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Resources designed and used in statistics education in Bachelor of Technology courses in France

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Abstract

The French education system has numerous higher education institutions with various specialisations. *Instituts Universitaires de Technologie* (IUTs), established in the late 1960s, provide specific training. These schools offer three-year, practice-oriented education that enables students to work or pursue a Master's degree. They are widely accessible and popular, even in small towns, and offer 24 nationally defined curricula in two areas: science and management.

The teaching of statistics in IUTs is unique since it is present in almost all specialties. Studying the teaching and learning of statistics in IUTs enables us to comprehend didactic phenomena in a teaching system that has been established for a long time throughout the country and is a privileged field for meeting teachers whose activity has been tried and tested and is part of a continuum. This research explores the factors that influence the format and nature of the resources designed and utilised in these lessons, how they are integrated into teaching, and what functions they serve.

Semi-structured interviews were conducted with seven mathematics teachers responsible for statistics courses. Often coming from secondary education, these teachers had to adjust the content taught to the objectives and teaching situations typical of French higher education.

Keywords: statistics teaching, educational material, Bachelor's degree

Introduction

In France, the teaching of statistics is typically viewed as a sub-discipline of mathematics, but it can also be considered as a collection of techniques for generating and analysing data. On the one hand, there are concepts related to a mathematical approach such as probability laws, random variables, and sampling, which are crucial when one has control or prior knowledge of the phenomena under study. From a pedagogical perspective, these concepts have their own purpose, and their exclusive study justifies their teaching. In other words, learning and understanding these concepts is valuable independently of their use in different application contexts. This knowledge is based on abstract mathematical knowledge and concepts that are usually taught at the end of secondary school or in higher education, including advanced algebraic manipulation, function analysis, probability, and linear algebra.

On the other hand, statistical techniques have practical applications such as central tendency and dispersion indicators, hypothesis testing, and linear regression. These techniques are essential when interpreting phenomena for which the behaviour of variables is unknown *a priori*. This knowledge is essential for specific fields of application and is relevant for non-mathematical activities. They can be understood by relying on mathematical knowledge usually taught at the beginning of secondary education, including calculating proportions and creating simple graphs.

These two poles are interconnected in the practice of statistics, but their teaching varies depending on the training context, the teachers' perspectives, and the availability of resources and technologies. The resources and pedagogical techniques employed in their teaching can vary widely. This article's aim is to present how educational resources are created and used in French higher education, especially in institutions known as *Instituts Universitaires de Technologie* (IUT).

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Teaching statistics

The issue of emotions in the teaching and learning of statistics and mathematics is too important to be overlooked. It is essential to consider this issue as one that affects all factors involved in learning mathematics. Garfield et al. (2002) have presented students' affective dispositions towards statistics, arguing that their attitude tends to limit their involvement and learning. Students are often discouraged by statistics instruction for reasons that are not cognitive. The emotional dimension of learning statistics, as well as learning mathematics, is crucial and is often treated as secondary to the resources and methods of teaching. Nonetheless, this facet of statistics education has long been important in France (Blanchard-Laville, 1981) and remains a central element sometimes referred to as 'statistics anxiety' (Trassi et al., 2022).

Educational materials as vectors of pedagogical evolution

In the late 2000s, the role of resources in statistics education was increasingly recognised as a factor in optimising learning. Chance et al. (2007) discuss available resources for teaching statistics with computerised technologies at the time, highlighting five strengths of these technologies:

1. Automation of calculations, which enables students to focus on data exploration and produce graphs
2. Visualisation of concepts and abstract ideas
3. Use of simulations as illustrations (data generation)
4. Study of real problems
5. Provision of tools for collaboration and student participation (Wikis were mentioned at the time).

The authors argue that the choice of software should be based on ease of use, interactivity, dynamic links between data, graphs, and analysis, and the need to encourage student interaction. They also suggest that a combination of different applications will be needed. More recently, serious games have been developed in the hope of improving learning. Hazan et al. (2018) gamified an

undergraduate psychology course to boost student skills and engagement in statistics, comparing a gamified learning group to a traditional learning group.

