Learning to teach the design in technology education

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Abstract

In France, the last five years have been marked by the reforms of the lessons of the college and high school. It is in this context that the design has made its entry in the teaching of technology at the college and in the series STI2D (Science and technology of the industry and sustainable development).

In parallel with this entry of the design in technology education, the series STD2A (Science and Technology of Design and Applied Arts) strengthens the place of lessons technological and scientific in the learning. This evolution of knowledge taught, by the link between design and technology, naturally connected in the industrial professional field, but treaty separately to the school, accentuated the fact to rethink teacher training.

This paper aims to address the issue of the interactions between design and technology in education in college and in high school, and to think about teacher training. The analysis presented here is based on observations made within the curricula of applied arts and technology in France as well as within the activities of teaching and learning of students, for students and teachers.

How to teach Design and Technology to teachers who will be responsible to account for the relationship of these two professional fields to students in college and high school?

In what the concepts of vocational teaching and activity of design can help to understand the process that led, today, to teach the knowledge on the design to teachers whose profiles are also different? To answer these questions, we focus on the study of the establishment of a Master Craft of the teaching of the training and education option "Technology & Engineering of industrial design" in France.

It will be as well to think about the objectives associated with the training of teachers for college and vocational "lycée" and their ability to articulate technological education and teaching of design thus aiming to circumscribe the effectiveness of their practices.

From a theoretical point of view, the analysis of the joints task-activity and situations of teaching and learning, within the framework of the teachings of technology and design, is proving to be a theoretical framework particularly suited to try to understand the specificities and common points.

Introduction

In a context of French educational reforms, the teachings of Design and Technology have moved significantly in recent years. While they were separated before, these curricula were crossed by comparing the knowledge belonging to each area. The Design invited itself in the teaching of technology in middle and high schools. And Technology is written legibly in the new curriculum Design. Note that the curriculum can have at least two directions (Marsh, 2004): On one hand, "this is all planned learnings for which the school is responsible"; on the other, the curriculum is "the totality of learning experiences provided to students so that they can attain general skills and knowledge, at a variety of learning sites" (p. 5).

Meanwhile, teacher training have undergone many changes in France since the Jospin Law (1989) and the creation of university institutes of education (in French: IUFM). Today, we can speak of a teacher vocational training university. Between 2006 and 2008, in law enforcement of guidance and program for the future of the school (or Fillon Law in 2005), IUFMs are integrated into their regional university. At the same time the construction of an offer of training made for the future teachers, requires to create Master's degrees.

Thus, IUFM do not prepare anymore only in education competitive examination but also prepare for a diploma of Master's degree (the BAC+5 level, in France). In some ways, the mastering of teacher training combines professionalization and "academicalization". The academic contribution to teacher training has been articulated with the previously curriculum in IUFM. Changes have been made both at the organizational level and at the level of training content. This is the way that teacher training has been backed by educational research. Indeed, the introduction of the LMD at European level has been followed up by the official claim of a formal link between research and professional training. It is in this context that the IUFM of the Aix-Marseille University, offers a Master of Instruction Profession, Education and Training (in French: MEEF). This master is cut into six specialties that contain multiple ways.

At first, we offer a brief curricular situation of the Technology and Design teachings. Then, secondly, we present some elements of our research on Design and Technology teaching activity, particularly through the way teachers take over the curriculum and through the way students act in this context. Finally, by taking into account the formulated reports, we focus on teacher training in vocational industrial and technological courses. So we try to connect multiple levels of thought: the organizational conditions for learning, the actual interactions and the epistemological and curricular teaching stakes.

The Place Of DESIGN TEACHING IN THE MIDDLE AND HIGH SCHOOLS

Over the years, design education in France has entered both in the academic field, in the art schools, in the middle and high schools (Tortochot & Lebahar, 2008a and b). At the beginning of the 80s, design education is offered in high school from the first year. The vocational high school diploma field still exists after undergoing two reforms. It is now a Science and Technology Design and Applied Arts high school diploma (STD2A, in French, too).

