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Digital Technologies for Students with Disabilities. When the Experimental Method Meets the Social World

Cristina Popescu, Petra Vlad, Mathieu Muratet
Grhapes (EA 7287) – INS HEA
58-60 avenue des Landes, 92150 Suresnes, France
(cristina.popescu@inshea.fr)

Abstract

Starting from initial considerations on the experimental method within natural and social sciences, this article aims to underline the modifications brought by the meeting of the "social world" with the different ways of doing experimental research in the field of new technologies for education as they are intended to encourage the autonomy of young people with disabilities.

Key words

E-education, digital innovation, teaching, ergonomics, usability, social innovation

1. Digital technologies at school

"*In autumn 2011, 210,400 students with disabilities go to regular schools, in a French secondary education institution. Starting from autumn 2006 when the French law of 11th February 2005 took effect, 55,000 additional students went to school, which means a medium annual progression of 6.3% while the number of students remained steady during the same period.*" [1].

According to the French Ministry of National Education, the numbers we have just shown are still growing. This phenomenon seems to be the consequence of transformations in the way governmental professionals dealt with education of students with disabilities who previously attended specialized institutions.

The different school actors have to change their practices within this new background. They are now including students with diverse profiles. And these practices are modifying both pedagogical and technical levels. All of these will therefore ask schools, social health-care professionals, young people and their families for greater involvement.

Digital solutions will therefore be seen, within this background, rather as an innovating option than a new one. It is not a new one, as students with disabilities have been using technical and/or digital devices for a long time, even if they significantly developed during the recent period. But it is considered innovative as new practices related to it have emerged. Contemporary digital devices are therefore supposed to encourage their user autonomy [2].

This paper aims to describe a technical and digital system, which was designed to help students with disabilities during their notes-taking activities. This presentation is not intended to be exhaustive. It is rather a part of an experiment that searches for good practices that appear as natural consequences of new political decisions. We especially think about the transformations made to the school system by the French law of 11th February 2005 [3]. In which way will the model of the experimental method transform the various actors' actions? What place does one person have within this model? Does he or she have any freedom within this process that implies both organisation and learning skills? We will try to answer these questions through the following paragraphs.

2. The experimental method

Natural sciences see the experimental method as a solution that brings innovation with it. "*By means of these active experimental sciences, the human being becomes an inventor of phenomena, a real foreman of the creation*" [4]. New hypotheses are therefore established starting from an initial observation. They will afterwards be tested through an experiment that relies on dependent and independent variables. According to P. Grelley, "*the experimental method is a scientific procedure whose aim is to control the validity of an hypothesis through repeated trials during which situation settings are modified one by one in order to observe the effects made through this transformation*" [5]. This method, which was initially applied to laboratory experiments, is now also used by social sciences. M. Grawitz [6] in turn defines natural and social sciences. She insists on specificities of the experimental method for each one of these big families of sciences. We will therefore find the experimental method within other study areas such as those belonging to social psychology (i.e. K. Lewin's [7] or S. Milgram's [8] research in the United States) or to economics. S. Dauphin [9] writes about this last study area. We will find out in her writings that E. Duflo [10] explains how the experimental method might provide a solution against poverty. It works in particular by trying to initially make a diagnosis in order to find where the problem is, and to finally solve it. More recently, the experiment was also introduced within learning sciences. Researchers talk about "evidence based education" for instance [11]. The construction "social experiment" will also be used within specific procedures of public policies [12].

2.1 The experiment as a model of scientific progress

One might sum up the previous paragraphs by saying that the experimental method concerns the use of the same operating procedure in order to identify variations within the way different actors are using the same device. Let us imagine an IT tool used by various testers within a specific environment. They will afterwards give their feedback in order to allow the object's adjustment and also its distribution at a larger scale. We will describe this situation as a "laboratory" one. We use the word "laboratory" in a very general way and in order to define an environment presenting conditions of use, which are very controlled ones. We will finally add that according to B. Latour, "*a laboratory experiment is a rare, costly, local, artificial set up in which it becomes possible for objects to become relevant for statements made by scientists* […]" [13].

2.2 Leaving the "laboratory" in order to meet the social world

The experimental method, as seen in a laboratory, tends to cross its borders. It will be therefore recreated by social sciences. But an important modification appears in this new context. Human actors become the main actors of the experiment. The non-human actors, the objects, remain secondary.

