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Recover the Lost Paradigm: Technology Guided by Teaching Methods

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Abstract. Looking at the educational context, the paper illustrates some multifactorial and integrated models that highlight the key role of didactics in the teaching-learning process, even in the current environment characterized by a high technological level.

Keywords: learning; teaching; didactics; pedagogy; technology.

Introduction

As is known, there are many factors affecting good teaching, as versatile they are the characteristic aspects of the teaching profession. Among them, "the subject knowledge and the pedagogical-methodological knowledge represent two fundamental pillars [...] as the research in the field shows", but "the current cultural scene needs to consider a further equally essential component: the technological knowledge " (Messina, L., & De Rossi, M., 2015, p. 86).

Technological knowledge does not refer so much to the acquisition of technical skills necessary to use traditional and digital devices, as to the possibilities of use of such technologies in teaching. More precisely, it refers to how to translate the potentialities therein in solving specific pedagogical and teaching problems situated in given contexts and how to develop situated knowledge of what technologies are able to do for those who use them.

Starting from these considerations, I intend to propose some models on the educational uses of technology, in which technological knowledge is connected with pedagogical, didactic and subject knowledge and and that that can form the basis for an equally integrated instructional design.

The development of integrated models

It is in 1983 that Lee Shulman, professor emeritus at the Stanford Graduate School of Education, raises the problem of the loss of a teaching paradigm (Shulman, 1999). In those years, he notes in particular, the lack

of scientific research on the interactions that occur between subject matter content and pedagogical-didactic principles.

The author aims to highlight how the relationship between the understanding of the contents of teaching by teachers and education that teachers provide to students is particularly neglected (Shulman, L., 1986a).

Therefore, in the model of pedagogical-didactic knowledge of contents he proposed and which is related to the teaching profession (the *Pedagogical Content Knowledge model* or PCK), they are represented the set of contents (the subject matter knowledge, Content Knowledge or CK), the set of pedagogical and didactic principles (the Pedagogical Knowledge or PK). The PCK is the result of the merger of the previous sets and constitutes "an understanding of how specific topics, problems or issues are organized, represented and adapted to the different interests and abilities of the students and presented for instruction" (Shulman, 1987, 8). These representations can arise from research or originate in the practical experience and they include analogies, illustrations, examples, explanations, demonstrations (Shulman, L., 1986b).

In a second step, to the model is added the set of knowledge of the students' learning process (the Student Learning Knowledge or SLK). This recognizes, explicitly, among the basic expert teacher's skills, the ability to transform the content knowledge possessed in pedagogically powerful forms and therefore adaptable to the different skills and experiences of the learner (Shulman, L., 1987) (Figure 1).

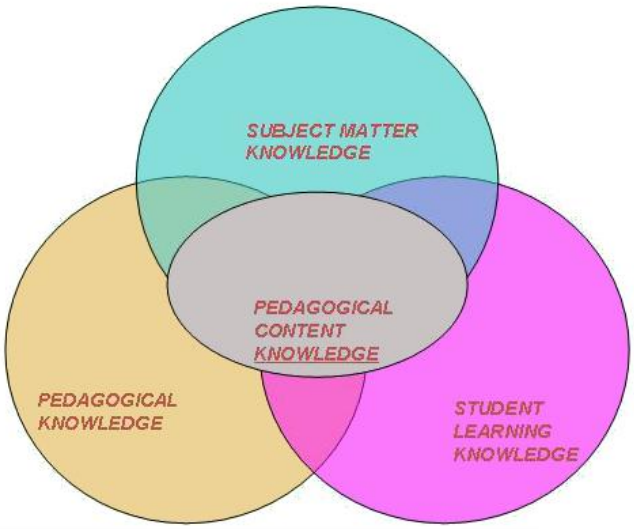

Figure 1: Pedagogical Content Knowledge model (PCK).

To the basic PCK model many additions follow (even by Schulman himself). Noteworthy is the Pedagogical Content Knowing model (or PCKg) developed in the environment of teachers' training by Kathryn Cochran, James DeRuiter and Richard King, of the University of Northern Colorado (Cochran, K., DeRuiter, J., and King, R., 1993) (Figure 2). Here

the emphasis is on the dynamic and situated nature of the learning process, which provides an integrated understanding on the part of the teacher of pedagogical-didactic principles, contents, student characteristics and context. The dynamism is created by the interaction of all components with each other and is the result of the maturation of new experiences and of participating in new learning activities.