For the higher education, design education has now found its place in the engineering schools. We may recall in this respect the innovative experience of the Compiègne technological University in the 80s, the first French university to open a major degree in industrial design and the first to train engineers-designers. This new model of university based on project-based teaching allows the actions of multiple educational fields in its different departments: mechanical engineering, chemical engineering, biological engineering, applied mathematics and computer science, electronics. These exchanges are at teaching, at research or at project level.

More recently, in secondary education, the design has also made its entry into the teachings of

Technology and Arts inside the middle school and in the Science and Technology Industry and Sustainable Development high school diploma (STI2D, in French, too). At the same time, the STD2A high school diploma strengthens the place of technical and scientific education in apprenticeship.

This evolution of the knowledge taught, by the attempt to approach of design and technology in curriculum (they bring closer naturally in the industrial field and in university today), does not seem to have ended in the middle or high schools. Indeed, we have seen the lack of appropriateness between the curriculum which is mixing design and technology and the teachers practical experiences. Yet the increasing complexity of technology, the obvious connections of industrial design and technological data but also artistic, are now demanding favorable options to think about more interdisciplinary technological education.

It is in this context that, as recalled Lebahar (2008), design education is a major technological and cultural stake. Today, old but recurrent questions still have no answers: "how to teach the design?"; "what respective educational parts to give to the technology and design?" The one is often privileged for the benefit of the other one (Tortochot, 2011, 2012). There is a conflict between the art and technology, between the need for subjective expression and the calculated harshness of the industrial feasibility (Rutland, 2009). We can imagine the usefulness of teaching design because of this notion of interdisciplinarity. We must go beyond the controversy of design education in the technology sector or of design education in artistic field. We must also consider the training of teachers in charge of these teachings.

Design Teachers And Curriculum Recommendation

A survey based on an activity analysis was conducted with nine teachers. They work in a team of trained vocational training certificate taken after the age of 18 (BTS, in French) in Design products. The aim of this survey is to better understand how the recommendation, written by Applied Arts Education, is understood by teachers (Tortochot, 2007). Since this is a design learning activity that includes a multidisciplinary approach, the principle of the survey was also to understand how teachers who are not specialists in the field include the specifics of the preparation for the diploma. For this reason, among the nine teachers interviewed, five belong to the general subjects (French, Foreign language, Philosophy, Mathematics, Physical Sciences) and one is an economic-management teacher. The last three teach Applied Arts. One of them is a professional designer who is regularly involved in training for several years.

The first three findings are crucial to better understand the reality of teaching industrial design: firstly, there is no agreement among teachers on a definition of design; secondly, the requirement is not known or very badly; and finally some design practical references are known by few professors teaching through knowledge that students may have and not through their own personal experience.

The reactions of the teachers confronted with the reference table as element of a recommended curriculum (Perrenoud, 2002), are hardly surprising. Almost all the teachers considered to respect it by assigning virtues of clarity compared to the old curriculum. But all admit to take liberties. Some recognize not to have read it, or late (teachers of French and Philosophy, for example), or reject it at once (one of the Applied Arts teachers). Others do not hesitate to say that they confer it a real importance in their educational choices, while being "obliged" to falsify it to make easier their work with the students. But all seem to have read the part that concerns them and under no circumstances throughout the text recommended in an attempt to share all the objectives. There is no more actual curriculum, but a hidden curriculum (Perrenoud, 2002), which is not revealed, and yet, is implemented in the classroom.

Design Students And Recommendation

The suspicion of the recommendation is shared by all operators as soon as the guide is essential to their activity and as they cannot maintain their necessary autonomy in the overall representation of the situation (Leplat , 2004). Between recommended text as a guide for action, and recommenda-

tion of the design activity, there are distinctions that should be updated to try to see more closely what is unique about the student activity.