Criticism was addressed to the laboratory's experimental method as it has been translated by social sciences [13], as a hybrid form might appear within this background. It "*represents […] an intermediary stage between rigorous, but artificial, laboratory survey and the exploratory research that provides a diagnosis*" [6]. The last type of survey concerns the field experiment. According to M. Grawitz [6], "*conditions to do a field experiment are more difficult than those from a* [scientific] *survey. The necessary qualities, the degree of training of the experimenter are inevitably high, the help provided by the subjects of the experiment is vital most of the time. It is compulsory to obtain more than permissions, which means to obtain very specific success conditions*". If someone tries to imitate these laboratory conditions within daily life, modifications might appear as variables get out of order and the social conditions of the experiment become more complex. According to B. Latour [13], there is a big difference between the laboratory experiment within natural sciences and that from the social sciences. Natural sciences study objects, while social sciences focus on the human being. If the experimental procedure remains available for objects, as they can keep their "opposition" power, it becomes less valid when it deals with humans as they might not show their real position. They sometimes follow what the "experimenters" ask them to say or do. Therefore, in order to have a methodological connection between social and natural sciences, the researcher should first leave the laboratory. Within this new configuration, it will be more appropriate to

consider the tester as an actor of a network, or rather as an actor surrounded by a network of "auxiliary persons". The results that the researcher will obtain take into account the initial variables, but the human actor will also play an important role within the network. He might modify the physical object that is tested. He might also evaluate it or use it in order to meet supplementary needs, by entering and leaving the experiment according to his own logic and motivation.

This article also aims to present and to categorize the main parts of the recruitment process of the users implicated in the project. We will firstly present the background of the project that aims to test the device. Its main steps will then be highlighted within a specific geographical area. A critical approach will finally be applied to this method. We will then underline, through the following case study, how the settings of the initial design of the "experiment" will be transformed while meeting the "social" world. We state that all of these concern a situation initially categorized as an "experiment". And at the end we will give more details on the experimental method as it is conceived by social sciences.

3. A tool that promotes autonomy

3.1 Description of the device

EyeSchool [13] is a tool designed to make the notes-taking process easier for students with visual and hearing impairments and for students with learning difficulties. It includes both software and hardware modularity and it adapts itself to the different educational needs. Its light equipment is intended to support the mobile nature of this solution. Thus, students use a mobile webcam and a mobile scanner in order to save information given by their teachers. This software is also compatible with interactive whiteboards.

Customization is both available for hardware and software. The user can "choose" the main options associated to the software. The main features of the device are as follow: Processing the static images previously captured by webcam or scanner (zoom, contrast, light, filters, etc.) in an adapted way; Combining writing notes with images previously saved and adapted; Optical character recognition of a textual document in order to allow its modification through a word processing program and its reading through a text-to-speech program integrated to operating system.

An automatic data management system saves all users' documents (images of the blackboard, scanned documents, written notes). This function is useful in order to keep a quick backup of information. This will still allow the student to organize his documents later on.

Some ergonomic settings are also available. The students can customize their user profiles (font, character spacing, colours, etc.). A text-to-speech program is also included. It allows its users to be less tired.

3.2 The project's background

This tool is intended for partially sighted students, for students with hearing impairments and for students with specific learning disorders (dyslexia, specific language impairments and developmental coordination disorders).

The project initially concerns students with disabilities in regular schools. In particular, one of the main aims of this tool is to promote students' independence and autonomy during their notes-taking activities. A few specialized institutions, as well as universities and higher education schools also took part in the project. Let us stress at this point that the French law of 11th February 2005 advocates that students with disabilities should go to regular schools. Students' education might be "individual", that means that students will either go to regular, or "group-oriented" classes. In this case, the students are part of a CLIS - *Classe pour l'Inclusion Scolaire* (Class for School Inclusion), when they go to primary schools, or part of a ULIS - *Unité Localisée pour l'Inclusion Scolaire* (Localized Unit for School Inclusion), when they go to secondary school.

An experiment protocol was therefore designed in order to test the device. Students from four French regions were expected to use this tool at home and at school during one school year.

3.3 A large-scale "experiment"

A pre-testing phase took place between April and June 2012. Eighteen students could test a first version of the device. There were ten students with visual impairments, six students with specific language impairments and two students with hearing impairments. A few improvements were made to the software and hardware solution after this short experiment. The device tested within the present project integrates the results of the first tests [15].

The project will then take into account the results from the first experiment. It will include a larger number of participants. Four regions from France will be part of it. And an identical experiment protocol is intended for each one of these regions. Various professionals guide the students so that they can take part in the experiment. On the one hand, the project defines "technical" professionals, also called "IT referees", on the other hand it defines the professionals concerned by teaching and learning matters. They are called "educational referees".

Two big categories of actors are then defined as participants to the experiment. On the one hand, health and social care professionals, on the other hand, education professionals, for instance school officials and teachers. The models and the time limits initially planned for the experiment were reconsidered after observing how diverse the main actors and their activities were.

