After a short analysis of misconceptions and mental schemes an overview of open questions and unresolved problems concerning knowledge construction is reported. The description of the ways computers entered in education and how they were used to help students in overcoming their difficulties follows. At last the analysis of two experiences the author made up with the use of Web technologies is reported and the adoption of an Information System is suggested with the main aim of improving the everyday work of teachers, helping students in overcoming their wrong ideas, making deepen the analysis of students' ideas and attitudes when they approach scientific disciplines.
Preconceptions, misconceptions and mental schemes

Among the first studies on concepts’ construction and mental schemes there are the ones made by Piaget and Ausubel who are considered the founders of constructivism.

Very interesting for what follows are the results of four different meetings on misconceptions and meaningful learning collected in the MLRG (Meaningful Learning Research Group) site (http://www.mlrg.org/).

Questions arising from the above conferences and from the author studies are:

1. **What** misconceptions were detected?
2. **Where** misconceptions were found?
3. **When** misconceptions appeared (students’ people age)?
4. **Why** are there misconceptions?
5. **How** to help people in overcoming their difficulties?

Most relevant problems are: **is scientific knowledge a particular and deep natural knowledge or it is something different?** Different disciplines base themselves on unique knowledge methods or not? Are scientific knowledge structures resistant to time? Are students ever the same?
IT and education: a survey - 1

Computers entered in education very early in their history, often under the influence of different pedagogical and psychological theories. Two points of view can be identified to describe their intervention in education: a former one we will call **bottom-up** assigning the task of supporting specific teaching situations or at least disciplinary teaching situations to computing; a latter one we will call **top-down** where IT and computing are directly involved in planning and design of information systems and learning environments fully or partially based on psychological and pedagogical theories.

The above hypotheses have nothing in common with R. Taylor metaphors (Taylor, 1980) on computer use: **tutor, tool and tutee**. L. Galliani (1999) extended the meaning of these terms and used **tutor** appellation to describe a computer system supporting or substituting (in the specific situation of auto-instruction) teachers and tutors in their work. Examples for this kind of systems are software packages like CAI (Computer Assisted Instruction) or CAL (Computer Assisted Learning). The former ones having their roots in Skinner’s planned education (stimulus-reaction-reinforcement sequence).
The term **tool** is used to describe the software students use to produce and manage information (i.e. editors, word processors and more generally office automation tools), and the term **tutee** has been adopted to describe the use of software tools for the creation of specific development environments (like the ones Papert created with LOGO).

After Taylor's metaphors many other software tools falling in his classification were developed, but there were also packages that didn't belong to those categories. As an example we remember here two results of Artificial Intelligence application in education: ICAI Systems (Intelligent Computer Assisted Instruction Systems) and ITS (Intelligent Tutoring Systems).

The Internet, its development and its influence on education are further phenomena that don't find a specific place in Taylor's metaphors. The relationship between the Internet and education can be seen from two different points of view: **a.** the influence of the new medium on knowledge structure and construction, **b.** the different ways this medium can be used in educational contexts.

It has to be noted many researches on misconceptions and mental schemes found a useful support in computer systems and specific software tools.
Comparison of two studies on CS misconceptions

When all Seems to Work Wrong

The first experience concerns some students of an Italian Technical High school (16-17 age students) involved in Computer Programming teaching-learning. This experience can be split in two phases:

A. the former one concerning computer programming teaching, the analysis of the students' results (school year 2000-2001) and the consequent recovery action (beginning of school year 2001-2002) involving all the class. The use of constructivistic strategies led many students (76%) to overcome the wrong ideas on CP usually reported (variables and their use, control structures etc.).

B. the latter one relating to a specific test (selection for CS Olympiads) the same students were submitted to during school year 2001-2002. Only 15-20% of the students gave the right answers to the questions concerning the themes in a).

This is not surprising: the same results were obtained by the author in different disciplines (Physics and Statistics) when submitting specific tests to students of different school degrees and ages (also after a great work to overcome their difficulties).
Comparison of two studies on CS misconceptions - 2

2 - Teaching on the Web

The results of two experiences involving the use of the Web to teach CS introductory concepts are compared (in both cases an on line self assessment test with closed answers was reported and an explication for the selection of wrong answers was given together with the links to the course pages).

A. The addresses of the first on-line course were teachers and educators involved in a project supported by Sicily region, EU etc. Main traits of the experience were: a) the presence of an introductory CS module, b) on-line and presence tutors helping people to overcome their difficulties.

