The role of context in learning (that is contextualized) and motivation (that arises in context) implies a need of designing, promoting, revising the physics learning integrated into social issues. Road safety education should be the ground to build conceptual knowledge as well as the context of meaning for the safety rules. Good examples of activities related to context-based physics pointed out a need to study how the conceptual knowledge of physics can be built in science & society contexts, thus grounding a new way of looking at the setting of both physics and science & society. This innovation in the way to look at contents to activate effective teaching-learning processes needs adequate teachers formation. Many dimensions are involved in this process: teacher professional development, ways to teach physics in different contexts, design-based research, proposals design. A research was planned to address these levels, founded in the methodology of Inquired Based Learning and in the Model of Educational Reconstruction as a framework for the re-structuration of the physics content in the proposals, the issue of the motion in its levels of both description and aspects relevant to active and passive safety in the mobility. Formative activities were offered to schools, involving in two years 40 kindergarten and primary/middle school teachers of different subject areas, interested in road safety education. We analyzed the process activated in teacher education and the teachers' works during the formation and in their experimentation in school. The main value emerges from the integration of the competences of teachers in treating problems about traffic safety in different topics and the researcher competences in scientific education. The main results concern good practices as suggestions for curricula innovation, alternative proposal integrating learning of both scientific and safety aspects in new contexts and promoting student motivation, improvement in teachers' PCK..

Introduction

There are several perspectives in which the link between context and scientific learning could be considered. Research pointed out that learning is contextualized (being shaped by the phenomenological context of learning) and that motivation for learning implies the personal involvement of students, that occurs in context (Lave 1988, Taasoobshirazi & Carr 2008). Scientific concepts should be built in familiar contexts for students: subject content related, everyday life, socio-cultural contexts (Euler 2004, Michelini 2005, Duit 2009) to address the challenges of building meanings for the concepts and motivation for learning. It is increasingly necessary to include a large context for scientific learning, to provide to the students opportunities to build and shape their learning. From the educational point of view this implies a need of designing, promoting, revising the physics learning integrated into social issues as a way of improving the students' scientific knowledge and their acknowledgment of the role of science in society and everyday life. In this perspective road safety is a context where the scientific concepts play a crucial role as keys for understanding phenomena, risks, safety rules.

Students' learning studies pointed out that in certain learning contexts (such as the issue of energy) physics concepts are evoked but they do not take the value of conceptual knowledge. What has the role of reference, evocation, application should be the ground to build conceptual knowledge in physics as well as the context of meaning for the safety rules. Good examples of activities related to context-based physics education, also concerning traffic and safety were proposed (Waltner, Wiesner and Rachel 2007; PLON, 1986; Parchmann, Luecken, 2010; Duit, Mikelskis-Seifert and Wodzinski, 2007). These projects pointed out that there is a great need to study how the conceptual knowledge of physics can be built in science & society contexts, thus grounding a new way of looking at the setting of both physics and science & society, not as evoked context

Figure 1. Laboratory activities during the teacher training concerning the different proposal offered in the training course: starting from left: Proposals 1, 2, 3

Figure 2. Steps of the activity with pupils using mattresses to explore friction (Case study 1)

Then he exploited a set of equal bicycles that the school devoted to outdoor activities and speed meters to perform some qualitative experiments showing the role of the speed and of the gears on the stopping distance and the possibility of crashes (Figure 3).

Figure 3. Stopping distances using rear brakes at two different speeds, 15 km/h (left) and 20 km/h (right): activity performed by middle school pupils.