However, each region taking part in the project has its specific institutions and organizations. In this article, we will present how the "experiment" was deployed across one of the four regions.

4. Overpassing small numbers

4.1 Regional specificities

The chosen region has three educational service districts. Their students have very different profiles. A specific hierarchy allows a better management within each academy. To this effect, one can find specialized inspectors, resource teachers for each kind of impairment, or managers for the adapted educational equipment. The first step of the experiment period is about obtaining the approval from the major actors within the education system. And if the initial protocol was based on a simple scheme of actors, the "field" work will soon show the experimenters that the organization of these actors is much more complex. We also underline that these actors take an important part into the education of students with disabilities. Moreover, the experiment was conceived for one-hundred students with disabilities during a school year (2013-2014). At the end, the students were expected to take part in an evaluation process. They were asked to express their satisfaction with the device and also to describe in which way they used it. Anyway, the large number of participants to the experiment brought some complexity to the way in which the experiment went on.

The various paces of work and agenda of the large number of professionals directly influence the way the experiment is organized and carried out. The initial project planned a limited number of regional meetings, but the specificities of the area brought modifications to this protocol. Thus, more than thirty meetings were finally planned during a period of four months in order to organize the experiment. There were different categories of meetings: Introductory and training meetings; Follow up meetings or meetings allowing to install the equipment; Limited number meetings with one or two participants and large number meetings with about twenty participants; Meetings with only one category of actors like the officials from the Ministry of Education, the health and social centres' representatives, the students, their families, or with multiple categories of actors.

This organizational form brought some delays, especially at the beginning of the experiment. And this is an important point to take into consideration for the final evaluation.

However, each educational service district functions differently. This will therefore bring variations to the way the students who were participating to the experiment were identified. In this case, the education professionals work together with health and social professionals in many varied forms. Moreover, each educational service district has its own organization concerning the way in which students with disabilities are recruited for the experiment. If one of them is helping the experimenters from time to time, one other gives them full freedom, while another wishes to have a

central place to choose the participating students. All of this requires respecting the various regional organization specificities. It also requires the experimenters to adapt themselves to each demand.

Several information channels helped to identify the students with disabilities potentially interested in the experiment. Thus, the experimenters were provided with official lists of students coming from the representatives of the Ministry of Education, with lists made by the health and social care professionals or lists directly sent by schools. This information was summarized and clarified and a number of students were pre-selected by experimenters. This updated information was afterwards sent to academic staff.

The way in which the experiment was managed from a technical point of view also varies from one educational service district to another. That was a multiple level work. The first level concerned the initial contact; the second one was about showing the device, while the third one included the training of the professionals to its use. It was a transition moment allowing them to learn how to teach it to their students. An important number of modifications were also made to the initial list of students during this period of time.

The referees taking part in the project asked to have their own equipment even if this was not provided within the initial project. They argued that is was vital for them in order to show students what the experiment was about. This unplanned demand introduced a new step into the protocol and risked having a negative impact on the number of students that took part in the experiment as the number of hardware components decreased.

Not all the students would use the device at the same time because of the management modifications we previously described. Consequently, this transformed the way the final evaluation was made.

4.1 Participating institutions. The main actors working with students with disabilities

Students with disabilities participating to the project attended elementary schools, secondary schools, high schools, specialized schools and universities. They also had activities related to specific health and social centres like SAAAIS[1], SIAM[2], SDIDV[3], etc. These institutions mostly work with visually impaired children and with children with learning disabilities.

[1] *Service d'Accompagnement à l'Acquisition de l'Autonomie et à l'Intégration Scolaire*, that is an office that assists the young people with obtaining autonomy and with school inclusion.
[2] *Service d'Intégration en Accueil collectif des Mineurs* – Office for Integration within Collective Reception of Minors.
[3] *Service Départemental pour l'Intégration des enfants Déficients Visuels* – Regional Office for Integration of Visually Impaired children.

The meetings we have previously presented give a quick overview of the different actors who work with the students. They are on the one hand, health and social care professionals like speech therapists, orthoptists, child psychologists, or occupational therapists; and on the other hand, education representatives like inspectors, managers of the adapted educational equipment, resource teachers, or school principals. Our list of actors is not thorough, but we just try to give some examples in order to show the various ways in which work was done with the students.

Moreover, there is also an unexpected *margin population* within the experiment. It allows us to have a useful counterpoint when analysing the manner in which the device was used. Higher education students from public and private institutions form this population, in addition to several other students coming from other regions than the four already taking part in the experiment. As a result, new organizational procedures have to be tinkered, according to a concept first used by anthropologist C. Lévi-Strauss [16], as needs and autonomy potential are not the same for each student.

