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How critical thinking should be at the heart of digital interactions?

Associate Professor Thibaud HULIN
Université de Bourgogne-Franche-Comté
FRANCE
thibaud.hulin@u-bourgogne.fr

Abstract: In this paper, we study how to teach critical thinking at the digital era, in order to promote practitioners autonomy. A theory of interactions is proposed to identify constraints that structure digital creativity. This model helps to design a critical pedagogy, by connecting without opposing a procedural approach to a reflexive one. The paper presents an implementation of this model into a course about writing on a social network. The study of activity diaries of students shows presence of objectivity forms and reflexivity forms, which reflects the development of a critical thinking. This approach offers a way to develop critical thinking not from outside, in a course of argumentation or media analysis, but within the practice itself, in order to become aware of how interfaces structure our expression and thought.

Keywords: critical thinking, pedagogical design, interactions, reflexivity, digital writing.

Comment la pensée critique doit être au cœur des interactions numériques?

Résumé : Dans cet article, nous étudions comment enseigner la pensée critique à l'ère numérique, afin de promouvoir l'autonomie des praticiens. Une théorie des interactions est proposée pour identifier les contraintes qui structurent la créativité numérique. Ce modèle aide à concevoir une pédagogie critique, en reliant sans opposer une approche procédurale à une approche réflexive. L'article présente une mise en œuvre de ce modèle dans un cours d'écriture sur un réseau social. L'étude des journaux d'activités des élèves montre la présence de formes d'objectivité et de réflexivité, ce qui reflète le développement d'une pensée critique. Cette approche offre un moyen de développer la pensée critique non pas de l'extérieur, lors d'un cours d'argumentation ou d'analyse des médias, mais à l'intérieur même de la pratique, afin de prendre conscience à bon escient de la manière dont les interfaces structurent notre expression et notre pensée.

Mots-clés : pensée critique, design pédagogique, interactions, réflexivité, écriture numérique.

Introduction

Teaching critical thinking is a necessity with our students who have to adapt in changing environments. At the digital era, critical thinking is not the stumbling block of a culture of distrust, that would negatively impact them, destabilizing them, inviting them to be permanently disconnected from the Internet or from the professional world, sulking useful innovations. At the contrary, critical thinking is a key skill for future professional to have the capacity to choose the right tool depends on her or his aims. Critical thinking have to help them to not depend of the monopoly of a single industry and of their updates; students must become able to create new uses, not prescribed, and they have to be able to determine risks and opportunities that such digital product can bear them.

However, it is much easier to teach how to use a software, following procedural instructions, than to teach a student more complex skills like searching the risks and the opportunities, and to decrypt the stakes of power that structure a software. This is particularly important with social networks for example, which them it is very easy to learn how to use them when it is much more difficult to learn how to protect privacy while continuing to use them.

At the digital era, we note that the critical approach is the most often discarded of the procedural approach, as testifies the profusion of how-to and video tutorials on the Internet. Critical thinking (reflexive approaches) and technologies learning (procedural approaches) are divorced: when students have to choice between the both, they will choose the most often how to learn technologies from inside, not to critic them from outside, because they want to acquire useful skills for their professional project. In fact, we consider that critical thinking will help them to adapt themselves to their future environments. So it becomes pressing to make up the both approach, and to develop methods of teaching critical thinking to software users rather than to sell them short-term cooking recipes.

Moreover, procedural approach limits strongly the interest that a software for a learner, because she or he will not be able to appropriate it. In last decades, public institutions have heavily invested to facilitate the access to the digital world. However, a number of evaluation studies showed that the use of new technologies in the classroom or at the university does not improve significantly the performance of learners (Alava & Morales, 2015; Condie & Munro, 2007; Russell, 1999). Our hypothesis is that the implementation of new technologies must be accompanied by a critical pedagogy, which can not depend on the procedural approach that dominates current practices. Here, critical pedagogy is a form of consciousness and of freedom like in the Freire (2018) theory, but in a different perspective: it aims to develop forms of reflexivity for the learner, but those forms are supposed inseparable that objectivity forms that help her or him to overtake ideologies. Critical approach is not a special political praxis, this is an ordinary social praxis to acquire more autonomy when using digital devices.

From Ennis' perspective, critical thinking is associated with specific skills, crossing different domains of knowledge, but associated with specific capacities that are related to the logic and norms of argumentation. But this perspective does not, from our point of view, succeed in teaching critical thinking to students who know the art of argumentation and other critical thinking skills, but who do not use them when they are confronted with digital technologies. It is complicated to use and teach critical thinking skills from an external point of view, from outside the digital practices. Therefore, we have to develop critical thinking from within the digital praxis, at the hearth of digital interactions. It is not a question of learning to use them, but of using them with a sufficient critical distance.