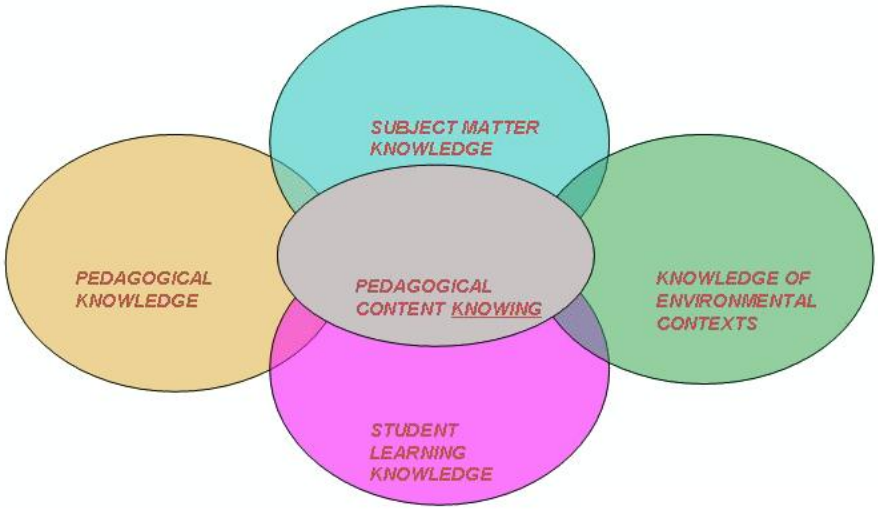

Figure 2: Pedagogical Content Knowing model (PCKg).

Having thus outlined a framework that can give an account of the components of the teacher's pedagogical-didactic knowledge, Professor Shulman moves in search of the steps and actions necessary to the transformation of personal understanding into forms that can be understood by those who learn. The pedagogical reasoning model resulting (Shulman, L., 1987) is cyclical in nature and includes:

- understanding the purpose and structure of the subject matter content, of the ideas inside and outside the discipline;
- the transformation of content knowledge in pedagogically powerful and adaptable forms (articulated in the phases of preparation, presentation, selection, adaptation to students' characteristics);
- education, which includes several observable forms of teaching and active learning;
- evaluation, with verification of students' understanding and evaluation of teaching;
- reflection, stimulated from the critical analysis of their own performance and that of the class;
- new understandings of the purpose of teaching and of disciplines, of students, of themselves.

Conceptually linked to the studies above, the concept of *didactic transposition* (*transposition didactique*) as used by Yves Chevallard, professor emeritus at the Université d'Aix-Marseille, to designate the transition from wise knowledge, addressed to the explanation of

phenomena, to taught knowledge, aimed to the teaching of knowledge (Chevallard, Y., 1981-82).

In fact, scientific knowledge, can be considered the subject, both of a selection of contents by politicians and experts for the construction of formal programs (*external didactic transposition*) and of more socially negotiated transformations through didactic contracts within the system, where the interactions between teacher, students and taught knowledge take place and lead to the real and implemented educational program (*internal didactic transposition*).

Even in this case, the concept is developed by various scholars including Michel Develay (1987), professor at the Université Lumière Lyon 2 and Philippe Perrenoud (1998), professor emeritus at the Université de Genève. Starting from their contributions they are confirmed and integrated some aspects of the didactic transposition which result in the following key elements:

- the constant dialogue between knowledge and prevailing social practices and wise knowledge;
- the occurrence of an external didactic transposition concerning the knowledge to be taught which flows into the formal program;
- the occurrence of an internal didactic transposition related to the teaching-learning process leading to the taught knowledge and to students' learning.

As Laura Messina, Full Professor at the Università di Padova, says, the conceptualizations of Shulman and Chevallard despite the dated epistemology, retain undisputed heuristic significance and they still try conjugations of it (Messina, L., & De Rossi, M., 2015).