Family implication also varies. For instance, on the one hand, there are families that are very available, coming to project meetings; on the other hand, there are totally absent families that never answer organizers' invitations. We can therefore formulate the hypothesis that this presence / absence can directly influence the way in which the students will use the device.

4.2 Multiple forms of training

We previously saw the different categories of schools for students with disabilities who could be individually or collectively included into regular classes or rather attend specialized classes. The way in which the participant students were trained to use the device had various forms too, as we noted earlier. In addition, the implementation of the experiment requires to modify actors' traditional roles. As the project established that there were *IT referees* and *educational referees*, several health and social care professionals saw their role transformed, and even more, they became IT and educational referees at the same time.

These professionals are often those who teach young people how to use the device. Moreover, the software installing process is not the same for every participating student. It depends on the nature of the hardware and computer each student has. Sometimes the Ministry of Education gives them these through schools; sometimes students have their own computers, etc. We are only mentioning these examples without giving, for the moment, a complete picture of the ways in which students can be trained to the devices' use. There are nonetheless some variations depending on training duration and actors' availability.

One of the most present configurations within the experiment consists of a student included in a regular class who also works with professionals from a health and social care centre. When experimenters met exceptions to this configuration, they needed to *innovate*, and once again, to *tinker*. This means for instance that they had to find replacing referees such as professionals working for private practices or even professionals from the general education system.

All these elements might seem trivial and one might wonder about their availability from a technical point of view, but the experiment quickly showed the importance of human presence within technical implementation and knowledge production.

5. The isolated subject does not exist

A potential *modularity* comes with the device tested within the project both at a technical and human level. The initial project covers the technical matters, while the experiment showed how the modularity could also apply to human configurations. That is why this point might easily support the new paradigm of autonomy, which empowers people with disabilities, as promoted by national and international public policy. Autonomy therefore becomes possible through customizing settings of different life experiences.

The previous illustrations make us think about how difficult it is to find an isolated subject who deals with technical and digital devices all by himself.

Throughout this article, we tried to present the main steps of an experiment concerning the use of digital tools in schools from one French region. An experiment protocol was first designed. It was then replaced by an evaluation procedure concerning the way in which the tested device was used, understood and received by the main actors. Nonetheless, the methodology of this evaluation will be the object of a future study.

We were also able to observe how the protocol of a scientific experiment was difficult to apply outside *laboratory-controlled* conditions. That is why we now rather talk about a multiple-steps social experiment, which brings bypasses and even *ad hoc* arrangements, or tinkering activities, made by the participants. Levi-Strauss [16], for instance, considered the tinkering activity as an innovative one. The strategies of the experiment get modified after meeting the social world. The timing, the number of meetings, the number of actors involved, etc., will encounter variations. In the end, the student as user turns out to be part of a *practice community*, which is configuring around him.

That allows us to understand the social reality as *configuration* [17]. In this way, the groups, as well as people we are interested in, could be seen as networks of interdependencies, which are always useful to the different individuals. As such, according to N. Duvoux, who follows the ideas

of N. Elias, "*in order to better understand society, our thinking must be based on relationships, as on the object that it seeks to analyse*" [18]. And we also keep in mind the idea that this configuration is continuously changing according to the different actions of the actors. That is why it has a dynamic aspect [17]. The actor-network theory will therefore help us to better explain this movement [19] and to analyse the possible relationships established between the participants. According to this theory, the social world is made of networks of human and non-human actors, for instance computers, laptops, software, hardware components. The non-human actors are nonetheless essential, as they influence directly the actions made by human actors.

We have presented a case initially conceived as a *laboratory* experiment applied to the social world, but we can conclude that we are in front of a complex experiment organized around an object seen as an essential non-human actor. In order to better understand this complex experiment, we should accept and respect the inherent diversity of the social world. And it is also important for us to take into consideration all the unexpected modifications that appeared in relationship with the initial protocol, which provided different time and material resources. Let us then conclude together with B. Latour that "*what the social sciences, together with the natural sciences, can do, is to represent those things in all of their consequences and uncertainties to the people themselves*" [13].

This case study underlines once again the idea that the researcher, or the experimenter who meets the social world is never neutral. He always has to change his position, to modify his bias, to review his methodology and protocol according to field restrictions and realities. He should not forget that there are human participants, but also non-human ones. And he also has to deal with relationship issues that appear during the research process.

In the end, the experiment tests a technical tool, but it also raises new questions. These last ones might be related to educational or organizational practices. By seeing matters in this way, we realize that experiment is far from being neutral. It modifies the general environment of the participating actors, as well as their daily activities. Last but not least, all of these happen within the world of disability, which is characterized by norms about the specificities of each person. The average person does not find his or her place within this universe.

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