

Titles and Abstracts of Papers Presented by Invited Participants

“The concept of information in the sciences: an epistemological critique”

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The word “information” is highly polysemic. We cite Shannon’s scientific definition: information is a DIFFERENCE that makes a DIFFERENCE. Consequently, its legitimacy is conditioned by the Latin phrase “ceteris paribus:” “all other things being otherwise equal.” The explanation of that which must remain “otherwise equal” in order for a piece of information truly to constitute information reveals the limitations of the concept. We shall illustrate these general principles through examples taken from Information and Communication Sciences and the relationship between genetics and biology.

“Developing systematic thought at the elementary school level: conceiving the learning experience using systemic thought”

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The analysis of complex systems has renewed our ways of thinking. It is now possible to make a relevant argument for the importance of including systemic thought among the goals of education. In society today we have a greater and greater need for intellectual tools that can help us understand and confront the ongoing challenges of a complex and problematic environment.

The cognitive obstacles to this understanding stem from several sources: the phenomenology we are exposed to, the cognitive strategies we practice, including counter-intuitive strategies such as non-linear, non-deterministic causalities, self-organization, statistical distributions, the decentralization of controls, different gauges of time, and the emergence of phenomena.

The offerings in the schools (curricula, teaching, textbooks) would seem to amplify these obstacles.

We shall present data collected during an experiment conducted in elementary schools. our goal was to conceptualize the evolution of the notion of an urban system. We use arguments drawn from the experiment to discuss the learning process in the context of the learning environment.

“Possible Interactions between Epistemology, the History of the Sciences, and Didactics: What’s the Use?”

MAYRARGUES Arnaud

Despite the ongoing discussion, implementing epistemology and the history of the sciences in teaching is institutionally desirable. These areas of study occupy a significant place, particularly in French college programs effective in fall 2006 as well as in French high school (“lycée”) programs. After Dominique Lecourt’s report in 1999, there was further development of the teaching of epistemology and the history of the sciences at the university level. We demonstrate the interest and goals of a project involving epistemology and the history of the sciences in the schools, possible interactions with the field of didacticism in the discipline, as well as the changes in these fields that would be necessary in order to create a coherent ensemble.

“Argumentation in the arts of proof”

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- Lexicon: to argue, to prove, to demonstrate
- Fields: proof, demonstration, argumentation
- Theories of argumentation and their relationship with proof and demonstration
- Ruptures and continuities of argumentation / demonstration. The question of the emotions (examples taken from the physics lab [TP: “travaux pratiques] corpus).

Abstracts of Papers and Postings

“From the study of parent-child interactions in a science museum setting to a proposal for parents’ innovative intervention”

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After considering the importance of the role of parents who accompany their children while visiting an interactive scientific and technical exhibit, we then undertook two subsequent studies: the first suggests a typology of parental modes of intervention in relation to their ability to adapt more or less to the context of the activities at the exhibit and to their children’s abilities. Based on this study, the second study seeks to evaluate whether or not a preliminary action that heightened the parents’ awareness of their tutorial role had an impact on the way they acted when they accompanied their children. The critical apparatus used to sensitize the parents is an original one whose fundamental characteristics we present.

Key words: parental education – parent interaction – child – science museum

“The role of students’ epistemological points of view in their decision-making process related to a socio-scientific controversy”

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In the case of controversial socio-scientific questions, students find themselves face to face with a “science in the making.” (Latour 1989). Scientists are in disagreement and the controversies are rife with uncertainties. In this context, how do students apprehend these situations? What sort of stances do they take? How do they justify these positions? Some decide to emphasize values (Fensham 2002; Fleming 1986; Grace & Ratcliffe 2002). For others, the students’ own socio-epistemological considerations are decisive in their decision-making (Aikenhead 1985; Kolstø 2001). Lastly, some studies question the importance of using scientific knowledge when a decision must be made about a socio-scientific question (Leach & Lewis 2002; Tytler, Duggan & Gott 2001). We have attempted to pinpoint the role of epistemological points of view in students at the first technological level of agricultural studies as they make decisions about the ill-defined and controversial topic of the danger of using cell phones. The students’ positions were collected in writing before and after a classroom presentation of a role-playing exercise that simulated the debate over the question (Hind, Leach, Ryder & Prideaux 2001) from the standpoint of public education on the nature of the sciences. The students mainly justified their positions on the basis of current ideas about the effect of the waves emitted by cell phones on health and epistemological considerations. Scientific and technological knowledge carried little weight. The request for more science and scientific proof informed the conditions that changed the students’ opinion about the danger of cell phones. In the absence of any conclusive proof, most students affirmed their intention to continue using

their phones just as they had before the role-playing in class. These results point to an overvalorization of the role of proof in resolving the controversy; like other studies, they also emphasize that a belief in the central role of empirical proofs in scientific activity is an important factor in students' decision-making processes. (Leach & Lewis 2002 ; Sadler 2004 ; Zeidler et al. 2002).

Key words ; epistemology – controversies – decisions

“The contribution of interactive mediation in Tunisian students' learning experience of the notion of shadow”

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Schools today are no longer equipped to teach awareness. The young learner has several extra-curricular sources of information at his or her disposal that may serve the learning experience. After observing the failure of trying to teach the notions of shadow and half light in school, we decided to study other ways of inducing this learning experience outside the classroom. Most students who took part in the activities have a quasi-materialistic concept of shadow, and believe that it is the presence of something rather than the absence of light. They may also have more than one conception of shadow at the same time. It was proven that students have real difficulty acquiring these notions in class, despite their apparent simplicity. Under certain conditions, however, locations outside school may be conducive to developing this knowledge to a better degree than classroom teaching that does not always encourage students' contributions. The activities we suggest are designed to lead students to discover the physical meaning of the notion we have studied, which exists in a “cause-effect” type of relationship, through the use of a geometric point of view.

“Problems facing teachers in introducing sex education in Portugal: the influence of gender, religion, and several other parameters”

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The goal of this research project is to identify the difficulties facing elementary school teachers as they address the responsibility of teaching sex education in Portugal. The ministerial guidelines clearly seek the development of sex education in the four elementary school classes, but the majority of teachers do not apply these guidelines. We present the complete research protocol used to conduct our research on the topic. To date only the first phase of our research has been enacted. This took the form of an extensive private questionnaire that was completed by 486 primary school teachers. We present the results dealing with questions about their difficulties in the four major areas of sex education (the developing body, expressions of sexuality, interpersonal relationships, sexual and reproductive health). These results also address a variety of topics that are specific to sexuality, teachers' apprehensions, and the tools that support the teaching of this material. The responses are cross-referenced with teachers' individual parameters such as sex, age, academic qualifications, full-time course work, single unit course work, the work environment, family situation and number of children, religion and religious practice. The results indicate that sexual intercourse and all aspects of sexual pleasure are the most difficult topics to present for teachers. Responses vary significantly within certain parameters: men, young

adults, the sexually abstinent; those who have already formally studied sex education seem to experience the fewest difficulties. Local, social, and religious contexts serve as fundamental obstacles that block Portuguese instructors from effectively teaching sex education.

Key words: Sex education - health education – elementary school – teachers’ pre-conceptions – obstacles to the learning experience – gender – religion

“Epistemological reflections and the scientific status of biological evolution: one classroom example in Tunisia”

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The goal of this study is to design and produce a didactic model that will serve to develop the scientific dimension of teaching evolution in Tunisia. The model includes teaching students to think epistemologically in a social context. The aim of this line of thought is to characterize the argumentative references and the scientific criteria of the theory of evolution. We have done an intrinsic evaluation of the model as a guide for teachers as well as an outside evaluation. Were there any epistemological changes: were students better equipped to distinguish argumentative references after the teaching model was introduced? The epistemological change is characterized by the classification and integration of the following aspects that arose from students’ verbal interactions: the use of a single argumentative reference, the affirmative recognition of at least two different explanations of the diversity of living forms, the discussion of the validity of scientific proof, and the generation of other questions about biological evolution. Before instruction, none of the participants (18 students) was able to distinguish between argumentative references. After the lesson, 12 students seemed to be able to distinguish argumentative references. Besides having recognized the existence of two different explanations of diversity, the students were able to articulate the differences between the two points of view and their respective arguments. They also justified the scientific legitimacy of the stages of biological evolution. The only linguistic argumentative register they used was the language of biological evolution, and they expressed the need to know more about the origin of life and the reversibility of evolutionary phenomena. These results lead us to affirm that there is a possibility of encompassing the teaching of biological evolution within the status of science, by integrating epistemological reflective thought and introducing students to the scientific criteria of the theory of biological evolution and its methodology.

Key words: didactic model – epistemological reflection – biological evolution

“Students’ reasoning processes in the study of electromagnetism”

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Rare studies in the teaching of physics on the topic of electromagnetism reveal the existence of students’ problems understanding and using the concept of the magnetic field and other related

concepts. This study¹ initially confirmed the problems enumerated by earlier studies and sought to expand that work by looking at the source of these problems. To do so we activated Gérard Vergnaud's theory of conceptual fields (1990) that offers a theoretical framework for this type of research, specifically for research on complex cognitive activities, like those required by physics. This theory allowed us to grasp the dynamic of students' cognitive functions by inferring their reasoning process in different classic, open-ended situations (during interviews) that brought the concept of the magnetic field and other related concepts into play. In fact, we were able to articulate students' reasoning process based on their own words by referring to the operative constants (invariants) they used to express their thoughts. Consequently we were able to identify the cognitive design used by the students we interviewed. In this paper we describe the methodology used to conduct the study and illustrate it through the use of a sample student in an open situation.

