from the onset of schooling that become even more severe at the end of their schooling, which is in part due to the segregation that occurs within the institutions attended by the children (1966, p. 22).

Another explanation that differs from that which describes differences in school performance as the result of a "deficit" is found in Basil Bernstein's theory of the socio-cultural codes (1976) and in Pierre Bourdieu's theory of cultural reproduction (1977). In both cases, the explanation lies in the rela-

tionship established between the two distinct cultures and their encounters at school.

Sociolinguistic studies contribute with evidence showing that codes used in the communicative processes by workers are characteristically restricted, local, and contextual. On the other hand, those used by the middle class are elaborated, universalistic, and not contextual and these are the codes that predominate in the school and, therefore, the working class students are at a disadvantage. According to the theory of social reproduction the issue is not limited to having different linguistic codes but having different cultures. The dominant culture is expressed neutrally in the curriculum; the working class culture is not recognized and, therefore, is removed from the school. Thus, the students from these sectors have less cultural capital than those that come from middle and higher class sectors. In both cases (based on the theory of codes or the theory of social reproduction) there is the possibility of falling into determinism if the difference in scholastic achievement by social class is considered a sociological phenomenon over which the school has no incidence and for which it cannot be responsible.

The Middle Level: Frame Factor

Based on the domain of the theories described above, the present proposal considers that teachers and boards of directors should be able to plan and evaluate their activities placing the students and their cultural heritage at the center. The student should be recognized as an educational subject, with a unique history, motivations, needs for personal growth and recognition, in process of becoming an active citizen, integrated into social tasks. Therefore, it is fundamental to develop autonomy in the teacher, autonomy based on rigorous knowledge and praxis of the complex educational processes that allow the development of learning materials and units under a perspective of cognitive and socio-affective modeling, in order to develop the skills that society requires from children. This generates the need to introduce different forms of work. In this respect, by the logic of participative management as suggested by UNICEF and the Chilean Ministry of Education, the Frame Factor theory deserves analysis.

When evaluation theories centered their attention on didactic processes, the Swedish researcher Urban Dahllöf presented evidence that the level of educational achievement was associated with the diversity of conditions in which the students worked (1967, 1989, and 1990). The Frame Factors or *ramfaktorerna*, as they are called in their original language, are variables such as school entrance requirements, group consistency, work standards, curriculum, infrastructure, relationship with parents, etc. These variables “frame the educational process” and affect student achievements. For that reason these variables should be taken into consideration, not only at the

moment of analyzing them through standardized tests but also in school management models.

The challenge of this theory lies in the need to see the educational process in interaction with variables that teachers cannot manage from the classroom but still have a logical relationship to what the teacher wants to do. As an analogy, we can say that the school should organize itself like a greenhouse. In this environment, a space that allows the regulation of the external variables is generated, producing the facilitating “micro-climates” for the development of the species that we want to see sprouted and grown with autonomy.

What is interesting about this theory is that it also leads to study the ways in which the factors that generate educational spaces for intellectual growth can vary. They can be related to institutional management or scenarios for learning, strengthening the capacity for leadership for both teachers and director boards, by increasing their capability to regulate the micro and macro variables of the educational context. In spite of the intense discussion and application in the Nordic countries, this approach has remained unknown in the European continent, where no equivalent theory is known. Nonetheless, this perspective is essential to the comprehension and praxis of school management in the educational system and the practices within the classroom. It helps to understand the importance of the Frame Factors and the role that they play in the regulation and “synchronization” between the micro and macro educational levels, in order to improve the quality of learning.

The Micro Level

The cognitive theories formulated by Piaget (2001), Vigotsky (1985), and Ausubel (2002) regard the importance of the individual’s relation to the environment, and the mechanisms that determine this relationship as key elements for its constant development. From a theoretical perspective, it can be shown that the solutions to inequality and the opportunities for achieving quality learning lie in making the curriculum more flexible, transforming the pedagogical practices and improving the school management. The question that arises then is whether this would be enough to get results.

