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LEARNING THROUGH A RESEARCH ACTIVITY: A DESIGN PERSPECTIVE TO BUILD PEDAGOGICAL PRACTICES

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ABSTRACT

This paper presents an experiment of a pedagogy through scientific research. Relying on concepts from previous studies, this experiment was designed to create intentional learning classrooms (Campione & A. L. Brown 1990; Scardamalia & Bereiter 1991) and communities of practice (Lave & Wenger 1991). Based on this experiment, I point out the similarities between design and this scientific research pedagogy to question design culture as a prime means to conceive new pedagogical practices. This year experiment is described from a double perspective, as I have mentored a research classroom myself and I conducted a series of interviews with the different actors of the program.

Through the analysis of this experiment, I expose the many insights that design culture offers for learning activities and I discuss the place design should occupy in new pedagogical practices with a particular focus on the limits to reduce design to a method.

Keywords: authentic activity, intentional learning, communities of practice, design, research practice, project-based pedagogy, reflexivity, capable subject

1 INTRODUCTION

Savanturiers is a program that experiments a new pedagogy in French primary schools involving PhD students – mainly from scientific disciplines – as teachers. This pedagogical method through research, designed from observations of researchers activities in laboratories, assumes that children are born researchers (Gopnik et al. 1999). This experiment was first designed and tested by a teacher of a CM2 class, in collaboration with a scientific research team. Last year, it was tested on a larger scale, in 40 classrooms, with more than 2000 children, aged from 7 to 10 years old.

This experiment seeks to apply the principles of some previous studies made in learning sciences and students are given the opportunity – and the responsibility – to take charge of their own learning and to evolve into "communities of learning" (A. L. Brown 1992; Scardamalia & Bereiter 1991). This previous research has led to the concept of intentional learning classrooms, where students are active members of such communities of learners and where the figure of the teacher becomes the one of a guide, helping them in their discovery process. "In the intentional learning classroom, students are encouraged to engage in self-reflective learning and critical enquiry. They act as researchers responsible to some extend for defining their own expertise" (A. L. Brown 1992).

I intend to underline the similarities between the design culture and this pedagogy through research, to understand how design can help building these new educational paradigms. Thereby, I would like to propose a new analysis grid that reconciles science, humanities and design education by looking at education through methods and processes rather than contents.

In order to fully understand and analyze the core principles and theoretical implications of this experiment, I have used a two-fold methodology: first, I (designer-researcher) mentored a research classroom myself for a whole year, where students questioned the way we learn at school. In that sense, I experienced an action-research methodology (Freire 1982; Lewin 1946). Then I conducted a series of interviews with the coordinators and creators of the program, and with some of the PhD students involved.

From these data, I will first briefly describe this "pedagogy through research" and the way it was applied in classrooms. Then I will extract its characteristic elements and analyze them in the light of their commonalities with the design field. At the end, I discuss the perspectives these similarities offer to think and design new pedagogical practices.

2 THE PEDAGOGICAL PROCESS

Inspired by the practice of researchers in laboratories of biology and physics, the first experiment proposed a pattern of the research process and transposed this pattern to pedagogical activities in classrooms. These activities were composed of four major phases.

2.1 OBSERVING

Observing
The PhD student that conducts the workshop proposes a work theme to the class. Depending on the theme, various resources can be brought to class, shown to the group and discussed. Any type of material can be used (videos, pictures, books, sculptures, fabrics, games,…). For living science workshops for example, the resources can be animals (such as gnat, ants or phasmids). Some classes studied the school direct environment, such as the school courtyard or the river close by. A discussion emerges from that material, guided by the PhD student who engages students to closely observe, share remarks and ask questions.

2.2 ASKING QUESTIONS & BUILDING HYPOTHESIS

Students' questions are collected and discussed together. Objects of research arise from their observations. Questions are ordered collectively, creating sub-themes. Some are discarded after discussion, but it always results in a collective choice. From those questions, pupils build hypothesis and scenarios that are going to be tested.

2.3 EXPERIMENTING AND DOCUMENTING

Protocols of experimentation are collaboratively designed to answer the research question. Then, they test and document the whole process with pictures and

notes. Failures and errors are also recorded; they are analyzed and serve as a base from which to imagine new hypothesis or improve protocols.