Key words: electromagnetism – magnetic field – operative invariant – design – theory of conceptual fields

“Learning $W = mg$ at the third high school level: understanding the physical phenomenon vs. applying the formula”

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This study looks at the acquisition of the concept of gravitational pull at the third level of study at a French lycée. After studying the lesson, students are supposed to have understood this physical phenomenon and be able to manipulate the formula $W = mg$ that relates weight and mass. Several teachers' experience suggests that these goals were not achieved and that students have difficulty applying the formula numerically. Our goal is to achieve an understanding of the reasons for these shortcomings by studying the connections between applying the formula and other skills related to the concept of gravitational pull or to its algebraic calculation. We isolated five different skills: 1) an understanding of the formula related to 2) an understanding of the physical phenomenon, 3) the ability to work the formula $y = ax$ and its application in order to 4) apply $W = mg$. This transference may be subsumed (or not) to 5) a recognition of the proportionality of weight and mass. Results showed that only 19% of students were able to manipulate the formula $W = mg$ correctly. These students generally possessed other skills, in particular they either had reasoning skills that allowed them to “make the formula speak” or else they were familiar with mathematical procedures, or both. However, we also note that if these are necessary skills, no single one is sufficient to the task. Many students cannot associate the symbols of the formula with the meaning of the concepts they represent and this can be an obstacle to applying the formula. Students who know how to use $y = ax$ are unable to apply this knowledge to the calculation of $W = mg$ in physics. This leads us to believe that the physical meaning conferred on the symbols and the formula prevents students from abstracting their deep structure and recognizing a formula that has the same algebraic structure as $y = ax$. Recognizing the proportional relationship between weight and mass does not seem to be a factor in applying $W = mg$. Our results suggest that the learning experience of the physical phenomenon and its corresponding formula $W = mg$ should not occur independently of each other, and also indicate that the relationship between the formulae $W = mg$ and $y = ax$ should be emphasized more from the point of view of an algebraic calculation that is required by numeric applications than in relation to proportionality as such.

¹ Defended thesis (R. Bagherii-Crosson, 2004)

Key words:

“How teachers of the physical sciences use their knowledge in course preparation”

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Our research was conducted from the perspective of how educational content is adapted to what a teacher needs to know. This study seeks to discover how new and experienced teachers draw from their professional knowledge to prepare a course of study. This knowledge may be related to the teacher’s discipline, or may be of a pedagogical, didactic, or institutional nature. We recorded explanatory interviews with new and experienced teachers and then analyzed this data based on a categorical model that represents different modes of acquiring and transmitting knowledge. The study allowed us to highlight the use of institutional and/or opportunistic resources. Depending on his or her degree of expertise, these resources are incorporated differently into the teacher’s professional practice.

Key words: Teachers – Knowledge – Physics

“The use of simulation software at science exhibits for young children: can it be a tool for understanding the real?”

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Through the study of the reinvestment of knowledge acquired through the use of a computerized simulator at a science exhibit for children under six years of age held at the “Cité des sciences et de l’industrie” in Paris, our research examines the intersection of the “virtual world” and the “real world” that young children are capable of articulating. Twenty children between the ages of 3 and 5 were observed in the context of one element of the exhibit (“draw with your finger”) that asked children to paint and mix colors using a computerized software program. What we observed showed us that there is an ambiguity for children between virtual representations and real objects, and that the way children relate these two “worlds” is not systematic.

Key words: simulation software – science museum – young children – learning

“Teaching human reproduction and sexuality in secondary school programs from 1950 to the present”

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Research in the area of the didactics of biology on teaching human sexuality has mainly addressed AIDS and the necessary preventive education that it required (see, from among hundreds of studies, Motta 1996, Marzin 2001, and Saccadura 2002). Our project analyzes the way this topic has been introduced into secondary school education in France, using a historic approach that compares programs (and the official ministerial texts that precede these programs) over the past fifty years. In reality sexual practices and values have radically changed over the course of those years. How and at what intervals of time has this evolution been integrated into secondary school programs when they have been successively modified?

After a long silence in programs and manuals that only went so far as to discuss the sexuality of plants and certain animals, the movement that supported a sexual revolution in May 1968 was finally able to achieve a revision of this material, after a delay of five years, with the publication of the 1973 memorandum “Sexual information and education.” “Sexual information” corresponded to biology classes, while “sex education” was an after school option. The arrival of new knowledge that was more focused on reproduction than human sexuality, did not take place in these programs until 1976. This “didactic lag time” was much shorter when it came to AIDS education. In 1981 the New England Journal of Medicine published studies on an acquired immunodeficiency syndrome called AIDS. The French media publicized this information in 1985; the date coincided with the immediate introduction of the acronym AIDS in high school programs, in a clear effort to launch an effective prevention campaign. The concept of “sex education” appears from 1996 onward: moving beyond “sexual information,” it became necessary to develop a program that taught responsibility from the standpoint of preventing behavior that would put students at risk. All these innovations in the programs were limited, however, to a bio-medical health model (of cure or prevention). The views of the World Health Organization on promoting health have only been introduced more recently, including a program of sex education that is less limited to its biological dimensions.

Key words: Sex education – didactics of biology – didactic transposition – history of education

“Causality and explanations in the teaching of physics and in general thought: calculating and understanding”

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The notion of causality has long been a subject of debate for philosophers and scientists. Currently the predominant tendency is largely to avoid any discussion of causality, in favor of functional relationships and systemic descriptions. However, didactic research shows a strong presence of causal explanations in ordinary reasoning. In my research, I analyze some of the tendencies of causal reasoning used by physics students, using questionnaires and interviews on the mechanics of solids and fluids. Approximately 250 pupils, 170 students and 36 teachers responded. I compare the differences between ordinary reasoning and scientific practice, with suggestions for the classroom. I present three interconnected aspects that are also related to everyday thought patterns: 1) the confusion between efficient cause and contingent cause, and between the conditions under which a phenomenon occurs and the cause that directly produces it;

2) a tendency to displace or delocalize causes; and 3) difficulty associating local causes and universal effects. All three aspects are interrelated: insufficient analysis of local details can lead to the formulation of a general perspective that poorly distinguishes the specific places where interactions occur. This in turn can lead to delocalizing or displacing forces and causes, which can create confusion between that which triggers or induces a phenomenon and that which actually produces it. Students and the generalist are apparently not satisfied with applying formal laws and functional relationships in order to understand a physical situation. They expressly demand a causal explanation or a mechanism that explains the dynamic of facts and effects that brought about a specific state of things. This leads to a critique of the prevalent attitude among teachers that overemphasizes static or stationary situations, approached using a-causal rules and formulas, with an emphasis on calculations and algorithmic procedures instead of understanding. On the other hand, ordinary reasoning requires an explanation of what constitutes a balanced or stationary situation and applies reason mainly in terms of change. These trends in reasoning should be recognized by teachers not only as obstacles but also as resources available to the student, to be incorporated into a positive dynamic that fosters conceptual development.

Key words: Causality - Reasoning – Physics

“A laptop computer for every student: possible influences on the teaching of science and technology at the French college level”

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In this paper we present the preliminary results of three studies that observed the contribution of using laptop computers in systems of transmitting information, specifically the appropriation of knowledge in the teaching of science and technology at the college level. Two different inquiries were conducted in order to identify and characterize changes in teaching practices that took place when they relied on the use of laptops. A third inquiry looked at the use of a shared workspace that was favored by the introduction of the laptops. The goal of all three inquiries was to collect information on students' and teachers' habits when they relied on the use of laptops in the context of their use in class but also outside class, in shared workspaces made available through the Internet.

The general context of the study is based on measures taken by the Council General of the department of Bouches du Rhone at the beginning of the academic year 2003. The goal of these multifaceted measures was to increase computerization: furnishing laptop computers to students and teachers at the fourth and third levels of all colleges in the department was the favorable response to this initiative. We tracked the delivery of these laptops and were especially interested in observing their use in physical science and technology courses. The empirical data we collected is based in part on teachers' presentations and practices and on our observations of these practices. Our analysis of transcripts of interviews has been organized so as to classify real or suggested uses on the part of the employees we interviewed. The description of new practices and obstacles encountered should allow us to determine the future influence of this hardware on the learning experience in the physical sciences and technology as well as other fields.

Key words: teaching – learning – teachers' practices –laptop computer – physical sciences – technology

“Tunisian high school students’ conceptions of the tectonics of geological plates”

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The goal of our study was to interpret students’ explanations of geological phenomena such as earthquakes and volcanoes following their presentation in class. Our analysis of Tunisian students’ conceptions shows that most students had recourse to a localized perception to explain the origin and activity of earthquakes and volcanoes. They did not mainly use the tectonic theory of plates as a unifying model to explain these geological phenomena.

Key words: unifying model – localized perception – central perception – overall perception – geology – earthquakes – volcanoes

“Instructors’ Perspectives on Technology at the Graduate Level”

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In the context of recent debates on scientific literacy, there has been renewed research interest in teaching the nature of the sciences to students. Studies have been done on students’ perspectives on the sciences (Abd-El-Khalick and Lederman, 2000; Driver *et alia* 1996 ; Désautels and Larochelle, 1989 ; Ryder *et alia* 1999). Only a few studies have focused on attitudes toward technologies, although we currently live in societies that some authors describe as a “technopoly” (Postman 1992) or “techno-nature” (Fourez 2002). Although students may conceive of the sciences as a direct reading of nature (Désautels and Larochelle 1989), or as disciplines where data leads in a non-problematic fashion to objectively accepted conclusions, social interactions and the role of human endeavor and debate (Sutton 1992) in the elaboration of this knowledge is unknown (Driver *et alia* 1996). This observation has led those who study the didactics of the sciences to examine the epistemological knowledge of primary school teachers (Guerra-Ramos *et alia* 2003) and science teachers at the secondary level (Désautels *et alia* 1993; Haidar 2002), Lederman 1992; Levinson and Turner 2001). To our knowledge no one has done a study of these perspectives in teachers of various branches of technology at the graduate level. This was the object of our research. Taking “epistemological knowledge” to mean situationally-activated perspectives, our work seeks to identify different viewpoints toward technology among teachers whom we interviewed at a graduate technicians training school in Tunisia. We attempt to define how these teachers perceive relationships between the sciences, technologies, and societies as well as how social and cultural aspects affect their discourse on these technologies. Our discursive analysis indicates that teachers perceive technology as an applied science whose goals are progress and consumption. The connections between technologies, the sciences, and societies expressed by the teachers offer varying degrees of complexity. Nonetheless, all of them believe that technologies influence individuals and societies on a socio-economic level. Different degrees of importance were ascribed by the teachers we interviewed to social, historic, and cultural influences on the development of technologies, ranging from no influence at all to definite influence with ascribed value. These results led us to question the educational background of teachers at the “electrical genius” level at the Instituts Supérieurs des Etudes Technologiques.