In this paper, an experience that implements a critical pedagogy of the teaching of digital writing is presented. We designed a training about the management of the digital identity and about the digital writing, using on-line documents and face-to-face situations¹. The session aimed to develop critical and reflexive skills of learners by the means of a comparative approach. During this experience at the university, freshmen promoted a personal project on a social network, describing their activity on a separated document called "activity diary". We analysed these documents using qualitative analysis software, in order to mark syntagms and distinguish reflexivity forms than objectivity forms. Analysing those different forms has as a goal to assess the quality of this critical and reflexive approach.

1. Critical pedagogy and theory of interactions

1.1 *Inside out the critical thinking in public spaces*

Studies showed that our students and pupils are increasingly using social media to inform themselves (Villanti et al., 2017), which is becoming the primary source of information for young people. However, social media are often accused of facilitating the spread of rumours and fake news. In response, the companies that manage these networks (Facebook, Twitter, Instagram, etc.) sometimes end up to ban massively hate propagator accounts. In doing so, they consider that the public space they have created is neutral, that evil comes only from the people who have inhabited these places; which is only partially true. Indeed, when one hand, the individual responsibility of "haners" have to take in account, it is necessary, in an other hand, to take into account the editorial policy of these companies, and the economic and social stakes of these areas. For example, Facebook focuses on spreading positive messages that facilitate the idealization of our "friends" (Chou & Edge, 2012). Therefore, the structure of the interfaces and their operation has a responsibility in the type of messages transferred: it is easier to be felt outraged by a shocking image than to check its sources.

¹This material is accessible online at http://thibaud.hulin.free.fr/precip_foad/reseaux .

Whether it is a question of blocking the "hangers" by force, or by law as the proponents of regulation want, those proposed solution remains external to the public space. Another solution is to develop the critical thinking skills of users internally. In the literature of the critical thinking movement, there is a debate between those who support the acquisition of critical skills, following the work of Ennis (1989), and those who consider that critical thinking is dependent on all knowledge in line with the work of McPeck (2016). It is true that logical skills, even when it comes to informal logic with the study of fallacies (Van Eemeren & Grootendorst, 2016), cannot be confused with the development of a critical mind, even if they can contribute strongly to its formation. Dewey himself remarked that "Knowledge of the methods alone will not suffice; there must be the desire, the will, to employ them. This desire is an affair of personal disposition" (Dewey, 1933, p. 30).

To fight against fake news, knowing how to argue or analyse a message is not enough, because this way of think is external to the concrete digital interactions. In fact, arguing skills makes it possible to face a logical argumentation, however it becomes more difficult to analyse an argument resulting from visual communication (persuasion by the image). And how to face a public space that structures expression and thought ? Indeed, from the three-point "powerpoint thinking" (Frommer, 2012) to Apple's "different thinking" (Frommer, 2012), we consider that digital writing (textual or not) develops its own "computational thinking", insofar as writing has fostered the development of critical thinking; and that the successive invention of different writing media has led to different world views, ideas and social organization (Goody, 1979). In this perspective, digital spaces are not neutral: they structure interactions, expression and communication.

Therefore, it is necessary not only to teach critical thinking from the outside, through dedicated courses, argumentation and media analysis trainings. Those knowledge and those skills will just be disable when the student will enter into action, when they will spend time on Facebook and Instagram though they know the risks perfectly well. They will, because they don't know no alternative.

It is therefore necessary to introduce critical thinking inside digital interactions, by encouraging people to step back, by putting words on their digital activity, and by describing and evaluating it; finally by comparing writing software or social media with each other, in order to better understand the principles that structure them and the communication, beyond the immediacy of scriptural production.

Knowing digital social networks is not only knowing the socio-political stakes, and it is not only knowing how to use them; it is probably both these things at the same time, and also knowing how to build a communication strategy and knowing how to manage with those interfaces in order to acquire more autonomy. In the end, in order not to divide public debate between those who criticize and those who do, it is necessary to articulate procedural methods with reflexive methods in pedagogy when dealing with social media issues.

