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What variables interact with metacognitive processes related to writing in university students: the role of demographic and education factors

Dyanne Escorcia[1], **Christine Ros** [2]

[1] School of Teaching Training, Research Centre on Cognition and Learning (CeRCA), Assistant professor, University of Poitiers, France
[2] Research Centre on Cognition and Learning (CeRCA), Project engineer, University of Poitiers, France

Poitiers (France)

Correspondence: Dyanne Escorcia. CeRCA - CNRS UMR 7295 MSHS - Bat A5 5 rue T. Lefebvre - TSA 21103 F- 86073 Poitiers cedex 9 E-mail: Dyanne.escorcia@univ-poitiers.fr

Abstract

Introduction. Although metacognition is considered to be a key component of academic success, few studies have explored the interactions between the development of metacognitive processes beyond adolescence and variables such as sex and education. In particular, there is a gap in the literature about how these variables determine differences in the metacognitive processes that are self-reported by university students. The present study aimed to ascertain how metacognitive processes related to planning of writing in higher education interact with sex and education (i.e., learning domain, high school diploma track). Our specific research questions was: Is the sex of university students a predictor for the levels of metacognition related to planning of writing? Additionally, we examined to what extent educational background and learning domain factors determine differences in the metacognitive processes self-reported by university students.

Method. A questionnaire that investigated three specific metacognitive dimensions was administered to 1051 students enrolled in different learning domains (Human and Social sciences, Language and Literature, Law and Economy and Sciences). Factor analysis (exploratory and confirmatory) showed three components measured by this instrument: conditional metacognitive knowledge (six items), covert or personal self-regulation (four items) and environmental self-regulation (five items). Participants were asked to identify the extent (using a Likert-like scale) to which a given strategy or type of knowledge reflected their planning of writing processes. This questionnaire also elicited information about respondents' sex, level of study, high-school diploma track and learning domain.

Results. The results showed that 1) female students self-reported the highest level of metacognition in planning of writing, particularly related to two metacognitive processes: conditional metacognitive knowledge and environmental self-regulation. Additionally, regression analyses showed that sex was a predictor for student's self-reported conditional metacognitive knowledge. 2) The technical and vocational French high school tracks induced statistically significant differences in the metacognitive processes. There were negative predictors for certain latter processes. There were also statistically significant differences in the self-reported scores of metacognition in the function of the learning domain.

Discussion and Conclusion. The first result is consistent with findings about the superiority of women in the communication domain, while the second finding highlights the contribution of skills acquired at secondary school towards learning at university.

Keywords: metacognition; academic writing; planning; sex; high school diploma track

Resumen

Introducción. A pesar de que la metacognición es considerada cómo un aspecto clave para el éxito académico, pocos estudios han comprobado las interacciones entre el desarrollo de los procesos metacognitivos mas alla de la adolescencia y variables tales como el sexo y la educación de los individuos. En particular, existe un vacio en la literatura respecto a cómo estas variables determinan diferencias en los procesos metacognitivos declarados por estudiantes universitarios. El presente estudio tuvo como objetivo indagagar las interacciones entre la planeación de producción de textos universitarios y tanto el sexo como factores educativos (ej. dominio de aprendizaje, diploma de secundaria). Nuestra pregunta específica fue: ¿en qué medida el sexo de los estudiantes predice los niveles de metacognición en processos de planeación de textos? Adicionalmente, buscamos examinar hasta que punto la trayectoria educativa y el dominio de aprendizaje de los estudiantes universitarios determina diferencias en sus procesos metacognitivos auto-declarados.

Métodología. Un cuestionario que mide tres components metacognitivos fue administrado a 1051 estudiantes inscritos en diferentes campos de estudio (Ciencias humanas y sociales, Lenguaje y literatura, Derecho y economía). Los analisis factorialess (exploratorio y confirmatorio) mostraron tres componentes medidos por este instrumento: conocimientos metacognitivos condicionales (seis items), autoregulación personal (cuatro items) y autoregulación del contexto (cinco items). Los participantes debian indicar la frecuencia (escala de Likert) en la cual cada estrategia o tipo de conocimiento forma parte de las actividades de planeación en la producción de textos académicos realizados por los estudiantes. Este cuestionario pedia igualmente información sobre los participantes: sexo, nivel de estudio, tipo de diploma de secundaria obtenido y dominio de aprendizaje en la Universidad.

Resultados. Los resultados mostraron que 1) las estudiantes declararon niveles significativamente mas altos de metacognición en sus procesos de planeación de la escritura, en particular teniendo en cuenta dos procesos metacognitivos: los conocimientos metacognitivos condicionales y la autoregulacion del contexto. Adicionalmente, los análisis de regresión mostraron que el sexo fue un predictor de los conocimientos metacogninitivos condicionales auto-declarados. 2) Los diplomas del nivel secundario de tipo tecnológico y profesional inducen diferencias estadísticas significativas en los procesos metacognitivos. Estos tipos de diploma fueron predictores negativos de ciertos procesos. Tambien encontramos diferencias significativas en los niveles declarados de metacognición según los dominios de aprendizaje en la Universidad.

Discusión y **Conclusion**: El primer resultado es coherente con otras investigaciones que muestran una cierta superiodad del sexo femenino en dominios relacionados con la comunicación; mientras que el segun-do hallazgo muestra la contribución de las habilidades adquiridas en la escuela secundaria al aprendizaje en la universidad.

