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# Systems of resources for science teaching in high school: a French Case Study

PREPRINT

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## Abstract

The EDA laboratory at Paris Descartes University has been responsible from 2016 to 2019 of a research project supporting the development of a software resource aiming to help students understand the various stages of a research process, in several disciplines at both the primary and secondary levels. This article presents a case study about the usage of resources by teachers at grades 4 and 5 in France. Our conceptual framework of systemic analysis and thematic analysis led us to the conclusion that teachers are offered various online resources designed to support them and actually use a resource system they have themselves built in the classroom. Online resources are a part only of the resource system. The various resources are nimbly mobilized in order to facilitate the realization of the pedagogical project or to overcome the problems that occur unexpectedly. The use of these resources is made possible through teamwork and teacher pedagogical expertise.

## Keywords

Innovation, Learning resources, educational Practice, Learning design

## 1. Context and research question

We shall present here a part of the research we performed in a research project: "Les Savanturiers du Numérique" (LSN). This project took place in a national scheme (*les savanturiers*, a portmanteau word joining *savant* (scientist) and *avanturier* (adventurer). This scheme, which aims at developing a research attitude in students involves voluntary teachers and "mentors". It has benefited from a steady interest by decision makers, both at the national and local level (Ansour, 2017).

The main idea of the project has been to develop and to test a software resource helping students to develop a research attitude for the study of scientific phenomena: "Cahier Numérique" de l'élève chercheur", CNEC – digital notebook for student- researchers (Cisel and all, 2017). The CNEC is a LMS-like environment accessible on a computer and on digital

tablets having an online connection. It has been designed with different modules that can be used to support students constructive thinking, in a participative manner.

The main research question we consider here is how teachers have mobilized different types of resources (both material and digital) at their disposal during classroom sessions. Our contribution is one among a series of papers produced by this research projects (Baron & al., 2019, Barbier, 2019; Cisel & al, 2019).

## **2. Theoretical and methodological approach**

We adopted a systemic approach considering instruments, actors and systems along the lines of Baron & Bruillard (1996): instrument have affordances, but also a wide range of possible usages. They are used by people who have specific values and constraints within a system that however lets them a margin of action. We also used methods and insights of a preceding research ANR *Révée* considering the ecosystem of resources used by teachers (Bruillard, 2019; Bento, Baron & Voulgre, 2015).

We shall concentrate here on a class (year 8) in Paris supervised by two teachers that we followed during 6 weeks with an ethnographical approach, and shall also mobilize observations done in another elementary class of Paris, following the same method.

We carried out a thematic analysis of exploratory data obtained during the working sessions or from research on the internet. These data are composed of notes of observations, audio and video captures as well as interviews with teachers and students.

We are conscious that the conclusions we present here suffer from limitations and must be taken with caution: we present one case only. However, what we found is well aligned with the general conclusions of the projet (Baron& al 2019).

Two main categories of resources have been identified. The first one has been specifically devised for teacher training. They have been produced by the *Savanturier* project itself and have probably been used by teachers before their lessons, but we have no direct measurement of the extent of their actual usage. The second category concerns the resources observed in the classroom. Those resources were chosen and used by the teachers themselves, sometimes in an improvised fashion.

## **3. A resource system for teacher professional development**

In order for primary teachers to teach science through an investigative approach, a series of educational resources have been developed to insure teachers' professional development. The *Savanturiers* website gathers a bank of resources with which teachers can interact (Voulgre, Roux-Goupille & Guedet, 2018).

### **3.1. Savanturiers - School of Research**

On the page <https://les-savanturiers.cri-paris.org/>, the "Savanturiers - School of Research" is presented as an "educational program, developed by the *Center for Interdisciplinary Research*, which mobilizes and federates the educational communities and scientists who co-create and innovate in the service of the School. ". The program promotes an active pedagogy and pursues three axes of development: one to develop projects in class and around, one to develop research and one to train professionals in education (blog).

### **3.2. The "Savanturiers of the ice" blog, active in 2017-2018**

The blog <https://savanturiersdesglaces.wordpress.com/>, the Ice Savants, active in 2017-2018 describes the objectives and the *raison d'être* of the climatology theme at primary school.

According to the website, "Students are asking themselves many questions about climate change, the disappearance of glaciers, ecosystem transformations and their impact on biodiversity. These questions combine citizen concerns and fundamental scientific knowledge in construction. Moreover, the project-based approach promoted by the research school seems to be able to be used to the extent that projects in climatology are "multidisciplinary in nature" (blog).