2.4 SHARING RESULTS

As in research communities, the results are communicated to the rest of the class and discussed. With the use of digital technologies, publishing can even overstep the school walls and reach other communities. Several PhD students have used Twitter in their class and videos have been posted on YouTube and other platforms.

3 COMMON ELEMENTS TO THIS PEDAGOGICAL EXPERIMENT AND THE DESIGN DISCIPLINE

From the brief description of this research pedagogy, I intend to underline some of the characteristic elements of the experiment and analyze them in the light of their similarities with the design discipline.

3.1 LEARNING COMMUNITIES

This pattern of activity works as a loop, as in the spiraling curriculum model (Bruner 1960), driven by the students themselves. Students become actors and decision-makers of their own learning. According to PhD students' observations, the more they understood that stance transition and figured out that the activity depended on their engagement, the more responsibly they acted. It supposes that students can navigate via different routes and at different rates (A. L. Brown & Reeve 1987) which does tie in the Zone of Proximal Development theory of Vygotsky (Vygotsky 1978; A. L. Brown et al. 1993).

This vision of education as paths of knowledge and zones of development through where students navigate is commonly applied in design education. In most design schools, students are invited to built their curriculum through the choice of workshops, compiling knowledge and developing the skills they want to develop the most at their own pace. They acknowledge others expertise, learn to ask for help and are aware of being part of a community.

In the program, interactions were encouraged with others within the class and outside of it. Review systems been tested by PhD students, such as systematic presentations of group results, written reviews on others project proposals, votes, and even a wiki-platform prototype, used to document the research and leave comments on each other's works. During class, interactions and chats between students were the rule rather than the exception. Interactions were also encouraged with scholars, other schools, and more largely to any kind of audience students found relevant for their research. The use of Twitter allowed anyone browsing the web to react and worked as a motivation and a rewarding element.

Students often asked who was going to see their work: that awareness changed the way they engage themselves in the activity. The notion of perceived audience and its impact has been well established in Forte and Bruckman studies (Forte & Bruckman 2006). The awareness of otherness brings students to take into account other's points of view when experimenting, documenting and

sharing. Audience gives credit to what they are doing and publishing becomes a powerful stimulating tool as it plays both on extrinsic and intrinsic motivation. Moreover, it engages students to be more precise and accurate both in their research and in their communications. PhD students who used Twitter in their class explained that pupils never published anything on Twitter without asking for orthographic and syntactic corrections first, which shows their will for credibility.

The pupils I had in my class were surprised to discover that other people (adults and professionals) were thinking and working on the same matter – learning at school. Through their research and thanks to interactions with scholars, students became aware and experienced being part of collective process of knowledge building. This awareness represents the first step to shape a community of learning: "In a learning community the goal is to advance the collective knowledge and in that way to support the growth of individual knowledge. The defining quality of a learning community is that there is a culture of learning, in which everyone is involved in a collective effort of understanding." (Bielaczyc & Collins 1999)

This attempt of building a community of learning has been one stated goal in the history of design education. To exemplify, it was one of the priority for the Bauhaus founders, as they claim themselves a "cooperative effort of all craftsmen" (Gropius 1919). This ideal survived in the design community and can be found in other design education initiatives such as the Ulm School, which was created as a teaching and research institution to foster a community of humanistic creators, concerned by contemporary matters. The audience issue is completely internalized for designers as they produce artifacts for specific audiences with intentional purposes. The review process is also a basic and old feature in design education, as it was a prime means in apprenticeship – ancestor of design education: learning was made from the master's comments about its apprentice's work. The intentional learning classroom has thus been a reality implemented in design education for a long time.
The same spirit of collective knowledge building through interactions and the awareness of the audience are also found in scholar communities, as the review process is *the way* of producing knowledge.