In this direction, trying to highlight the dynamic interaction among pedagogical knowledge, pedagogical knowledge of the subject matter, didactic transposition and personal constructs, Frank Banks, Jenny Leach and Bob Moon professors at the Open University UK elaborate the *Teacher's professional model*, a model of the teaching profession (Banks, F., Leach, J., & Moon, B., 1999) (Figure 3). The core components that the authors identify are defined in terms of: subject knowledge, school knowledge (didactic transposition), pedagogical knowledge and personal constructs. Personal constructs are made up of beliefs and prior knowledge, learning experiences, personal views on what is good teaching and act as catalysts of the three domains of knowledge considered.

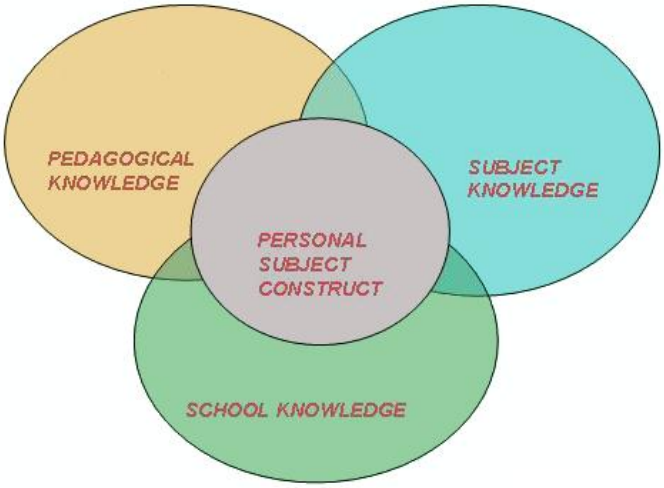

Figure 3: Teacher's professional model.

The technological dimension

The diffusion of technologies for information and communication increases the amount of knowledge that needs to be capitalized by the teacher. It is not just to know and master technological tools, but above all, to reconsider the way we think about technology. We need to rethink our relationship with technological devices and to operate an effective integration of them in teaching through the resolution of real problems (Mishra, P., & Koeler, M., 2003).

From 2005, Matthew Koehler and Punya Mishra, professors at the Michigan State University, develop in this sense the PCK paradigm of Shulman, proposing a new model, the *Technological Pedagogical And Content Knowledge model*, TPCK or TPACK (Koehler M., & Mishra P., 2005). It consists of three basic forms of knowledge (content, pedagogical and technological) and of the interactions of these forms among them, which result finally, in a integrated comprehensive knowledge of a technological, pedagogical and content type (Figure 4).

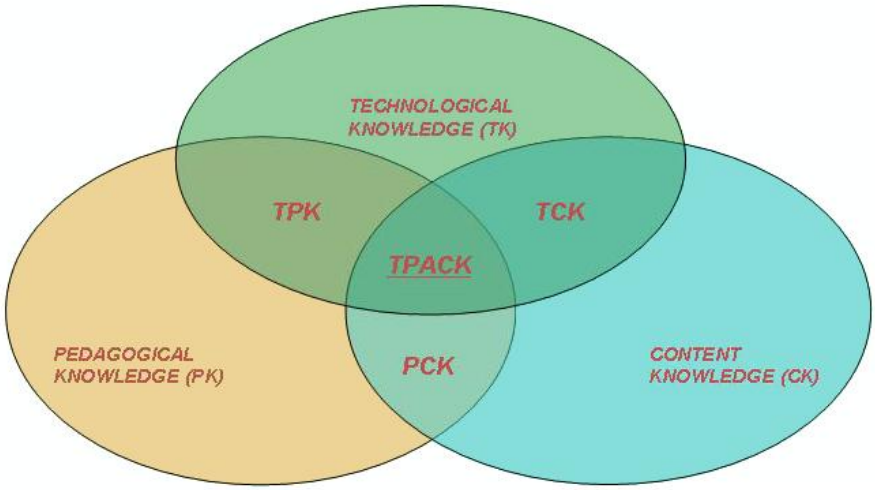

Figure 4: Technological Pedagogical And Content Knowledge model (TPACK).

Content knowledge refers to concepts, theories, procedures, explanatory frameworks, pursued objectives, forms of representation within the disciplines.