The site offers teachers the opportunity to work with students on the following issues: "knowledge of past climates, the impact of global warming on fauna and flora, the practical means to fight on its own scale, etc." » (Blog)

The main goal is to transform teaching practices and rename the class to "labs" and students to "apprentice-researchers". The notebook is also renamed "laboratory notebook". This change in denominations may imply a paradigm shift.

However, the objectives behind the blog discourse are very near from the classical objectives: "Observe document", "ask yourself questions", "define a problem", "work in a team", "communicate your results and programs".

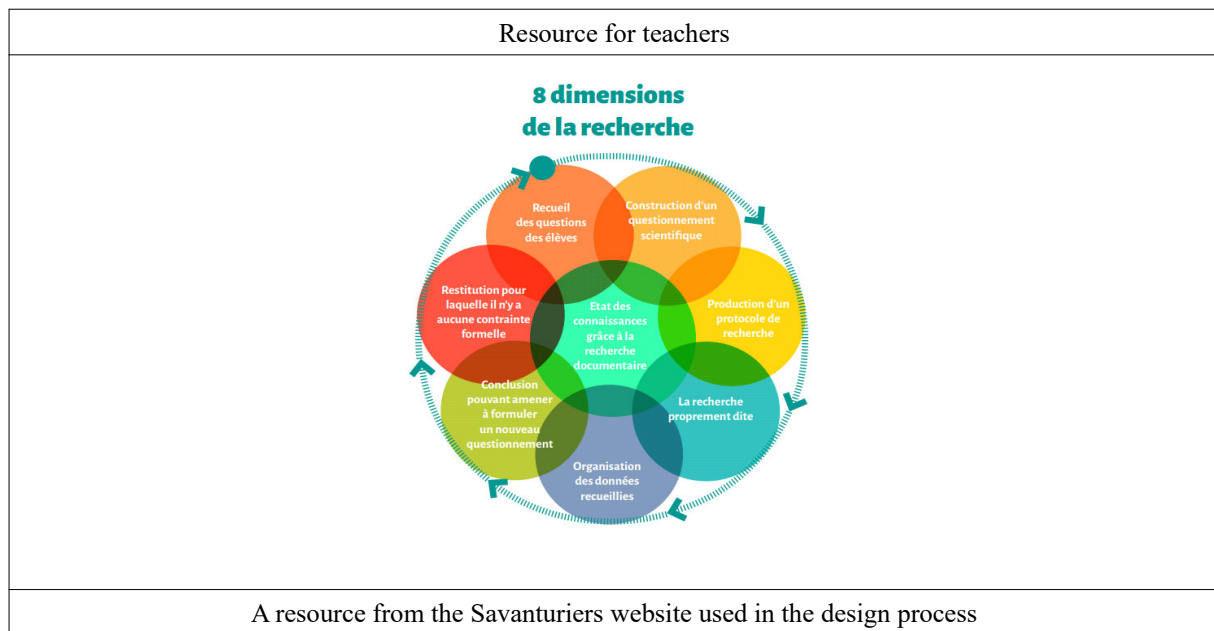
What is original in the program is the presence of a *mentor*, generally a specialized researcher. This person outside the school allows to create a dialogue throughout the work, motivates students and guarantees the steps taken in the classroom or at least who can give his opinion.

### **3.3. Example of a specific resource for teacher education**

The following illustration presents the eight dimensions of research that are promoted by the actors of the Savanturiers program in order to train teachers in their investigation of scientific issues in the classroom.

The aim is to make students successively work on the state of the knowledge thanks to the documentary research then on the collection of the questions of the pupils, the construction of a scientific questioning, the production of a protocol of research , the research itself, the

organization of the data collected, the conclusion of the research which can lead to formulating a new questioning or a restitution for which there is no formal constraint.



#### 4. In the Classroom: Another System of Resources

Four kinds of resources were used by teachers in the classroom. First of all, as in all common classrooms, there are “environmental classroom resources” such as exercise books, pens. The “pivotal resource”, central to the activity of teachers and students, is the CNEC. Third, there are some “retro actioned resources” for reactivating knowledge, built in a previous pedagogical sequence and mobilized in a new one (for example results about the reasons for the de-regulation of the climate). Last but not least, “palliative resources” are sometimes necessary for teachers to bypass obstacles such as a loss of the WiFi connection.

We have identified several practical functions for the CNEC: it has sometimes been used as a medium for writing questions, a common space to visualize and to know all the questions, and a support to discuss the relevance of the questions.

Some difficulties for using the CNEC depend upon the students' progress in their understanding of the current scientific project and upon the fact that teachers have to limit the risks of losing the face when using instruments with their students.