In Chile there have been programs such as P-900, MECE-Rural, Project LEM³, and Critical Schools that have shown this tendency. The common

³ The program P-900 is a strategy of technical and material support for schools by the Chilean Ministry of Education that began in 1990 with the aim of improving the quality of learning of students in primary schools with educational risk. MECE-rural: Program for Improving the Quality and Equity of Rural Basic Education, implemented by the Chilean Ministry of Education in 1992. LEM, Campaign proposed by the Chilean Ministry of Education in 2002 for improving learning achievement in language, writing and mathematics from Kindergarten to 4th grade.

experience in all these initiatives is that when they end, the schools tend to return to their initial situation (Castro, 2001). At the same time, it should be pointed out that the situation in Chile is not an isolated case. An analysis done by Castro, (2001) of thirty years of Swedish research in this area, shows that even the projects that imply greater student participation in the classroom do not attain the expected equality outcomes. These researchers attribute this to two basic factors: a) persistence of the macro social contexts; that is, persistence of the differences of social classes and cultures associated with these and b) the traditional role of the teachers, in the sense that they are the ones who ultimately define what is true knowledge and what is not. The study is interesting and also hopeful, as it focuses on the teacher as the one able to open a door and break social reproduction through the school.

In this proposal, we assume the descriptive value of social reproduction theories, expressed in the studies of Bourdieu (1977–2007), Bernstein (1990), and Willis (1988). In essence, we propose that once a problematic and complex relationship between the official curriculum and the culture of the underprivileged children is detected, the next step should be to determine how these children's cultural heritage is related to the school culture. Later, based on this reality, we should make use of the contributions that come from the theories that try to explain human learning by establishing the theoretical integration and articulation of sociological theories, learning theories (from a dialectical perspective), cognitive motivating mechanisms of learning, and neuroscience; epistemological basis of the curriculum in different areas so that an action plan can be designed according to the teacher's needs and challenges.

Education as a scientific phenomenon can be defined as the process of intentional interaction that leads to the development of cognitive and socio-affective skills that determine a person's relation to their environment, making them more or less efficient according to the situation at hand. The result of this process is also called education; that is, the materialization of a series of acquired skills, knowledge, attitudes, and values, producing social, intellectual, and emotional changes in the person, to name a few. These changes depend on the degree of awareness and may be life-long or last for a period. In the latter case, they become part of the individual's memories.

Three essential aspects can be distinguished in these processes: a) transfer of concepts (scientific or tested experience); b) development of cognitive and socio-affective abilities; and c) formation of values and attitudes. Each one of these processes, from the point of view of its genesis and development, has its own dynamic; although interrelated, they are distinguished by the type and quality of the educational activity established for each aspect. But this matter cannot be understood by using only educational scientific concepts. Other disciplines make contributions to explain and give an account of the educational phenomena in a school context.

The phenomenon of learning is essential for understanding the interaction indicated above and the processes derived from it. The organism, in this case the person, requires the necessary capacity of processing and interpreting the signals from the environment and from itself, regarding stimuli and consequences. On the one hand, at a given moment, the behaviorist paid attention to the behavior, focusing more on the doing than on the thinking and assigning more importance to reinforcement (Skinner, 1968). On the other hand, the cognitive theories accentuate the importance of thought and the principles of accommodation and assimilation that occur in the interaction with the environment (Piaget, 2001).

Along the same line, Vigotsky (1978) indicated that cognitive processes are based on the individual, in a context of social interaction.

The basis of this theory indicates that learning precedes development and that the potential that the environment provides will be determinant for the person. However, Vigotsky does not clarify the learning mechanism through which the surroundings influence the cognitive development as Skinner (1977) does with respect to the role of positive reinforcement in the development of new behaviors.

Both theories have played a key role in education and have generated pedagogical tendencies associated with the exercise of the teaching profession. The question is whether these theories can be integrated in order to offer a better response to the process of intentional human interaction leading to the development of capabilities. As we understand it, these two theories can be reconciled if we accept the reality of the cognitive processes and the importance of the theory of reinforcement for strengthening or weakening these processes, not only in terms of behavior. According to this perspective, external or self-reinforcement not only affects behavior but also cognitive and socio-affective development. The consequence of this is that the cognitive processes can be “modeled” or shaped, or guided.