Since the late 2000s, spreadsheets have been the most frequently studied software in school settings. Tort et al. (2008) identified a link between spreadsheet instrumentation, mathematical skills, and computer skills in secondary education. At the time, the use of spreadsheets in classrooms was rare, and students' skills were not well developed (Bruillard et al., 2008). Automatic data generation is a technique particularly used in early higher education, with much research on its effects, such as in South Africa, where Barr and Scott (2011) illustrate the use of a classroom experiment to explore student-generated statistical distributions. Teaching sessions are then built around a series of simulations performed with Excel, in Visual Basic, which show random variations in distributions, allowing students to discover how statistical tools can be used to explore the notion of uncertainty.

Meanwhile, there are also studies on the teaching of statistical concepts with spreadsheets. For example, Roditi (2009) teaches the chi-square test with a spreadsheet, taking advantage of automatic data generation to help students understand the chi-square law. Data generation, often referred to as 'simulation', has been implemented in undergraduate education and is now part of teaching techniques such as learning by doing and participation in group activities to potentially maximise student learning. For example, Park et al. (2022) used Microsoft Excel as statistical analysis software to increase student engagement and participation in an undergraduate statistics course.

All of these studies support the assertion of Jean-Paul Benzecri (Murtagh, 2005) and Philippe Cibois (2007) that the increase in computing power has generated new uses of statistics. As a result, those who use statistical processing software can focus more on interpreting results and presenting data rather than on calculations. This evolution has consequences for training devices, as the instrument runs the risk of making the most common school knowledge obsolete.

Despite the abundance of literature on the use of spreadsheets, the most widely used instrument for teaching mathematics remains the blackboard, which appeared in the 18th century and is an even older modification of the slate. This is also the case for undergraduate economics curriculum in the U.S. Before the Covid-19 pandemic, Asarta et al. (2020) and Harter et al. (2022) reported that 'chalk and talk' remained the preferred method of instruction in introductory economics courses, along with the use of textbooks. Nonnon (2000) examined the case of the blackboard in French language instruction, interpreting it as an instrument at the junction of planning and teacher improvisation that illustrates the 'interpretative and strategic bricolage' of their practices, rather than an unrecognised, invisible, and illegitimate tool of practice.

Teaching at the IUT

In the IUT specialty devoted to statistics education (named STID), the spreadsheet is a central instrument (Grégoire et al., 2012). Oriol (2007) considers that the teaching of statistics at IUT includes an epistemological caesura: on the one hand the collection and processing of data, and on the other hand an approach based on the calculation of probabilities, which is more distant from social practices. By developing activities and resources in two IUT specialties, he believes that conducting surveys and simulating random experiments can mitigate this initial disparity, allowing learners to construct meaning in their learning.

Lauton (1994) conducted a study on the metacognitive perceptions of IUT students in learning financial mathematics. By means of a questionnaire, the author identifies an evolution in their perception of mathematics, moving from a traditional vision to one more focused on its professional applications. Moreover, he believes that this new perception is mainly constructed by students who have encountered difficulties in mathematics during their schooling.

The question of the professionalisation of knowledge, as posed by Lauton in 1994, and of the caesura identified by Oriol, raises questions about the pedagogical attitude of IUT teachers, i.e., their point of view regarding knowledge. Van Steenkiste (2011) partially answers this question in a qualitative study of IUT teachers and considers that their attitudes are shaped by their status, their discipline, their field of study, and the specific environment of their institution. Tralongo (2017) describes a particular socialisation process that is much less found in other academic institutions. This socialisation is framed by an apparatus (discourse, devices, instruments, tools, scaffolding) aimed at articulating a 'professionalist' discourse with pedagogical practices organised around internship situations.

Questioning and explanatory framework

Understanding how resources are collected, produced, and shaped for use in the classroom requires consideration of two categories of factors.

First of all, those that are imposed on the teachers, with which they must deal, adapt and adjust: the students' profiles (their familiarity with mathematics, their speciality, the position of the establishment in relation to others: small rural town, working-class district...), the organisation of the training courses (timetable, rooms, number of students, lecture course or directed work...), and the curricula.