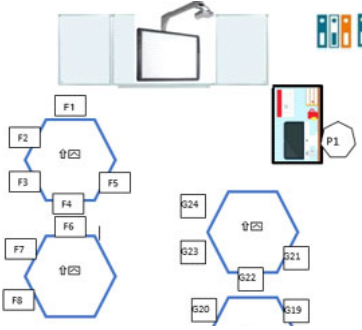


Other difficulties are due to the current prototypical status of the CNEC, ergonomic problems have been found, in particular the identification of the functional zones of the interface...

##### 4.1. Examples of Environmental classroom Resources

The following illustration shows resources that are accessible in the classroom.

Among these resources are the resources of major necessity that are used by teachers and students. The interactive whiteboard allows teachers to show during the session, the key stages of a science research during the collective review of the work done during previous sessions.

The furniture (chairs, tables) makes it easier for students to work in pairs and observe the activities of others. Then note the resources of minor necessity in the observed project such as machine tools and textbooks.

Resources of major necessity	Resources of minor necessity	Resources of minor necessity
		
Digital interactive board and classic furniture	Some technologic tools	School Manuals books

**4.2. Pivotal Resource: the idea generator**

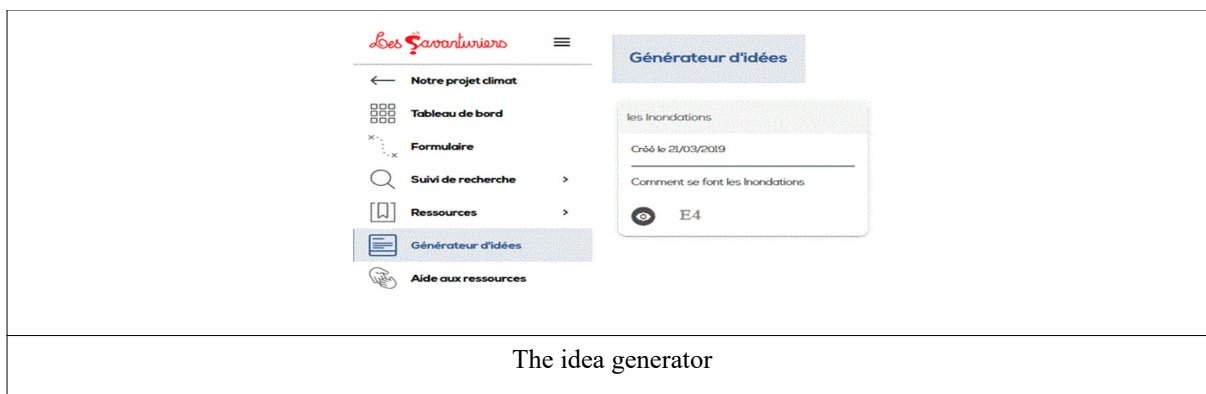
The CNEC is offered to voluntary teachers. It offers many features that are not always easy to use.

The software called "Researcher's Digital Book" (CNEC) has a feature called "Idea Builder" (image below). It is accessible from the drop-down menus and allows to create a digital wall of ideas. Its design has been influenced by the Knowledge forum (Bereiter & Scardamalia, 2003).

The idea generator may be exploited in many different ways brainstorming; association exercise; follow-up task (ideas are tasks that fall into the categories that correspond to progress reports); sharing resources (ideas contain links to online articles).

Students can add their ideas to the wall as a post-it. It is also possible to sort these ideas by categories. The teacher has a command for him or her to be visible to the machine of his students.

Researcher's Digital Book (CNEC)



The idea generator

### 4.3. **Examples of retro actioned resources**

The following resource is the result of co-developed work with several students.

Teachers printed maps of an environmental game found on the Internet to help students think about the systemic links between several events that can accentuate global warming. Students use the notion of concept map to reel the elements.

This work, carried out before the session observed, came to nourish and enrich the students' representations concerning the scientific theme of the session observed. The teachers therefore thought the work upstream as a support for the reflection of the course. The questioning phase on the causes of global warming should allow students to consider classroom experiments.