Following this logic, teachers organize the learning situations according to the cognitive processes (imbalance, accommodation, assimilation) they want to generate and, given a certain response: they provide the appropriate reinforcement in order to strengthen the way in which the information is processed. In fact, this is what happens in most formative processes and it is the core of the educational process, which involves, at the micro level, a teacher and a student and, at the macro level, the entire school system.

Because it deals with interaction processes that occur in social contexts, it is necessary to clarify that this relationship is not free from difficulties; the students do not start the formative processes as a “tabula rasa”, but rather bring with them a history of learning. According to Ausubel (1968), there is a relationship between what is learned and what is to be learned, the latter being easier if there is a positive connection between the previous experiences and what the teacher intends to teach (i.e., if it is significant for the student). From another point of view, Castro (1981) indicates that there is a

dialectic relationship between what is learned and what is to be learned that may be complementary (as in the case of significant learning), neutral, contradictory, or antagonistic contradictory. The ease or difficulty with which something new is learned depends on this relationship. This last case is documented with evidence contributed by Willis (1988), who described the active resistance toward school from working class students in England.

Although this type of evidence has not been reported in Chile, it is likely to exist. Nonetheless, Willis' comparison of the school culture and the working class culture describes characteristics of both, with the former being manifested as theoretical and the latter, that of the working class, as practical. Therefore, it is possible to think that the relationship between the students that resist school and the school culture are not antagonistic by nature, but may become this way when the vision of the praxis that these students bring with them is not valued and is not incorporated into the school work.

In this context, it is important to appreciate the dialectic relationship between school culture and the cultural heritage which the working class children bring to school. By incorporating elements of their culture of origin into the educational process, the teacher gives students value and implements reinforcement programs that strengthen the students' identification with the school. At the same time, it is possible to apply the reinforcement theory, but this time in a broader sense, in order to strengthen the cognitive, socio-affective, and behavioral processes that allow a positive experience of the school-learning relationship and the use of this knowledge in daily life (valuing the practical).

We feel that it is possible to make the dialectic relationship between the official curriculum manifested in the school action and the culture which children bring to school compatible, if we look at the educational processes from a perspective of reinforcement (Skinner, 1977) as well as constructivism (Carretero, 1993). Both theories, as seen from an evolutionary focus, help us understand how different forms of learning arise and how they are interrelated (Castro, 1999).

An experience of this type was observed in some Chilean schools in the area of functional literacy, where school texts were elaborated for the sub-sectors of language and math. The thematic axes that organized the learning units of these texts corresponded to productive tasks of the Lafkenche people articulated in ethnically representative families and community stories, a context which the children of that area feel completely identified with. The validation processes of the elaborated school book texts revealed that the Lafkenche children, who were in first and second grade, not only learned to read and carry out basic mathematical operations in a shorter period, but that this knowledge was also transferred functionally to the family and community life (Castro, Figueroa, Maldonado, 2012). In this case, the perception of the school culture as something distant from the actual needs of the community (because it takes up time required for other practical rural and domestic

tasks, forming a contradictory relationship) was solved. Thus, the school contents have a practical and closer sense to the students, adding value to what they do in their daily lives (complementary relationship), generating a potential virtuous cycle between the search for knowledge and its application. This can be useful for the development of skills to overcome poverty.

When trying to scientifically understand specific aspects of a social group's culture, through the theory of social representations developed by Moscovici (1986), Jodelet (1989), Abric (1996), and Moliner (2001), it is possible to obtain a vision of the phenomenon observed as a process and as a product, joining cognitive and social perspectives. The social representations, understood as a form of socially elaborated and shared knowledge, have a practical perspective that contributes to the construction of a common reality for a social community. It is labelled as "practical know-how" and is related to the experience from which it is produced, as well as the contextual conditions in which it is manifested (Jodelet, 1989). The theoretical methodological approach, in this study in particular, allows us to access the cultural representations that arise among the actors involved, regarding the educational phenomenon that occurs when trying to identify the points of convergence and divergence between the family's social reality and the school's reality (in vulnerable areas).