Then come the factors that depend on the teachers' activity. Firstly, their training and their links with the post-graduate level (*agrégation*, PhD, training at university or in a school, etc.), then their adaptation to the conditions of entry into their career (beginning in secondary school, taking over a course from a colleague who is retiring, etc.). Finally, there are the factors of socialisation (team members who coordinate the teaching methods; colleagues, family or friends in the teaching world; professional network of IUT teachers, etc.).

The meeting of these factors produces an intellectual movement. This movement starts from the training in mathematics, from which comes a vision of what a mathematics course is – which we will call orthopraxis – and arrives at the implementation of the conditions for success in their daily work. A pedagogical point of view is created by this daily work on the objectives of teaching, a distinction between what is important and what is not in their teaching situation. This pedagogical point of view most often results in wanting to transmit to students a practical understanding of statistics and sometimes leads them to detach themselves from a form of mathematical dogma inherited from the training they received. In this process, the way educational materials are produced and used constitutes a realisation of this point of view.

Method

To characterise this adaptation, an interview framework was constructed to gather information on the resources used. The interviews focused on the participants' relationship with statistics and their training and professional background, as well as contextual elements such as their teaching methods, number and profile of students, and particular fields of study. Between 2019 and 2021, interviews were conducted with seven statistics teachers in IUTs specialising in Business and Administration Management and Biological Engineering, with five in the Paris area and two in the south of France.

The interviews were recorded and transcribed for analysis using grounded theory (Glaser & Strauss, 2010). This involved identifying elements of meaning to construct general themes presented below. The data analysis was done by identifying the themes and responses expressed by the interviewees, then grouping them in a way to produce a semantic framework consistent with the interviews.

The interpretation of these data was based on Geertz's theoretical perspective (1998), which views the object of study as an interpretive science in search of meaning rather than an experimental science in search of laws. The researchers attempted to read a 'foreign, faded manuscript, full of ellipses, inconsistencies, suspicious corrections, and tendentious commentary, and written not from standardised graphic conventions, but rather from ephemeral patterns of behavioral forms' (Geertz, 1998).

Results

The resources used and designed are the product of the meeting between a teaching context and a pedagogical point of view

In their resource design, teachers adhere to a principle of filtering and organizing the concepts presented to their students. The aim is to steer clear of presenting a multitude of information or options for action that could lead to students becoming overwhelmed or lost, in other words, to limit informational 'noise'. The goal is to prepare students to recognise the potential uses of data, statistical methods, and technical means. The objective is to learn to use controlled information and to limit it to the most important aspects so that students can recognise these elements in non-educational situations. This common principle controls the selection of resources and pedagogical decisions. This rationale governs the choice of instruments as well as the selection of documents and data presented to students. In the following section, we will present the resources that these teachers have produced and used. The resources can be classified into three categories: instrumental resources, documentary resources, and data.

Instrumental resources

The calculator

The calculator is a key instrument in statistics courses, particularly when data processing software is not a focus of the teaching. Calculators serve both as tools for mathematical activity and as objects of education. This distinguishes them from spreadsheets. They require minimal training for data manipulation, require little maintenance, and are readily available. Additionally, they allow for the use of individual tools already owned by the students. There is a preference for high school models. The most important factor is their ability to manipulate at least two distributions and return indicators of central tendency, dispersion, and those of a least squares regression. The preferred calculators are those that strike a balance between being not too sophisticated and not too simple.

The spreadsheet

The spreadsheet, although less frequently used and less ergonomic in class than calculators, and less focused on statistics than statistical software and languages, was mentioned only once by an interviewee and was considered discredited and even despised as a teaching instrument. Its use goes against the principle of limiting informational 'noise', as it allows for the presentation of too much information to students. In the context of teaching statistics in the IUT, it creates more problems than it solves, hindering the progress of the courses and the achievement of the pedagogical objectives. As an educational material, the effectiveness of spreadsheets compared to calculators or data processing software and languages is limited.

According to the interviewees, since spreadsheets are primarily administrative tools, their ergonomics require training that cannot be incorporated into the statistics course. Three interviewees mentioned that the use of spreadsheets in class would be possible if students received training on them prior to taking statistics courses. The second element reported in the interviews that explains the low esteem teachers have for spreadsheets is that they are not well-known by the

teachers. In fact, spreadsheets are not part of the range of software tools used by mathematicians, such as LaTeX or programming languages.