Pedagogical-didactic knowledge concerns processes, methods, teaching and learning practices, principles and educational objectives, theories of development cognitive and socio-cognitive theories, direction of the class, educational planning and teaching and its implementation, evaluation.

Technological Knowledge extends from traditional media to digital ones.

Pedagogical content knowledge questions the differences among disciplines and the opportunity to use the same teaching strategies in different disciplines.

Technological content knowledge deals with the way contents are modified through the application of technology, the choice of the most appropriate technologies to address certain topics, how arguments determine or modify technologies.

Technological-pedagogical knowledge is to know the pedagogical affordances and limitations of technological tools in relation to projects and appropriate teaching strategies from a disciplinary and evolutionary perspective.

The concept of *affordance* is the basis of the interesting PST model (*Pedagogical Social Technological model*) proposed by Qiyun Wang, associate professor at the National Institute of Education in Singapore, in 2008, to complete the TPACK of Koehler and Mishra (Wang, Q., 2008).

With the term *affordance* you define the perceived and real property of a thing, especially the functional characteristics that determine how you might use that particular thing (Pea, R.D., 1993). A further definition

of *affordance* is that of signifier, indicator, signal of the physical or social world, which can be interpreted in a meaningful way (Norman, D.A., 2008).

In the educational field the connotation of the term tends to move more and more on feasible uses and relationships and it is in this sense that is used by Wang. The author distinguishes three types of affordance in relation to the integration of technologies in the teaching-learning process:

- *pedagogical affordance*, concerns the characteristics of an instrument that determine whether and how a learning activity can be implemented in a particular educational context;
- *social affordance*, refers to the real and perceived properties of an instrument that can promote social interaction of users;
- *technological affordance*, pertains to the way a tool allows to realize a set of tasks in an efficient and effective way and in a way that satisfies the users (Wang, Q., 2009).

The TPACK is therefore proposed as a "neutral" model that does not indicate the contents to teach, the pedagogical approaches to use and the technologies to adopt in teaching, but expresses a cognitive framework whose possibilities of implementation are open to multiple solutions.

The *Conversational Framework*

In that same spirit is conceived the learning model of Diana Laurillard, professor at the London Knowledge Lab (Laurillard, D., 2014) (Figure 5).

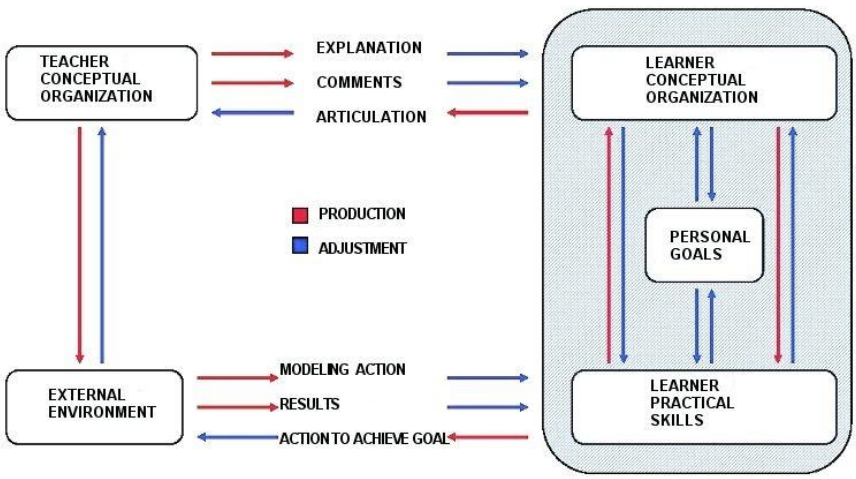

Figure 5: Learning model.

The author, from an extensive analysis of the existing literature, represents in a single view, the main concepts and relationships associated with learning seen as an active process, and takes as reference

the associative, cognitive, experiential, socio-constructivist, conceptual, constructionist, collaborative modes. The structure is formulated to be relevant in any context of learning (implicit, informal, formal) and it consists of continuous and iterative cycles, which are summarized below.