From a perspective of theoretical interdisciplinary integration, learning and cognitive development are socio-cultural phenomena; they are achieved with the help of linguistic categories and mechanisms and tools that allow us to interpret the world according to specific cultural models. Learning is, from this perspective, situated and local. Adult intervention, or intervention from other students, is critical to achieve successful learning (Säljö, 2010). A person in interaction with the social environment is required as a desirable condition for the occurrence of learning. A dialectical relationship of complementarity that favors the cognitive development of the person occurs. As circumstances and people's experience networks are unique, it can be understood that each person has a different dialectical relationship with the environment, conditioned by the uniqueness of his/her experiences.

Neuroscience and Education

The previous conclusion is also reached from another discipline and from other scientific data. From the genetic point of view, we are all different. Our brains, where learning occurs, are also different. Likewise, cognitive learning styles differ from one subculture to another, the same as from one individual to another, activating different brain areas, depending on the cognitive demands of the tasks and/or didactics applied in the classroom. For learning, mainly brain areas like the hippocampus, the brainstem and dorsolateral Prefrontal Cortex are activated (Salas, 2008). Different learning areas focus

on different levels of information processing, thus the mathematic, for example, train analytical reasoning, while the humanist train a more verbal style; however, according to the holistic approach of this research, the focus of learning should be in flexible cognitive styles, independent of the student's learning area.

Moreover, each of the brain areas may have been "inherited" from different people of our genetic heritage (Klingberg, 2013). Another interesting contribution of neuroscience is the evidence that the brain is constructed to act with the environment and does not develop apart from it. The theoretical model provided by Torkel Klingberg in the book "The learning brain" (2013) is particularly interesting from our perspective. The environment is definitely important for the behavior of people beyond their genetic inheritance. The data indicates that new neural connections arise in direct relationship to the environment while those which are not used are assimilated. Besides, the brain has the potential for development throughout life.

Neuroscience is the discipline that attempts to explain how millions of nerve cells act in our brain to produce certain actions or behaviors, and how at the same time, these cells are modified by the surroundings and the environment. The latter implies that the central nervous system has neuronal plasticity, i.e., it is constantly changing their neuronal circuits as a result of the individual's relationship with the environment.

The neural plasticity mentioned is the structural and functional adaptation of the nervous system to endogenous or exogenous changes. No doubt that changes in the environment may cause both synaptogenesis and neurogenesis, a matter that we only learnt a few years ago. For example Brea et al., working with ischemic patients, states that "... the generation of new vessels allows neuro-repairing processes that include neurogenesis and synaptogenesis phenomena" (Brea, 2009).

Supported by the scientific community, we have a biological basis for creating and developing teaching strategies that cause effective, lasting and pleasurable learning. Some of these strategies have been implemented by teachers in their praxis; neurogenesis and synaptogenesis are a happy announcement for teachers because they constitute a tangible, verifiable and visible evidence of their pedagogical action, the possibility for them to reaffirm their profession and their professional identity. Their work leaves tracks, their actions have particular implications for the development of the mind, they can see themselves not just as a mere transmitter of contents that are easily forgotten but as specialists in cognitive development that may be demonstrated. That is the announcement the project brings and wants to communicate to teachers.

As described, each of the sciences mentioned bring a conceptual basis that can be considered in the practical didactic teaching decisions and therefore give scientific support to a multimodal practice for the pedagogical lesson in the classroom; for example, the concept "habitus" from sociology of educa-

tion, “reinforcement” from psychology, “flexibility of the brain” from neuroscience. But each also contributes to a common phenomenon to be considered in practical didactic decisions during lessons.