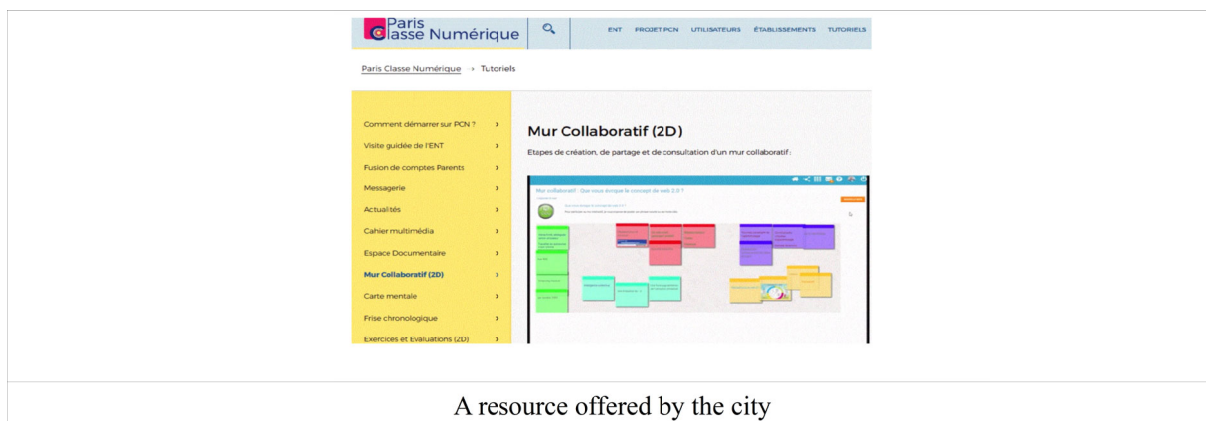


### 4.4. **Palliative Resources**

The emergency resource is a resource that teachers use when what they planned to use does not work. It is used to palliate a difficulty. The resource presented (image below) during the course observed is made available through a territorial device to give digital resources to teachers. The teachers asked the students to use software to write their ideas as in the CNEC Ideas Generator. The latter did not work well, so teachers used an application they had already tested in another class to try to continue the activity. It is the expert practice of teachers that has made it possible to bounce back.







A resource offered by the city

## 5. Discussion

We have in this paper considered the appropriation by teachers of a new instrument designed to foster a research attitude among high school students studying scientific matters. The teachers were innovators involved in a national scheme and therefore they had enough self confidence to take the risk of participating in the essay of an unfinished software system.

They had received support from the savanturier community : First, mentors occasionally went to the classrooms and students generally remembered sessions with them, because they were perceived as scientists having a high social status. Members of the Savanturiers support team also organized periodic meetings at the Savanturiers building. Last but not least, digital resources were available for teacher training. Those resources are related to scientific and methodological contents and are organized by theme on the Savanturiers website. Their functions are to enrich the knowledge of teachers if they wish.

On the other hand, teachers have also designed and used their own resources for classroom use. Some of them are activity sheets for students; diverse documents have also been created, the main function of which has been to keep track of classroom activity related to the project. Those resources both served as reminders for organizing the pedagogical activity and also as potential testimonies available for community cooperation and decision makers.

The second group of resources is specific to the *real-time pedagogical action*, such as the interactive digital board, and school furniture and textbooks. These resources contribute to the well-being of the class life and to the spatial organization of sessions. They are organised around a pivotal resource (The CNEC idea generator, organizing the sequence by giving students specific writing tasks).

But other resources are heavily mobilized either for bringing solutions to the questions that teachers ask students during the session or to solve the problems that unexpectedly occur during the course.

Overall, we have confirmed the great dexterity of teachers, who did not hesitate to tamper with the “official” guidelines in order to keep their control on the classroom, seizing any opportunity to keep groups on the task.



Perhaps the main point is that teachers gave systematically a priority to what they considered as profitable for the achievement of the task over what was the suggested good practice. In particular, they used resources that have not been officially approved by an academic institution, which they had found on diverse sites.

A fluid classroom practice is then the ultimate legitimation of the use of resources by teachers. The local adaptation of resources is made possible thanks to the collaboration between several teachers (sometimes 2, sometimes a collective).

Using different kinds of resources, as described above, supposes that the teacher has a systemic understanding of the situation, which fluctuates from one session to another. This is possible because they are experienced and innovative teachers having a high agentivity and because they inscribe their action in a community of practice.

This community has allowed them to benefit from help, encouragement, inspiration and justification from others and to take the risk of implementing unstable instruments during their sessions and to maintain a balance between, on the one hand, the educational and teaching objectives they pursue and, on the other hand, the reality of the classroom reflected in students' attitudes and technical skills (Baron & Zablot, 2017, Beauné & al, 2019).

In the future, it would be interesting to organize a follow-up of the activities that have been implemented. Teachers who have welcomed us into their class, and to whom we are deeply grateful keep on working on innovative projects: some on the same Savanturiers program and others on other topics such as programable objects such as Beebot and Thymio in order to introduce young students to programming.

In any case, we may surmise that they will organize systems of resources to foster their action along the lines we described here and will and manage them collectively.

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