R (programming language)

Three out of seven interviewees use R for teaching statistics. One of them uses it for preparing assessments and photocopies. Two other interviewees, who work together, use R to prepare lectures and student activities. R, like calculators, is preferred over spreadsheets. It allows for maintaining the principle of limiting informational 'noise' while adding new notions and activities by using other resources like photocopy, blackboard or websites. During the course, only default functions of R are used and no additional packages are used with the students. However, for course preparation, photocopying, and evaluation, the more sophisticated functions and packages are used. One interviewee does not use R with students but uses it to create evaluation topics.

The use of R, like any programming language, reveals a second principle in the teaching of statistics. While what is presented to students is based on the principle of limiting informational 'noise' and readability, the preparation resources are complex, abundant, multiple, and require great skill. The apparent simplicity of what is presented to students is the result of a high level of complexity in its conception.

Teachers' resources

The reference books cited by the teachers have relative unity in the topics covered, which likely reflects their dispositions towards statistics. Books were cited for teaching (Valleron, 2001 and Hasquenoph, 2016), learning statistics (Wonnacot, 1999), machine learning (Witten et al., 2021), or from a mathematical perspective. Notably, interviewees often have difficulty citing works due to a lack of reference or forgetting them. This can be explained by the fact that statistical concepts are widespread and easy to acquire for mathematicians, rendering reference books less essential. 'What I didn't manage to find in other books was that they either went off on a tangent, with calculations, big formulas, big demonstrations and the whole interpretation side was quite poor. Or it was completely the opposite, [...] no calculations are explained, no formulas are demonstrated to make a course, it's too poor at the mathematical level [...].'

Documentary resources for students: exclusively produced by teachers

The principle of limiting informational 'noise' and readability is evident in the documentary resources presented or given to students: no reference documents are recommended to students, and this is one of the main conditions for student success according to the interviewees. What is given in class is recommended exclusively, no documents other than those of the teachers are recommended to the students; on the contrary it is often an instruction: 'do not consult other documents'.

First, because each teacher has his or her own progression and the order of presentation of the concepts is very important to avoid confusion, according to them. Too much information for the students could make it difficult to achieve this progression. Statistics books are too complicated for students and could be at best a waste of time and at worst a source of disgust. In addition, each teacher adapts the concepts taught to the students. What is presented to them is therefore 'tailor-made' according to the students' profiles and other factors that we will describe later. As we have already mentioned, if the documents presented to the students follow a principle of limiting informational 'noise', the production process does not follow this principle; on the contrary, a large quantity and variety of documents is necessary to be able to produce documents that are readable and accessible for the students.

The blackboard: a form of narration combining writing and orality

The preferred teaching tool in the classroom is the blackboard, which may be used alone or in conjunction with a photocopy containing exercises or a website. Using the blackboard for teaching implies a narrative style, where the teacher writes the course content in front of the students rather than simply presenting it. For instance, during the initial lockdown in March 2020, one of the interviewees acquired a whiteboard to teach remotely by recording herself in front of the board.

> M: For online teaching, isn't it easier to write in advance and post it as you go?
>
> N: I don't like doing that. Because I find that we lose a bit... Already we don't have much interactivity. If on top of that I post and only comment on my thing, I find that it's even less... As we write the calculations, sometimes we comment on them, intentionally making mistakes to see if they are following, and we rectify them. So, if there are notes that are already displayed before, we can't do all that anymore.

In this context, writing on the blackboard represents a fusion of writing and speech, allowing for the manipulation of concepts in a single activity, and demonstrating the construction of reasoning in one motion. It is a collective instrument that enables mathematics to be performed 'live'. This method of teaching, commonly used in mathematics, helps students become comfortable with the writing and oral expression of concepts, allowing them to engage with writing. With the exception of one interviewee, the board is typically used in conjunction with other resources such as photocopies, websites, and software.

Photocopies

Just as in high school, photocopies are central documents in teachers' pedagogical activities (Khaneboubi & Roux-Goupile, 2020). Photocopies can serve as course handouts, fill-in-the-blank texts, exercises, or assessments. Often, photocopies are also available in digital format. The use of photocopies is integrated with other resources, such as charts and/or presentations, instruments, or data. Their function in teaching depends on their nature (e.g., gap-fill, evaluation, exercises, handouts) and the teaching context.