A first attempt for theoretical integration

In the psychological discussion “self-concept” is an interesting contribution. Self-concept is one of the main sources of students’ motivation and of higher predictive capability on academic performance (Marsh & Martin, 2011; Rosário, Lourenço, Paiva, Rodriguez Valle & Tuero-Herrero, 2012). It is conceptualized as a self-referential construct consisting of what the person thinks and feels about himself/herself. It has different dimensions: social, physical, and academic (Esnaola, Goñi, & Madariaga, 2008). The academic self-concept (Marsh & Martin, 2011), refers to the student’s self-perception of his/her own competence to carry out certain school activities and homework. A positive self-concept leads to active involvement of subjects in the learning process, increasing their sense of competence. When a student is confident in his own abilities he/she develops high expectations of self-efficacy, values homework and feels responsible for the learning objectives (Esnaola et al., 2008). The development of a positive academic self-concept favors the use of more effective learning strategies when confronted with cognitive tasks of greater difficulty (Martin-Anton, Carbonero, Román, 2012).

The epistemology of the discipline: two examples

Teachers are usually asked to transfer contents but content transfers need to be replaced by the integration of contents and the principles of reasoning behind the scientific or humanistic areas that teachers are dealing with. The latter is what we may call the epistemology of the discipline.

Mathematics

In the field of mathematics training, it is currently understood, in an increasingly explicit and reasoning manner, that the mathematics teacher performs his work based on a particular epistemological aspect of construction, which is not necessarily shared in its entirety by the disciplinary mathematician. According to Fiorentini and Lorenzato (2010), there is a difference in purpose between the mathematician and the mathematics educator that essentially lies in the object of study. The object of study for the mathematician is mathematics itself and therefore, when involved in teaching contexts, they tend to center on an education for mathematics which prioritize disciplinary knowledge. The object for the mathematics educator is different, because

the educator focuses on mind development, using knowledge and mathematical reasoning as a means and as motivation.

This difference, therefore, accounts for the need to structure and develop a defined professional and scientific field for mathematics education. This is currently under development and is generally associated with the practice that includes the area of specific mathematical content and the pedagogical processes associated to teaching and learning for the development of the human mind. This new field of development, for various researchers such as Fiorentini (2010), Kilpatrick (1992) and Ma (2010), is built through collaboration and understanding among different areas of knowledge such as philosophy, psychology, sociology, history, anthropology, economics, biology and also mathematics. The relationship of mathematics education and mathematics is unfortunately still distant in several ways as the two disciplines are held up by two non-interacting professional groups. The pursuit of a theoretical dialogue between the two disciplines would provide insights and influence the educational phenomenon of learning and teaching mathematics in a significant way, integrating the various current investigations.

Teaching of Science

The results of national and international tests show that Chilean children and youngsters get low scores in standard tests like SIMCE and TIMMS. Based on the interdisciplinary approach, we propose considering the following factors suggested by Sanmarti (Sanmarti, 2010) in order to address the "problem" of teaching Science:

1. social changes, democratic societies that regard as necessary that people have sufficient scientific literacy to understand, give opinions and make personal decisions or present a critical perspective on topics related to Science, like abortion, transgenic food, the environmental impact of production activities and power generation etc.;
2. development of educational sciences, psychology and neuroscience: the emergence of a didactic of science, the development of learning theories where constructivist perspectives stand out, and the explosive growth of neuroscience that explain the biological phenomena involved in the process of learning are vital issues when building classroom management that favors learning and cognitive development;
3. the development of information and communication technologies (ICTs), which we prefer to call learning and knowledge technologies (LKT) when they are applied to education, with all the impact they have in the school, in the students and teachers as themselves and as individuals;
4. changes in the epistemological basis of science teaching: the way students learn Science through the mere transmission of its contents is evolving. The project, from its interdisciplinary view, assumes the logic that science is learned by doing science, that science is learned not by

mastering its many contents, because what is learned is the logic of the discipline, and the way the discipline thinks, sets out and solves problems.

The adoption of a new role of the teacher in the classroom is proposed in our project. The teacher guides students to develop scientific thinking skills by encouraging them to observe, to ask questions and to experiment with objects, with near and real phenomena, leading them to identify evidences, to develop critical and logical thinking, to share, discuss and communicate ideas, to give interpretations and to facilitate the resolution of everyday situations and social interactions under the logic of scientific reasoning. The same trend is found in the area of language. A clear example is the name of the subject Spanish or Castilian that today is called Language and Communication. There is a similar trend for Physical Education.

