Progress in Science Education
2022, Vol. 5, No. 2, page 64-72
ISSN 2405-6057
DOI.10.25321/prise.2022.1307

Researched-based report of practice

Teaching technology at primary school in Switzerland: A pilot study focused on repairing office items

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Received: May 2021 / Accepted: April 2022

Structured Abstract

Purpose: This pilot study aims at introducing a new teaching practice, which is the reparation of office items. The research question focuses on the way teachers adopt and adapt such teaching practice.
Sample/setting: Four teachers of French-speaking Switzerland voluntarily used a half-baked pedagogical design in various schools, totaling about 70 pupils at primary school level (9-12 y.o.).
Design and Methods: The collaborative approach adopted for gathering data allows an integration of the practicing teachers' expertise into the pedagogical design, not only through their feedback, but also by requiring them to make choices during the adaptation of the activity in their own classroom.
Results: The diversity of implementations of the pedagogical design, through the creation by participating teachers of various learning environments, confirms the relevance of the half-baked teaching design, and brings usefull insights for an efficient use by teachers. Notably, pupils engage easily and autonomously the repairing activity when teachers adopt a flexible classroom management.
Conclusion: Teachers' comments are stressing the high educational potential of a pedagogical approach centered on hands-on, game-like tasks, and using a documentation semiologically verified, in supporting pupils' autonomy and emancipation towards technology.

Keywords: *durability, critical thinking, hands-on activity, half-baked pedagogical design, repairing office items, technology*

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1 Introduction

This paper presents the results of a research project[1] aiming at introducing a new teaching practice on technology at primary school in French-speaking Switzerland.
Teaching resources specifically focused on technology for primary schools are missing (Andreucci, 2005), and teaching technology is generally subordinated to science in Switzerland (Kruse & Labudde, 2016). In France, where *science and technology* are explicitly addressed and distinguished in the curriculum, the objectives are notably to engage pupils into inquiry learning, for them to get "a thrust for innovation and a sense of invention" (Delserieys-Pedregosa, Boilevin, Brandt-Pomares, Givry & Martin, 2010, p. 4). However, these authors stress that the pedagogical intents are "hardly formulated and discussed" (ibidem).
In French-speaking Switzerland, the formal curriculum[2] does not include any specific objectives for technology teaching yet, despite local projects to promote it (Jacquemet & Müller, 2022): *technology* does not even appear as a *knowledge to be taught*[3], despite a few mentions integrated in natural sciences ("technical phenomena", "technologies"). Technologies rather have the status of an *object of study*, such as "natural phenomena". This curriculum nevertheless permits a teaching fitting the objectives stressed by these authors, namely to "relate and contextualize learning acquisitions to make it more meaningful in pupils' reality" (idem, p. 14), which could in terms "articulate learning on objects and phenomena, rather than on school disciplines as such" (ibidem).
Given this situation, we decided to design a teaching resource specifically focused on technology, with the aforementioned objectives, addressing two specific issues:

1. The appropriation and use of artifacts by pupils, in relation to making, buying, throwing away or recycling manufactured objects.
2. The orientation of pupils towards an autonomous posture in their observation and analysis of the artifacts, fostering critical thinking in relation to technical objects.

2 Theoretical Framework

2.1 Teaching technology specifically (at primary school)

The decrease of interest for science and technology by young generations has triggered research initiatives in order to diversify teaching practices (Delserieys-Pedregosa, Boilevin, Brandt-Pomares, Givry & Martin, 2010), notably in order to have "school disciplines getting out of partitioning that characterize it often, and allowing pupils to relate [these disciplines] to the society in which they live." (p. 10, *translated from French*).
Technology teaching is often focused on similar activities, summed up by Vérillon, Leroux & Manneux (2005) for the educational context of France:

- The making of material objects, the most frequent practice at school;
- The use of technical items in functional activities, such as communication (e.g. smartphone, blackboard) or cooking (saucepan, heater, etc.);
- The assembling or dismantling of objects, such as can be found in commercial kits (e.g. "make your own solar power plant").

In the present research, we introduced a novel activity relative to the list above: repairing artifacts. Inspired from various citizen initiatives such as cooperative bicycle workshops or *repair-café*, this activity emphasizes a positive attitude towards durability and recycling. Choosing to approach technology through object repairing also draws on the advantages shown by research on hands-on activities in science learning (Charpak, 1996), or more recent *Object Based Learning* in higher education and museum informal education (e.g. Chatterjee, 2010).