In the *learning process* the student brings into play some internal cognitive components that the teacher tries to influence and formulates objectives, which may consist in wanting to elicit a response from the teacher generating a conceptual network or in attempting to generate action to elicit an outcome in the environment.

In the *teaching process*, the teacher, starting from its own concepts and through the explanation, modulates the student's concepts; the student generates new conceptual organizations that allow the teacher to understand the situation; in turn the teacher creates a new explanation or comment to modulate the student's concepts. In these cases the feedback that is provided from the teacher to the student is *extrinsic* to the action.

In a similar way, the *environment* generates an action pattern that modulates the student's practice; the student's practice creates an action that matches the pattern; the environment generates the result of such action, which modulates the practice of the student. In these cases the feedback that is provided to the student from the environment is *intrinsic* to the action.

Starting from this basic learning-teaching representation, Laurillard elaborates what she herself defines *Conversational Framework*, since "inspired by the Conversational Theory of Gordon Pask, a cybernetic model of teaching and learning" (Laurillard, D., 2014, p. 128) (Figure 6). This framework provides "the most simple static visual representation possible for capturing the complexity of collective ideas produced in the literature on what is needed to learn and therefore what is needed to teach" and "it shows all the ways in which the teacher and other subjects learners activate the iterations in the internal learning cycle" (Laurillard, D., 2014, p. 128-129).

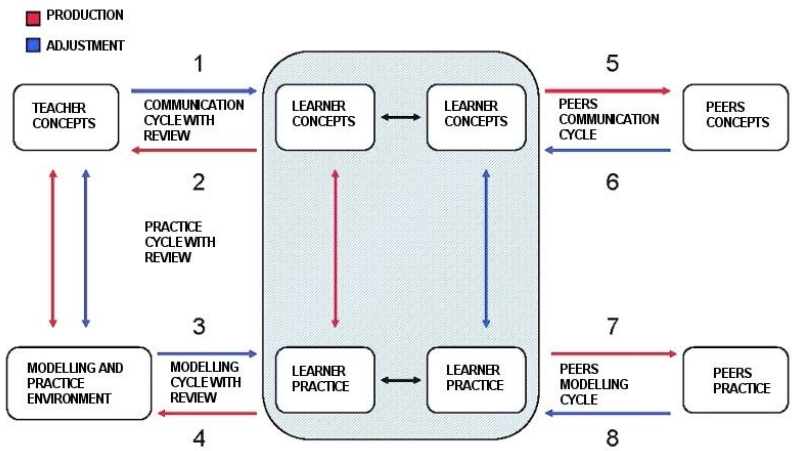

Figure 6: Conversational Framework.

The *communication cycle with teacher's revision* allows each learner to modulate his conceptualizations connecting them with those of the teacher (activity 1 of the model); the teacher's extrinsic feedback motivates each student to ask questions or to articulate knowledge and practice (activities 2 and 1).

In the *practice cycle with teacher's revision* the extrinsic feedback provided by the teacher motivates each learner to modulate his practice by generating the actions suggested (activities 4 and 1).

The *modeling cycle with teacher's revision* motivates each learner to modulate his practice by generating actions suggested by the intrinsic feedback provided by the modelling environment (activities 4 and 3).

The *peers communication cycle* allows each learner to modulate his conceptualizations comparing them with those of his peers (activity 6); activates each learner to produce a conceptual network with extrinsic feedback from his peers (activities 5 and 6).

In the *peers modeling cycle* each learner generates actions in a practice environment, while sharing the results of his practice (activities 4 and 7); it allows each learner to modulate his practice, using as a model the results obtained by peers (activity 8).

Exploring the specific learning activities that can take place in an educational context, the author distinguishes those typically individual (appropriation, research, practice, production) from those typically social (discussion, collaboration) and outlines their features.