1.2. *Procedural model versus critical and reflexive approach*

In the introduction, we have made an opposition between a procedural model and a reflexive and critical approach. The procedural approach is central when designing tutorials and prescribed know-how (Dewald, 1999). This learning model aims to convey a linear series of actions to achieve an identified goal. This approach focuses exclusively on procedural patterns of actions intended by the designer of a software. The designer focuses on a serial of actions without considering the meaning of these actions, the alternatives to them, or the unexpected uses. The problem is that it is difficult for the user to seize the concepts that subsumes the interface: the user of proceedings depends of a software release quickly outdated, and it will be difficult for her or him to adapted to new releases or to different useful tools. This kind of learning appears to be passive, submitted to standards uses, reducing her or his capabilities to innovate. In distant learning, for example with the Massive Open Online Course (MOOC), teachers had to simplify the learning in accordance with this approach, what involve a reduction of “the positive experiences of autonomy, diversity, openness and connectedness / interactivity normally expected from an on-line network”, according to Mackness, Mak, & Williams (2010). Through the procedural approach, only interactions can be described, as the most visible part of the activity, which is divided into clear and distinct steps that the learner just has to follow on, not to think. The cognitive operations are ignored. So doing, this approach induces a false opposition between theory and practice, a gap between science and action : according to the procedural logic, the practice could not be analysed, or what is say can not be useful for the action. The declarative knowledge is confused with the procedural knowledge. The learner is just a performer unable to think her or his activity and its meaning.

By contrast, the critical approach aims to enlighten the grounds of the actions by supporting a learner able to think the limits of the apparatus as a structure of powers. According to Dewey (1933), we consider that critical thinking is an “active, persistent, and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and the further conclusions to which it tends”. Following him, Glaser (1941) noted that critical thinking articulates an attitude to some “knowledge of the methods of logical inquiry”, and to some skills in applying them. According to Ennis (1989), critical thinking is reached on the register of beliefs, but also on the register of activity: “critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do”. Therefore, critical thinking is not a process dividing the activity of the learner into steps, but rather a process of self-representation as an active subject. Indeed, a critical subject is not a solitary subject discovering its solipsist existence. It becomes aware of her or his activity as a living subject interacting with an environment. The critical subject constructs her or his knowledge through a situation Suchman (1987). She or he is individualized as both an individual and a collective subject.

Considering the interest and the limits of the procedural approach, we are looking for an education model that promotes a critical as reflexive approach of the “ap-

paratus of power and knowledge” wherein learners work. Here we refer to the concept of apparatus (*dispositif* in French) from Foucault (1994), understood as “a thoroughly heterogeneous ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral and philanthropic propositions – in short, the said as much as the unsaid”. This concept involves that the critical information that must be identified during the analysis of the apparatus is not a transcendental or a formal structure. The aim of the critic effort is a historic inquiry about events that have constituted ourselves and have helped to recognize ourselves as a subject. For this, it is necessary “to confront ourselves to the reality and to the current events” (Foucault, 1994, p. 1393) in order to change something in our activity or our organization.

Indeed, the apparatus links up some explicit data but also some implicit information. It is composed by a technical part and a human part, by objects and concepts, by individual values and collective norms, and so on. This heterogeneity forms a framework within the activity of the learner is progressing. Consequently, analysing the apparatus is to analyse the interfaces and the interactions between the human and the machine. Doing this, the learner strengthens an awareness of her or his practice, that includes to take in account the set of constraints and the lines of power that structure her or his practice. This approach aims to confront the learner to the continuity and to the complexity of the learning activity. This teaching approach aims to develop critical capacities, that is to say reflexive capacities. For this, the learner has to make explicit the constraints that structure her or his activity. By making explicit the interactions by a reflexive posture, the user becomes more aware of her or his “action patterns” (Piaget, 1972) or of her or his “habitus” as a “system of durable and transposable dispositions” (Bourdieu, 2002).

1.3. *A human computer communication model*

Lines of power that structure the activity of the learner can be complex. However, it is possible to organize them onto layers in order to understand easier the communication between human beings and machines. Those constraints can be organized from a framework, a model of the interactions structured into layers. Inspiring by the work of Open Systems Interconnection OSI (Zimmermann, 1980) and by that of Bouchardon et al. (2011), this model is structured in four layers, as shown in table 1 and figure 1, described as follows.

- The physical layer or media layer determines the numerical representations. Manovich (2002) identifies two fundamental properties of this layer: its material is mathematical and formal; and it is submitted to algorithmic manipulability, which makes it programmable. Human interactions are determined by those properties.

- The applicative layer (host layer in the OSI model) enables communication between services (InterHost communication), from the kernel of the operating system to the software in the foreground. At this level, interactions can be determined by the designer of the software. For a user, controlling the physical layer and the application layer depends on the learner’s own digital culture (Beavis, 2012).