Key words:

“Scientific Learning through problematizing in physics at the Terminal S Level”

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In order to study how students in terminal S problematized a concept – in other words, how these students designed, set up, and solved a problem - related to how an electric circuit with a condenser works, we analyzed their conversation while they discussed in groups or as an entire class. In these sessions, we were mainly interested in how students learned about the electrokinetic model of a condenser. To problematize how the two electric circuits work – one charging and the other discharging the condenser – students juxtaposed and extrapolated from the data related to the problem in a mechanistic explanatory logbook, broadly defined to include flux, in order to construct the necessary conditions for a log of different models.

The sequential reasoning the students used in studying these problems does not allow them to differentiate the roles of the condenser and resistance in the way these circuits operate. Analyzing the working of the circuits did not allow the students to build an electrokinetic model of the condenser, but it did enable them to analyze how the condenser works as a receiver and a generator. We studied the students’ work further to measure the influence of the dynamics of the debate on their problem-solving and in order to position problematizing more accurately in the context of a learning experience using situation problems.

Key words: problematizing – physics – teaching – learning – constructing necessary conditions

“Intra- and intermolecular connections and the transformation of matter from the students’ viewpoint”

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In order to distinguish a chemical transformation from a change in state, one must not only have mastered different “objects” (a chemical substance, molecules, atoms, ions, and elements) but also their interrelationships (macroscopic and nanoscopic levels; covalent or ionic connections; intra- or intermolecular connections). Several studies point to students’ difficulties in distinguishing between these two types of transformation.

Through a study that ran the length of a class that was the antepenultimate before the final year of study, the goal of our work was to identify how students interpret chemical transformation and a change in state in terms of a rupture or non-rupture of connections.

Our inquiry involved students at the second and first levels before the terminal year, as well as in the final year of lycée studies. In order to collect the relevant data on students’ mastery of the concept of chemical connections, they were asked four questions, using a paper and pencil questionnaire: they were asked if they agreed or not (on a scale of 1-4) with affirmations regarding the rupture of intra- or intermolecular connections during a chemical transformation and then during a change of state; they were also asked to explain their choices. Based on our observation of students’ responses related to chemical transformation, we were tempted to say that most of them were able to interpret the overall phenomenon that is connected to a chemical transformation: they understood the necessary rupture of intermolecular connections that allows molecules to interact with each other, followed by the rupture of intramolecular connections (which some final year students state is not uniformly necessary). However, our analysis of these justifications forced us to moderate this optimism. Very few of them were able to justify the

rupture of intermolecular connections (the number of justifications increases from the second to the final and then the terminal year) or to interpret the rupture of intramolecular connections in terms of the rearrangement of molecules: this is the formulation that students are expected to have mastered by the end of college instruction. For example, 40% of the justifications given by students in their final year were done so in terms of the formation of new molecules or else stated as “the reagents produced different substances.” As for the interpretation of changes of state, we observed that despite the instruction given, about one-third of the students in their final year could not conceive of such changes in terms of the rupture of connections and were likely to interpret a change of state as a rupture of intramolecular connections. The proportion of these choices and the fact that few students were capable of justifying these transformations led us to the hypothesis that many students have only a vague idea of the concept of an intermolecular connection, which they easily confuse with inter- and intramolecular connections.

Key words: inter- and intermolecular connections – chemical transformation – change of state – conceptions

“The development of an exercise bank and its analysis for the teaching of the sciences at the lycée level”

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The goal of this research study is to give teachers evaluative tools (exercises and companion material) to help them verify students’ mastery of basic concepts of mechanics taught at the second-to-final year of the French lycée. The usual constraints on teaching (limited time, the program itself, preparation for taking the baccalaureate degree) were a strong influence on the development of these tools. Our work was done in collaboration with a group of teachers and researchers. In the context of the SESAMES project (Situations d’Enseignement Scientifique : Activités de Modélisation, d’Évaluation, de Simulation: Situations in Science Teaching: Activities for Constructing Models, Evaluation, and Simulation) and in response to a request from teachers, this group developed a set of evaluative exercises that were adapted to teaching sequences that arose from an earlier project. Using these exercises and tests devised by researchers to evaluate the knowledge acquired by students after a lesson (pre-test and post-test types) as a model, we developed and adapted four tests to the teaching practices of French instructors. These tests were used in class by teacher at the second-to-final level and at the end of instruction. The in-class tests were administered in three classes (to approximately 90 students). The fourth test (at the end of instruction) was given in ten extra classes (to a total of 400 students). The statistical analysis based on categories of students’ written responses (after analyzing their knowledge) allowed us to evaluate the degree of complexity of each question in order to give a reference point to the teacher and cross reference students’ answers to examine the coherence of their responses. The preliminary results of this work are presented. An illustrated example on the concept of movement shows how these tests might be used as a tool for classifying problems in comprehension.

Key words: evaluation – comprehension – mechanics – developing tools

“A Comparative Epistemological and Didactic Study of the Concept of the Fossil: the teacher’s role in facilitating discussion”

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The focus of our work problematizes discussion of the concept of the fossil in the context of the history of science and teacher training. What controversies over the origin, formation, and significance of fossils have been disputed by naturalists? What kind of discussion of this topic can a third-cycle primary school teacher or a college teacher generate? Referring to the analysis of two case studies, an excerpt from a discussion between Guettard and Voltaire, and an excerpt from the discussion in a CM 1 class, our research attempts to identify the dynamic structure of problems teaching the concept of the fossil. This didactic investigation took place on three methodological levels, from the teacher’s preparation to its analysis. It includes:

- the conception of an interactive tool for analyzing students’ initial conceptions. This tool is intended exclusively for the teacher’s use; it is meant to be as exhaustive as possible vis-à-vis our sampling of approximately 200 students,
- the filmed sequence where students were presented with the initial conceptions, followed by the teacher’s monitoring of the discussion,
- the cross self-confrontation sequence that permits the teacher to self-analyze his or her professional service.

Relying first of all on the microanalysis of discourse, epistemological explanations in the 18th century and didactic inquiry offer a comparative analysis of restrictive “spaces.” The three registers – the empirical, the level of models, and the explicative – all present a common obstacle: the question of whether or not mankind was contemporaneous with the fossil shells. But these registers also reveal divergent problem-spaces through different peripheral lines of questioning: the formation of mountains and the regression of oceans for naturalists or the color of a fossil and the cause of the disappearance of dinosaurs for students. These explicative systems abound in obstacles and lines of questioning; taken together, they construct a conflictive argument that confronts current and past fauna, as well as juxtaposes the imagination with scientific objectivity or the students’ own objectivity. The attempt rationally to reconstruct the history of life on earth forces us paradoxically to make references to life today, whereas it is the product of an irreversible evolution that cannot be reproduced. That in itself is an obstacle. Would familiarizing teachers with historical texts that illustrate the conceptual leap between theory and the collected fossilized object modify their professional activity?

Key words: discussion – problematizing – restrictive space – fossil – history of the sciences – teacher training – cross self-confrontation

“From primary school to college, the relationship to forms of life in students ages 10-11”

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A human’s relationship to forms of life, especially mankind’s attitude toward animals, is historically complex. Although these relationships present different characteristics and vary from person to person, they often labor under the dual stress of attraction and repulsion, or admiration and fear. They may also unconsciously lead to a hierarchy of living things that influences conceptualized constructs. A pupil’s relationship with living things at the end of elementary school may be considered as the result of multiple psychological, epistemic, cultural,

anthropological, and social factors. In order better to understand the relationship to forms of life in a scholastic context from elementary school to the French college level, to contribute to its description in pupils ages 10-11, and to study its eventual impact at the entrance level to college and more rigorous instruction, we followed a group of students through the presentation of a thesis topic and built a corpus of material that consists of several elements: we analyzed the assigned curriculum, the observations made in class over a period of two years in order to target the real curriculum, students' written responses to questionnaires on two short video clips on forms of life; finally we analyzed semi-guided individual interviews where students were confronted with a group of life form. This was done with the students we had been tracking at the end of CM2 and at the end of the sixth form.

Key words: animal – relationship with forms of life – CM2 – the sixth level

“Designing an experimental protocol with a dedicated software program: learning experiences and difficulties encountered by students in Terminal S”

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The research projects presented here concern the evaluation of one meeting of a chemistry practicum (Travaux Pratiques) with the special feature of the possibility of fully completing the assignment remotely. During this meeting, students were expected to develop an experimental protocol that allowed them to add a grenadine syrup to the colorant E124. To do so they used a dedicated software program that was accessible via the Internet. The dosage was completed long distance by means of an articulated robot according to the given protocol. Our effort was to characterize the learning experience as well as the problems encountered by students in Terminal S who did this practicum. Both learning and problems were evaluated based on the knowledge that was necessary to perform the experiment, according to a categorization of theoretical, methodological, and performative knowledge.

Key words: virtual laboratory – chemistry – experimental approach – designing a protocol

“The experimental dimension in mathematics: myth or reality?”

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Although the experimental dimension of mathematics is well represented today in current programs of instructions, taking the form of a strong recommendation to use a scientific approach, how is it applied to the building and diffusion of scientific knowledge in school? To answer this question, and in reference to the epistemology of the notion of experimentation, we suggest some self-reflexive didactic and epistemological elements. We also refer to the notion of “milieu” (Brousseau 1990 and Bloch 2001) as the temporal teaching situation conceived by the teacher with which students interact. In this fashion we are initiating a new way of characterizing an experimental type of milieu in certain didactic situations.

