TRANSITION BETWEEN EDUCATION AND PROFESSION: EXPERIENCES OF STATISTICIANS

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Résumé. Les compétences en statistique sont de plus en plus recherchées, et ce quelque soit le domaine d'application. Bien que l'offre d'emploi pour les statisticiens soit en augmentation, il est parfois difficile de recruter les jeunes diplômés principalement parce que les statisticiens développent un savoir et des compétences spécifiques à leur milieu professionnel (Pfannkuch & Wild, 2000). Afin de reconnaître comment ce savoir et ces compétences spécifiques sont développées, des statisticiens se sont engagés dans une réflexion sur leur expérience. Les résultats révèlent d'importantes compétences en statistique requises en milieu professionnel, reconnues par les professionnels eux-mêmes. Reconnaître ces compétences permettra d'offrir une expérience pratique aux étudiants de statistiques et futurs statisticiens.

Mots-clés. Pratiques statistiques, transition vers le marché du travail, enseignement des statistiques.

Abstract. The demand for statistical skills is growing in many different fields and sectors, and the employment of statisticians is expected to increase drastically. However, employers are experiencing difficulties in hiring mainly because there is a misalignment between the skills acquired through statistics education and the skills required of a statistician at the workplace. Indeed, statisticians develop practices that grow out of experience (Pfannkuch & Wild, 2000). In order to investigate statistical practices that are developed at the workplace, I engaged statisticians in a reflection on their experience. Preliminary results revealed predominant and newly developed statistical skills from the perspective of the practitioners and can inform how to better promote authentic practices throughout education.

Keywords. Statistical practices, transition to the workplace, statistics education.

1. Introduction

From actuarial science to zoology, the field of statistics has applications in many diverse disciplines and in the era of big data, statistical skills are increasingly valuable on the job market. For example in the United States, even though the number of degrees in statistics and the number of students seeking degrees in statistics have been increasing over the past few years, the supply of graduates still does not match this thriving demand for statistical skills (American Statistical Association, 2015) and employers are experiencing difficulties in hiring statisticians across disciplines and sectors (Society for Human Resource Management, 2016). Most employers are looking for experienced statisticians when hiring (Occupation Outlook, 2017) and the job market offers very few entry-level openings for positions in statistics. As a result, graduates in statistics are encountering many challenges as they transition from their education to their profession.

The purpose of my research study is to explore the transition experienced by graduates in statistics as they enter the workplace. Previous research has shown that the transition from education to profession is challenging for graduates in general (Grosemans, Coertjens, & Kyndt, 2017), and in particular for graduates in statistics because there is a misalignment between their training and what is required of them at the workplace (Van der Berg, 2017). The main reason is because statisticians develop practices, or practical skills, that grow out of experience and are relevant to their discipline and context (Pfannkuch & Wild, 2000). Research is needed to understand how statisticians develop these practices in a professional environment and what can be done to facilitate the transition. In general, the role of mentors was found to be crucial to support recent graduates in their transition (Grosemans et al., 2017) that is why statisticians and their mentors are involved in this study. More specifically, the following research questions guide this study:

1. How do statisticians and their mentors perceive the experience of the transition between academic settings and the workplace?
2. How do statisticians learn and develop practices while in transition to the workplace?
3. What key statistical practices should be implemented in education as recommended by statisticians and their mentors?

This paper follows a paper presented at the 50èmes Journées de Statistique where attendees took part in a sorting task and discussed important practices performed by statisticians at the workplace. Important statistical practices revealed during the sorting task conducted at three conferences (in Texas, France and Japan) are presented. After reviewing previous research on the transition to the workplace for statisticians and introducing the methodology to conduct this study, I will share the results and introduce the next stage of the study which involves interviews with statisticians and their mentors. Attendees will be encouraged to participate in the study.

2. Transition to the workplace

The transition to the workplace often presents challenges because it involves adapting to a new environment, with a new role, different rules, and learning new practices (Grosemans et al., 2017). An example of difficulties encountered by individuals in transition is the misalignment between the learning outcomes provided by the educational background and the expectations of the workplace.

In particular, previous research shows that there is a misalignment between the training of statisticians and what is required of them at the workplace. For example, Harraway and Barker (2005) followed 913 recent bachelor's, master's and doctoral degree holders in five different disciplines (statistics, economics, business, the biological sciences, and psychology) into their early career and identified discrepancies between techniques taught at the university and used at the workplace. The findings indicated that even though the nature of the methods lacking in the statistical training of graduates differed across disciplines, graduates from all disciplines agreed they needed more training in regression, multivariate methods, research design, and power analysis.

