



HAL
open science

Analysing statistical teaching practices in a specific institutional context

Charlotte Derouet, Camille Doukhan, Hussein Sabra

► **To cite this version:**

Charlotte Derouet, Camille Doukhan, Hussein Sabra. Analysing statistical teaching practices in a specific institutional context. INDRUM2024: Fifth conference of the International Network for Didactic Research in University Mathematics, Jun 2024, Barcelona, Spain. pp.326-335. hal-04633881

HAL Id: hal-04633881

<https://hal.science/hal-04633881v1>

Submitted on 3 Jul 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Analysing statistical teaching practices in a specific institutional context

Charlotte Derouet¹, Camille Doukhan¹, and Hussein Sabra²

¹Université de Strasbourg, UL, UHA, LISEC, France, derouet@unistra.fr; ²Université de Reims Champagne-Ardenne, CReSTIC, France

We study the teaching practices of Statistical Sampling Theory in a specific context of professional Education in France. We focus on a specific moment of teaching practices, called SAÉ (Learning and Evaluation Situations). After discussing the SAÉ as the main object of the study, our aim is to characterise the links made in the teaching between the SAÉ and 1) the Ressources (courses), 2) the professional competencies to be developed by students and 3) the professional environment. From an anthropological approach, we investigate these links in terms of personal didactic praxeologies developed by a teacher. This empirical study sheds light on several aspects of the teaching practices, like the didactic choices made by the teacher to take into account the students' needs in this specific institutional context.

Keywords: Teachers' and students' practices at university level, Curricular and institutional issues concerning the teaching of mathematics at university level, Anthropological approach to didactic, Ressources, Statistical Sampling Theory.

INTRODUCTION

The present study focuses on teachers' practices in tertiary education. Our research work is part of *Dida-Stat_{Expl}* project, which aims to carry out an exploratory study to analyse and characterise the teaching practices in Statistical Sampling Theory for future practising statisticians in France. We aim to bring elements of understanding on teaching Statistics in a context of post-secondary professional Education. The scope of our research is understudied, the context is related to a recent reform; we therefore followed an empirical approach, based on a case study (single case) to explore the field. We seek to build a theoretical framework and a method for studying practices to identify the didactic choices made by a teacher, as well as the reasons, which explain these choices in this institutional context. We focus on a specific moment of teaching practices, called *Situations d'Apprentissage et d'Évaluation* (Learning and Evaluation Situations) – designated by SAÉ in the following to keep the French acronym. Our aim is not to study the evaluation practices in teaching the Statistical Sampling Theory, but rather the way in which the SAÉ offers the possibility of understanding teaching practices. This type of situation is reminiscent of the recommendations for curricular reform proposed by Pepin et al. (2021) for the training of future engineers.

After presenting the specific institutional context of the study and in particular our object of study SAÉ, we will describe the theoretical framework based on the Anthropological Theory of Didactic (Bosch & Gascón, 2014). We will then define our methodology of data collection and analysis. The final sections are devoted to analysis, results and conclusion.

INSTITUTIONAL CONTEXT

Curricular analysis of the Technological University Bachelor in France

From the start of the 2022 academic year in France, the Technological University Institutes (*Instituts Universitaires de Technologie* in French), a component of the university, offers three-year undergraduate programs called the Technological University Bachelor (*Bachelor Universitaire de Technologie (BUT)* in French). These programs are designed to provide students with knowledge and practical skills. This professional bachelor, which is a post-secondary education, is based on a national curriculum, which is then specified according to various specific fields (e.g. legal careers, chemistry, information-communication, etc.). One of the major innovations of this curriculum is the ‘Competency-Based Approach’. As part of the curriculum reform, each pathway is certified by 4 to 6 final competencies, and competencies are “understood as ‘complex knowledge of how to act’ implemented in a professional context and which mobilise and combine resources acquired during the course”² (MESR, 2022, Appendix 1). In the rest of this paper, when we talk about competencies, we are referring to the competencies targeted in the curriculum. As Bolou-Chiaravalli et al. (2022) point out, this refers to the meaning of competency as “complex knowing how to act based on the effective mobilisation and combination of a variety of internal and external resources within a family of situations”² (Tardif, 2006, p. 22).