A teacher of technological education (Case Study 2) carried out the activity in a first class of middle school, with pupils aged 11-12. Starting from the proposals of the formation and suggesting the context of the home-school round bus trip, he proposed to the pupils to study the role of an accelerated reference frame in the description of phenomena and in their interpretation. Particularly interesting here is the focus of the proposal on the braking bus, but for physics and the possible related risk. In the first phase of his planning he did not take into account the learning difficulties in physics, and the possibilities coming from an active role of the students. After a survey of the concepts needed for the activity emerged the need to relate the definition of center of gravity given to the pupils by the math teaching of triangles to its meaning in physics. As a co-planning result, the aim of the educational path was the exploration of the role of the center of gravity for the equilibrium, to exploit it then to understand what can be observed on a braking bus. The teacher proposed to the pupils to find the center of gravity of a slab of wood, first on the base of the symmetry of geometrical systems, then, after the recognition of students' difficulties on this point, with an experimental search on "bi-three dimensional" objects with a regular/non regular shape, including the pupils themselves (Figure 4).

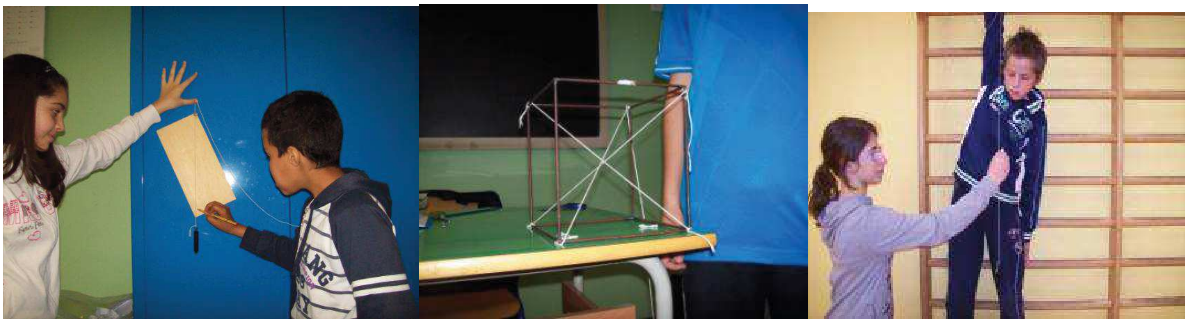

Figure 4. Middle school pupils' activity for finding the center of gravity of a wood slab (left), of a 3 dimensions body (center) or of a pupil (right).

The teacher followed the same teaching method also in an exploration of the role of mass distribution on the equilibrium of an object / pupil on a braking bus: he proposed a first experiment with laboratory equipment, an articulated parallelepiped provided with a plumb line hanging from its center of gravity and a mass added at different heights; then he transferred the previous outcomes to a pupil, reproducing the situation on a braking bus bending himself forward and changing the kind of contact surface between floor and pupil's shoes to explore the role of friction (Figure 5).

Figure 5. Explorations of the equilibrium conditions with school laboratory objects (left, center) and with pupils (right).

The teacher was very surprised for the final claim of a pupil, "when the bus suddenly starts, it is as if I were still on a carpet and somebody pulled it forward", focusing the issue of the different description (and interpretation) of the movement in different frames of reference in a manner that the teacher didn't foresee as possible in a pupil's answer.

In the second year of the Project a kindergarten teacher (Case study 3) carried out the activity with 15 pupils of 3-4 years old. The teacher selected and enriched the concepts proposed in the course. She embedded in her teaching plan some activities about the concept of direction (pupils' walks, in a common direction and in opposite directions) and about the concept of length, position (as a vector), trajectory, displacement. She followed an input emerged during the co-planning discussion: she used as teaching method storytelling and role play, then games for an exploration of the space realized by the pupils' bodies (moving as a worm to experience the straight trajectory, as a snake to experience a curved trajectory). She proposed to the pupils a role-play activity where they were the characters of a tale, "Little yellow cap" of B. Munari (a contemporary version of Grimm's fairy tale "Little Red Cap"), concerning also traffic and traffic lights. To perform the activities she proposed a model of a real context, a town, realized by cushions of simple shape (cylinders, cubes, parallelepipeds) labeled with pictures. In pupils' walking across the town, role-playing the tale, they experienced the concepts of position, displacement, trajectory. The teacher realized a context of meaning for abstract concepts with real objects, made simple representative mediums both for the real world (in 3 dimensions) and for some abstract concepts: wool threads on the floor marked directions, floor or cacao power under the pupils' feet marked the trajectory, the pupils' body represented oriented directions (with one raised finger), Concerning road safety, she proposed traffic light and its colors meanings. These activities produced a great learing in pupils on the meaning of trajectory, direction, remaining open the knot of the orientation of this direction.(Figure 6).