For example, Moineau (2011) observed students in two separate curricula: a design BTS and a bachelor of Applied Arts in France. The first students are faced with an exercise developed by a professor, and, for the latter, an actual order of a manufacturer. Moineau finds a confusion expressed by students in both curricula. This confusion indicates that the produced assumption of artifact model has a different status in the two situations. In the case of the teaching situation, the assumption of artifact is gone with a goal which is the development of a skill. In the case of the situation of operational design, industrialization is the purpose of a product or, more generally, the making of the artifact from the final state of the model designed by the designer. We find this dichotomy in Dutson et al. (1997) in the course description called "capstone" for technological design in U.S. industrial engineering: those who rely on "simulations" in "laboratories" and those based on a "authentic involvement" in a real situation with real "clients" (p. 18).

The falsification of the task ("subjective assimilation by erasing or modification of certain essential requirements", Lebahar, 2007, p. 255) is inherent in the situation of artificial design: general strategies and coping strategies are then used by students. The necessary balance between the two factors of this dialectic assimilation/accommodation (Piaget, 1974) supposes:

- Design activity may be slowed down by the subjective assimilation, or feed on it (novelty seeking or awareness of the reality principle).
- This awareness is sought by some teachers who base their teaching on a knowledge of the student activity.

With such a consciousness of itself and its activity, the student subjectively assimilates some specification imposed by dialogue with others. This form of falsification, requirements modification, widespread among students, is similar to the evolutionary solutions given by the designer to the different problems (multiple, ill-defined, incompletely defined, etc.).

Students learn to read specifications, to answer to the more or less complete problems, to plan tasks, from an initial state to a final state representations, leading them to an artifact model. It is through the tasks set by teachers that students get acquainted with such processes specific to the design activity. It is with teachers action guides that students learn to fight at first. At least that is what shows the state of research in this field (Lebahar, 2007; Tortochot, 2012). This struggle of the "fancy" against the specifications inherited the profession questions inevitably about the possible or about the impossible transmission of the professional methodologies to exercise designer's activity.

We note particularly the relationship that students develop with the recommendation through teachers (Koehler & Mishra, 2005; Tortochot, 2012). The analysis of the discourses on design activity supervised by teachers brings a lot of information.

For example, in another more recently research, we learn what teachers expect such relationship, as dialogue, and how students perceive this relationship (Tortochot, 2012). If this aspect of teacher-student dialogue is not unique to design education, it indicates the implications of a single word, of one meeting, of one comment on planning design tasks by students. The emotional and affective interactions aspect is also revealed by this analysis. Between recommended and actually performed, between intention and actually implemented, we see that people do not realize the same thing. When teachers say they do not want to impose methods, in fact, they do not impose, but also intervene decisively, sometimes. And these interventions, or statements about any aspect of the student design activity is like a hidden method, a value system that interferes in the relationship between teacher and student.

We also learn that the approach to technology design is considered by Masters students as a challenge, a fun (Koehler & Mishra, 2005). By the technological pedagogical content knowledge (TPCK), the authors show that the students assembled a team of designers with teachers, get in-

volved in "the development of deeper understandings of the complex web of relationships between content, pedagogy and technology and the contexts within which they function" (p. 149).

Training Teachers In The Design Teaching

Research on teaching and teachers, on students and their relationship with teachers, and with design and technology teaching, provide us information about a situation that can be considered satisfactory or not.

After asking the question "can you teach industrial design and how?", another is imperative: "can we train future teachers to teach design and how?". Because we have recognized subject content in the technology teaching, we have focused our main effort on the acquisition of new objectives: to develop in our future Technology teachers a professional interdisciplinary practice quality to teach design.

Like Reeves et al (2005) say, teaching by an approach based on the design in the field of computer engineering, leads to highlight six major features (pp. 109-110):

- "Explore significant educational problems, rather than conduct research for its own sake.
- Define a pedagogical outcome and create learning environments that address it.
- Emphasize content and pedagogy rather than technology.
- Give special attention to supporting human interactions and nurturing learning communities.
- Modify the learning environments until the pedagogical outcome is reached..
- Reflect on the process to reveal design principles that can inform other instructors and researchers, and future development projects."

This observation, combined with research that has been conducted on the forms of design teaching in applied arts or in technology, brings us to radically change our educational approach to teacher training by placing the student teacher at the center of his learning and by creating conditions for continuous stimulation taking to sustained motivation (Dewey, 1915; Piaget, 1979; Vygotsky, 1997).