With the aim of developing the competencies targeted in the program, the teaching modules are structured around *Ressources*¹ and *Situations d’Apprentissage et d’Évaluation (SAÉ)*. The *Ressources*, which take the form of courses, enable “the acquisition of fundamental knowledge and methods” and the *SAÉ* encompass “the professional situations in which the student develops the competence” (MESR, 2022, Appendix 1). *SAÉ* are “situations which have an integrative aim, confronting the student with activities similar to those encountered by professionals in the field”² (Bolou-Chiaravalli et al., 2022). *SAÉ* are also intended to be assessed for certification purposes. *SAÉ* seek to be “authentic”, even if this type of situation in training (i.e. outside professional environments) cannot really exist as such, so it is recommended to design and to organise them pedagogically to encourage learning and the development of the targeted competencies (Bolou-Chiaravalli et al., 2022). These situations are added to those encountered during work placements in order to increase the potential for professional development of the diploma (Bolou-Chiaravalli et al., 2022). The place of *SAÉ* is quantitatively important, they represent between 40% and 60% of the content of the national curriculum. *SAÉ* are described in the national curriculum by means of recommendations. They are therefore an important part of Bachelor (*BUT*) students’ education. Moreover, although some projects may have existed in the past in Technological University Institutes, this new format, closely linked to the Competency-Based Approach and the professionalisation aspect of the diploma, is a new and original feature that needs to be taken into account in the study of teaching practices. The *SAÉ* are at the interface between the competencies to be

developed in the training, the *Ressources* provided in the training (the courses) and the professional environments for which the students are destined.

In this paper, we are going to focus on the *SAÉ* as a research object to understanding teaching practices in this Bachelor.

The specific case of an *SAÉ* in Data Science

Our study focuses specifically on the Bachelor (*BUT*) “Data Science”, specialising in “Statistical Exploration and Modelling”, which aims, according to the national curriculum, “to train professionals skilled in the collection, processing and statistical analysis of data”² (MESR, 2022, Appendix 24). This pathway is based on four final competencies, which are: Processing data for decision-making purposes; Analysing data statistically; Adding value to a product in a professional context; Modelling data within a statistical framework.

The *SAÉ* that interests us in our research is studied in the second year of the Bachelor in the third semester. It aims to develop these four competencies and is entitled “Data collection and analysis by sampling or experimental design” (*SAÉ* 3.EMS.01). The objectives of this *SAÉ*, as stated in the national curriculum, are to:

- “deepen the notion of survey and polling in a more general framework” than students have already been able to develop in the first year;
- “make students understand the difference involved in a draw without replacement, the most common situation in a survey”;
- “encourage students to think about setting up a design of survey experiment”² (MESR, 2022, Appendix 24).

The description of the *SAÉ* in the national programme only states:

“The student is put in the situation of setting up a survey based on a data collection plan to respond to a defined problem. This *SAÉ* provides an opportunity to study survey methodology in greater depth. The student must be able to define the target survey population, be able to choose a sample judiciously before drawing up the data collection plan, determine the data collection plan [...], determine the sample size, design and draw up the questionnaire [...], collect the data, judge whether the sample needs to be adjusted [...] and judge the quality and reliability of the sample survey.”² (MESR, 2022, Appendix 24, p. 136).

This *SAÉ* is mainly linked (but not exclusively) to the *Ressource* entitled “Survey sampling techniques and methods” (R3.EMS.10), the contents of which include the different survey sampling techniques (simple random sampling without replacement, stratified, multi-stage, clustered random sampling), adjustment methods, sources of biases, etc. The principal *Ressource* associated with the *SAÉ* is officially 20 hours long. However, teachers could suggest additional sessions depending on the need and the content they decide. These additional sessions are considered – following the curriculum – as complementary *Ressources*. *Ressources* and *SAÉ* from the first year of the Bachelor may also be useful for the *SAÉ*, according to the national curriculum.

Figure 1 illustrates the links recommended institutionally, according to the curricular analysis, between this specific *SAÉ*, the competencies, the *Ressources* and professional environments targeted by the training.