> P: Little by little, I'm giving them... So, it looks like... [searches his desk], but... there it is, it's a course, it's a paper document, that they have digital access to, that looks like a course in a book. It looks like a book [a textbook]. I give them at the same time, we look at it together. It's hole-in-the-wall lectures. From time to time, even those who fall asleep have to wake up because they have to fill in the blanks.

As often in high school, students, especially in the business and management speciality, write slowly and have difficulty taking notes and identifying the most important elements of the course. Therefore, it is necessary to provide them with a written trace of the course so that they can work on it later. However, this written trace must be carefully calibrated because students do not have a completely fluent and integrated relationship with writing. For the two interviewees who spoke most about the use of the blackboard, photocopies of lectures are not or no longer given to students voluntarily. This is part of their teaching strategy to encourage students to focus and engage during class.

Two interviewees work in pairs and have created and maintained two websites. Their websites are used in a computer room and serve the same function as photocopies in a regular classroom. Originally developed for 30 students to centralise questions and problems, the website has since grown to serve a larger audience. A new tutorial is created on the site as soon as a student asks a question.

Data used

Data are a special resource as they serve as the foundation for statistical work. Their utilisation is essential in preparing students to become proficient in their field. They enable students to tackle

tasks that closely mirror those encountered in the professional world, to gain hands-on experience in applying statistical methods, software, and instruments. Furthermore, in the context of the IUT, they facilitate the meaning extraction of tables, which is one of the most crucial outcomes of statistical work and is referred to as 'interpretation' by the interviewees. The interviewees mentioned five types of data, namely:

- Data generated from another course or coursework
- Generated or fabricated data pertaining to the training area
- Research data in the field
- Administrative data
- Sports data

Basic data, such as simple distributions, cross-tabulations, or graphs, are used in exercises, while more intricate data are drawn from research in the field of application of the specialty, such as dietetics, agronomy, medicine, etc. The selection of such data is always careful.

> N: So for me in statistics, to create the exercises, etc., I took articles, actually. I have colleagues who are researchers, who have codes to enter sites like Pubmed. I used that or, with colleagues, we will attend a dietetics conference in Paris. That allowed me to access articles and I used that to do my exercises.

Data plays a central role in advancing and empowering students with statistics. It is through the use of data that teachers can assist students in recognising treatments suitable for different types of variables. Initially, students will acquire reflexes, followed by practical intelligence that enables them to derive meaning and interpret the results of tests, graphical representations, and so on.

> A: They will arrive with data that they collected during plant physiology lab work, and the lab work that they collected with another colleague. Well, they'll have to process them to be able to make statistical reports, scientific reports for this colleague. So, I help them. I give them increasingly vague instructions. At the beginning, I tell them step by step how they will have to process their algorithm. And then, little by little, I tell them to just go and get that test. Then, as usual, we compare averages. I get more and more vague with each session.

Lastly, open or easily accessible data on the internet may also be utilised. For instance, in a pedagogical exercise, students are required to search for data to answer the question, 'Are women's sports records catching up with men's records?' The students are expected to create a paper poster, with the teacher guiding them in selecting the sport, choosing the data, and determining which data processing methods will allow them to address the question. This activity enables students to engage in the essential statistical activity of creating meaning from data. While data form the foundation of the exercise, the sophistication lies in the pedagogical design.

Conclusion

Resources serve as the interface between content and pedagogical organisation, with the resources produced and used by teachers reflecting their teaching approach. They materialise the adaptation of content to a teaching context and an intellectual perspective. The teachers we interviewed explained the format and content of their resources in light of two key factors: the teaching context and their pedagogical point of view. The former is characterised by students' profiles, training organisation, and available technologies, while the latter stems from an intellectual evolution that has occurred over the course of their careers, informed by their initial training and socialisation.

The intersection of these variables leads teachers to adopt a pedagogical perspective that enables them to define objectives and implement them, with resources being the product of this encounter. The materials presented to students are based on the principles of limiting informational 'noise',

readability, and accessibility, but their conception and preparation are not limited by complexity. On the contrary, they are diverse, complex, multifaceted, and mobilise a wide range of skills.