- The semiotic layer refers to the operations and limitations of situated cognition that allows a human being to interpret the semiotic forms she or he can see on a screen. Brain and sensitive sensors, but also history and experience of an individual determine those interpretations.

- The politic layer is that of the public sphere as a space of constraints produced by the system of collective action in terms of values or norms, from practical communities, collectivities or institutions. It involves the socio-economical and political spaces, the proper “civic culture” (Dahlgren, 2009) concerned by digital media industries.

Those layers help us to identify the particular constraints that structure the activity of reading and writing on digital media. In order to help a learner to become more aware of the role of a constraint, this model allows us to present this constraint in relation with others concepts and layers.

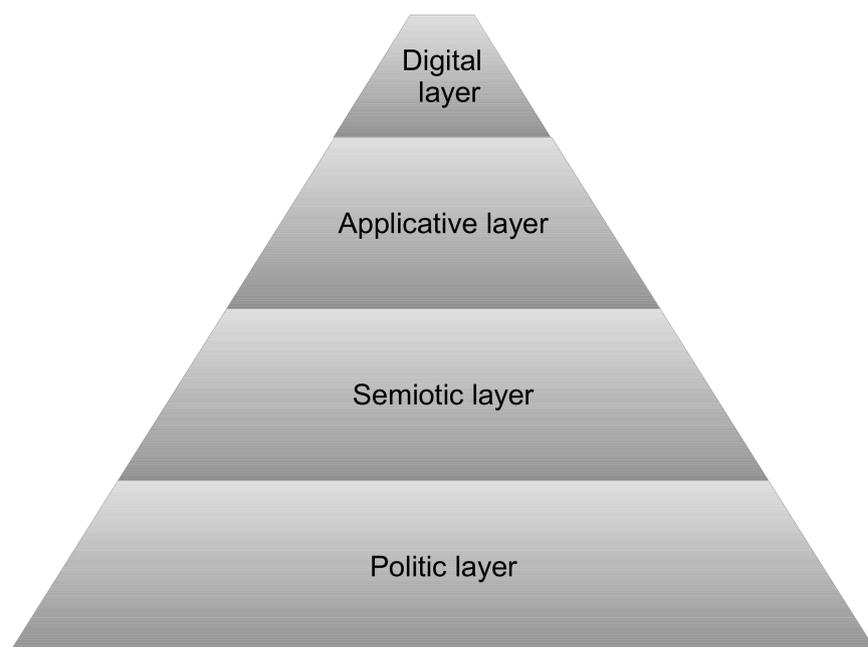


Figure 1. *Architecture and layers of the Human / Machine model*

Table 1. Architecture and layers of the Human / Machine model

Centrality	Unit	Layer	Constraints on human activity
The machine	Bytes	Physical	Mathematical and formal material
The application	Service and its object	Applicative	Interactions intended by software
The human	Form	Semiotic	Cognitive and perceptive limits of human understanding
The collective	Norm	Politic	Social and collective norms

2. Pedagogical design

After the presentation of the theoretical approach, this section describes the design of the teaching session before analysing results of the experience.

2.1. *Design of the pedagogical apparatus*

Here we will describe the university context of the training; then, the model and the stages of the training.

2.2. *Context*

This paper focuses on a training entitled “writing on a network”. It is one of the six training about digital writing and digital culture² carried out initially during the regional research project PRECIP. The five other trainings concern other forms of digital activities such as: collaborative or multimedia writing, production of a map, writing on a blog.

2.3. *Model*

The training session is structured on the one hand from the layers model, on the other hand from pedagogical reasons. In deed, freshmen can meet sometimes difficulties to understand concepts insomuch as they are not very familiar with the abstract think, so we chose to make them go up in abstraction at the middle of the teaching before going down back. Learners follow instructions in order to practice digital writing; in this training they have to make a multimedia report after visiting a museum of Fine Arts.

² See the complete courses in French at this address: http://thibaud.hulin.free.fr/precip_foad/reseaux

Consequently, we organized our training in five stages as follows.

1. A discovery session allows the learner to experiment the writing activity, here the network writing, by identifying the main functions of a writing software, here a social network. She or he follows a straightforward tutorial for using the software with procedural instructions, in order to reach expected results and to understand the main features of the interface. She or he acquires a minimum procedural knowledge and finally masters the main features of the studied software.