Van der Berg (2017) investigated the transition experienced by statisticians who just completed an internship at the end of their training in an institution for official statistics. 95 interns answered a survey to reflect on their experience of the transition to the workplace. Most interns (70.5%) agreed that they acquired the appropriate *statistical knowledge* needed at the workplace through their training, however, most interns (71.8%) also indicated that they did not acquire the appropriate *statistical skills* needed at the workplace. Therefore, the statistical knowledge acquired in academic settings does not align with the statistical skills required at the workplace. Furthermore, interns listed 28 skills required at the workplace with the indication if that skill was taught or not. Out of these 28 skills, 21 were marked as not having been taught. For example, the most cited skills were data collection (mentioned by 54 interns), questionnaire design (mentioned by 54), communication (mentioned by 49), writing skills (mentioned by 45), and using statistical software such as SAS

(mentioned by 32) or SPSS (mentioned by 21).

In addition, Van der Berg interviewed ten mentors who accompanied interns during their transition to the workplace in order to explore how interns were prepared for performing statistical tasks. Most mentors agreed that even though interns had some theoretical knowledge, they were lacking practical skills and had to learn how to perform most of the statistical tasks. From the perspective of eight of the mentors, statisticians should primarily develop skills in academic settings for using statistical software packages such as SAS, performing data analysis, and writing. Seven of the mentors also agreed that future statisticians should acquire skills in communication, data collection, sampling, and survey methodology before entering the workplace.

Therefore, a misalignment between some aspects of statistical training in academic settings and statistical tasks to perform at the workplace has been identified (Harraway & Barker, 2005) and the lack of preparation for statisticians has been examined in a specific context (Van der Berg, 2017). Now, we need to understand how statisticians learn new practices in order to become professionals.

3. Theoretical framework

To understand how statisticians develop practices at the workplace, this study draws on activity theory (Vygotsky, 1978; Engeström, 1987; Konkola, Tuomi-Gröhn, Lambert, & Ludvigsen, 2007) and more precisely on the concept of boundary crossing and boundary objects (Akkerman & Bakker, 2011; Star & Griesemer, 1989). Academic settings and the workplace can be conceptualized as *activity systems* whose goal is to develop statistical practices (the *object* of the activity). The activity is mediated by *tools* and regulated by *rules*, and the *division of labor* ensures the distribution of tasks and authority within a *community* and a *subject*, or individual of focus. For example, in academic settings, a student (*subject*) develops statistical practices (*object*) using curricula materials (*tools*). The *community* of students, teachers, and advisors work together ensuring that the student meets the degree requirements (*rules*). The teacher defines the responsibilities (*division of labor*) of each participant. At the workplace, a statistician (*subject*) develops statistical practices (*object*) using statistical software (*tools*). The collaboration between statisticians, managers, and clients forms a *community*, following regulations (*rules*) and a specific organization of the different tasks (*division of labor*). Thus, statistical practices are considered from different perspectives (student and statistician) and are not necessarily aligned between the two activity systems of academic settings and the workplace.

The misalignment between statistics taught in academic settings and statistics practiced at the workplace creates challenges that statisticians learn to overcome. The concept of *boundary crossing* represents the process of establishing continuity between two activity systems and the involved challenges, or boundaries. *Boundary objects* can function as bridges between systems (Akkerman & Bakker, 2011; Star & Griesemer, 1989) and assist boundary crossing. In the context of this study, statistical practices are characterized as boundary objects because they could be utilized to facilitate the transition boundary crossing and should be coordinated between the two activity systems. Figure 1 represents academic settings and the workplace as activity systems and statistical practices as boundary objects.

Through the lens of activity theory with the concepts of boundary crossing and boundary objects, this study explores the transition experienced by statisticians as they move between the activity system of academic settings and the activity system of the workplace. We need to analyze how participants identify and coordinate practices from each activity system, and how they can eventually transform practices. The collaboration of statisticians, mentors, and educators will help build boundary objects, namely statistical practices, to facilitate the transition between academic

settings and the workplace.