This work shows first that for statistics teaching 'less is more'. Teaching statistics requires identifying what is essential and only what is essential to present to students at a particular point in the pedagogical progression.

Statistics teachers do not separate technical knowledge from disciplinary expertise or pedagogical skills. They approach these three types of competencies simultaneously. Teachers produce/choose their resources with consideration only for disciplinary knowledge, in regard to student skills, which guides the pedagogical organisation of the course.

The pedagogical capital of these teachers is a slow acquisition, developed through both encounters with real teaching situations and a deep understanding of the teaching field. The teacher training institution might be able to use those experiences to shorten the process.

Biographical notes

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References

Asarta, C. J., Chambers, R. G., & Harter, C. (2021). Teaching Methods in Undergraduate Introductory Economics Courses: Results from a Sixth National Quinquennial Survey. *The American Economist*, *66*(1), 1828. https://doi.org/10.1177/0569434520974658

Barr, G., & Scott, L. (2011). Teaching Statistics in a Spreadsheet Environment Using Simulation. *Spreadsheets in Education (eJSiE), 4*(3). Retrieved from http://epublications.bond.edu.au/ejsie/vol4/iss3/2

Blanchard-Laville, C. (1981). *Les dimensions affectives de l'apprentissage des statistiques*, Éducation permanente, *61*, p. 41-62.

Bruillard, E. (2021). Textbooks and educational resources: Overview of contemporary research. *IARTEM E-Journal*, *13*(1), Art. 1. https://doi.org/10.21344/iartem.v13i1.879

Bruillard, E., Blondel, F.-M., & Tort, F. (2008). DidaTab project main results: implications for education and teacher development. Society for Information Technology & Teacher Education International Conference 2008, 2008(1), 2014-2021. Retrieved from http://editlib.org/p/27496

Chance, B., Ben-Zvi, D., Garfield, J., & Medina, E. (2007). The Role of Technology in Improving Student Learning of Statistics. *Technology Innovations in Statistics Education, 1*(1). Retrieved from http://www.escholarship.org/uc/item/8sd2t4rr

Cibois, P. (2007). *Les méthodes d'analyse d'enquêtes*. Paris: Presses Universitaires de France.

Garfield, J., Hogg, B., Schau, C., & Whittinghill, D. (2002). First Courses in Statistical Science: The Status of Educational Reform Efforts. *Journal of Statistics Education, 10*(2). Retrieved from http://www.amstat.org/publications/jse/v10n2/garfield.html

Grégoire, G., Jollois, F.-X., Petiot, J.-F., Qannari, A., Sabourin, S., Swertwaegher, P., Turlot, J.-C., Vandewalle, V., & Viguier-Pla, S. (2012). Software and statistics education in the 'Statistics and Decisional Computing' (STID) departments of IUTs. *Statistics and Teaching*, *2*(2), 524.

Harter, C., & Asarta, C. J. (2022). Teaching Methods in Undergraduate Intermediate Theory, Statistics and Econometrics, and Other Upper-Division Economics Courses: Results from a Sixth National Quinquennial Survey. *The American Economist*, *67*(1), 132146.https://doi.org/10.1177/05694345211037904

Hazan, B., Zhang, W., Olcum, E., Bergdoll, R., Grandoit, E., Mandelbaum, F., Wilson-Doenges, G., & Rabin, L. A. (2018). Gamification of an Undergraduate Psychology Statistics Lab: Benefits to Perceived Competence. *Statistics Education Research Journal*, *17*(2), 255-265.

Hasquenoph, J.-M. (2016). *IUT ET BTS - Management mathematics - Statistics, probability and financial mathematics - Course and corrected exercises*. ELLIPSES.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An Introduction to Statistical Learning: With Applications in R* (2nd edition). Springer-Verlag New York Inc.

Khaneboubi, M. (2019). Analysis of statistical curricula in French undergraduate courses.15th IARTEM conference on textbooks and educational media UCL, Odense, Denmark.