In *individual learning* the learner conducts an internal dialogue, while he thinks about what he is trying to learn. He reflects on what he is listening or reading, or receiving through feedback and reviews and inspects his own theoretical and practical knowledge in a coordinated mode:

- through *appropriation*, the learner, reads, listens or witnesses a teacher's explanation or observes a teacher's pattern of action and reshapes his own personal knowledge, but does not generate action or thought;
- through *research*, the learner is encouraged to select resources that reflect the knowledge and ideas that are taught; the learner has more control over the path, but is guided in comparing knowledge and information, in investigating and using resources and data; he reshapes its conceptual organization thanks to the researches carried out and the exposure of what was found;
- through *practice*, the learner uses his actions, puts theory into practice while working for a purpose, performs an action to reach it and uses the feedback to modulate action and knowledge; teaching offers a modeling environment that requires an action and provides an intrinsic feedback;
- through *production* the learner is motivated to consolidate what he has learned, to articulate the knowledge acquired and the ways to use it in practice; the exposure of the learner's thought allows the teacher to

respond with extrinsic feedback, directions and further explanation.

In learning through *discussion* the teacher provides some stimuli and learners produce ideas and questions that set in motion the need to remodulate personal ideas, this generating additional ideas and questions.

In learning through *collaboration* (which includes discussion, practice and production), the teacher provides means to create shareable results, identifies a task aimed at creating a common product and an environment for the modeling and practice, aimed at developing personalized results. Students exchange the products or the results obtained from their practice and are thus motivated to remodulate their actions and to produce a discussion on the reasons that have determined their choices.

Each activity can be based on technologies, from the most traditional to the most advanced (Table 1). In the case of *research* teachers can use a set of materials and digital resources, make a field work, visit sites and virtual reality environments. In the case of *practice* they can refer to type-answers, examples of work, interactive games, simulations, micro-worlds and adaptive models. In the case of *production* they stimulate the learner to realize an essay or a representation, but also to undertake the solo exposition of his own thought. In learning through *discussion* they can be employed work in small groups, seminars, asynchronous on-line discussion forums and synchronous chats. In learning through *collaboration* they can make use of group projects, group work in modeling environments, wikis and other online environments for the construction of knowledge.

Table 5: Learning types and types of activities that can be performed with traditional and digital technologies.

LEARNING	**ACTIVITIES WITH TRADITIONAL TECHNOLOGIES AND DIGITAL TECHNOLOGIES**
Appropriation	Reading of texts and documents; listening to the teacher's presentations in person; lessons; participation in experiments, expert classes.
	Reading of multimedia content, web sites and digital resources; listening/watching podcasts, webcasts, animations and videos.
Research	Use of study guides based on texts; analysis of multiple materials and resources to search for information and ideas; use of conventional methods for

	collection and analysis of data; comparison of texts for research and evaluation of information and ideas.
	Use of online tips and guides; analysis of a wide range of digital resources searching for information and ideas; use of digital tools for collection and analysis of data and for comparison of digital texts in research and evaluation of information and ideas.
Practice	Conducting exercises; realization of projects based on practice; participation in laboratories, study visits, on site role playing.
	Use of models, simulations; participation in micro-worlds, experiments and study virtual tours, online role-playing games.
Production	Production of articulated thoughts using documents, essays, reports, projects, performances, artifacts, animations, models, videos.
	Production of digital documents, projects, performances, artifacts, animations, models, resources, slideshows, photos, videos, e-portfolios.
Discussion	Participation in tutorial classes and seminars; discussions in groups, forums, classroom; comments in blogs.
	Participation in on-line tutorials and seminars; discussions by e-mail, in group, in forum; participation in synchronous and asynchronous videoconferencing.
Collaboration	Implementation of projects in small groups, discussion of the results of the class mates, joint creation of products.
	Implementation of projects in small groups using online forums, wikis, chats; discussion of the results of other participants; joint creation of products in digital format.

Conclusion

A similar lack of paradigm in teaching, as that found by Lee Schulman in the 80s, is perceived nowadays. Scholars who take a closer inspection can see how, today, technologies for communication and education themselves remember their own role in learning: that of new

particularly brilliant companions next to their solid older colleagues. The studies treated in these lines, resulting in some modeling, give an account of this type of approach.

Technologies, due to their social penetration, consequence of their versatile utility and thanks to that sense of urgency that they impose on their use in teaching, are making it inescapable a further reflection on what is didactics itself, what are the meanings that it assumes, which are exactly the educational values it promotes and how to concretely realize all this in the learning-teaching process. In the end, I think it will be through the knowledge of itself that it will take that leading role that is widely hoped-for.

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