2. This second stage groups broaches two different layers. Firstly, the learner discovers the applicative layer by finding out the concepts than structure her or his writing activity. For example, she or he may compare two software dedicated to the same type of activity, observing how these apparatus differently constrain the writing activity. Secondly, the learner discovers the physical layer by grasping how the digital media influence or structure their writing activity compared to traditional media like paper and pencil, telephone, face-to-face meeting, etc. It is easier to present altogether those two layers because of the abstract level of the physical layer, when the applicative layer is more intuitive to understand.

3. Then the learner discovers a socio-economic stage: confronted to the politic layer, learners get aware of the economic, social and cultural context in which they use a writing software. They situate the technical functions into the communities of interest that have produced them.

4. An artistic session may be introduced here in order to discover more clearly the actions prescribed and how artist can exceed those limits or create unattended uses. The study of literature and digital arts serve as an illustration of thee concepts previously studied.

5. At last, learners study writing production as semiotic forms (visual forms, texts, multimedia objects...), determining how a human reader perceive, know, or judge them. Here good practices or ergonomics rules can be presented. So to do, the student may compare different network productions.

To resume, in the first phase, we match the need of the student who wishes to achieve a minimum level of competencies with the presented software. This phase facilitates the understanding of the software, and prepares the reflection of the student. Then, we go up in abstraction to study the media as an apparatus. The artistic phase links the concepts of the previous phase to the work of artists which illustrate and question the power and limits of the media. This phase aims to open possibilities to learners in order to develop their creativity in a critical perspective. Finally, we go back to more expected demands of students such as “good practice” or ergonomic rules to follow in order to create a digital product.

At the end of each phase, students are required to meet at least two open questions, called “synthesis questions” to make them thinking about their activity and using their personal culture in writing a short essay.

Consequently, in the network writing case, the course was divided into five sections:

1. introducing to the free software of microblogging identi.ca: acquisition of the needful procedural knowledge;
2. comparison between networking applications: analysis of software interfaces: Facebook, Twitter, identi.ca, including their business models;
3. comparison between the digital social networks and traditional systems like face-to-face meetings;
4. exploration of digital works that question or play with limits of social networks;
5. comparison of existing practices, uses and productions; analysis of their impact on the reader.

3. Methods for studying lexical words

3.1 Participants

All courses taught from this theoretical framework was done at the university. They involved 102 freshmen of DUTs (University Diploma of Technology, Services and Communication Networks speciality), 28 sophomores and 12 students in remediation following an University Diploma (UD). In this paper, we focus on the work of the students of the UD. Indeed, the size of this small group of students is adapted to an ethnomethodological approach which aims to capture the microscopic dimensions of the critical activity. Those students failed to their exams at the first year. UD gave to those students a second chance to upgrade and come back to the university the next year. During the course session, students were invited to discover a Museum of Fine Arts and to produce a multimedia work from this visit. Doing this, the course has created a link between the cyber-culture and an older culture. Finally, this approach considers the idea from which having an unique and large concept of culture is more relevant than to oppose digital culture to the humanities.

As participants work in groups with online training support, the teacher has led the session after supplying to students a digital document with instruction, bringing clarification to students according to their demands, and reformulating the document elements if necessary. In participant observation situation, the teacher has tried to stimulate interest of students without providing answers, but as a coach, by helping them to describe their creating activity, following a guideline. This guideline had rules like using open questions and avoiding questions like “why”, that lead the learner to justify himself, building power relationship. Without questioning the students, the teacher has just observed their work and the evolution of their multimedia production, supporting them discreetly.

3.2. Instruments

The discourse analysis of learners was supported by the software IraMuTeQ: R Interface for Multidimensional Analyses of Texts and Questionnaires³, developed by Ratinaud & Dejean (2009). This open source software is based on the statistical software R. It can show the “lexical worlds” of speakers based on lexical distances and proximities. This software helps the analyst to build topics in a more objective way. The analyst goes back and forth between the statistical results and the verbatim. From the classes of discourses delimited by the software, the analyst make assumptions in order to analyse data from speeches of students.

Always based on R, we used R-QDA software⁴ in order to make qualitative analysis and to identify the grammatical forms of reflexivity of the student. We tagged the discourses from ten reflexivity forms proposed by Derobertmeasure & Dehon (2009). RQDA software has allowed us to make a statistical analysis. Data are traces of the discursive activity built from syntactic proximities.

During the course, students had to use status.net, a micro-blogging software, an equivalent of the social network Twitter that we have installed on our own server.