Figure 6. Kindergarten pupils' activity for experiencing the same direction (left) or the same length in different directions (center) and storytelling (right)

Two teachers (case studies 4-5) in primary school (both non-science teachers) proposed the same activity in 2 classes of 41 pupils 10 years old. They organized a large exploration of the school surroundings (in space and time), including several subjects (physics, geography, languages, history…). They adapted several activities proposed in the course into their design: the role and operation of a reference frame; the role of friction for moving. They could exploit some ancient maps of the land near to the school, showing the structure of the small villages where the pupils were living, to compare with contemporary maps and with the actual place, explored and represented by maps drawn by the pupils. The need of a common frame of reference and the subsequent introduction of the role of the compass arose among the students when they wanted to perform a comparison between the maps and to communicate information about them. A review about a recent trip allowed the pupils to describe it by a coordinate system or by positions and displacements as vectors, distinguished from the trajectory they had followed. A comparison between the role of the ancient road system and the contemporary one (with more vehicles on the road and higher speeds than in the past) made clear the need of the safety rules to avoid crashes (and, more generally, of a traffic policy with a planning aiming at a matching between the road users needs and the environmental needs). The historical development of vehicles and the role of the wheel was the stimulus for focusing on exploration of friction to understand its role on the (vehicle) motion, following an approach similar to the one experienced during the course, of changing one feature at a time to explore its role. The materials for this section of the activity were suggested by a science teacher, colleague of the two non-science teachers who attended the course, and was only begun in class for the little time remaining at the end of the school year (Figure 7).

Figure 7. Ancient maps on contemporary maps of the pupils' villages (left) and pupil's map (center); activity about friction (right) performed by pupils 10 years old.

The teachers involved other experts in their project, to obtain a support on each aspect they considered. The activity followed the path proposed in the course, but applying it to the school village and its surroundings well known by the pupils.

Two teachers (both non-science teachers) in primary school (case studies 7-8) proposed activities planned together (including peer education) to one class of 25 pupils 11 years old (last grade of Primary school) and one class of 17 pupils 6 years old (first grade). They organized two specific contexts taking into account the past experiences of pupils also in road safety education (particularly for the older pupils) and the geography of the surroundings of the school (particularly for the younger pupils). They introduced pupils to the need of a reference frame and the use of a compass for describing positions and movement when

Figure 8. Activity of peer education with a game on a self-made circuit (left) and with a model of the village (right).

Both teachers followed a very similar path, one of them considering more road safety education than physics, the other performing more experiments, according to her better attitude in doing experiments.

Discussion and conclusions

Research on learning processes pointed out the central role of contexts and the need to deepen the studies about the ways to link them with learning. We made an hypothesis of development of scientific knowledge building it into social contexts, as a way to build the scientific meanings. We focused on the topic of motion in the context of road safety education and carried out a formation activity involving 40 teachers, from kindergarten to middle school; 30% of them experienced the proposed activities in their classes. We analyzed the process of teachers' professionalization and the materials produced starting from the proposals offered in the course. The following outcomes emerged.

All the teachers involved in the project modified the proposals experienced during the course, in different perspectives: concerning contents, new topics were introduced particularly in middle school (role of the brakes and the tires, center of gravity…), with a social perspective, as a need towards pupils (to avoid crashes); developing basic pupils' skills integrated in social needs to enhance pupils' level of comprehension and expression of their environment, particularly in kindergarten and primary school. These teachers embedded the proposed activities in very large contexts, eventually with a careful selection of the aspects of the proposals to develop (kindergartner teacher). These teachers had as a reference for their planning the cognitive level of their students.