B. The second on-line course, devoted to first year university students, was based on a self-made e-learning platform interfaced with a database where all operations the students did were stored. It could be tested with only 31 students at the Faculty of Humanities (having already attended an introductory CS course) and the analysis of their interaction with the site evidenced what follows: 18 students (58%) read only the self assessment tests; 10 students (32%) started from the self-assessment tests and read only a part of the course Web pages; only 3 students (10%) read nearly all the course pages before answering the questions in the self-assessment tests.
Comparison of two studies on CS misconceptions

In both the above experiences an ending test was submitted to people attending the online courses and most part of the answers they gave was correct. Some questions and particularly the ones concerning the meaning of Operating System, the function of the screen pointer and the meaning of the word browsing need further remarks because there were many wrong answers. The following table reports the percentages of the wrong answers to the above questions:

<table>
<thead>
<tr>
<th>Items analysed</th>
<th>Teachers</th>
<th>Educators</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>48%</td>
<td>50%</td>
<td>74%</td>
</tr>
<tr>
<td>Screen pointer</td>
<td>48%</td>
<td>56%</td>
<td>77%</td>
</tr>
<tr>
<td>Browsing</td>
<td>20%</td>
<td>22%</td>
<td>55%</td>
</tr>
</tbody>
</table>

It has to be noted there is small or no correlation at all among the students approach to the course and the answers they gave to the written test (i.e. the students who read all the pages before using the self assessment tests gave the wrong answers just as the students who used only the self assessment tests).
Comparison of two studies on CS misconceptions

The first comment naturally arising from the data reported in the above table concerns the relevant role the on line and presence tutors played in the learning process (~25% of correct answers more than in the students case). Furthermore if it is true the above results are partial as they involve a little sample of students and there is the need for more and deep experiments, some questions arise:

- the site structure revealed important in helping the students to overcome part of their difficulties but didn't solve all the problems they had and, once more, ambiguous situation were responsible for the students' wrong answers

- how much distance learning environments can be used in everyday teaching work with school students? It is perhaps too early to say, but an experiment the author is carrying on with the students of an Italian technical high school shows it's very difficult to persuade them to currently use the Internet for their work.
The amount of themes the work faces up imposes a great attention in the definition of scenarios and hypotheses concerning teaching-learning processes. In the author opinion very important questions marking future studies (emerging from a paraphrase of the questions settled in the different sections) will be due to:

1. **deep analysis on human knowledge** and particularly: what differences are there between natural and scientific knowledge? How human mind builds scientific knowledge?

2. **what disciplines have to be involved in the analysis of teaching-learning processes**? what strategies and techniques have to be adopted?

3. **what role the teachers have to play** in educational processes?

With respect to the first question it has to be noted that if a natural knowledge emerging from human interaction with the environment and leading to the construction of mental schemes works pretty well in everyday life, more complex is the situation with respect to scientific knowledge and its interaction with natural knowledge: the hypothesis assigning to scientific knowledge the meaning of a deep natural knowledge seems to find no confirmation in the results of the researches (why people use natural mental schemes when they have scientific ones?).
Conclusions

In the author's opinion, a model more suitable to interpret misconceptions and mental schemes presence with respect to the above one can be hypothesised: scientific knowledge is the result of the superposition of scientific paradigms to natural mental schemes; in this model, scientific paradigms never substitute natural ones but intervene in phenomena interpretation if they are strongly impressed in individual practice (they become a sort of glasses for seeing reality from a particular point of view).

With respect to the second question, the scheme in Fig. 1 is suggested; IS appears as one of the relevant disciplines involved in knowledge analysis.

Fig. 1 - Disciplines involved in the study of teaching-learning phenomenon
Conclusions - 3

The above hypothesis bases itself on the adoption of specific Information System for monitoring teaching-learning processes (like the one adopted by the author in his last researches).

What role the teachers have to play in teaching-learning processes?

The author agrees with many recent studies falling in Action-Research tradition attributing new and more important functions to teachers: they have to become didactic researchers in their everyday work, that is while collecting data from the working environment they have to interact with it and modify it (i.e. the feedback from students' behaviour increases the teacher knowledge on the learning processes and makes easier the finding of the elements useful for a scientifically correct knowledge; it is then possible for the teacher to intervene in the construction of a meaningful learning in students' minds).

Also in this case a great support to teachers everyday work will be given from specific Information System storing all the data coming from the students and giving suitable representations for them.