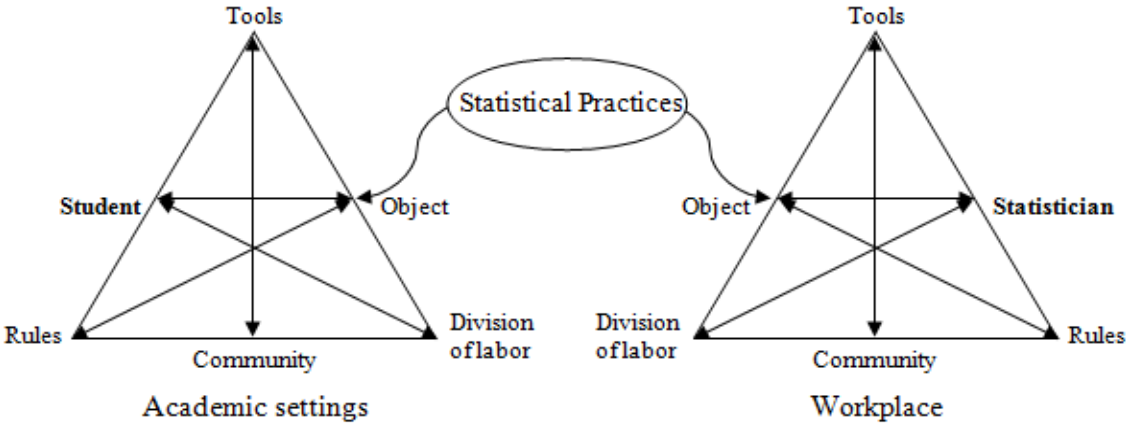

Figure 1: Activity systems and boundary objects

4. Methodology

The goal of this study is to give the opportunity to statisticians and their mentors to share their experiences on developing statistical practices at the workplace and how they overcome the challenges created by the misalignment between practices developed in academic settings and practices required at the workplace.

There are three stages in data collection. First, statisticians and their mentors were recruited during a workshop at conferences focusing on statistical practice. During the workshop, participants engage in a sorting task, derived from Q-methodology which aims at exploring inner perspectives and the possible differences and similarities of perspectives within a community (Brown, 1996). The purpose of the task is to prompt attendees to share their perspectives on which important practices are crucial to the role of statistician. In particular, participants sort a list of 24 practices marked on slips of paper and add to the list with practices relevant to them. Participants are asked to arrange the slips of paper into a grid of 9 columns (see Figure 2). Each column is assigned a value of importance for the practices present in that column, from 1 (least important) to 9 (most important). If statisticians cannot provide additional practices to add on the blank slips of paper, they place the blank slips of paper in the middle of the diagram, which is considered neutral.

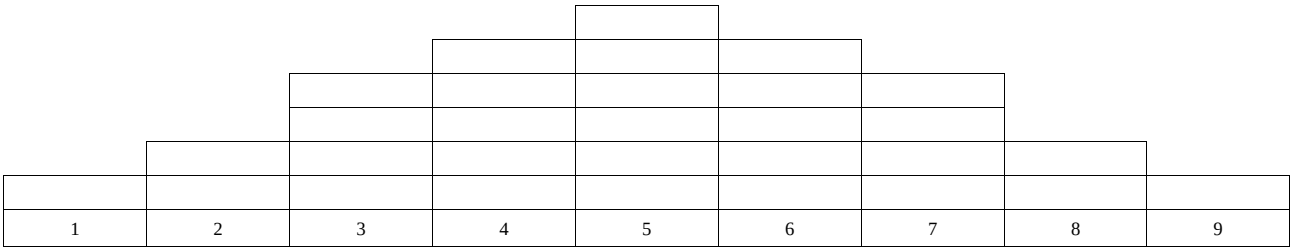

Figure 2 : Grid for the sorting task

After engaging in the task, participants are offered to complete a paper survey. The survey consists of mainly open-ended questions that collect information about educational background, professional experience, and the transition between academic settings and the workplace. The responses on the survey are used to select participants for the next stage of the study: interviews. Interviews allow for rich and in-depth description of the experiences of the participants. Participants are chosen to represent the diversity in education and fields of applications for the role of statistician.

5. Preliminary Results

At the time of writing this paper, the sorting activity had been conducted at three conferences: the Conference of Texas Statisticians (COTS) in Texas, the Journées de la Statistique (JDS) in France, and the International Conference on Teaching Statistics (ICOTS) in Japan. Overall, a total of 41 completed sorting tasks were collected from attendees with different experiences (see Table 1).

Table 1: Number of sorting tasks and principal role of attendees

	COTS	JDS	ICOTS	**Total**
Statistician	2	4	2	**8**
Professor	9	4	1	**14**
Lecturer	0	0	4	**4**
Graduate student	2	6	0	**8**
Undergraduate student	7	0	0	**7**
Total	**20**	**14**	**7**	**41**

Additional practices mentioned by the attendees were regrouped under the same practice if they had a similar interpretation. After analysis, 7 additional practices were added and are listed in Table 2 with the number of times they were mentioned.