Key words: scientific approach – experimental – milieu – programs of instruction – didactic situation – research situation

“The advancement of a reaction in science class at the first level”

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As a science, chemistry is essentially concerned with chemical transformations. A chemical transformation is represented by a chemical reaction that is symbolized by the equation for the reaction. At the beginning of the school year in 2000, the new second level program was launched. In the section entitled “The Chemical Transformation of a System,” the designers of the program offered a new “tool” for studying the state of a chemical system during a chemical transformation: advancement. Use of this “tool” continued in the first level science class (first level S) and the final level of the science curriculum (“Terminale S”). Our study focuses on the introduction of the notion of the advancement of a reaction in the teaching of chemistry at the lycée level. Current research will attempt to evaluate the real contribution of this “conceptual tool” in relation to high school students’ mastery of understanding a chemical reaction. We looked at responses to a questionnaire distributed in first level science classes.

Key words:

“Articulating old and new knowledge: Learning about the energy of a chemical system taught by a TICE”

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Our study looks at how a learner can modify what he or she already knows in order to gain new knowledge. The context we chose is the teaching of the notions of the energy of chemical connections and chemical reactions in the first level class of the science curriculum (S). The teaching sequence used incorporates an assignment that uses a TICE to articulate representations of the energy of a chemical system whose microscopic and macroscopic aspects are being considered. We decided to describe the students’ knowledge using a model-making approach that allows different kinds of knowledge to be articulated: microscopic, macroscopic, simulated, and theoretical. We asked ourselves how chemistry students would activate their prior knowledge when they began to approach the notion of energy, and what the role of the simulation provided by the TICE would be. To do so, we filmed three sets of students and read seventeen students’ written reports. As a result, we could supplement the case study provided by the video data with an expanded amount of work generated by students. We found that prior knowledge of chemical connections and energy could be modified because 1) this knowledge was activated by the simulation and the questions accompanying the assignment, 2) the same knowledge appeared on different semiotic levels, 3) the interrelationship of different elements was highlighted by the simultaneity of simulated events, 4) the knowledge could be qualitatively and quantitatively evaluated which, for example, recalled much earlier (and therefore very stable) knowledge of proportionality, and 5) this knowledge was articulated with other data available on the interface. We also gathered result on both the microscopic and the macroscopic levels on the possibility of guessing that was permitted by the simulation used. The differentiation between energy and temperature was difficult to obtain. This did not come as a surprise to anyone who had consulted

the didactic research in this field. However, the notion of evaluation was easily transferred to the proposed situations that implied new concepts.

Key Words: prior knowledge – TICE – chemistry – energy – chemical connection – heat – temperature

“Argumentation and Conceptual Differentiation in the Sciences”

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Our research, based on a case study of a discussion of electricity between four students at the fifth level, shows how sketchy reasoning that is articulated in weak, indefinite terms can lead to the regression of its constituent terms. As a result, the verbal interaction that uses this reasoning becomes more definitive. Consequently, this progression leads to the construction of similarly strong concepts. In order to mutually agree and understand each other, students had to define the meaning of the terms they were using. Our work relies on a conception of the learning experience that gives critical importance to the linguistic aspects involved in the act of learning (Vygotski and Popper). To evaluate the nature of the exchange within the dynamic of verbal interactions in a heuristic context (where knowledge is formed), Grize’s framework (including the idea of a “natural logic”) seemed particularly useful in elucidating these aspects. Consequently, the analyses reached overlay a linguistic point of view, since they use systematic chains of signifiers, with a didactic point of view: the categories used to characterize these chains were devised in relation to the problems of understanding that arose from the contents of the learning experience in question. These chains of signifiers show the evolution from the use of “weak” and “imprecise” words, often pronouns, toward more precise, lexical terms; in general they indicate the relevance of the meaning of these terms brought about by the analysis of the linguistic coherence of “predicative couples” (subject groups/verb groups). These evolutions may be interpreted through the negotiations required by the necessity of reaching an agreement after initial disagreements, by marking irrelevant predicative couples in the discussion, and through the interaction of oral discourse and the demands of the written text to be produced simultaneously. Finally, although the first part of the study might lead us to believe that the whole group progressed from using “soft” language toward more definitive discursive expressions (which would indicate a conceptual differentiation), the follow-up with several students allowed us to highlight different profiles of the conceptual constructs we encountered.

Key words: verbal interactions – conceptual differentiation – electricity

“A proposal for a didactic approach to environmental education: reaching a perspective that enables long-term development at the primary school level”

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Since July 2004, the long-term development of environmental education in France (EEDD is the French acronym for “l’éducation à l’environnement pour un développement durable”) has been officially recognized in general use. The roots of this new educational dimension lie in thirty years of environmental education (EE), based on teachers’ voluntary involvement. Besides the

question of the meaning of the phrase "long-term development of environmental education" that has given rise to several debates among concerned educational participants, our particular interest in doing this project is to uncover the possibilities of and restrictions on this type of educational approach at the primary school level.

We offer a bibliographical synthesis of the major works dealing with this environmental issue. The results of the synthesis presented us with several new elements: most of the studies on environmental education at the primary school level emphasize the validity of an interpretive approach whose goal is to develop a universal relationship (sensory, symbolic, and cognitive) with the immediate environment. Several authors feel that the notion of environmental problems should not be introduced in an EEDD course at the primary school level. These two elements go against the grain of the official instruction (developed for general purposes) that recommends a positivistic approach based on acquired knowledge and behavioral changes in response to environmental problems. Still basing our opinion on a synthesis of the work relative to our field of interest, it would seem that the EEDD's presence in an elementary school should give greater importance to the specific nature of the latter educational approach at that level, especially taking into account the fact that pupils at that level have difficulty using environmental notions and perceiving relationships between different elements and aspects of the environment.

The object of this paper is to begin a necessary thought process on the topic of the EEDD through an initial didactic approach to the environment and long-term development of its study. There are other avenues of research to be explored, but we feel that initially the EEDD at the primary school level should be defined as a stage of sensory and cognitive discovery of the environmental milieu(s) inhabited by different human societies.

Key words: environmental education – long-term development – primary (school)

“A video analysis of students’ learning experiences in science courses: the contribution of gestures and outstanding aspects of the situation”

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Most research on students’ conceptions and conceptual changes are exclusively based on the analysis of verbal production. Basing our findings on recent work on a) language and discursive practices, and b) the pragmatics of communication based on the words, gestures, and the outstanding elements of a situation, we propose a different definition of “conceptions.” We define conceptions as the articulation of meaning through the words, gestures, and outstanding elements of a situation. These three aspects of meaning cannot be reduced solely to the linguistic level, since gestures and “salient” aspects constitute other modes of communication. Based on data collected throughout a physics teaching sequence on gases in a second level class (“Seconde”), we demonstrate the fundamental importance of a) analyzing the gesture simultaneously with the words it is associated with, b) identifying the “salient” aspects of the situation which students use as semiotic resources (insofar as they are used to express meaning). Based on these results, we propose a) to redefine the notion of “conception” by defining an “idea” through its relevant semiotic resources (words, gestures, and situational “salient” aspects) that are made public by a person’s discourse, and b) to consider conceptual change through the evolution of ideas over time, in other words, the temporal evolution of students’ use of the semiotic resources offered by words, gestures, and situational elements.

Key words: learning experience – conception – gestures

“Environmental Education as a Reflection of Ecology”

HAMDJ Aii

The abuse of the environment is one of mankind’s greatest concerns today. In fact, the teaching of ecology as a scientific discipline could play a pivotal role in environmental issues. Our work develops two primary aspects of this topic: first of all, we strive to bring forth views that are promoted by teachers of ecology. Secondly, we analyze the textbooks they use as a way of introducing environmental instruction into scientific teaching. Our goal is to instill values in students and give them the means of becoming ecological citizens as consumers who make responsible choices and are capable of evaluating the consequences of their actions on their immediate environment as well as on a more global level.

Key words: ecology – didactic environment – education – epistemology – history of science

“The physical sciences in the service of technology at a professional lycée”

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How should the physical sciences be taught at a professional lycée? In this academic context where students follow a technological path that leads to a professional credential, the role of the physical sciences must be clarified, especially their relationship with a technological specialization, before any teaching proposals are put forth. Our project was done in the context of creating a model of mechanical interactions for students at a professional lycée who are being trained in the area of automotive mechanics at the BEP (professional teaching certificate) level. Juxtaposing the two disciplines allows us to see that in the professional lycée setting, the physical sciences occupy a place of a corollary discipline in the service of technology. This comparison also brought out other peculiarities regarding goals, the way of perceiving objects, models used, and specific skills to be developed; it also indicated the possibility of formulating complementarities or synergies between the two disciplines. Only the property of “the transmission of a force through a mechanical connection” is incompatible with the properties of a force in physics. Our analysis allowed us to make justifiable curriculum proposals, by valorizing elements that may contribute to or reinforce a student’s technological training, always being mindful of the specific nature of each discipline. One sequence was developed and evaluated from the standpoint of the relevance of the problematic. Taking the critical stance of looking for articulations between science and technology led us to make certain choices about the characteristics of models, choice of vocabulary, and learning strategies. Our analysis shows that it is not only legitimate but also beneficial for students at a professional lycée to take on this role of science as a service discipline.

Key words: service discipline – professional lycée – physical sciences – technology – force

“Obstacles in learning the concept of ‘reflex action’ and their relationship to experiments using animals”

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We show how experiments involving the dissection of animals may be the origin of psychosociological obstacles. Cultural and socio-geographic variables apparently play an important role in whether or not this type of experiment is acceptable to students. Under these circumstances, one cannot assume that there is equal familiarity and motivation among learners at the outset.