3.2 CULTURE OF LEARNING THROUGH AUTHENTIC ACTIVITIES

Another characteristic of this pedagogical program deals with the activities students get involved in. These activities can be qualified as *authentic* activities. Authentic activities have been analyzed as strong means on motivation and learning outcomes (Harel et al. 1991). Several authors described with more or less criteria what "authentic activity" referred to (Herrington & Oliver 2000; Shaffer & Resnick 1999; J. S. Brown et al. 1989; Bruner 1971), but one of the elements that reached consensus is the 'real world' aspect of the activity: to be connected to the world outside school.

We found out through our interviews that this 'realistic' concern is recurrent and operates at two different levels.
Students did indeed address the question of the connection with the outside world and wonder about the consequences of their actions ("Is what we are doing *really* useful for science?"). In my class for example, children did not believe me at first when I told them that their projects and desires for a better way of learning at school could really be considered. When they found out that

this was not another way to occupy their attention but that we were designing solutions 'for real' and that their crazy ideas about video-games and vegetable gardens were not only their dreams but also others, their attitude radically changed. They felt invested in some kind of a mission. As they realized that their ideas might be implemented, our discussions became more serious, focused and concerned. As an example of that seriousness and concern, here is a transcription of one of our discussion with a group of students (8 years old) in my class:

> *Student 1*
> "It would be great to do more stuff in groups because we always work alone."
> *Student 2*
> "I don't know. I find it very difficult sometimes to agree when we are several persons."
> *Student 1*
> "Yes me too, but we also have more ideas, so we have more chances to have a really good idea."
> *Student 3*
> "It is true that it is harder because we don't agree and we fight sometimes but it is also more fun. When we are in the classroom, we are often bored but if we worked with others, it would not be so boring."
> *Student 2*
> "Then, we need to decide what to do when we do not agree or how to behave when we don't like the other person we work with."

On the other hand, this 'reality' concern also addresses the question of the level of mediation in the activity ("Are we going to touch the phasmids *for real*?", "Are we *really* going to *make* our chair?"). Their willingness to be direclty "in touch" with what they learn, to experience some materiality of it is clearly visible. They are usually confronted with representations of what they study and they learn almost exclusively through abstractions (written signs, numbers, speech,…) This aspect refers to the constructivism theory of Piaget, which insists on the importance of physical manipulations in the cognitive process.

The 'real world' aspect of an authentic activity therefore implies two dimensions: the notion of purpose and the one of materiality. In other words, an *authentic* activity addresses the question of *designing* ("dessiner à dessein", which could be translated as "making something with an intention"). The four-steps method described earlier (observe, ask questions, experiment and share) necessarily drives the class activity to that double characteristic, mainly because of the iterations it requires between intentional projections and concrete experiments.

Shaffer and Resnick (Shaffer & Resnick 1999) expose three other dimensions to describe "authentic activities":

- personal (students care about it),
- disciplinary (aligned with the intellectual tools and practices of the domain),
- assessment (assessment aligned with learning activities).

We already discussed the two first dimensions – and their presence in design activities (students driven research and the constitution of learning communities).
In the experiment, there were no assessment requirements. The discussion is opened to design assessments and they deal with the process more than the

results. The objective pursued is that students develop a reflexive approach about their own learning process ("learn how to learn") and perceive the method in itself as valuable knowledge. Assessments therefore would have to value argumentations, collaborations, documentation and coherence: any criteria relative to the successful conduct of a research activity and the interactions with the learning community.
Here, design schools and design pedagogy can offer models to inspire new assessments and evaluation modes. A plurality of practices exists to evaluate design students, from the most informal to some very formal ones. But in most case, the emphasis is put on the documentation of the research process and the choices argumentation. Those different practices should be systematically studied and analyzed to offer a grid for assessing. This study should include the analysis of the role of the design teacher, its status and its relations with its students.

3.3 PROJECT-BASED PEDAGOGY

The experiment used a project-based learning pedagogy, according to the definition of Blumenfeld. (Blumenfeld et al. 1991) "Students pursue solutions to nontrivial problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and findings to others, asking new questions, and creating artefacts". It implies the implementation of a problem-focused process through iterations and a continued back-and-forth between a question and a production: "it requires a question that serves to organize and drive activities, and these activities result in a series of artefacts or products, that culminate in a final product that addresses the driving question".