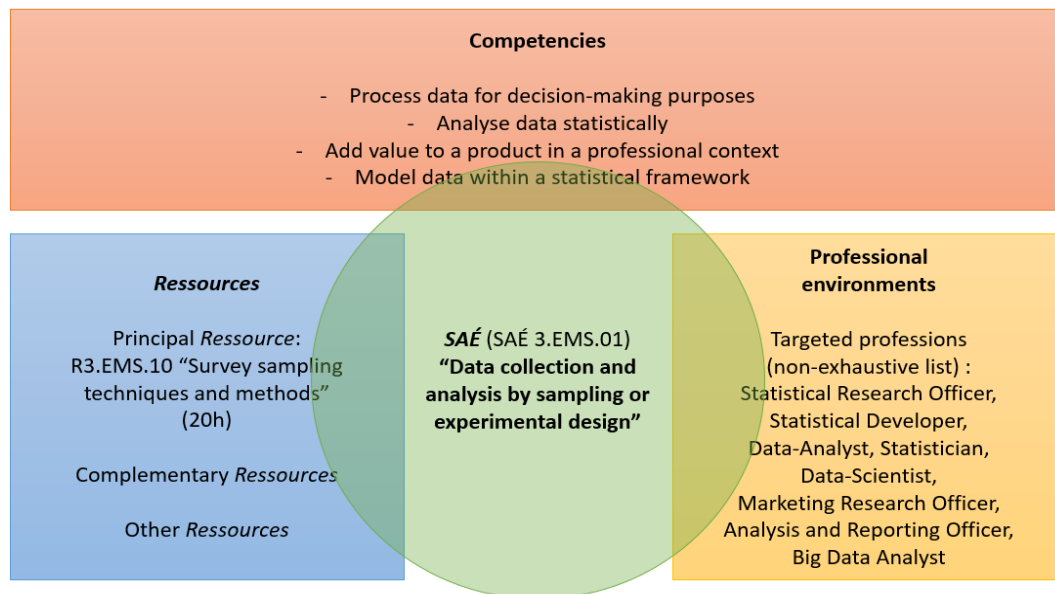


Figure 1: SAÉ at the heart of training

In the light of our preliminary analysis, we make the working hypothesis that *SAÉ* is a hub of teaching practices. It makes it possible to highlight the links that the teachers establish between the theory and its applications, the content across the *Ressources*, and the future workplace of the students. We also consider that the *SAÉ* functions in the considered context, intricately guides and drives teaching activities and choices. Within this context, the preparation and the implementation of the *SAÉ* serves as a “valuable” moment that allows to explore several aspects of teaching practices, and teachers’ choices on different levels, including institutional, didactic and epistemological considerations.

We are therefore seeking to understand the teacher's practices of Statistical Sampling Theory through the implementation of the *SAÉ* “Data collection and analysis by sampling or experimental design” in relation to these three inputs:

- What links are made between the *SAÉ* and the different *Ressources*? how? why?
- What links are made between the *SAÉ* and the competencies to be developed by students? how? why?
- What links are made between the *SAÉ* and students' future professional practices? how? why?

THEORETICAL FRAMEWORK

In order to investigate teaching practices in the institutional context of the Bachelor “Data Science” described above, we use the Anthropological Theory of the Didactic (ATD, Bosch & Gascón, 2014). Indeed, the particularity of this study seems to be the very strong link that exists between the teachers’ practices and the specificities of this

institution. These links are due in particular to the existence of a national curriculum specific to this training, which is something quite rare in tertiary education. The ATD, which considers that the knowledge taught is shaped by the institutions, seems to us to be entirely appropriate for the purpose of this study. In the manner of González-Martín (2021) and Gueudet et al. (2022) who used the ATD to analyse teaching practices for non-specialists' students in tertiary education, we investigate the personal didactic praxeologies of a teacher for the specific case of the *SAÉ* "Data collection and analysis [...]".

According to the ATD, any human activity can be modelled by a praxeology. Unlike mathematical praxeologies, which are specific to mathematics (e.g. "Determine the sample size"), didactic praxeologies model ways of teaching mathematical praxeologies (e.g. "Ensure that students complete personal work" (Gueudet et al., 2022)). For a given didactic type of tasks T , there is one or more ways of doing things, known as didactic techniques τ . These techniques can be associated with a technological rationale θ that justifies the technique's ability to perform the type of tasks considered. Finally, in the praxeology model (Bosch & Gascón, 2014), a theory Θ is used to justify the technology, but in the case of didactic praxeologies, this last component is implicit.

Following an empirical approach, and drawing on the results of the curriculum analysis (previous section), we focus our investigation on didactical types of tasks associated with the implementation of the *SAÉ* "Data collection and analysis [...]". We then suggest focusing on: "Link the *SAÉ* with *Ressources*" (T_{ress}), "Link the *SAÉ* to institutional competencies to be developed" (T_{comp}) and "Link the *SAÉ* to students' future professional practices" (T_{profes}). In this exploratory study, we seek to describe the personal didactic praxeologies associated with these types of tasks.