The choice of daily use items is made for pupils to feel concerned by the activity (Kruse & Labudde, 2016) and to develop a critical thinking in respect to consumer habits, notably repairing instead of throwing away. With this aim, the analysis of the defect item is the core of the task, allowing pupils to understand the artifact design, functioning, and to take consciousness of the domination induced by the market in post-industrial era. The consumer is often captive of programmed obsolescence, errors of design, or poor choices in materials. As an alternative, the repairing activity offers pupils a sense of control, a potential ownership, and occasionally the possibility to improve artifacts distributed on the market, providing them with power and autonomy (emancipation).

1 Research project RECODIS (2017-2020), conducted by the Universities of Teacher Education BEJUNE and Fribourg (Switzerland), with a partial financial support from the Centre de compétences romand de didactique disciplinaire (2CR2D), https://www.2cr2d.ch/3057-2/.
2 PER, *Plan d'Études Romand*, available at www.plandetude.ch. See for instance MSN 15, 16, 25, 26, 35 and 36.
3 This expression refers to a distinctions made by Tiberghien (1997).

Verillon, Leroux & Manneux (2005) stress the tipping point of post-industrial era, when *alienation* appears, as explained by Arendt: the work[4] is transformed into the industrial *product*, from the moment it becomes an *object of consumption*, destined to be sold on the market. It is no longer an *object of usage* anchored in the durability and stability allowing human beings to establish an emancipatory posture regarding their own vital needs: "permanence, stability, duration, have been sacrificed to abundance, the ideal of the *animal laborans*" (idem, p. 15).

Quoting Vernant, the authors (idem) recall Aristotle's distinction between production and action, in which the action of an artifact user has its own value – it is *free* – while the *producer* depends on the evaluation of his *product* made by the consumer. Following these few considerations, the authors challenge the relevance of "scolarized forms of productive activity" (idem, p.15), since it starts from the "logic of *work*" to mimic some kind of (industrial) productive activity, yet neither identical to usages nor techniques existing in professional activity (Perret & Perret-Clermont, 2001). In order to reshape the relation of pupils to their own activity in school context on technology, we propose a *reflexive* task rather than a *productive* one.

Discovering she or he is able to repair a daily use artifact, a pupil may experience this liberation from the socio-economic oppression, that Freire (1967,1975) aims at with his *pedagogy of freedom*, leading her/him to regain confidence in her/his own autonomy and learning abilities.

In this paper, *artifact* refers to a man-made (industrial) object (type) with a set functionality within a given cultural context. The functionality set by the artifact designer ("fonction constituante", Rabardel, 1995, p.5) may be different from the one defined by the user ("fonction constituée", ibidem). An artifact may be "technical" as a machine, designed for handcraft work (e.g. a screwdriver), or even semiotic. Rabardel (idem) distinguishes the artifact itself from the knowledge a subject has of it (mainly *schemes* in a Piagetian meaning), with which one may turn the artifact into an *instrument* (idem) for one's own motives. Here, we will also differentiate the (prototypical) *artifact* and the particular item, which refers to a specific material instance of any *artifact* (as in "this bag contains five items"). *Technology* refers to any usage or knowledge related to artifacts, such as *how to use it, how to make* it, etc. (for a discussion on technology definition, see for instance de Vries, 1997).

2.2 Introduction a new knowledge to be taught

Introducing new teaching practices raises the issue of collaboration between researchers and teachers. Methodologically, *collaborative research* (Desgagné, 1998) is recognized as one of the best ways to achieve durable setting of newly introduced practices. It often relies on a *community of practices* (Lave & Wenger, 1990). However, this way of introducing new teaching practices requires a time-consuming engagement from teachers. Moreover, Couture, Aurousseau, Lévesque & Tremblay (2017) stress the difficulty to grasp effective outcomes of such collaborative research in educational practice over time. Also, in Switzerland, teachers' participation in research is very rarely supported as a professional activity.

For all these reasons, we have chosen a more concise form of collaborative research, centered on a *boundary-object* for all partners: a *half-baked pedagogical design* (Kohler, Chabloz, Perret-Clermont, 2015). Such a pedagogical design is deliberately unfinished, regarding specific chosen features, in order to benefit from the teachers' field experience in "finishing" the design while having the opportunity to easily adopt new ideas, by the means of teaching material partly ready to use, and a complete freedom in terms of teaching methods. No objectives, key-values, nor other constraints are imposed by researchers.
Hence, the aim of research is to observe the various learning environments teachers create in their class when provided with new knowledge to be taught (technology) through a half-baked pedagogical design.