Consequently, the present proposal considers that teachers, based on the domain of the theories from the different scientific disciplines described above, should be able to understand, plan and evaluate their activities putting students' cultural heritage and learning differences at the center of their practices. The student should be considered an educational subject, with a unique history, with his/her motivations, needs for personal growth and recognition, in the process of becoming an active citizen, integrated into social tasks. Therefore, it is fundamental to develop autonomy in the teacher, autonomy based on a rigorous knowledge of the human being as a whole, in connection with its surrounding environment, and the praxis of complex educational processes that allow the development of learning material and units from a cognitive modeling perspective, in order to develop the skills society requires from children. And ultimately, the teachers will improve their professional skills, autonomy and confidence.

Consequences and difficulties

A recurrent matter in the theories studied is the importance of the *students' experiences* – what in Spanish is known as *vivencia* (according to RAE *vivencia* is the fact of experiencing something and its contents, what a person has lived) – in relation to the surrounding environment. Some people have a lot of “*vivencias*” but a few experiences. People acquire experience from a “*vivencia*” when they identify, analyze, conclude, and mainly, when something changes as a result of it.

In English we use the concept *experience* meaning events that make up an individual's life, this experience necessarily includes feelings and consciousness (*vivencia* in Spanish, *upplevelse* in Swedish).

Those experiences (*upplevelser*, *vivencias*) acquired in interaction with the environment are represented in self-perception, self-esteem, motivation,

linguistic codes, representations, and in habitus as expressed by Bourdieu or levels of consciousness as indicated by Paulo Freire. This idea is reinforced by a principle emerging from neuroscience that states that our brain is made to interact with its environment and it depends on it for its development, through learning processes that we will call development of the mind.

This discussion has led to a redefinition of our research problem regarding the integration of the different disciplines and how they contribute to move from the pedagogical knowledge to something which is more precise, that is to say, how each one of the disciplines mentioned previously contributes to elaborate a favorable “vivencial” (experience) atmosphere for learning that connects dialectically, in a natural way, with what has been experienced (“vivenciado”) by the students and that leads them to higher levels of mental development.

Some final reflections

An important challenge of this investigation that has also been set out by the evaluative peers of the project is to determine if teachers are prepared to understand the contribution of the different sciences to their school work, as for example, neuroscience and psychology of education. Our experience until now indicates that teachers can identify the contribution of the disciplines already mentioned as they can explain some of the phenomena that occur in the classroom but, when it comes to planning, they still work traditionally.

One of the biggest concerns that evaluators have raised about this project, when we wanted to upgrade this research to a larger scale, is whether teachers are able to understand disciplines which are so different from education and whether they can extrapolate findings so that they eventually can apply them to their own work. Another difficulty that has arisen is that scientists from different areas involved in research, consciously or unconsciously, regard their findings as the most important for the development of successful learning environments, such as the reduction of negative stress, repetition or the use of creativity, not considering that each learning area of the curriculum also requires the command of the subject’s epistemology.

Finally, it is important to note that our initial findings show that teachers become more aware of the significance of their profession when they consider that their work can not only be demonstrated by evaluation results, but also by the fact that their work leaves very specific physiological traces, as evidenced by neuroscience. At the same time, their work can now be explained scientifically to a greater extent than before, generating a professional parity with other professions.

We expect to publish the evidence of these results later on in 2016.