4. Results and analysis

4.1 Analysis of linguistic proximities

Firstly, we tried to get a first glance of the representations of the learners. The “similarity analysis” function of IRaMuTeQ relies on graph theory in order to provide “communities of linguistic forms”) Such communities are built through the identification of syntactic proximities within the terms used by speakers. As depicted in table 2, the analysis of the corpus shows up seven communities. None of these linguistic forms is specific to a single group of students: linguistic communities structure is not the reflect of the students organization by group. Three forms dominate: “information”, “Facebook” and two close forms: “social network” and “allowing”).

By convention, in the following analysis, we put the linguistic forms in quotation marks.

3 <http://repere.no-ip.org/logiciel/IRaMuTeQ>

4 <http://rqda.r-forge.r-project.org>

By studying the similarities between linguistic forms within each of these communities, we can get some observations and interpretive hypotheses that we check by returning to the context surrounding a particular form and by crossing assertions.

In the graph, we observe that “Facebook” and “social network” forms are separated although Facebook is a social network. We interpret this separation as follows. The semantic relationship of the form “Facebook” with the form “social network” is of type Class / Individual. Discussing the class “social network” means for the student to place her or his analysis on a more abstract plan than if she or he focused on the individual Facebook. Thus, speaking of the “social network” brings to the student more distance, and finally it develops her or his critical thinking further.

Consequently, the network can be considered not as an end but as a “means” to “serve” its user, for example by developing “contacts” and “exchanges”) Speeches of students indicate a promotion of the network concerning its efficiency (it is “simply”, it is “easy”); moreover, they questioned its “goals”, that is to say which it will “allow” their user to do.

4.2. *Quantitative analysis*

In tables 3 and 4, we present the frequency and the distribution of the forms of reflexivity and of objectivity identified from speeches of students. The number of instanced forms may vary because a student may need more or less words to develop the same idea. These rankings help us to identify specificities in the use of reflexive or objective forms. Here they show that both types of approaches, reflexive and objective, are clearly present in learners' discourses.

Table 3. Reflexivity and objectivity forms by number of forms

	Forms	Nb of forms	Rates	
Reflexivity forms	describing.narration	1	1%	42%
	justifying	1	1%	
	thinking.ethics	1	1%	
	alternating.proposition	2	2%	
	describing.theorics	2	2%	
	thinking.knowledge- advices-tastes	3	4%	
	describing.practice	3	4%	
	thinking.practice	6	7%	
	thinking.technics	7	8%	
	alternating.exploration	10	12%	
Objectivity forms	comparing	11	13%	58%
	assessing	11	13%	
	explaining	13	15%	
	describing	14	16%	

Table 4. Reflexivity and objectivity forms by number of characters

	Forms	Nb of char.	Rates	
Reflexivity forms	describing.theorics	4650000	6%	61%
	thinking.knowledge -advices-tastes	5133333	7%	
	justifying	6500000	9%	
	describing.narration	8400000	11%	
	thinking.practice	10000000	13%	
	describing.practice	14400000	19%	
	thinking.techinics	16514286	22%	
	thinking.ethics	18200000	24%	
	alternating.exploration	22300000	29%	
	alternating.proposition	34500000	45%	
Objectivity forms	explaining	18392308	16%	39%
	describing	21150000	18%	
	comparing	18163636	15%	
	assessing	18245455	15%	

4.3 Qualitative analysis

Here we study in more detail what the forms of objectivity and subjectivity refer to.

4.4. Objectivity

During the course, students have to identify and to *describe* components of software they use: for this, they have to formulate objective judgments. It implies a critical retreat or a recoil posture in order to eliminate too subjective or unreliable elements. Concretely, students distrust “rumours” and “intox”. They are interested in the ergonomic aspects of the software, identifying some features (search for information, notifications, alerts). They analyse more general impressions in a semiotic approach (“the design is a bit too cold”). They identify the legal aspects and distinguish them from possible interpretations (the image of Facebook “may be considered intrusive”) and their temporal variants (“you can quickly be disillusioned”). Some remarks are purely informative (“the service was purchased by Facebook in August 2009”).

Finally, students are able to *compare* technical features between software (how to converse, instant discussions) and situations (“it’s easier to exchange ideas when people are in front of you than behind a computer”). Users are able to identify specific public (amateurs and professionals). They know to nuance their judgements by spotting quantitative differences (short or long messages, retention time of data, distance between users of a network more or less “close”, how to converse by exchanging more, page more or less restricted).

Students try to well-argued when they formulate *assessing* judgments from these observations. They propose personal syntheses (in broad outline). Such assessments relate to the possibles or “limits” of the apparatus, the presence or the absence of functionalities, the uses, the risks; they concern too judgments about Internet users, “monopoly” positions, and so on. The most of the time, opinions are said positive or negative without referring to more subtle scales of values.