Thus, our research question is the following: in the preparation and the implementation of the *SAÉ* "Data collection and analysis by sampling or experimental design", and in relation to the three types of tasks T_{ress} , T_{comp} and T_{profes} , what are the didactic praxeologies developed by the teacher (a case study)?

METHODS

Within the *Dida-Stat_{Expl}* project, our general methodology consists of a combination of three types of analysis: an epistemological and a curricular analysis of knowledge at stake (Statistical Sampling Theory); an analysis of the content taught, the resources designed and used by the teacher; and an analysis of the teaching practices in terms of the epistemological aspects and the institutional context. Regarding our research question, we will focus in this paper on the latter type of analysis. We present an analysis based on declared practices from an interview of a teacher, called Carine in the following. We start in this section by presenting Carine, we continue by the presentation of the grid of the interview and of the data analysis method.

Profile of the teacher and local context

Our study of teaching practices focuses on a single case study, the case of Carine, who is a statistics teacher and biostatistics researcher. She has been teaching in the pathway “Data science” of the Technological University Institute at university for 13 years. She has been teaching the Statistical Sampling Theory course for four years (she began before the reform). In the context of this new curriculum, she is in charge of the 20-hours *Ressource* “Survey sampling techniques and methods”, which she devotes to lectures and tutorials, to which she completes by ten hours of practical work (local choice). She is also in charge of the implementation of the associated *SAÉ*. In the following, when we use the term “principal *Ressource*”, we are referring to lectures and tutorials (according to the meaning in the curriculum), otherwise we will refer to practical work.

Grid of the interview

The grid of the interview comprises five distinct parts. To explore the teaching context, and the practices of Carine in this context, we tried to cover by the interviews different didactic aspects. In the first part, we ask her to provide a comprehensive presentation of her profile and background. The second part delves into the context of teaching “Survey sampling techniques and methods”, exploring institutional dimensions and organisational aspects that shape the content taught and influence the teaching process. The third section is dedicated to the teacher’s perspectives on students’ needs and difficulties, while also examining the connection between teaching decisions and students’ future career opportunities. The fourth part focuses on the use of various resources, including those designed by the teacher for the principal *Ressource* and the practical work. In the fifth and final part we ask questions around the preparation and the implementation of the *SAÉ*, the main object of the study. We will develop this choice in the following.

As a methodological choice, the *SAÉ* plays a pivotal role in our exploration of the way the teacher tries to establish connections between the competencies, the *Ressources*, and the needs of the workplace. In the interview the types of tasks are prompted by the questions we asked. What interests us is more particularly to identify the “how” (techniques) and the “why” (technologies) of the tasks which fall within the types of tasks related to our centre of interest, namely T_{ress} , T_{comp} and T_{profes} . The questions in the grid of the interview related to each type of tasks make it possible to identify the techniques. The technologies that justify these techniques are sometimes determined within the answers where the techniques are identified. Otherwise, the technologies can be identified from the answers to the other related questions. We will develop this point for each of the retained types of tasks.

For T_{ress} , we asked the questions: “How do you consider the resource in relation to the *SAÉ*?”, “Do you make connections between the *SAÉ* and the [principal] *Ressource*? Can you give an example?”, “Do you make links with the lecturers and tutorials of other courses?”. These last two questions lead us to distinguish two subtypes of tasks

associated with T_{ress} : “link the principal *Ressource*, the practical sessions and the *SAÉ*” (T_{ress1}) and “link the *SAÉ* to other courses of the semester” (T_{ress2}). The first question provides us with elements of the technological rationale and the different techniques (noted τ_{ress_i}) are identified in the answers to the last two questions.

For T_{comp} , we asked the following questions: “What links do you make between the *SAÉ* and the institutional competencies?”, “What are your objectives in terms of students’ learning and skills development from the *SAÉ*?”. The first question provides answers more on the techniques (noted τ_{comp_i}), while the second question allows us to identify the technologies which justify the choices made.

For T_{profes} , we asked the question “What is the place of the *SAÉ* in your teaching?” and additional questions that allow us to identify the way or not the future professional practices of the students impact the teacher’s decision-making or choices (technique noted τ_{profes_i}) (the interplay between the teaching choices and the real-world needs of students’ future careers).

Carine's interview took place at the end of August 2023, before the start of the academic year. It took place over video and lasted 48 minutes. Two researchers (of the three authors) were present, but only one conducted the interview. The interview was video recorded and transcribed for analysis.