2.3 Research hypothesis

In this paper, we present the results on two hypotheses:

1. Teachers easily adopt and adapt the proposed half-baked pedagogical design for their own context and objectives, even when they feel unprepared for teaching technology;
2. Repairing technical artifacts allows pupils to engage in a personal relation to the artifacts, timely perceiving it as *their own work* after succeeding the reparation.

4 Translated from the French *oeuvre*, as for a *masterpiece* made by a craftsman.

The choice of hands-on tasks for pupils, is expected to provide teachers with easily adopted resources (little time consuming), and to offer researchers opportunities to gather the teachers' field-expertise in the way they put resources into a specific learning environment for pupils.

3 Methodology

3.1 Description of the pedagogical design

The half-baked pedagogical design made for introducing repairing activity is designed as a transportable box made of recycled plastic, including documentation and 50 office items (paper clips, staplers, scotch unreeler, scissors, pen, pencil sharpeners, etc.), each packed in a stand-alone bag (Appendix 1). Each bag contains a specific *riddle-card*, specifying the issue to repair and addressing secondary questions for further thinking (Figure 1). When needed, tools (e.g. screw-driver), or supplementary material (e.g. staples, paper to test scissors) are provided in each bag.

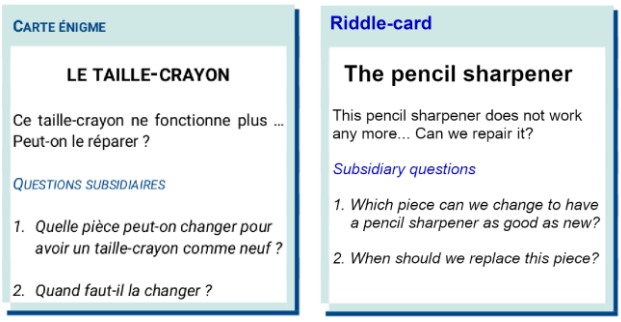

Fig. 1. Example of riddle-card in the original language, and in English

Riddle-cards were designed to induce critical thinking by pupils, and inspired from board games for the format and the autonomy in the task. The *riddle-cards* and the documentation for teachers were designed in a semiological approach: Precautions on semiotics were taken to allow teachers and pupils to understand the pedagogical documents autonomously, minimizing the risks of misunderstanding (Kohler, 2015, 2020).
Documentation for teachers include an introductory single page for hasty readers, containing all that is needed to get started (Appendix 2), and an extensive explanation (6 pages) about all repairing actions, with illustrations (Figure 2).

Fig. 2. Example of explanation (translated in English)

3.2 Participants

Four teachers of French-speaking Switzerland voluntarily used the half-baked pedagogical design, in various schools, totaling about 70 pupils from two ordinary classes at level 6H (9-10 y.o.), from one ordinary class at level 8H (11-12 y.o.) and from one special need education class (various ages). Teachers received the transportable box successively without any instructions.
Semi-structured interviews were conducted with all teachers, shortly after their teaching, with notably the following questions:

1. How did you use the repairing activity in class?
2. What have you noticed in terms of pupils' engagement, emerging difficulties, etc.?

3. After this trial, what do you think of the provided documents, the material management, the repair?

These interviews aimed at providing data on how the activity was introduced in the various classes, and on how pupils engaged with the repairing activities according to observations made by teachers *in situ*.

3.3 Method of analysis

Data analysis was made on the transcriptions of the interview, by two researchers in double blind. Teachers' discourse was coded thematically according to the various variables (Table 1 an 2). The selected discourses were subsequently categorized according to various modalities (see below, in bold characters) emerging from them and chosen by the researchers for summing it up.

4 Results

We present here a synthesis of the results at two levels:

1. First, we document the diversity of teaching based on the half-backed pedagogical design, in order to describe the actual teaching this research succeeded to introduce in practice, and to check the easiness of appropriation (hypothesis 1);
2. Second, we discuss the teachers' testimonies about the courses of the activity in the various classes, in order to evaluate our hypotheses about pupils' engagement in the activity (hypothesis 2).