With regard to *explaining* judgments, the learner looks for causes: she or he identifies explicitly or implicitly certain concepts such as the “economic model” and the choices that result from it, the conditions of use or the parameters that influence the user activity. Doing this, students imagine general objectives to the authors of the software. However they can refer to the history of networks to capture intentions (Facebook at its start, as an intranet in Harvard).

Therefore, the critical thinking is developed by the student at the price of an effort to explain the principles of the software and an effort of synthesis.

4.5. Reflexivity

Into speeches of students, reflective *exploration* is the most common form because of its flexibility. It does not require a feedback but relies on objective postures in order to synthesize an experience. It considers alternative action or possible uses. For example: “This social network can make it possible to organize all kinds of events like an evening of integration, a sports meeting, an organized meal”. In this verbatim, envisaged possibilities refer to the experience of the student, considering the needs of freshmen. In some cases students can project themselves by talking in a given situation, chatting with a peer, using a more familiar mode of expression: “It’s also useful if you are looking for information or wanna follow information or actions in real time”. This posture calls out their personal experience to put it to the test of the possibilities of the apparatus. More rarely, learners consider possible uses that they have not yet explored or did not perform during the exercise but at another date.

From this point of view, the analysis of the technical functionalities makes it possible to raise an interrogation on the constraints of the user (“the Internet users are constantly submerged by a flow” of information) and on the objectives of the user (“they must share and diffuse their information with the biggest possible public”). The interrogation on the vocabulary of the software involves a reflection on the social dimension of the apparatus (“It is also possible to put this information at

disposal of our friends and of their friends"; "The economic model of Facebook is to consider all users as customers"). In fact, it is not from an expert point of view that the technical question is raised; it is rather from a reflection about the place of the human face to the technique ("the social networks have taken an important place in our daily life and we use them for any research of information").

Considering their described practice, students rarely use temporal markers to describe their activity ("Next we have..."), preferring a synthetic style. When they use reflexive forms to describe their practice, they willingly describe it from a same syntagma ("our work consists of ..."). They express their main activity differently, that can be: to "retrieve information", to "share information" or to "go to a website". Sometimes, students can meet difficulties to separate analysis of a media (like Facebook) from their own writing activity on a media: speaking about their activity is speaking about the media. However, they show an attitude of attention concerning the visibility of publications, the sharing of information or of "relations". This attention can take shape of a piece of advice towards readers ("pay attention to the data that you share"), that shows a concern of ethics.

When students think about their *knowledge*, they refer to the experience they have of other social networks, underlying the interest they have for them. When they consider the *ethics* dimension of the software, they measure the consequence for their privacy: they refer to their own experience. Only a little part of the students succeed to conceptualize their experience. For example, one of them differentiates a friend from a relation, but he doesn't limit himself to observe a difference of vocabulary: he extends this idea as a general and important rule that must be taken in account by every social network user: the idea accesses to a *theoretical* level.

When students easily explore their activity, they achieve less often to formulate real *alternative propositions*. When they reach this level, they consider uses that are not really prescribed by the social network like create a close group or organizing an event. Or, they see a path to access to information they were not searching, following a principle of serendipity. Those alternatives show a real distance between the student and her or his past activity. All those reflexive propositions help students to understand how the networks work. More seldom, they reach to swap places with the social network designer, considering the necessary elements to design. In this case, they can justify the position of the designers. Therefore, justifying is an act reserved to the designers, probably because they don't consider that they have to justify themselves as a client.

4.6. *Synthesis*

Finally, we observe that different forms of reflexivity are convened by users, but they are inseparable from objectivity forms.

Objective argumentation helps students to constitute a necessary start point for the student in order to organizing concepts that go across the interface, and clearly distinguish the facts from the value judgments. When objective arguments help stu-

dents to understand interfaces as apparatus, *reflexive* arguments help them to understand their interactions; both approaches can be strictly separated, however they are complementary and they must be articulated and bring nearer.

Comparing helps students to organize functionalities, reasoning between the class and the instance, and measuring the performance or the degree for every function.

Assessing helps students to seize the choices of the designers and to conceive what would be done, and what might be done.

Explaining helps students to know the principles or the concepts of the apparatus, strengths, weaknesses, occasions and risks, causes and consequences.

