Misinforming, Misunderstanding, Misconceptions: What Informing Science Can Do

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From data to knowledge: a survey

Datum is any kind of sign or combination of them that is expressed in a well defined or socially accepted symbolic system and that is used to represent a qualitative or quantitative aspect of a given phenomenon or event.

Information has been defined in many different ways but recently Lehner (2000) proposed a dynamic scheme within which it holds the place between raw data and knowledge.

Communication is reported here for the reason that (in the author opinion) there is no knowledge or information without communication. Reference schemes are the Shannon-Weaver (1949) and the Loose (1997) ones.
Knowledge is analyzed with respect to the reference frame to be used for its construction, so that we will focus our attention on: a) the concepts that will be analyzed, b) the paradigms that will be adopted:

1. **only scientific knowledge**, i.e. concepts and ideas belonging to well structured and organized disciplinary fields, will be investigated,
2. the **constructivist paradigm** will be adopted, because of its characteristics:
   • meaning is not transmitted (learning occurs as a process of adjustment of existing concepts)
   • understanding is based on interaction among a complex weave of factors (i.e. the learner's goals and existing concepts, the content of the learning experience, the context in which the learning takes place, etc.)
   • puzzlement motivates learning (the sense of dissatisfaction emerges from experiences that threaten existing conceptual structures)
   • social negotiation and viability are the principle forces involved in the evolution and construction of knowledge.

The author’s choice has its roots in the limits that positivistic and post-positivistic paradigms highlighted while interpreting knowledge-learning phenomena, in the results of the psycho-pedagogical studies carried out during the last century and in the outcomes many research groups recently pointed out while experimenting the construction of special learning environments.
Authors and experiences to refer to are:
J. Piaget and his theory of genetic epistemology

D. P. Ausubel and his ideas concerning knowledge construction by addiction of new elements to previous ones and the difference between a meaningful learning and a mechanical learning (based on the effects that the existence of subsumers had on the above addiction)

D. H. Jonassen (1994) who founds the project of learning environments on the following elements: a) knowledge construction, that is based on individual and social influences, b) significant contexts, supporting problem solving skills that come from real situations, c) cooperation, between student and teacher and among peers.


The studies on the influence that technologies and especially computers had on human learning and knowledge: Taylor’s metaphors (tutor, tool and tutee), Galliani’s extensions of the same metaphors, Papert’s constructionism, CGTV’s use of complex simulation environments and Mc Linn’s proposal of the computer as a learning partner.

The Internet and the use of virtual communities, the proposal of connective intelligence and the creation of cooperative and collaborative learning experiences.
Misinforming, misunderstanding, misconceptions

The theories and hypotheses reported in the above section are pervaded (in the author opinion) by an optimistic perspective; i.e. the description of the good results of the experiments is made with the main aim of showing the effectiveness and correctness of the corresponding theories. Main questions are on the contrary:

1) how much of the above results and experiences can be transferred to the everyday school teaching to help students in overcoming their difficulties (as they are evidenced in the International Organizations Reports - IEA, OECD)?

2) if the use of constructivistic experiences and strategies (supported or not by technologies and computer) leads to a meaningful learning how this knowledge can be related to the mastery of the usually accepted scientific paradigms?

The need for an answer to the above questions comes also from the results of the great amount of studies on the wrong ideas that people show while explaining natural phenomena or while answering specific questions. These studies were carried out all over the world during last decades and involved differently aged people from pupils, to middle school, high school and university students and extended sometimes to workers, professionals and teachers (MLRG). From the above needs was born the idea of analyzing wrong ideas with respect to the communication process and more generally data, information and knowledge.
**Data, information and wrong ideas** are related to Lehner’s hypothesis of data and information context dependence (it is well represented by the ambiguous image of the woman in the picture).

Very similar to the above one are the two images representing respectively:

a) an hypothetical well crossing the earth;

b) a metallic guide forcing a little ball to follow a curvilinear trajectory in a constraint motion.

**Communication and wrong ideas**

is analyzed only from a didactic perspective (the image below reports some of the most common figures that many physics’ books use to explain motion, speed and force composition and sum).
Knowledge and wrong ideas links are well described by the image that L. Viennot (1978) used to analyze students’ thinking in elementary dynamics; she asked in fact for the force acting on the six balls that a player was throwing up on different trajectories and that at a given instant were all at the same height with different speeds.

The main conclusion one can draw from the above examples is the possible presence of wrong ideas within each element of the communication process or more precisely in the different parts of the traditional didactic communication process.
Meaningful learning and wrong ideas

If someone could think that constructivist strategies helped people in overcoming the problems of a traditional didactic communication here follows a counter-example. The situation concerns some students of an Italian Technical High School and the author professional experience as a computer programming teacher (s.y. 2000-2001 and 2001-2002). On the bases of the results of previous studies, teaching work was now strongly based on constructivist principles, so that at the end of the first school year 76% of the students of that class overcome the problems that their friends usually showed while making computer programs and only 24% among them still manifested wrong ideas (6 students with respect to 19).

At the beginning of the second school year after a short recovery and widening action the students confirmed their good knowledge of computer programming techniques, strategies and skills.

When taking part at the selections for Computer Science Olympiads and answering some specific questions (we limit here to the questions concerning computer programming) only 15-20% of the above students gave the right answers (it has to be said that most part of the items in the test were strongly misleading).

Further discussions the author had with the students showed they soon understood where and why they were wrong… but they were wrong!
Conclusions and implications for Informing Science

Wrong ideas can affect the different elements in the didactic communication process, i.e. data, information, communication and knowledge.

1. With respect to data and information, where only context and interpretation can intervene in modifying the value of a concept, different elements have to be regarded when communication and knowledge are analyzed.

2. Also after having used special constructivistic strategies it can happen that special problems and questions can induce the appearance of wrong ideas in scientific disciplines.

Main conclusion emerging from the above points is that most part of the theories on knowledge construction don’t give the right and complete explanation for the phenomenon of the wrong ideas so that the author hypothesizes that human knowledge is the result of the superposition of the scientific paradigms to the natural mental schemes (they act as seeing glasses that one can wear when sight problems make difficult the understanding of the reality).

Some questions remain open:

1. Is it possible to plan specific didactic strategies to make scientific paradigms permanent in human mind?

2. Are there new strategies for the analysis of the didactic process?
If it can be difficult to give an answer to the first question it appears more easy to suggest the use of specific instruments to monitor the didactic process (very different from the tests and the interviews until now used by teachers and scholars to evaluate and assess teaching and learning).

In the author opinion the time has come for the adoption of Web Technologies and Information Systems to collect data on the didactic processes. This hypothesis will also assign a new role to Informing Science with respect to Educational Sciences.