Key words: experimentation – life form – social representations – obstacles

“Why does a chemical reaction stop? Students’ explanations in Terminal S”

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This paper evaluates the reasoning process and problems of Terminal S students in explaining the halt of an incomplete chemical transformation. The anticipated explanations are introduced in the context of an analysis of knowledge that presents the intersections of a theoretical level, the level of thermodynamic and kinetic models, and an empirical level. There are two kinds of explanations, but both refer to the thermodynamic model to justify the halt in the process or to kinetic models to resolve this apparent contradiction constituted by the presence of all the chemical elements in the absence of a macroscopic evolution. Terminal S students were asked to respond to a written questionnaire after the lesson had been presented over a period of two years. Analysis of their responses showed that the main topic anticipated –to prove that the system is in a state of chemical equilibrium – was of minor importance and also indicated that the number of students from whom we inferred a static conception of the state of chemical equilibrium was as significant as the number of students who indicated a dynamic conception of it. The explanations we anticipated that used the models available to the students were all in the minority. This leads us to believe that students did not make sufficient use of the tools provided by these models in answering the question they were asked.

Key words: chemical transformation – students reasoning - models – chemical equilibrium

“The status of the gene between students’ conceptions (SVT2) and scientific realities: a didactic approach”

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Genetics is a branch of biology taught at both the lycée and university levels. Theoretically, the notion of the gene becomes more and more complete as one advances from one level to the other. However, a certain number of factors may influence how knowledge is acquired and create different conceptions of the gene among students. In our work we propose to study how students in SVT2 define the gene before comparing their definitions with different historical stages of the target concept. The research considers a sampling of 266 SVT2 students enrolled at different faculties in Tunisia. Students were given a set of words relating to the concept of the gene and were asked to construct their own definition of the gene. The results showed that students basically fell into three main categories, each with a different meaning: the physical signification of the gene that primarily emphasizes chromosome theory; the gene that is responsible for the synthesis of proteins; and finally an assortment of ideas that revolve around the notion of genetic characters. Ultimately, the pupils’ and students’ notions of the definition of the gene were mixed

and recalled the epistemological and diachronic information relative to the concept of the gene. Among this information we found the notion of the chromosome, the protein gene, the gene as a structural unit and as a functional unit. Ultimately, no valid definition of the gene was produced. Several definitions were offered, however, but no one definition encompassed all known instances. According to Morange (1998), in the past few years the gene has become an unstable and elusive concept.

Key words: gene – lycée students – university students – conceptions

“What is the impact of the teaching of life and earth sciences on students’ knowledge, behavior, and attitudes in Moroccan secondary schools in the area of AIDS prevention?”

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Health education and AIDS prevention are topics that teachers of life and earth sciences habitually approach with their students. The school is the setting where it is possible to reach the greatest number of children and adolescents and make a positive impact on their behavior. Especially because of the type of relationship they have with their parents, young Moroccans have an especially strong bond with their teachers when it comes to AIDS prevention and sex education in general.

The arguments in favor of doing AIDS prevention in the schools are both obvious and numerous. There is currently no treatment, vaccine, or other medical means for protection against or treatment of AIDS. The only effective means of protection to date is to adopt sexual practices where one is not at risk, such as abstinence.

The goal of our work is to identify the impact of the teaching of biology in general and immunology in particular on students’ knowledge of the effects of HIV on the immune system, ways of becoming infected by the virus, and the symptoms of the disease. This is done to verify whether or not their knowledge is accurate and sufficiently developed. If this is the case, does this knowledge ensure tolerant behavior toward a person with AIDS or not? Does it allow for a conscious awareness of risk? The study we conducted with 398 students in second year baccalaureate studies in experimental sciences (200 boys and 198 girls) provided us with answers to these questions.

Key words: health education – acquired immuno-deficiency syndrome (AIDS) – AIDS prevention – human immuno-deficiency virus (HIV) – life and earth sciences teaching – students

“Graphs as a teaching aid in physics: teaching kinematics at the secondary school level in Tunisia”

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In this paper we suggest the use of qualitative graphs of movement as a tool for enhancing the understanding of different kinematic concepts, such as trajectory, speed, and acceleration at the third year level of secondary school instruction in Tunisia (ages 17-19). At this level these

concepts are usually introduced in a purely mathematical form (integration and derivation, time equations, etc.). However, we feel that introducing other representations besides the algebraic material may be of use to students who are having problems with “meaning.” Students are led to reflect qualitatively on the information provided by different graphic representations of movement. They then discuss this information as a group with the teacher’s participation. Our results show that most students who took part in this experiment became more independent in their use of formulas and algorithmic procedures than students who received the more traditional instruction on this topic. We also noticed that our students had a better understanding of kinematic concepts such as speed, acceleration, trajectory, and position as well as their interrelationships.

Key words: teaching – kinematics – graphs

“Educating M.S. (Masters of Science) students: Modeling didactic situations as the basis for creating an adaptive IT Environment for Human Learning (IEHL)

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The plans for educational programs at the IUFM in Brittany reflect the institutional request for new didactic apparatuses for beginning and continuing master’s students that would rely on self-taught information through the use of TIC. Work related to the design and use of these IT Environments for Human Learning falls within the scope of the research on the didactics of science and engineering of the EIAH (Environnements Informatiques pour l’Apprentissage Humain). The EIAH research field on engineering is cross-disciplinary, and its projects must be carried out by multidisciplinary teams. In this paper we present the current research of the MODALES project (Modelling Didactic-based Active Learning Environment in the Sciences); the project is the collaborative effort of researchers on teaching methods in the sciences and the science of education, cognitive psychology, and informatics. Our research looks at the development and application of training sequences for future teachers focused on the teaching of the sciences (lycée professors and professors at the French national schools), based on the use of multimedia resources and relying on actual praxis. We hope to explore the issue of modeling real didactic situations in the guise of different scenarios and their integration into an IT framework in the context of an adaptive learning (EIAH) environment.

Key words: EIAH – training programs for Masters’ students – sciences

“Teaching the physical sciences in the ‘Sciences and Techniques’ series for engineers with an applied arts specialization”

LORILLOT Véronique and CAILLOT Michel -Laboratoire Éducation et Apprentissages - Université René Descartes - Paris 5, Paris, France

The goal of our research is to examine the role of teaching the physical sciences in a specific training such as the applied arts. We used a double methodology: the study of the curriculum and interviews with teachers. The curriculum analysis (of the STI section of Applied Arts and post-baccalaureate teaching) allowed us to look at the question of the significance of scientific teaching in this series as well as the knowledge that is to be imparted therein. Consulting the archives of the Ministry of National Education on the development of this baccalaureate degree, and specifically the program in the physical sciences, allowed us to foreground different points of view on the form and content of the two curricula under investigation. The discursive analysis of the speech of some of the physical science teachers allowed us to define certain “ideal types” (scientific-designers, scientists, and professors) based on their own particular relationship with knowledge (as a discipline, cross-section, or based on the transmission of knowledge) and professional identity. Our results indicate that the meaning these physical science teachers confer on their teaching in this series depends on their relationship with scientific knowledge and its design as well as their own professional identity.

Key words: curriculum – reference practicum – professional identity – relationship to knowledge

“The concept of the fossil and its relationship(s) to knowledge: a study of the third cycle in elementary school”

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In this study we seek to uncover possible relationships between the fossil as a scientific concept and the concept of the “relationship to knowledge.” Since the end of the 1980s, more and more research and publications have been devoted to the topic of the “relationship to knowledge.” Today use of this concept extends to clinical psychology (BEILLEROT 1989), microsociology (CHARLOT 1997), and the didactic practices of various disciplines (CHEVALLARD 1992, CHARTTRAIN & CAILLOT 1999) that were the locus of our own work. Using references to different theoretical approaches to the relationship to knowledge, the goal of our work was to illustrate how some of these notions may be implemented in a didactic approach to the concept of the fossil. Of particular interest were the notions of the institutional and personal relationship borrowed from Y. Chevallard’s anthropological approach (1992). Initially the analysis of the scientific knowledge related to the concept of the FOSSIL and its comparison with the “Science and technology” programs of the third cycle level of elementary school allowed us to elucidate institutional expectations and define the institutional relationship (Chevallard 1992). Subsequently, the development of a written questionnaire and interviews with CM2 students allowed us to evaluate the relationships a student forms with knowledge of the FOSSIL. In this instance we were looking for the personal relationship. Our study, which was conducted in an academic institution, enabled us to perceive similar knowledge in other institutions. The continuation of this work will permit an understanding of the way this form of scientific knowledge exists in the different institutions mentioned by the students and how an individual’s personal relationship is implicated in that setting.

Key words: fossil – relationship to knowledge – personal relationship – institutional relationship – elementary school

“The history of the sciences as a research and a teaching tool: the example of colors derived from light passing through a prism”

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This study attempts to sort out the difficulties encountered by students in studying the refraction and dispersion of white light by a prism, especially problems understanding the origin of colors. Inspired by the history of optics, we also propose to study whether or not students had difficulties similar to those encountered by scientists in the past. Two paper-and-pencil questionnaires were devised and distributed both before and after instruction to a population of approximately sixty students (in the fifth, fourth, and second grades in the French system). Before the lesson was presented, the students' conceptions seem close to the Aristotelian theory of modification: colors are only the result of the action of the prism on white light, which is taken to be homogeneous. After the presentation, students did not seem to make a connection between dispersion and refraction: the prism was like a black box that “twisted” light and caused colors to appear. Two other questionnaires are being circulated, which should enable us to refine and complete the first evaluation and weigh the relevance of the pedagogical sequence that we carried out earlier on this topic using historical texts.