The idea of active learning by the project is to place students in situations of "learning need" by offering challenges (problems, projects, assignments) and using the group as motor learning (Brassac & Gregori, 2003; Safin, Leclercq & Decortis, 2007; Ostergaard & Summers, 2009; Zager, 2002). Besides the interest of such an organization recognized by many universities, we want to analyze the advantages and disadvantages of such a mode of teacher training and its direct influence on actual practices from the field of education.

We decided to organize teacher training in professional and industry using an approach based on project-based learning (PBL) (Dym, et al., 2005; Poell, Yorks & Marsick, 2009; Raucent, 2004; Savery & Duffy, 1996, Swan, Scar-brough, & Newell, 2010; Wrigley, 1998). The project-based learning allows students to train for interdisciplinarity, design principles and management activities of long duration (2 semesters). This organization has been established in many universities (national upper school of industrial design [ENSCI], Paris; University of Technology of Compiègne [UTC]; Lima, Ohio; Buck Institute for Education [IBE], USA; etc.). Courses such as "capstone" project-oriented in the USA (Project-Oriented Capstone-Course) are built on this principle. This structure is innovative in the field of teacher training.

The Based-Project Learning For The "Meef" Master

The students will face industrial design projects opening on the development of learning materials and / or didactic engineering. No teaching has been given them beforehand. Students will define and accurately analyze each problem. They will formulate draft solution based on prior knowledge of the group. Each student will identify its own targets in terms of new learning to perform. It is assumed that they will construct their own knowledge and take it over, without restricting to receive

passively knowledge transmitted by a teacher. The role of the teacher, who becomes a tutor, will guide students in their learning.

As part of our training for future teachers with the project-based learning, students will face a real scenario, involving a real problem of instructional design (due to time, limited resource, group work, making the final result, etc.), which also involves learning a specific working methodology. The final prototype is no longer a "result" but the concept validation and the confirming that the group has achieved the objectives.

The goal of project-based learning is threefold:

- Develop skills related subjects (knowledge and skills);
- Expand the educational skills related to the subjects;
- Make acquire working methods (clarification, research solutions, study solutions, modeling, simulation, testing, implementation, documentation, management of group work, reflection on the work).

Our work will be based on an activity analysis by the analysis from the points of view (Wolf, Burkhardt & de la Garza, 2005). Within this framework we will use in a joint way a discursive analysis and a data geometrical analysis (principal components analysis) in reference to work of Burkhardt concerning the analysis of the points of view of designers in production system.

Thus, our methodological approach will contribute to explore the points of view of the actors of the formation. We will use talks and verbalization analyses through specific methods allowing the reproducibility and the comparison of various corpora.

This approach will enable us to analyze the speakers speech finely and to give consequently useable results by the means of semi-directed talks. For all these studies, the speeches of the teachers and students will be re-transcribed in verbatim. In addition, the software Tropes, founded on work relating to the propositional model of Kintsch and Van Dijk (1978), Van Dijk and Kintsch (1983), Kintsch (1988), will make it possible to validate a good amount of content analysis, starting from propositional analysis of the speech.

In the long run, it will be a question of continuing our study through an analysis of the teaching practices developed in establishment by the students. A prospect for use of the Transana software to analyze video data or digital audios will be considered.

Conclusion

The future teachers design training, in France, has a concrete purpose: it meets the needs that the field programs generate while leading to a reflection on the multi-field exchanges and collaborates. Nevertheless, it is often in an empirical way that the teachers built gradually a practice based on the interdisciplinary approach. It is the goal of this research: observing the young teachers in training and to offer them to build a project-based learning project. This training should make it possible to the teachers to apprehend their teaching while being based on exchanges with other subjects and while working in a collaborative way within more or less important pedagogical teams. The result will be the object of a psycho-semiotic analysis deepened by a propositional analyses of the speech and a principal components analysis. The analyses of the trainers speeches and the future teachers should enable us to release the large features of this method of teaching, the objective of which, determinedly, is to renew the relations bound to the situations of teaching-trainings.

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