References

- Abric, J. C. (1996). *Pratiques sociales et représentation*. París: PU F.
- Ausubel, D.P. (2002). *Adquisición y retención del conocimiento. Una perspectiva cognitiva*. Barcelona: Paidós.
- Ausubel, D.P. (1968). *Educational psychology: a cognitive view*. New York, Holt, Rinehart and Winston.
- Ávalos, B. (2002) *Profesores para Chile. Historia de un Proyecto*. Santiago: Ministerio de Educación.
- Bernstein, B. (1990). *Clases, Códigos y Control: La Estructura del Discurso Pedagógico*. Madrid: Morata.
- Bernstein, B. (1976) *Socialklass, språk och socialisation*. Frans Gregersen (Ed) 1976. *Klassspråk. Sociolingvistik & utbildning*. En antologi. Gidlunds.
- Björklund, A. Lindhal, M. (2005). *Utbildning och Ekonomisk Utveckling. Utbildning- och kulturdepartementets Skriftserie raport 8*.
- Björklund, S. (1991). *Forskningsanknytning genom disputation*. Acta Universitatis Uppsaliensis. Almqvist&Wiksell. Stockholm.
- Blaug, M. (1987). *The correlation between Education and Earning: What does it signify? The Economics of Education and The Education of an Economist*. New York. University Press.
- Boström, Ann-Kristin (2003) *Lifelong Learning, Intergenerational Learning, and Social Capital. Institutionen för internationell pedagogik*
- Bourdieu, P. (1977). *La Reproducción*. Barcelona: Laia.
- Bourdieu, P. (2007). *Capital cultural, escuela y espacio social*. Buenos Aires: Siglo XXI.
- Brea, D. e. (2009). *Reorganización de la vascularización cerebral tras la isquemia*. *Revista de neurología* , 49 (12), 645–654
- Butt, R.; Raymond, D. y Yamagishi, L. (1988). *Autobiographic praxis: Studying the formation of teachers' Knowledge*. *Journal Curriculum Theorizing*, N° 7(4), 87–164.
- Carretero, M. (1993). *Constructivismo y educación*. Buenos Aires: Aique.
- Castro, A. (1981). *Det institutionaliserade övervaldet. C-uppsats*. Pedagogiska Inst. Stockholms Universitet.
- Castro, A. (1999). *Reflexiones acerca de la Evolución de la Cognición*. *Revista Paideia* N° 27 Facultad de Educación. Universidad de Concepción.
- Castro A, Rodríguez A. (2001). “Evaluación escuelas participantes en los programas de las 900 escuelas básicas rural en la VIII Región”. Ministerio de Educación. Facultad de Educación Universidad de Concepción. ISBN 978-956-7909-10-0
- Castro, A., Figueroa B., Maldonado, C. 2012. “Estrategia de alfabetización funcional en contexto intercultural y vulnerabilidad social”. Editorial Universidad de Concepción. ISBN 978-956-227-354-1
- Coleman, James S., et al. (1966). *Equality of Educational Opportunity*. Washington, DC: U.S. Department of Health, Education and Welfare.
- Dahlöf, U. (1990). *Towards a new model for the evaluation of teaching; An interactive process-centred approach*. OCDE 1990.
- Esnaola, J., Goñi, A. & Madariaga, J.M. (2008). *El autoconcepto: perspectivas de investigación*. *Revista Psicodidáctica*, 13, 69–96.
- Fiorentini D., Lorenzato S. (2010). *Investigación en Educación Matemática. Recordos históricos y Metodológicos*. Brasil: Autores Asociados.
- Freire, P. (1996): *Pedagogia da Autonomia*. Río de Janeiro: Paz e Terra.
- Freire, P. (2000): *Pedagogia da indignação – cartas pedagógicas e outros escritos*. São Paulo: UNESP.