4.1 A diversity in teaching

In order to describe variations in teaching with the half-baked pedagogical design, six variables have been examined, with open modalities (in bold characters in the list), which were defined by the keywords emerging from the interviews (Table 1):

1. The appropriation of the half-baked pedagogical design by teachers.
2. The degree of preparation consented by the teacher, wherever she has **tried** all *riddle-cards* herself, red the **explanations**, or none of the two.
3. The teacher's objectives, either centered on pupils' **interest**, on the **autonomy** it allows them, or on the education to **durability**.
4. The social and temporal setting decided by the teacher, either as an optional **workshop** where pupils could go a pick a bag in the box, or as a **classroom** activity with joined attention and synchronous activity.
5. The role endorsed by the teacher during the activity, wherever she was providing **guidance** to pupils (e.g. help for choosing the object, clue for the repair), was engaged in **observing**, both or neither.
6. The expected outcome from pupils, wherever they were **spontaneously** displaying their work, or were expected to have them verified in **oral** interaction or by **written** answers to the r*iddle-cards* questions. We also mentioned when pupils spontaneously undertook to **sabotage** the objects for handing them over to their peers.

Var.	Classe A (special needs)	Classe B 6H	Classe C 6H	Classe D 8H
1	very easy	easy	easy	some difficulty
2	complete trial	partial trial	partial trial explanations	complete trial
3	interest durability	interest autonomy	interest autonomy	durability
4	workshop/ class	workshop	workshop	class
5	observing guidance	neither	observing	guidance
6	oral	- sabotage	spontaneous sabotage	written

Tab. 1. Variations in the teaching.

All teachers tried the *riddle-cards,* at least partially, but one only red the repairing explanations. The only teacher reporting some difficulties when taking the half-baked pedagogical design in hands, decided to set a traditional synchronous activity with the whole class, each pupil working on the same item at the same time (the **classroom** modality). Under this condition, she encountered a difficulty in managing the items, having to reset each bag herself with sabotage. She nevertheless recognized the box "well designed". Interestingly, the researchers only noticed missing material and errors

in the sorting and sabotage after the activity of class D. Yet, in this class, the teacher led pupils to try practically all items each.
All other teachers have left the pupils to manage the items, put them back and help each other. Overall, when pupils are free to choose an artifact, they generally pick the ones they already know from daily use. Pupils' autonomy exceeded these teachers' expectations, while the *riddle-cards* were nevertheless challenging both intellectual and manually (dexterity).
Teaching in class A took a mixed format, in which pupils were autonomous for the repairing tasks (main questions), choosing and picking as many items as they wish over several days. In addition, the teacher occasionally chose "the object of the day" to lead a discussion on one item (secondary questions), focusing the attention of all pupils. In such setting, the teacher does not encounter issues in the management of items, despite double checking the sabotage herself. She insists, in the interviews, on the interesting discussion the activity triggered. Secondary questions have not been used by the other teachers, yet several declared they would conduct such plenary discussions, were they to perform the activity again.

4.2 Effects of the pedagogical design on pupils

The effects on pupils are analyzed through five variables, of which modalities are drawn from the teachers' descriptions in the interviews, and reported on Table 2 (see below):

1. The mention of a gender effect, such as a stronger interest in repairing by **boys**.
2. The emergence of fine dexterity **issues** for some pupils, and wherever these could be **overcome** by pupils.
3. The skills practiced by pupils during the activity (**collaboration**, an attitud**e** towards **durability**, knowledge in **mechanics**, reflexive **thinking, resourcefulness**, scientific **inquiry**, **structure** and organization at work).
4. Which part of the activity was of particular interest for pupils (the confrontation to a **challenge**, a self **discovery** task, the **game** structure of activity, a **hands-on** task, the chosen daily **objects**)?
5. Which part of the activity was of particular interest for teachers (emerging **peer dynamics**, **hands-on** task, the **riddle-cards** and its questions, emerging **discussions** with pupils, **mixed levels** of difficulty)?

Var.	Class A (special needs)	Class B 6H	Class C 6H	Class D 8H
1	-	-	-	boys
2	overcome issues	overcome issues	-	-
3	durability	resourcefulness collaboration thinking inquiry	collaboration thinking inquiry mechanics structure	durability
4	challenge hands-on objects	challenge objects	challenge game hands-on objects	game discovery
5	discussions	mixed levels peer dynamics	hands-on riddle-cards	

Tab. 2. Teaching effects (teachers' point of view).