Key words: dispersion – refraction – color – conceptions – history - secondary

“Prefiguring a high school debate protocol on socio-scientific questions relative to the development of the neurosciences”

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Recent research developments in the neurosciences raise several questions about society, especially regarding the potential use of embryonic stem cells in treating neurodegenerative illnesses and those caused by the reduction of mental states to cerebral states that present the conditions necessarily determined by these states. Instigating a debate is seen as one possible solution to approaching these socially pertinent questions in the context of formal or informal education. The research we present is based on a debate protocol whose principal goal is to train high school students to argue socio-scientific questions. More specifically we examine the sphere of scientific and technical mediation when it engages with procedures for citizens' participation in scientific and technical choices. Our research also borrows from the didactics of the sciences that identify the ability to take part in argumentative debates from a socio-constructivist perspective as a significant aspect of one's education. The tools of discursive analysis developed for this purpose allowed us to evaluate the influence of the conditions of activating these science-society debates on the quality of the students' argumentative skills. An experimental protocol of group discussions was set up within the scientific and technical meditative structure that surrounds the high school students. The chosen topic of debate concerned the use of embryonic stem cells in basic research and from a therapeutic perspective. The procedure was characterized by the interaction between students and a researcher who offered scientific expertise on the topic. The suggested protocol allowed us to examine the consequences of “contextualizing” the debate

by focusing on the quality of the students' argumentative skills. The debate was contextualized by the participation of a representative from an association of persons with Parkinson's disease in addition to the scientific expert. The bulk of our research, which deals with the debates organized for a first level "S" class, is being re-transcribed and analyzed. In this paper we suggest different approaches for analyzing this material: a comparative analysis of the quality of argumentation in the two debate groups, where only one group benefited from the expertise of a person with Parkinson's disease. Furthermore, we will also analyze the scientific expert's discourse as well as how the students utilized it.

Key words: neurosciences – debates – socio-scientific questions – high school students – argumentation – expertise.

“An interdisciplinary approach in elementary school to the angle concept through the notion of the visual field of perception: intersections of didactic and psychological perspectives”²

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Our work is part of a collaborative research project involving didacticians in physics and developmental psychologists on how students learn the angle concept. It is known that this concept is a difficult one for third cycle students; the traditional mathematical approach often leads to incomplete or wrong conceptions. We present the hypothesis that approaching the topic through physics would enable a more effective acquisition of the concept. This in turn led to our choice of an interdisciplinary approach using both mathematics and physics.

In this paper we present a teaching sequence that is based on the notion of the visual field, developed and tested with a CE2 class. Changes in the students' conceptions were analyzed from a didactic point of view using a methodology similar to that of didactic engineering; individual follow-ups were carried out by developmental psychologists, enhanced by clinical interviews before and after instruction. We first present the results of our evaluations of students, which indicate the usefulness of the interdisciplinary mathematics-physics approach we have adopted. We then compare the results obtained by the didacticians and the developmental psychologists.

This comparison reveals significant differences in student performance as a result of the interrogatory follow-up. These differences in themselves support the relevance of the double didactic and psychological perspective in refining the analysis of the level of conceptualization reached by the students.

² This study is part of a two-year project financed by the ministry of higher education and research in the context of the call for “cognitive sciences and school” offerings.

“The double aspect of the reaction equation: difficulties and obstacles encountered by Tunisian students in the first year of secondary education”

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The goal of our research project was to locate difficulties in mastering the concept of the chemical equation and isolate problems encountered during the quantitative analysis of chemical reactions: the analysis of quantitative results must be channeled through a model and symbolic representation of chemical phenomena that allow the analyst to move between the macroscopic and microscopic levels. Students lack awareness of this correspondence between different levels because traditional teaching plunges them directly into formalism to the detriment of qualitative reasoning. The difficulties students encountered in writing and balancing a chemical equation and solving quantitative chemistry problems show how extremely significant (LA PREGNANCE) symbolic value is in relation to the macroscopic. Students seem not to have grasped the double symbolic aspect. On the other hand, in order solve their problem set (realistically grounded in principles) whose goal is to calculate the material quantity of a reactive or product based on knowledge of other quantities, most secondary level students use rote memorization of formulas and definitions. A flaw in memorization or mistaken understanding of the reactive process and the connection between the proportions of different quantities could block the students' understanding or cause other problems.

Key words: chemical equation – quantitative results – problems – symbolism

“Teaching respiration at a lycée in Gabon: what knowledge do the teachers need?”

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Work on didactic transposition and scholastic disciplines has shown that what students learn is not always the logical consequence of scientific knowledge. By way of example we chose the concept of respiration whose didactic transposition has already been studied. We conducted interviews with biology professors at a lycée in Gabon; our goal was to determine if these teachers were aware of the transformations that scientific knowledge undergoes when it becomes teaching material. The interviews addressed the historic dimension of the concept of respiration as well as what was actually taught in class. The most important result was that high school knowledge of respiration is a “miniature” of the scientific knowledge of the same subject. Furthermore, the teachers referred more to high school than university level knowledge when they talked about respiration.

Key words: respiration – didactic transposition – Gabon

“The principle of actualism: a stumbling block for lycée students confronted with problems in historic geology”

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Earth sciences are simultaneously concerned with the earth's operations today and the reconstitution of its history. Within the tension created between these two performative and historic poles, earth sciences construct a complex relationship between the past and present. The past offers periods of time that extend beyond the human capacity of perception and only reach us in the form of fragmentary traces that we are called upon to identify and interpret. In order to “read” the earth's archives, geologists are forced to study nature as it exists today and observe what occurs there now. In so doing, they are introducing the methodological principle of actualism. This principle is based on the belief that the phenomena that occurred at the beginning of geological changes in the past (in other words, their geological causes) existed and still exist in nature today. When confronted with problems of historical geology, how do high school students implement these phenomena? In the theoretical context of learning by examining a given problematic, our work analyzes the complexity of the principle of actualism and shows that it is possible to define it on two different levels. We call the first level actualism by analogy, and refer to the second level as a long-term actualism. We compare both researchers and students' use of these levels when working with a problem in historic geology: the explanation of ophiolites. Unlike the researchers who use both types of actualism, the students spontaneously valorized actualism by analogy and immediate catastrophic occurrence. They apparently have no use for the second level of actualism that structures problems in historic geology. We deduce that students do not actually construct problems in historic geology.

Key words:

“Acids and bases: from standard perception to scientific models in Tunisian students”

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In our work we intend to identify and describe Tunisian students' knowledge of acids and bases. In order to chart the changes in students' knowledge after receiving instruction in the second year of secondary education, we used the results of paper and pencil questionnaires distributed both before and after teaching took place.

Our results allow us to state the following: the concept of a base is grasped less easily than that of an acid; acquired knowledge is transitory for some students; students have difficulty making the connection between models and phenomena. They seem satisfied to base their reasoning on only one level and are far from using pH as a tool for determining the degree of acidity in a substance.

Key words: acid – base – conceptions – models

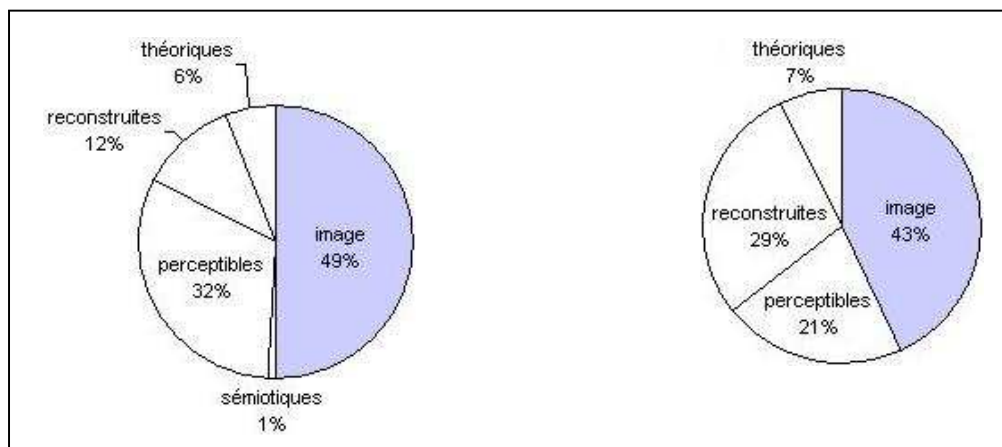
“The influence of two types of film text on their use by learners”

PEKDAĞ Bülent, LE MARÉCHAL Jean-François, UMR ICAR, Lyon, France

The simplification of video techniques has allowed for more and more chemistry films for instructional purposes to be made. We intend to analyze their cognitive impact from a didactic point of view. As part of our project, we made 34 instructional films on acids and bases; 26 of these films had two different versions of the companion text that was superimposed on the image. One text emphasized the description of what was seen on the screen (called version P for “perceptible.”) The other, which we refer to as version R (for “reconstructed”) used the vocabulary of chemistry (ion, molecule, etc.) more often.

We also designed a series of exercises that were informed by the use of these films. When we compared the knowledge displayed by six sets of students at the first S level with the text and/or the images in the films, we were able to demonstrate the influence of the film on the cognitive use the students made of it. The different uses students made of the information in the films are illustrated in the diagram below. The P films led to a greater use of images, and the knowledge gathered from their companion text was of a more visually perceptible nature. On the other hand, the R films that make less use of visual images contributed to a learner’s discourse that made more use of the vocabulary of chemistry.

Students’ knowledge acquired from the films distributed by type: P films (left) and R films (right)



Key words: film – hypermedia – analysis of an image – analysis of a scientific text - acids and bases – chemistry

“Is the development of physics knowledge a neglected teaching goal? Analyzing of intersections between the relationship to knowledge and the stated praxis of student teachers at a lycée”

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Since the year 2000, second level physics teaching programs in French lycées have required that teachers convey to their students how the knowledge of physics is constructed. Teachers have difficulty putting these specific instructions into practice, especially those who are doing their training as student teachers. In the context of the anthropological theory of didactics, we attempt to identify the type of connections that student teachers will form between their personal relationship to “the development of physics knowledge” as an informational object and the way they teach this “object of information” to second level students. To do this, we analyze these teachers’ own discussion of their teaching practices. Most of these teachers have a somewhat incoherent and underdeveloped personal relationship to the object in question. The situations in which they have been studied, learned, and taught physics has not allowed them to construct an intellectual framework for developing and imparting their knowledge of their field. We were able to find four teachers, however, whose personal relationship with the material was more coherent than that of most of the others. While the personal relationship of each of these teachers differs significantly from each of the others, they all teach the “development of physics knowledge” in a similar fashion. Analyzing the intersections between the personal relationship and the way of teaching on a case by case basis highlighted several different ways in which this specific object of knowledge is subjected to its relationship with the academic institution where it is taught.