Data analysis method

We selected for our analysis the excerpts related to the questions presented above. We started by looking for the type of tasks mentioned by the interviewer or that specified the teacher in her answers. We then looked for the techniques used by the teacher to perform the type of tasks and the possible justifications for using these techniques. We consider these justifications to be an integral part of the praxeology related to the type of tasks, and we interpret them as elements of technology (logos).

RESULTS

Links between the *SAÉ* and the different *Ressources* (T_{ress})

To address the didactic subtype of tasks “link the principal *Ressource*, the practical sessions and the *SAÉ*” (T_{ress1}), Carine uses various complementary techniques. She explains that she takes care to design an *SAÉ* that makes it possible to apply the theoretical concepts encountered in the principal *Ressource* (τ_{ress1_1}). She justifies this by explaining that it enables her to ensure that the students have fully understood what is presented and seen in the *Ressource*. Conversely, she says that she adapts the methods and concepts presented in the *Ressource* according to what will be needed to study the *SAÉ* situation (τ_{ress1_2}). Carine explains that she has to proceed this way because of the *SAÉ* nature:

Carine: The *Ressource* is the support for the *SAÉ*, without the *Ressource* [students] cannot do the *SAÉ*.

The element of technology that emerges from these two techniques can be summarised as follows: the principal *Ressource* provides theoretical elements while the *SAÉ* enables practical application; the *SAÉ* and the *Ressource* interact together. As concerns the practical sessions, she explains building these sessions in order to illustrate the situations and examples encountered in the *Ressource* ($\tau_{\text{ress1_3}}$). She also adapts the practical exercises to complete what could not be illustrated in the *SAÉ* ($\tau_{\text{ress1_4}}$). She justifies these techniques by pointing out that the *SAÉ*, being a situation that is intended to be realistic and close to a survey, does not allow all the concepts encountered in the principal *Ressource* to be tackled. Therefore, the practical exercises enable the students to put other situations into practice:

Carine: It's not necessarily easy in a real survey [the *SAÉ*], to be able to apply all the concepts [encountered in the *Ressource*]. [...] So that's where it's complementary, practical sessions are an illustration of the course.

The second subtype of task we identified is the following: "link the *SAÉ* to other courses of the semester" (T_{ress2}). To do this, she proposes a situation that would network two *SAÉs*: the one associated with statistical sampling techniques and the one linked to data compliance and regulation (in France, we talk about the RGPD rules) (τ_{ress2}). There are two elements of technological rationale that justify this technique, firstly, for the teacher thinking about legal constraints when collecting data is part of the survey practice. Secondly, she explains this way of working is convenient for her and the other teachers as it allows the evaluation to be shared:

Carine: We worked like this on the *SAÉ* because it's more convenient for everyone and it's a real case study, so we didn't have to do another *SAÉ* for the students.

These two subtypes of tasks (T_{ress1} and T_{ress2}) are associated with the didactic type of tasks "Link the *SAÉ* with *Ressources*" (T_{ress}). The description of these two related praxeologies allows us to emphasise elements of response to our research question in the case of the didactic praxeology associated with T_{ress} .

Links between the *SAÉ* and the competencies to be developed by students (T_{comp})

To address the didactic type of tasks "link the *SAÉ* to institutional competencies" (T_{comp}) Carine uses various techniques. She displays, at the beginning of her slideshow, competencies from the national curriculum that she is targeting in her course (the *Ressource*) ($\tau_{\text{comp_1}}$). She explains that this enables students to find their bearings with regard to the expectations of the national curriculum. She also helps students to take an inventory of the competencies they have acquired or are in the process of acquiring ($\tau_{\text{comp_2}}$). This inventory takes the form of a *portfolio*:

Carine: Students are expected to report on the competencies they have acquired in relation to the professional situation encountered. [...] They list these competencies in something called a *portfolio*, I help them to build their own.

As part of the *SAÉ* assessment, the teacher asks the students to self-assess their institutional competencies ($\tau_{\text{comp_3}}$). To do this, she asks them to position themselves

on a competency grid and to produce, where appropriate, proof of mastery of this competency. She gives little justification for this practice, but she indicates that she is “obliged” to do so, due to the constraints of the institution and the competency-based assessment, which governed the course. The description of this didactic praxeology provides elements of answer to our research question in the case of the didactic praxeology associated to T_{comp} .

Links between the *SAÉ* and students' future professional practices (T_{profes})

To address the type of tasks “Link the *SAÉ* to students' future professional practices” (T_{profes}) Carine proposes a concrete situation in the *SAÉ*, linked to the professional world (τ_{profes_1}). She justifies this choice by explaining that she is trying to get the students to project themselves into a professional context:

Carine: The idea is that in this *SAÉ* they should be able to project themselves as if they are in the professional world. (31'21).