Gender effect is only noticed in class D, where pupils are all performing the same task at the same time. In the other classes, the workshop or hybrid setting probably allowed differentiation. One teacher suggested an improvement: adding artifacts specific of girls' daily use, such as hair-clips. Dexterity issues were rarely stated, related to dyspraxia, and could be overcome by spontaneous peer support.
The quantity and diversity of skills which the teachers reported in the interviews is unexpected. In particular, the spontaneous collaboration among pupils described by teachers of classes A, B and C is remarkable. Teachers were also surprised to watch the emulation risen by pupils addressing challenge or supporting one another, in a way that released them from most of the classroom management. The workshop setting proved particularly relevant.
All teachers described a sustained interest in the activity, even generally less engaged pupils. They outlined the activity drawing pupils' attention on durability, despite the challenge of having them adopt such attitude. Some pupils spontaneously related the activity with other topics from their own daily lives. For these, we have a clue of a non-alienated relation to the activity, in which it is perceived as meaningful beyond the borders of school.
Teachers adopting the workshop setting especially appreciated the various levels of difficulty in relation to the various artifacts, and the autonomy pupils could sustain during the activity, working mostly in groups spontaneously formed and transformed over time. They stressed the outstanding verbal interactions and incentives among peers which the challenge and game structure of *riddle-cards* seemed to foster, together with the approach of technology through hands-

on tasks. The teacher who introduced a discussion on secondary questions, emphasized the relevance and high involvement of pupils in these moments as a valuable input of the activity.

5 Discussion

The half-baked pedagogical design allowed teachers an easy appropriation and an adaptation into various teaching practices (hypothesis 1), even for primary school teachers considering themselves unfamiliar with technology as a teaching matter. The fact the items could be directly distributed to pupils, and included the riddle-cards with questions, allowed pupils to repair an item and pick another one autonomously. It greatly contributed to the easiness of appropriation for teachers adopting such a flexible setting: they sometimes observed pupils repairing and performing sabotage without having to understand all of the technological issue themselves. Half of the teachers did not try repairing every single item (Table 1, variable 2).

The learning environments teachers created are indeed diverse (able 1), and the half-baked pedagogical design permitted teachers to use their own experience and expertise when introducing the repair activity in their classroom.

Some pupils at least, have experienced their activity as their own *work*, taking distance both with *production* and a consumer relation to artifacts: enticed by the *riddle-cards*, pupils engaged the tasks as *challenges* and many shared their results with their teacher or peers, or even offered their support. We have hints that they considered their action in repairing artifacts as "their own".

We may consider that a part of the seventy pupils at least, experienced a personal relation to the artifacts (hypothesis 2). In class A, where a plenary discussion took place on secondary questions, some pupils explicitly engaged in reflexive thinking about artifacts design and functioning.

These promising results should nevertheless be taken with care, since the research methodology only relies on the observations made and verbalized by teachers, the attention of whom is too limited to encompass the multiple dimensions of a teaching practice. The most probable limit in this case, is the fact some pupils benefited more than others from the teaching.

The construction of a positive attitude towards durability requires more than a single activity – it is merely "a first step" as teacher from class D stated – yet two teachers out of four reported the pedagogical design useful for this objective.

The focus of most of the teachers on objectives from the non-disciplinary skill group[5], like "developing the pupils' autonomy at work", "organizing a workplace", "engage with interest in the activity" or even "collaborate with peers" came as a surprise, since we expected teachers to rather relate the activity to objectives in science or craft.

6 Conclusion

Despite a rather limited number of trials (4 classes), these were sufficient to stress the high educational potential of a pedagogical approach centered on hands-on, game-like tasks, and using a documentation semiologically verified, in supporting pupils' autonomy and emancipation towards technology. The various teaching practices benefited pupils, in fostering their interest to engage in challenges, and for their active part, peer support and material care. It also benefited teachers by releasing them from a part of the classroom management.

However, such potential is only visible in classes where the traditional setting – all pupils performing the same task at the same moment or listening to the teacher – is replaced by a more flexible organization – here called "workshop" by the teachers – where pupils can take initiatives, spontaneously re-group and interact with peers, and more or less choose the task they are working on.