Key words: teaching – lycée – personal relationship – institutional relationship – epistemology – physics – student teachers

“Introducing the concept of branching human evolution in Life and Earth Science textbooks used in the final year of the scientific lycée”

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The 2002 program on human evolution in the final year of the scientific lycée introduced the notion of branching evolution that did not appear in the 1994 programs. On the other hand, the notion of linear evolution is still very much present, as it was in 1994. The first part of our study is an epistemological approach to these notions. The prevailing image of the genealogical tree causes a double confusion for students between recent historical time and geological time as well as between a direct genealogical relationship between individuals and a hypothetical link between species. The linear notion evokes a direct link between several fossil forms and a teleology of evolution moving towards *Homo sapiens*. A phylogenetic tree posits links between species (real or fossil); when it is considered in a specific period in which several related forms cohabited, it takes on a branching shape. We demonstrate that the theory of punctuated equilibrium is implicit in the concept of branching evolution, whereas the concept of linear evolution is implied by

gradualism. The second part of our study analyzes the 1994 and the 2002 editions of both the Bordas and Nathan textbooks used in Terminales Scientifiques classes. These texts meticulously follow the programs and privilege the notion of the direct line; the notion of branching evolution is introduced in 2002. They also present different illustrations: the 2002 Bordas edition includes either stratigraphic or phylogenetic images (cladograms); the Nathan edition features images that combine the two categories. The two editions exceed the limits of the program by discreetly referring to a mosaic-like form of evolution and an evolutionary network. On the whole they both occasionally juxtapose contradictory notions without ever indicating their limits or the epistemological implications that we reveal in the first part of our study. In our conclusion we suggest that teaching this type of evolutionary problematic - where current knowledge is in debate and regularly enhanced by new discoveries that are highly publicized - introduces an epistemological dimension to the discussion that will help students assimilate new discoveries and interpretations in the future.

Key words: human evolution - didactic transposition – student textbooks – linear evolution – branching evolution – phylogenetic trees

“The classification of vertebrates as conceived by pupils ages 12-14 in a Tunisian college”

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In this paper we intend to demonstrate that pupils in the seventh year of general education in Tunisia (which corresponds to the sixth year of instruction in France) use strategies for classifying vertebrates based on criteria such as habitat or locomotion. This type of reasoning seems to be the result of using a blend of different concepts including the terms “fish,” “birds,” or “man and animal” from everyday language, the Arabic meaning of other concepts (“reptiles” and “amphibians”), and general knowledge whose terms for designating different groups of vertebrates are a source of errors for these pupils.³ Using these criteria, we were able to identify several obstacles to learning, especially epistemological and linguistic obstacles that prevent the scientific acquisition of these concepts in class.

Key words: conceptions – obstacles – conceptualization

“Simulating mechanics at the lycée level: conceiving and analyzing activities that use a computerized model”

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BEAUFILS Daniel, DidaScO, IUFM de Versailles et Université Paris-Sud, France

Computer simulation is often suggested today as an ancillary activity in teaching science in high school (lycée) classes. Since any simulation is based on operating a model, one hypothesis is that

³ Systematics is taught in Arabic in Tunisian these Tunisian “colleges.”

any and all investigative activity originates in a “theoretical” sphere. our second hypothesis is that offering several different representations that can be manipulated may be useful in an investigation, especially if it involves an activity with a specific target. In the work we present in this paper, we seek to determine 1) whether or not the simulation environment enhances a student’s ability to activate his or her knowledge of physics in order to solve a traditional problem, and 2) how they make use of the computerized representations and the different ways of manipulating the model. Our first task in beginning the study was to design the simulation sessions themselves. We first show how the choice of where to position the model, the preliminary and introductory activities, and our evaluation of the semiotic representations themselves guided the development of the other activities we carried out later. We then present our methodology based in particular on the video recording and the sequencing of the students’ “performance.” To do this we rely on two situations that differ in the way the activity is presented, the level of instruction, and the modes of collecting data, although they both deal with Newtonian mechanics. We then present the initial results of our observations and analysis which already reveal several highly indicative points. We give particular attention to the possible shift toward a familiar rational framework – and its accompanying activation of “spontaneous” reasoning and conceptions – despite the context of an explicitly theoretical environment and line of questioning. In other words, this shift would move toward a framework of mathematical rationality that could obscure the physicist’s reasoning. Our observations support the hypothesis of the relevance and importance of the representations and “stagings” used in the simulations.

Key words: simulation – model – didactic – physics – mechanics

“The coherence of light and the interference: the history of ideas and problems encountered by students”

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This article presents the development of our research on difficulties encountered by students (aged 20-24) when they study the interference of light. Our research focused on problems that arose from the notion of optical coherence. New questionnaires dealing with the concepts characterizing the temporal and spatial coherence of a light wave (wave train, spectrum, length of coherence) allowed us to reconfirm the results of our earlier study. Students have difficulty distinguishing between the criteria of temporal and spatial coherence and tend to consider two wave trains of different periods as coherent. The questionnaires also reveals that students associate the term “coherent” with “in phase” and do not use the wave train model to interpret situations where there is partial coherence. We conclude with an analysis of the history of these concepts in order to study the obstacles scientists encountered in the past and the ways they found of circumventing them; this allowed us to enhance our own pedagogical proposals.

Key words: light – interferences – coherence – history – conceptions – university

“Graphic representation of the earth’s structure by elementary school pupils: obstacles and perspectives”

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Diagrams of the earth’s structure found in elementary school science textbook beg the question of how and to what extent a pupil understands them. Most of the time graphic representations of spatial objects are not concerned with how understandable they are to students. Our work is based on an approach to different theorized types of space and the relationship between individual development and the ability to construct a concept of space; it presents the groundwork for a study that seeks to measure the extent of a student’s understanding of diagrams of the earth’s structure. Our study involved 201 students in the third cycle of elementary school. Our results show that only one-third of these students can represent the earth’s interior. Learning to interpret diagrams does not seem to be a given skill. Is this due to a flaw in the ability to conceptualize or a technical deficiency? In the next stage of our work, we will consider the use of software programs that would allow students to develop their own graphic representations as a way of freeing them from technical restrictions that some students might encounter.

Key words: representations – geology – earth’s structure – elementary school

“Students “in” technology: an analysis of their own comments on the curriculum”

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The four years of college in France are organized into subject categories that are determined by the distribution of schedules and teachers’ areas of specialization as well as classroom space. In the course of their schooling, students live through a variety of educational “moments” that become more and more specialized as they vary from each other, moving from once subject to another. In our work we attempt to analyze the consistencies and variations expressed by students during the set of these educational moments labeled “technology,” as well as how they characterize its teaching (based on regular attendance). We look at whatever coherence they may find and describe in all the related activities in which they took part. Finally we examine the relationship that may exist between the structure of the prescribed curriculum and the same curriculum as it is actually taught.

These primary issues are the fundamental elements of our investigation into a student’s relationship with the “subject curriculum.” In this paper, we identify the elements of this theoretical construct, its different possible applications as described by students, the methodological choices we made in analyzing these applications, and the results of the preliminary analysis of the interviews we conducted.

Key words:

“Student videos as a tool in teacher training: possible uses?”

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Currently in its initial phase, the research project, “The Use of Videos to Train Teachers,” is based on video recordings of students during laboratory classes in physics and chemistry at a lyc ee. We study the contribution of these videos as student teachers (beginning and advanced) reflect on the learning experience of science students.

The videos are incorporated into a study of assignments where the student teachers critically analyzed student activities. Beginning with the individual student and then groups, they conducted an *a priori* analysis based on the assignment sheet that was distributed in class. In groups of two, they continued to work on a series of videos filmed using a group of students. A final discussion compared the results obtained from different groups.

The data collected for this project consists of the student teachers’ written expectations, the video recordings of four dyads, and verbal exchanges between student teachers during the synthesis of results. Preliminary results show how the teachers explicated the students’ conceptions and indicate their awareness of the path students must take to formulate their responses.

Key words: training – video – didactics in the sciences

“Is high school students’ perception of the sciences affected by researchers’ presentations of their work?”

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The Universit e des Lyc eens is a plan that was put into place by the MAA (Mission d’Animation Agrobiosciences – a group for the promotion of agrobioscience) for restoring the relevance of scientific knowledge among students and alleviating students’ disinterest in the sciences. The plan involves lectures and debates presented to students by researchers. The presentations we analyze dealt with such topics as “Plants: miniature chemical factories” “What will our climate be like tomorrow?” and “Can economic science help Africa?” One of the goals of the teaching of science is to develop student awareness of the interdependence of society and science.

The study of controversial scientific questions is part of this relationship. Anglo-Saxon didacticians have introduced the notion of “socio-scientific issues” to describe social “problems” that are related to scientific fields. These issues generate divergent opinions and have implications in one or more of the following areas: biology, society, ethics, politics, economics, and the environment, among others. The educational goal is to allow students to formulate an informed opinion on these issues, to give them the ability to discuss and make choices about prevention, action, and usage. Different didactic studies have examined the relationship between students’ perception of the “nature of science” and their analysis of socio-scientific questions. Our evaluation addresses how the themes of the lectures appropriate scientific knowledge and the image of science in the students’ minds, the teaching of science, and scientific professions offered to the students. We collected data from before-and-after questionnaires on the entire proceeding, from interviews with approximately ten students, and from our analysis of the debates. Despite the socio-cultural differences we observed, the students were enthusiastic about science, scientists, and scientific careers.

Overall we found that the conferences had little impact on existing pre-conceptions about science and scientists or the appropriation of knowledge. However, we found significant to very significant differences in the impact of some of the conferences on certain variables; these differences may be related to the topic, the presenter's effectiveness, and also to the fact that student participation involved classes from different sequences. Moreover, we also observed a generic effect on several variables and significant dependencies among variables, especially those concerning the importance of research for society, the decision to do scientific studies, and feelings about the development of research.