Two of the assertions underlying this statement are important for our analysis, as they compose the core of the design discipline:

3.3.1 ***A project-based pedagogy supposes the production of artifacts.***

During the interview, the program founders insisted on the role of writing for the research method. "Writing is proving to be a prime vehicle for the acquisition of the scientific research method. It allows the switch from 'trial and error' to 'method'." (notes from personal interview with one of the founders) As the sociology of sciences has showed, inscriptions, traces and technical mediations are essential in the way knowledge is built (Akrich et al. 2006), and according to certain anthropologists like Goody (Goody 1977), it is because of the exteriority of the written language that "scientific" way of thinking has emerged.
In learning theories, making the knowledge visible is also a central component in the constructionist theory (Papert 1980) and the impact on learning to reconnect the traditional separation between abstract, decontextualized knowledge and situated activity has been since largely discussed (J. S. Brown et al. 1989; Lave & Wenger 1991).

Different studies have underlined the importance of expressing ideas using different media for learning purposes (Tversky 1999; Kirsh 2010) and positive results are attributed to alternative pedagogies, which have based their learning activities on objects manipulation and artifacts production. Malaguzzi made the famous statement that "children speak one hundred languages" (Edwards et al. 1998) and that each one of those languages represents a particular medium that

contributes to the enrichment of our ability to express ourselves, to understand and to think.

Students of the experiment were encouraged to develop different kind of literacies, such as video-making, drawing, assembling, coding, data-visualizing for example, in addition to written text. They also built their own tools to collect data when their research needed it. For example, a tracker program has been develop in collaboration between a class and a computer-scientist, to track and study ants.

To be considered as an artifact, an object needs to be lasting, durable, public, and materially present (Kafai 2005). A project-based pedagogy then requires students to develop an appropriate answer using an appropriate mediation depending on the question and on the experimental protocol they have been creating. Traces, notes and then results will depend on that materialization.
As Ackermann suggests, children have to experience the mediatisation of their experiments to understand the benefits of gaining new literacies (Ackermann 2008). "Children will have to embrace the reasons which led so many people before them to give shape to their ideas (by writing them on media that keep records of inscriptions), to use those shapes (as vehicles to get a better sense of their thinkings), and to ease their circulation (by adopting easily decipherable conventions)." And she actually characterizes this reflective mediatisation as an "act of design". In fact, this iterative mediatisation process is one of the main characteristics of the design process, and design education necessarily built its pedagogical attempts around that characteristic. A survey of those attempts, once more, if structured, could offer a great analysis grid for generalization.

3.3.1 ***Such a way of learning involves a synthesis process and an abductive reasoning.***

The back and forth movements through intermediary objects to a "final product that addresses the driving question" (Blumenfeld et al. 1991) is a "*designerly* way of knowing" (Cross 1982) According to Nigel Cross, one of the main differences between scientists and designers is "that scientists problem-solve by analysis, whereas designers problem-solve by synthesis". That is to say that designers develop pattern formation through making and experimenting, which is an active process. "The solution is not simply lying there among the data, like the dog among the spots in the well known perceptual puzzle; it has to be actively constructed by the designer's own efforts."
Designers adopt an abductive reasoning to build their knowledge, which means that they learn about general rules by trying out solutions. The part of *intuition*, understood as in Bruner's definition ("the intellectual technique of arriving at plausible but tentative formulations without going through the analytical steps by which such formulations would be found to be valid or invalid conclusions"), dominates that reasoning type (Bruner 1960).

This active and intuitive synthesis process entails at least three consequences:

1. An open attitude towards failure and accident – recognition of the serendipity principle and the major role of the path towards the final answer.
2. A critical thinking towards problems definition – recognition of ill-defined problems and abilities to (re-)set problems.

3. A sense of responsibility and engagement embodied in the artifact produced as the proposal of a personal vision – it implies a personal exposure through the act of choosing one solution (synthesis).

These three characteristics can actually be seen in the research practice, if we consider research as a process of knowledge creation, which is an assumption that has been made (Eco 1992; Bernard 1865). The pedagogical experiment described here developed this synthetic process and therefore, implied the same consequences.