- García, B. (2009). Dimensiones afectivas de la docencia. *Revista Digital Universitaria*, 10(11), 2–13.
- Imbernón, F. (2006): *La investigación educativa como herramienta en la formación del profesorado*. Madrid: Graó.
- Jodelet, D. (1989). *Les représentations sociales*. París: Presses Universitaires de France.
- Kilpatrick (1992). A history of research in mathematics education. In: Grouws, D.A (Ed.). *Handbook of research on mathematics teaching and learning*. New York: Macmillan.
- Klingberg, T. (2013) "The learning Brain: Memory and brain development in children", U.S.A.: Oxford University Press.
- Koshecnikov, M., Evans, C. y Kosslyn, S.M. (2014). *Cognitive Style as Environmentally Sensitive Individual Differences in Cognition: A Modern Synthesis and Applications in Education, Business, and Management*. *Psychological Science* 15. 3–33.
- Ma L. (2010). *Conocimiento y enseñanza de las matemáticas elementales*. Santiago. Academia Chilena de Ciencias.
- Mallon, W. T., & Burnton, S. (2005). "The functions of centers and institutes in academic biomedical research". *Analysis in Brief*, 5(1). Association of American Medical Colleges (AAME)
- Marsh, H. & Martin, A. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology*, 81, 59–77.
- Martin-Antón, L., Carbonero, M. A. & Román, J. M. (2012). Efecto modulador de variables socioemocionales en el entrenamiento en estrategias de elaboración de educación secundaria obligatoria. *Psicothema*, 24(1), 36–41.
- Maturana, H. (1992): *El sentido de lo humano*. Santiago: Hachette.
- Mercado, R. (2002). *Los saberes docentes como construcción social. La enseñanza centrada en los niños*. México: Fondo de Cultura Económica.
- Moliner, P. (2001). *La dynamique des représentations sociales*. París. Presses Universitaires de Grenoble.
- Montero, L. (2001). *La Construcción del conocimiento profesional docente*. Homo Sapiens: Argentina.
- Moreno, P. y Mendoza, C. (2005). El saber pedagógico en la práctica: algunas claves para el análisis. En: Pulido, O y Baquero, S. (comp). *Formación de maestros, profesión y trabajo docente*. Colombia: Universidad Pedagógica Nacional y FLAPE. Pp, 124–130.
- Moscovici S. y Miles H. (1986). De la ciencia al sentido común. En: Moscovici, Serge (comp.). *Psicología Social II. Pensamiento y vida social. Psicología social y problemas sociales*. Barcelona: Paidós.
- Piaget, J. (2001). *Psicología y Pedagogía*. Barcelona: Crítica.
- Rosário, P., Lourenço, A., Paiva, O., Rodríguez, A., Valle, A. & Tuero-Herrero, E. (2012) Predicción del rendimiento en matemáticas: efectos de variables personales, socioeducativas y del contexto escolar. *Psicothema*, 24, 289–295.
- Säljö, R. (2010): Digital tools and challenges to institutional traditions of learning: technologies, social memory and the performative nature of learning. *Journal of Computer Assisted Learning*. Volume 26, Issue 1, pages 53–64, February 2010.
- Salas, R. (2008). *Estilos de aprendizaje a la luz de la neurociencia*. Bogotá: Cooperativa Editorial, Magisterio.
- Sanmarti, N. (2010). *Didáctica de las Ciencias en la educación secundaria obligatoria*. Madrid: Síntesis.

- Selander, S. Kress, G. (2010): Design för lärande: ett multimodalt perspektiv. Norstedts. Stockholm.
- Shulman, L.S. (2005): Conocimiento y enseñanza: fundamentos de la nueva reforma. Profesorado. Revista de Currículum y Formación del Profesorado, 9 (2), 2005.
- Skinner, B.F. (1968). The Technology of Teaching. New York: Appleton-Century-Crofts.
- Skinner, B.F. (1977). Sobre el Conductismo. Barcelona: Fontanella.
- Tardif, M. (2004). Los saberes de los Docentes y su Desarrollo Profesional. Narcea: Madrid.
- Taylor, CH. (1999). Det mångkulturella samhället och erkännandets politik. Göteborg: Daidalos.
- van Manen Max (2010). Qualitative Health Research, XX(X), 1–10, 2010
www.maxvanmanen.com/files/2011/04/2010-MomusTechnologies.pdf
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* Cambridge, Mass.: Harvard University Press.
- Vygotsky, L. (1985): Pensamiento y lenguaje, Buenos Aires: Pléyade.
- Willis, P. (1988), Aprendiendo a trabajar, Madrid, Akal. 1.
- Zeichner, K. M. (1993). El maestro como profesional reflexivo. Cuadernos de pedagogía, (220), 44.