7 Acknowledgment

We would like to thank the teachers who accepted to test our pedagogical device. We greatly appreciated their open-mindedness to novelty, adaptability and availability. We express here our warm thanks to Dr Romain Boissonnade, initiator of this institutional collaboration on teaching technology, and to Dr Bernard Chabloz and Dr Patrick Roy, who shared with us precious resources, ideas and reflections about technology teaching.

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Appendices

Appendix 1: Picture of the box.

Appendix 2: Single sheet presentation (in French).

Malette pédagogique – Réparation d'objets techniques quotidiens

– Série *Matériel de bureau*

HEP BEJUNE

Version BETA – A. Kohler & G. Blandenier

Projet *Enseigner la technologie au cycle 2* [1]

FICHE DE PRÉSENTATION

Liste du matériel

RESSOURCES DE L'ENSEIGNANT·E

- fiche de présentation
- fiche pédagogique
- fiches solution & sabotage spécifiques à chaque objet
- petit matériel de dépannage

+ Munissez-vous de papier !

MATÉRIEL POUR LES ÉLÈVES

- une « carte énigme » pour chaque objet (50 lots)
- marteaux et tournevis (10x)
- mini pinces à linge (8x)
- stylos démontables (7x)
- dévidoirs de ruban adhésif démontables (4x)
- paires de ciseaux à vis (6x)
- paire de ciseaux gaucher (1x)
- taille-crayons (4x)
- trombones (5x)
- fermeture de classeur (2x)
- boîtes métalliques (2x)
- montres métalliques (2x)
- montre en plastique (1x)
- agrafeuse défectueuse (5x)
- fiches/prises électriques (3x)

Mise en place et gestion de classe

La mallette contient un ensemble hétéroclite de matériel de bureau en panne : les élèves peuvent saisir librement un petit sachet et découvrir l'objet et sa panne, soit directement en examinant le matériel, soit en lisant la **carte énigme** qui propose aussi des questions subsidiaires.

Une fois qu'un·e élève a terminé avec un objet, il peut directement passer au suivant, ou faire vérifier sa réparation auprès de l'enseignant·e, selon les consignes choisies. En principe, les élèves peuvent vérifier eux-mêmes s'ils ont réussi à dépanner un objet, en testant sa fonctionnalité principale.

Au fur et à mesure que les élèves ont dépannés les objets, l'enseignant·e peut les « saboter » (voir fiches *solution & sabotage*) pour les redistribuer à d'autres élèves.

Les pannes présentent des complexités variables, qui s'échelonnent du simple assemblage d'un objet démonté à des problèmes plus difficiles à détecter, et qui nécessite l'usage d'un tournevis ou d'un petit marteau pour la remise en état.

FIN DE LEÇON

Les élève peuvent donner eux-mêmes les solutions des pannes et les réponses aux questions.

Pour un travail plus réflexif, l'enseignant·e exigera une brève rédaction des élèves pour chaque panne résolue, avec les réponses aux questions de la **carte énigme** de l'objet. Ces questions invitent les élèves à expliquer pourquoi et comment ils ont réussi à dépanner ou réparer l'objet technique, et à faire une analyse de son fonctionnement.

Quelques consignes orales sont nécessaires, notamment pour la sécurité :

- attention à traiter le matériel avec soin en fonction des matériaux ; s'il faut parfois plier du métal pour réparer un objet, il faut faire très attention avec le plastique, qui casse facilement (p.ex. la montre-bracelet), et bien réfléchir avant d'y mettre trop de force ;
- n'utilisez les marteaux que sur le support désigné par l'enseignant·e ;
- utilisez avec parcimonie les agrafes lors des essais de l'agrafeuse ;
- … et ne criez pas les solutions à voix haute, préservez le mystère !

[1] Roy, P. & Gremaud, P. (HEP Fribourg), Bousadra, F. (Université de Sherbrooke, Canada), Boissonnade, R., Blandenier, G., Chabloz, B. & Kohler, A. (HEP BEJUNE) (2017-2021). *Communautés de pratiques autour de démarches technologiques dans le cadre d'une ingénierie coopérative intégrant un dispositif d'enseignement mi-fini*, projet n°3 de *Recherches collaboratives en didactique des sciences de la nature (RECODIS)*, sous la dir. de E. Sanchez et co-financé par les institutions partenaires et Swissuniversities (2Cr2D). Plus d'informations à www.2cr2d.ch/3057-2/.