Khaneboubi, M., & Roux-Goupile, C. (2020). Educational photocopying in French secondary schools. *IARTEM E-Journal*, *11*(1), 1-14. https://doi.org/10.21344/iartem.v11i1.589

Lauton, M. (1994). *Enjeux et réalités de l'enseignement des mathématiques en IUT dans les départements de gestion : Le cas des mathématiques financières* [Thèse de doctorat, Paris 7]. https://www.theses.fr/1994PA070096

Lee, H. S., & Hollebrands, K. F. (2008). Preparing to teach data analysis and probability with technology. In *Joint ICMI/IASE study: Teaching statistics in school mathematics. Challenges for teaching and teacher education. Proceedings of the ICMI Study (Vol. 18)*. Retrieved from https://www.stat.auckland.ac.nz/~iase/publications/rt08/T3P4_Lee.pdf

Martinand, J.-L. (1999). 'The question of reference in curriculum didactics. http://www.if.ufrgs.br/public/ensino/vol8/n2/v8_n2_a2.html

Monino, J.-L., Kosianski, J.-M., & Cornu, F. L. (2007). *Descriptive statistics* (3rd edition). Dunod.

Murtagh, F. (2005). *Correspondence Analysis and Data Coding with Java and R* (1st edition). Chapman and Hall/CRC.

Nash, J. C. (2008). Teaching statistics with Excel 2007 and other spreadsheets. *Computational Statistics & Data Analysis, 52*(10), 4602-4606. https://doi.org/10.1016/j.csda.2008.03.008

Nonnon, E. (2000). The teacher's blackboard, between written and oral. *Repères. Recherches en didactique du français langue maternelle*, 22(1), 83- 119.

Oriol, J.-C. (2007). *Training in statistics through questionnaire surveys and simulation: Didactic study of a teaching experience in a department of IUT* [PhD thesis, Université Lumière - Lyon II]. https://tel.archives-ouvertes.fr/tel-00191166

Park, T., Hong, M., & Kondrat, D. (2022). Undergraduate Students' Attitudes toward Statistics: How Excel Makes a Student's Life Easier. *Journal of Evidence-Based Social Work*, *19*(3), 263271. https://doi.org/10.1080/26408066.2022.2025968

Roditi, E. (2009). A graphed spreadsheet for teaching statistics in the humanities and social sciences. In G. L. Baron, É. Bruillard, & L. O. Pochon (Eds.), *Informatique et progiciels en éducation et en formation* (p. 257-275). Retrieved from http://halshs.archives-ouvertes.fr/halshs-00609639

Saporta, G. (2006). *Probability, data analysis and statistics*. Editions TECHNIP.

Tenenhaus, M. (2006). *Statistics: Methods to describe, explain and predict* (2nd edition). Dunod.

Tort, F., Blondel, F.-M., & Bruillard, É. (2008). Spreadsheet Knowledge and Skills of French Secondary School Students. In R. Mittermeir & M. Syslo (Eds.), *Informatics Education – Supporting Computational Thinking* (Vol. 5090, pp. 305-316). Springer Berlin / Heidelberg. Retrieved from http://www.springerlink.com/content/u5457121103g7645/abstract/

Tralongo, S. (2017). Making/becoming a professionalizing higher education teacher. Tutoring in IUT. Formation emploi. *Revue française de sciences sociales, 138*, Art. 138. https://doi.org/10.4000/formationemploi.5103

Trassi, A. P., Leonard, S. J., Rodrigues, L. D., Rodas, J. A., & Santos, F. H. (2022). Mediating factors of statistics anxiety in university students: A systematic review and meta-analysis. *Annals of the New York Academy of Sciences*, *1512*(1), 76-97. https://doi.org/10.1111/nyas.14746

Valleron, A.-J. (2001). *Probabilités et statistique*. Editions Masson.

Van Steenkiste, G. (2011). *Enseigner ou former : Représentations d'enseignants(e)s en Instituts Universitaires de Technologie* [Thèse de doctorat, Paris 10]. https://www.theses.fr/2011PA100090

Wonnacott, T.-H., Wonnacott, R.-J., Cohendet, P., & Collective. (1999). *Statistics: Economics - Management - Science - Medicine* (4th edition). Economica.