Table 2 : Additional practices

Practices	Occurrences
Training constantly / Reading	6
Managing projects / budget / people	3
Mentoring/Teaching junior statisticians	2
Participating to conferences	2
Networking	1
Complying with Data Security/Privacy regulations	1
Advising / Consulting with other departments in the company	1

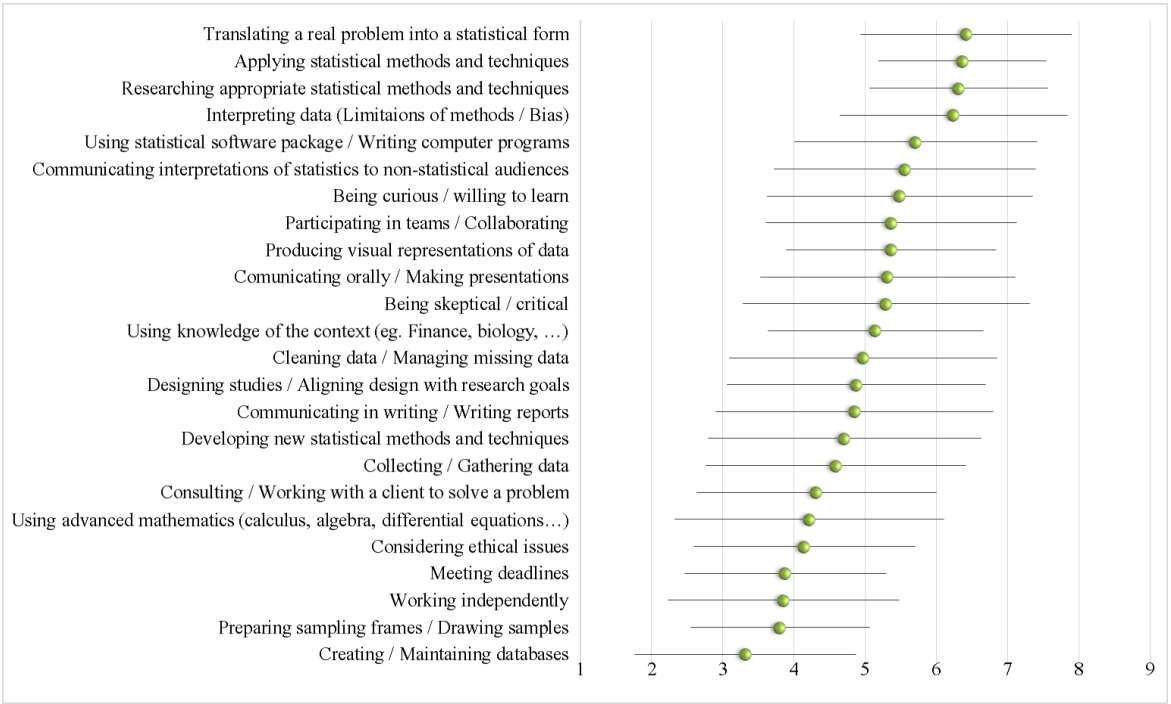

Figure 3: Statistical practices ranked from highest to lowest mean

In the sorting task, 24 statistical practices were sorted by order of importance with scores ranging from 1 to 9. To analyze and interpret the sorting tasks, the mean scores and standard deviations are compared for each practice given by the 41 attendees. The additional "blank" practices were principally placed in the middle of the shape with an average score of 5 for each of the six additional practices, therefore I am focusing solely on the 24 imposed practices. In Figure 3, the 24 practices are ordered vertically from the highest to the lowest mean score, with the mean scores represented by dots. An indication of the variation of scoring for a practice is given by an interval representing the deviation from the mean within one standard deviation. While the practice "Translating a real problem into a statistical form" was ranked the highest in terms of mean (M = 6.42), attendees agreed the most, with the lowest standard deviation (SD = 1.17), on the practice of "Applying statistical methods and techniques" which is scored the second highest in terms of the mean (M = 6.37). Attendees disagreed the most on the importance of more generic skills for example with "Being skeptical / critical" (M = 0.29, SD = 2.01) and "Communicating in writing / Writing reports" (M= -0.15, SD = 1.95).

6. Future research

The sorting task will be conducted at other conferences and is also now available online with the survey at http://statistician.intelligentedge.com/. An update on the findings will be given at the conference as well as preliminary results from interviews with statisticians and their mentors.

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