Key words: socio-scientific questions – the perception of the sciences and scientific professions

“Adolescents with learning problems and the learning experience in science”

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Students in SEGPA, the adapted general and professional education section (the French acronym for “section d’enseignement général et professionnel adapté”), are rarely offered science courses as choices. Their learning disabilities apparently exclude them from critical thinking activities that require a high degree of abstraction. The development of their cognitive skills, however, should be a significant aspect of their pedagogical learning structures. This article presents a teaching sequence designed for SEGPA students with significant learning problems that focuses on building the knowledge necessary for understanding acoustic phenomena. Analysis of the transcripts of the sequence (twelve one-hour classes) not only exposes the cognitive stumbling blocks the students encountered, but also the explanatory modes they tend to use most often. All our observations show that despite the institutional prejudice that assumes these students would prefer concrete activities, it is possible for them to assimilate and develop a preliminary model under didactic and pedagogical conditions that are adapted to their specific needs.

Key words: learning difficulties - SEGPA – the learning experience in science classes – phenomena

“Are the results of teaching methods in electrokinetics applicable to students training for electrical professions?”

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As the continuation of our earlier work on electrokinetics involving general education students at the lycée level, we applied this research to students in professional classes. This had never been done before. We examined their cognitive behavior in response to electro-technical problems as isomorphs of electrokinetic problems. The results showed specific aspects of students' reasoning skills and their ability to read diagrams.

Key words: electrokinetics – electrotechnics – reading electrical diagrams

“Second level students’ points of view on models and modeling in the physical sciences”

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This paper discusses the notions of models and modelling from the student’s point of view. Our goal was to determine how these notions are grasped by students and may eventually lead them to a better understanding of physics. To achieve this goal, it seemed of primary importance to us to decide if students were capable of expressing themselves using models or if these topics were still too complex to be approached at the secondary level.

Consequently the main issue of our research was to determine whether or not students had built a coherent point of view vis-à-vis the nature and properties of physics models. To address this issue, three “tools” designed to be used in experiments were tested: a written multiple-choice questionnaire, a series of classroom activities, and a set of open questions. Our goal was to lead students to express their personal points of view on the nature and properties of the concept of models. The results obtained from the three types of data would seem to indicate that students do have points of view related to physics models. Of course these approaches may vary from students to student and consequently they will correspond more or less to more informed points of view. Nevertheless, these points of view are not limited to naïve or elementary ideas, but rather they correspond to reflective thoughts built on the nature, properties, and functions of models.

Key words: modelling – physics

“Scientific debate in class, learning experiences in the sciences, and problematizing: the notion of human reproduction for students in the ninth year of basic education”

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In this article we look at Tunisian students in the ninth year of basic education who were asked to explain certain topics in physiology, specifically the concept of human reproduction. Our approach makes active use of the concept of scientific debate in class and the parameters of constructing a problem. This method aligns our work with the research of the C.R.E.N. team (the Nantes Center for Educational Research): the acquisition of problematized knowledge through scientific debate. We study how students construct a problem, with special attention to evaluating the abilities of students ages 15-16 to generate reasons on the subject of human reproduction. We were not concerned with enumerating students’ correct arguments in their oral remarks but rather we wanted to explore the reasons behind the students’ ideas. (Orange C. 2000, p. 15). Knowing is not “knowing that” but “knowing that it cannot be otherwise.” Our goal was to describe what took place during the debate from the point of view of how a problem is constructed. Using arguments generated by students during the debates, we attempted to pinpoint which problems could be constructed and how the restrictions that appeared were articulated. At the end of our analyses, we were able to designate areas of restrictions (Orange C. 2000) that gave us indications of what type of problematizing of the topic of human reproduction was accessible to students ages 15-16 in the ninth year of basic education. The restrictions expressed by students on the subject of the father and mother’s respective contributions allowed us to discern two operative areas of restrictions that express two different necessary conditions: that of an equal contribution

from the father and the mother for the student group 2 (EC2) and that of a more significant contribution from the father for student group 1 (EC1).

Key words:

“The reform of the Earth Sciences curriculum in 2000: environmental issues in the second-level classroom: toward a scientific education for all citizens?”

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The reform of high school (lycée) programs in the year 2000 proposes a cultural, interdisciplinary, and historical approach to the sciences. The natural greenhouse effect is incorporated into the discourse of the material to be taught and linked to the issue of the relationship between the surface of a planet and the composition of its atmosphere. Although the socially responsible question of the consequences of the increase in greenhouse gases from human-generated waste material was included in the curriculum for the final year of the science specialization, it is not present in the new high school programs. The semi-directorial management by a member of the program advisors group shows that the work of the designers of the programs, who are mainly scientists, is focused on the content of the material to be taught and takes into account the scientific and socio-institutional contexts of the discipline, along with highly mediatized environmental topics. Our study of the contents of three textbooks edited in 2000 indicates an awareness of the sequentialized and problematized nature of the knowledge involved in the natural greenhouse effect. Moreover, in a chapter devoted to the role of human activity in the quantitative increase of CO₂ in the atmosphere, the social context of this concept is reconsidered, in relation to the risks associated with global warming. The semi-directorial management at the hands of four SVT teachers indicates that the knowledge involved in the greenhouse effect is identifiable in scientific journals such as *Pour La Science ou La Recherche* as well as in some university level texts used as educational supplements in the first cycle of study. These teachers emphasize the limitations of the supplementary science apparatus that has been integrated into the new earth science programs (the Planet-Earth site at the ENS in Lyon). Academic textbooks seem to be the supplement of choice for teaching the greenhouse effect. In class the teachers we interviewed indicated that approaching the man-made dimension of the concept, which has been highly mediatized, sometimes offers them the opportunity to present their own interpretations before introducing the concept as it is presented in the formal program. This pedagogical approach sometimes relies on the use of teaching supplements taken from televised media discourse. By using the example of how this program reform has led to the didactic transposition of a socially relevant issue today, we offer a model of how knowledge circulates between science, the media, and the school. This model could help future researchers to define the characteristics of a plan for transferring socially relevant knowledge as well as faculty's scientific and media culture to the classroom.

Key words: teaching – education – science – didactic transposition – socially relevant question – the media – school

“Designing a computer environment for training surgeons”

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In this paper we present a project (still in the conceptual stage) that describes a computerized environment designed for training orthopedic surgeons. This program would allow the surgeon to master concepts related to the insertion of percutaneous screws in cases of hip fracture. It discusses the acquisition of knowledge and the necessary monitoring of the steps that must be taken when intervening in a real-life situation; it does not discuss how manual skills are learned. This auxiliary learning tool is based on a principle that validates the learner’s actions based on information that has been diagnosed during the resolution of the problem. Our paper explains specific aspects of this work: the analysis of professional learning situations and the modeling of knowledge. We also briefly present the informatics structure of the computer environment we are creating.

Key words: didactics – EIAH – knowledge – orthopedic surgery

“The influence of certain components of the academic environment on second-level students’ relationship with the knowledge of physics”

VENTURINI Patrice, LEMME, Université Paul Sabatier, Toulouse, France

This paper discusses our study of the influence of certain elements of the academic environment on second level students’ relationship with the knowledge of physics. It is based on semi-structured interviews with thirty-four students, chosen because of the proximity of their relationship with the knowledge of physics to one of the five ideal-typical relationships we were able to identify in an earlier study. The students’ relationship with physics knowledge was categorized with the help of inventories of information specific to the field that allowed these groups to be determined. The goal of the first part of the interview was to confirm the relevance of the selection, based on questions about the student’s perception of the subject, study habits, and extra-curricular habits. The rest of the interview allowed us to pursue other points, some of which touched on the academic environment in physics: questions about the teacher, instruction, the possibility of applying academic knowledge to society, the place of everyday objects and occurrences, lab work, the significance of self-examination, and academic success. In each case, students were asked to evaluate the influence of these elements on their relationship to knowledge of the subject. Our study demonstrates that all the factors involved in this paper had an influence on the relationship with the knowledge of physics, and that this influence – with the exception of lab work - varied depending on the ideal-typical relationship(s) with which each student identifies himself or herself.

Key words: relationship with the knowledge of physics – the relationship to knowledge – the teaching of physics – academic environment

“Measurements, numbers, and orders of magnitude in the second level high school classroom”

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In this class, notions like the measurement of magnitude, exact and approximate values, powers of ten, precision, and significant numbers are introduced in mathematics and physics. Are students capable of drawing relationships between how knowledge is constructed in the two subjects? A questionnaire that asked students about two different types of teachers led us to our first observation: there was a reciprocal misunderstanding of the content and practices of the other field, and in some cases there was even a rejection of the conceptual constructs of the other field. Although concepts like powers of 10 and approximate calculation are germane to both subjects, the ways of approaching them in the classroom differ widely.

Key words: cross-disciplinary studies – transference of skills – measurements – orders of magnitude

“An approach to problematizing the preparation of a course on the phases of the moon”

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Different ways of approaching problems and problematizing are developed in the course of academic learning experiences. There are currently various theoretical models that are recognized in the approach to “problematization.” For Michel Fabre, “problematization” is the process that allows us to locate a problem contextually before setting it up and solving it. Once the problem has been set, the work of problematizing leads to the realization of two dimensions: the necessary conditions that must be taken into account in setting up a problem in order for a solution to be possible, and what is given, the elements provided by the topic for setting up the related problem. In this article, we study a group of three students preparing for the CAPES examination (a secondary school level teaching certificate) in physics and chemistry who were given the assignment of preparing a class on the phases of the moon (one of these students would be asked to teach the class to students). We demonstrate that the assignment of “class preparation” guided students to choose problematizing as an approach, since it allowed them to elucidate and define the conditions and facts of the problem. These elements in turn facilitated more informed choices of content and methodology for the actual classes.

Key words: “problematization” – given information – conditions – astronomy – phases of the moon