Describing helps students to identify components of interfaces, in order to separate facts from judgments, elements of the interface from their interpretation. But describing is not only an objective judgment, it is a reflexive judgment too, because interactions are facts and not values. As a result, it can be difficult for the student to separate interactions from the structure of the apparatus.

Exploring helps students to open themselves to new ideas and to synthesize their experience in connexion with previous experiences; it helps in order to identify choices made, the results obtained and the offered possibilities, and to consider alternatives in order to build a different strategy.

Thinking her or his own activity and the interactions carried out is very useful in order to discover constraints imposed by the interface with both dimensions, social and technical. The social dimension is particularly important when a student is projecting into the social body, taking into consideration the needs and the objectives of the others. Thinking consists to understand the logic that organizes the technical fact, but also the experience of a user, her or his knowledge, and the ethics involvements.

Considering the *alternatives* helps to place the user experience in the time. When alternatives are raised by comparing two software of the same class, real alternatives are for a subject dependant from the choices that she or he assumes. Such choices can refer to the past, the present or the future.

From a more general point of view, we note that the egocentric reflexive forms (“I”, “what I like”, “we”) are more rarely used. Therefore, the reflexive attitude is indirect and willingly altruistic: the user's experience tends to become a model of behaviour for others.

Finally, *justifying* is a specific mode of reasoning used when a user puts herself or himself in the designer shoes. Justifying is not required for a user, because reflexivity does not consist to judge oneself, but it consists to evaluate a situation and consequences of choices made. The rationale is probably secondary compared to a reasonable thinking about possible interactions.

5. The critical thinking as a creative praxis

In brief, the analysis of the forms shows that the course influenced clearly the practice of the learner who is invited to formulate reflexive judgments in a more critical way. Moreover, forms of speeches are dependant on each other. This experience suggests that procedural knowledge and reflexive knowledge may form an alliance in order to develop the critical thinking. They wouldn't be separated arbitrary. Comparative practices feed critical thinking in order to develop the students autonomy during their practice of digital media.

This experience reveals too some limits: the course could be changed according to the type of public and their own objectives, because some layers can seem more or less difficult to understand. For example, it can be difficult to explain to the learners why they have to study other elements than procedural ones. During this experience, students had to make a report after visiting a Fine Art Museum, so they were sensitized to digital literature that we proposed. However, other experiences that we lead show that discovering digital arts might be a stressful experience if the learners do not appreciate the art works.

An other problem is to describe the type of constraints that structure every layer. When it does not exist a "one best way" to design a course from the layer model, it could be useful to list the type of constraints into every layer. We consider that it is not possible; in fact, every layer can be associated at different large parts of the science: the network science, the human factor science, the semiotic or the political science. Moreover, when we teach human/machine interactions, we teach too the how to interact and how to create new interactions; interactions concern the science, but also the art, because design is as much a science than an art.

Above all, we consider than teaching critical thinking is not a special field which could be list the polemics about Facebook, because this approach creates a gap between those who critic and don't use such a social network, and those who use it without be aware of all the consequences for their own life. A comparative approach is probably the simpler way to help the user to understand the principles of an interactive apparatus, helping the user to be more autonomous. This approach reverses probably the way by which we think when we oppose the theory to the practice. However, we have to keep in mind that the birth of writing has strengthen the development of critical thinking (Goody, 1979).

Therefore, critical thinking is not a just a theoretic approach: it is a creative praxis that is born in the act of writing, a practice of distancing. In this perspective, the question of knowing if we have to teach critical thinking as a specific skills or as (like logic or argumentation) or into specifics knowledge contexts is deprecated, because the both approaches remain outside the concrete activity. Our hope is that the reflexive effort, acquired during the course, will became incorporated and integrated for the student; long-term studies will allow to show this.

Conclusion

In this paper, we asked how to teach critical thinking nowadays, not only from external courses (argumentation or media analysis), but inside the practice of young, at the heart of digital interactions. At the digital public spaces era, we need to develop critical thinking as a reflective thinking of our own interactions. The theory of interactions we propose offers a framework to identify constraints into a layers model that reconnect the individual interactions to their political stakes. This model help us to design a critical pedagogy, by connecting a procedural approach of the pedagogy to a reflexive one. Here we presented an implementation of this model during a course about writing on a social network. By the study of activity diaries of students, we observed the presence of objectivity forms and reflexivity forms, which reflects the development of a critical thinking as defined. The birth of the writing enhanced the critical thinking and impacted the whole human think. For the benefit of humanity, scientific communities have to continue critical studies in order to make of the digital interactions a meeting point between private and public spaces, where the human think is active and aware; in order to make the digital a real empowerment tool.

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