A second technique we identified is to get the students to take on the role of surveyor during the *SAÉ* (gathering data, taking account of bias, collecting information) (τ_{profes_2}). She justifies this choice by making the link with the difficulties involved in carrying out a survey, it is an element of the technological rationale. According to her, these difficulties are encountered in the professional world:

Carine: To produce statistics you need surveys. There are always biases, and these biases come through data collection, particularly in the world of surveys. Students need to realise that it's complicated to get information. (31'21).

The description of this didactic praxeology provides elements to answer our research question in the case of the didactic praxeology associated with T_{profes} .

CONCLUSION

The empirical study that we implemented enabled us to define the *SAÉ* as a research object. It also allows us to suggest a framework for analysing teaching practices in this specific context. It appears that the *SAÉ* is relevant teaching situations which that allow to highlight several aspects of teachers' practices (didactic choices, institutional constraints, perceptions of students' needs, students' future professional opportunities). Following an anthropological approach, we highlight the role of certain institutional or personal factors in the choices made by the teacher. However, this approach should be put into perspective with a cognitive one to better understand the “agency of teachers” and the dynamics of its evolution in this specific institutional context of post-secondary professional education. For this reason, we want to deepen our analysis, by considering the purpose of the student activity from the teacher's point of view. To do this, we will analyse practices through classroom observations. The institutional context of this study with the presence of *SAÉ* is specific, but it seems to us that the questions it raises go beyond this particular context and can be generalised to professional training courses (for example engineering training) in order to analyse the links that are made with real professional situations.

ACKNOWLEDGEMENT

This paper is a result of a research program funded by the GIS Education et formation (Education and training) of Grand-Est (France).

NOTES

1. We will keep the French term *Ressource(s)* in italic used by the institution to designate the courses. We use the term “resources” (in English) to designate the term as it is understood in Mathematics Education, it could be curricular materials (a textbook, a teacher’s guide) or anything that could be appropriated by teachers for preparing their teaching.
2. Our translations.

REFERENCES

- Bolou-Chiaravalli, C., Bournel-Bosson, M., & Lasne, A. (2022). Professionnalisation et processus réflexif dans le nouveau diplôme proposé par les IUT : le Bachelor Universitaire de Technologie [Professionalisation and the reflective process in the new diploma offered by the IUTs: Technological University Bachelor]. *Communication & Professionnalisation*, 13, 122-143.
- Bosch, M., & Gascón, J. (2014). Introduction to the Anthropological Theory of the Didactic (ATD). In A. Bikner-Ahsbahr, & S. Prediger, S. (Eds), *Networking of Theories as a Research Practice in Mathematics Education. Advances in Mathematics Education*. Springer. https://doi.org/10.1007/978-3-319-05389-9_5
- González-Martín, A. S. (2021). The Use of Integrals in Engineering Programmes : A Praxeological Analysis of Textbooks and Teaching Practices in Strength of Materials and Electricity and Magnetism Courses. *International Journal of Research in Undergraduate Mathematics Education*, 7(2), 211-234. <https://doi.org/10.1007/s40753-021-00135-y>
- Gueudet, G., Doukhan, C., & Quéré, P.-V. (2022). Teaching mathematics to non-specialists: a praxeological approach. In M. Trigueros, B. Barquero, R. Hochmut, & J. Peters (Eds.), *INDRUM 2022 Proceedings* (pp. 385-394). University of Hannover and INDRUM.
- Ministère de l’Enseignement supérieur et de la Recherche (MESR) (2022). Dispositions générales des programmes nationaux de la licence professionnelle « BUT » et aux programmes nationaux de chacune des spécialités de licence professionnelle « BUT ». *JO du 23-4-2022*. <https://www.enseignementsup-recherche.gouv.fr/fr/bo/22/Special4/ESRS2211617A.htm>
- Pepin, B., Biehler, R., & Gueudet, G. (2021). Mathematics in Engineering Education: a Review of the Recent Literature with a View towards Innovative Practices. *International Journal of Research in Undergraduate Mathematics Education*, 7, 163–188. <https://doi.org/10.1007/s40753-021-00139-8>
- Tardif, J. (2006). *L’évaluation des compétences. Documenter le parcours de développement [Competencies evaluation. Documenting the development path]*. Chenelière Éducation.