4 DISCUSSION

We exposed the commonalities between the design culture – and more particularly, design education – and this experiment that claims to reproduce the scientific research activity. Those similarities affect the three main aspects of the learning experience: the social aspect (relative to others), the practical aspect (relative to activities) and the cognitive aspect (relative to learning mechanisms). They are actually so profound that one could ask if education through scientific research and education through design are not actually one and the same thing – and, if you bring this analogy to its extreme, if design activities and scientific research activities are not equivalent. We think that this is not a good way to address the question because it sets the problem from a content perspective instead of placing it from a learning method perspective.

A first remark to approach this question relates to the discipline of the research. The program founders indeed designed their pedagogical method from scientific research activities, but the method has been transposed to non-scientific disciplines with success. Sociology workshops or design workshops have been conducted, applying the same methodology. This detail is of importance as it underlines the crosscutting aspect of this pedagogical method.

There is nowadays a valuation of creative and crosscut profiles, as opposed to traditional specialized ones. In consequences, we are shifting the purpose of education: from a content-focus to a process-focus – "what to learn" becomes "how to learn". This experiment is an attempt to imagine what a process-focus education could be like.
Following Nigel Cross or Archer's taxonomy (Archer 1979; Cross 1982),there should be three areas of education: sciences, humanities and design. This taxonomy relates to the specific content of each area. Methods to learn those contents however, as described in this experiment, are horizontal to this division. Nigel Cross insisted on the interest of integrating design into general education, alongside humanities and science.
In our understanding and from our observations, we could discuss that taxonomy: what if design was not a third area but a meta-area? The discipline that teaches processes to learn how to learn? We showed in this article that design offers indeed great insights to think learning methods. Some authors, like Brown with his *cognitive apprenticeship* (J. S. Brown et al. 1989) or Schön and his *reflexive practitioner* (Schön 1983), have based their research to deepen some of those insights.

Considering design as a meta-discipline joins the point of view of 'design thinking' defenders who tend to establish the design methodology as a model to foster creativity, identifying clear steps and tools[1] (T. Brown 2009).

But saying that design could be a meta-discipline denies three things.
First, it denies the richness of the design culture. Design does not refer to one practice, one education or one methodology. That is why the setting of a definition so difficult and why the research community discusses design epistemology so passionately. This is also why we mentioned that an inventory of this plurality would be of a great interest in the attempt of designing new learning activities.
Secondly, this assumes that design relies very specific principles. But, as we have demonstrated all along the description, reconciliations have to be made with other cultures, to begin with scholar culture. In fact, what brings these similarities in terms of learning is the culture of a reflective process-focused practice. Process-focused education examines learners' activities instead of learners' knowledge, and no matter the discipline, the activity is considered from a subject perspective. Education, in that sense, is seeking the development of "capable subjects" (Rabardel & Pastré 2005), "who act, transform the real and transform themselves, and who will use all their resources to better ground and adjust their activity". This approach pre-existed design culture and is transverse to all disciplines. We cannot decently recognize what could be called a "know thyself" education to be an exclusivity of the design culture.
Finally, this assumption reduces design to methods and denies design as a discipline with its specific content. Design is not only a method as described by Nigel Cross (Cross 1982).Design has also its own values and its own phenomenon of study. Design is interested in the man-made world and design knowledge "rests on the manipulation of non-verbal codes in the material culture". (Cross 1982) As we evoked earlier, conducting authentic activities through project-based pedagogy ask for some design skills acquisition. Therefore, general education would benefit from design as a discipline to introduce to students the basic knowledge of the material culture.

5 CONCLUSION

The design culture and more precisely design education offers a great perspective to think and conceive new learning pedagogies. The history of design education is rich and has evolved – from apprenticeship to studio practices and this typology can help building new grids for general education. The analysis of this experiment, considered from its commonalities with design education, is a first step toward the understanding of the combination of field traditions in terms of education. But design education is not the only model and cannot be transposed as such. That being said, integrating design as a third area in general education seems to be relevant regarding the generalisation of project-based pedagogies that implies to mediate ones thoughts the production of artifacts.

[1] This tendency is visible in attempts such as "d.school" (Stanford design school), "the third teacher", "Design for Change", "Tools at schools" for example.

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