Palabras clave: metacognición; alfabetización; planeación; sexo; diploma de secundaria

Introduction

Metacognition, an essential component of learning, refers to knowing about cognition and the regulation of cognitive processes (Veenman, Hout-Wolters, & Afflerbach, 2006). Metacognitive processes have been shown to affect academic performance (Bakracevic Vukman & Licardo, 2009; Kistner et al., 2010), particularly at university (Casillas et al. 2012; Costabile, Cornoldi, De Beni, Manfredi, & Figliuzzi, 2013; Ibabe & Jauregizar, 2010). However, few studies have explored the factors that contribute to the development of metacognition in higher education (HE) (Hsu & Hsieh, 2014; Magno 2009). In particular, there is a gap in the literature concerning the individual factors and education variables (i.e. level of education, age, sex, choice of study programme, etc.) that predict learners' self-reported learning self-regulation (Kizilcec, Pérez-Sanagustín, & Maldonado, 2017). Given that metacognitive processes continue to develop beyond adolescence (Weil et al., 2013), and age is known to affect metacognition (Paulus, Tsalas, Proust, & Sodian, 2014; Veenman, Hesselink, Sleeuwaegen, Liem, & Van Haaren 2014), it would be interesting to elucidate the interactions between the metacognitive processes of university students and variables such as sex and education factors. The present research focused on the metacognitive processes of *writing*, as this is an essential skill required by students across all disciplines.

Overview of Metacognitive Processes

Since the seminal contributions by Flavell and colleagues during the early 1980s, metacognition has been traditionally considered to be "cognition about cognition" or "thinking about thinking" (Dinsmore, Alexander, & Loughlin, 2008). This primary definition emphasises the distinction between, on the one hand, knowledge about cognition (i.e., metacognitive knowledge) and, on the other hand, regulation and control of cognitive activity (Harris, Graham, Brindle, & Sandmel, 2009). More recently, authors have supported this distinction, for example, relative to the writing domain (Tobias & Everson, 2009).

Metacognitive knowledge concerns personal knowledge about different variables—personal factors or aspects related to the task and one's own cognitive functioning—that participate in various stages of the activity (Schoonen et al., 2003; Trapman, van Gelderen, van Schooten, & Hulstijn, 2018).

Self-regulation strategies relate to behaviours employed by individuals to achieve the objectives of the activity (Zimmerman, 2008). Researchers have primarily identified three

kinds of self-regulation processes: planning (anticipation and choice of strategies), monitoring (organisation and correction of actions) and evaluation (Harris et al., 2009; Mason & Graham, 2008, Zimmerman & Moylan, 2009).

Writing and Metacognition

Writing is a complex cognitive activity that comprises both cognitive and metacognitive processes. Among the cognitive processes that have been identified (i.e. planning, translating, and reviewing; Hayes, 2012; Kellogg & Raulerson, 2007), planning plays an important role, especially in HE, where students are asked to produce a variable quantity of written texts. Research has shown that writers who undertake detailed organization and preparation of their writing activity produce texts of a better quality (Authors et al., 2017; Beauvais, Olive, & Passerault, 2011; Galbraith & Torrance, 2004).

From a cognitive point of view, the planning of writing includes two key subprocesses (generating content and organizing ideas) that each perform specific functions (Hayes & Nash, 1996).When generating content, the writer tries to identify and select ideas that are relevant to the topic and to readers' expectations. Once the writer has selected the content, he/she can organize it according to a specific hierarchy in order to consolidate the information (Limpo & Alves, 2018). Decisions have to be made about the order of the content, resulting in the production of diagrams, schemas, notes, or outlines.

Concerning the metacognitive processes of writing, *Metacognitive knowledge about writing* concerns personal considerations about audience expectations, type of text, writing strategies, and the adaptation of these strategies according to the writing situation (Graham, Harris, & Mason, 2005; Schoonen et al., 2003). There seems to be a consensus on dividing metacognitive knowledge into three main categories (Harris et al., 2009; Pintrich, 2002; Sperling, Howard, Miller, & Murphy, 2002). *Declarative knowledge* pertains to personal characteristics (e.g. the writers strengths and weaknesses) and task specificities. *Strategic knowledge* includes knowledge about the strategies that individuals can use to perform a set of common activities. *Conditional knowledge* reflects knowledge related to occasions where it is convenient to use specific strategies according to task requirements.

According to (Harris et al., 2009; Schunk & Zimmerman, 2007), the self-regulation strategies of writing comprise a set of cognitive, affective-motivational, behavioural and envi-

ronmental processes that writers implement in order to readjust their writing activity as they write. These authors identified several specific self-regulation writing strategies that we explore in the present study: seeking help (asking peers, tutors, or teachers to help solve problems); structuring the environment (organizing the writing context to write effectively); and mental imagery (creating a mental image while writing to simplify written production). Following the categorisation of self-regulation strategies proposed by Zimmerman (2008), the first two strategies correspond to contextual self-regulation and the third one reflects personal self-regulation. Indeed, it is important to differentiate self-regulation from external self-regulation, a distinction that conforms to de la Fuentes's contributions (2017). According to this author, self-regulation refers to active self-management to which an individual engages during a task. External self-regulation concerns the extent to which the context promotes self-regulation, for example, through teachers' encouragements. The present research focus only on self-regulation processes.

What Variables Interact with the Metacognitive Processes of University Students?

Sex and cognitive and metacognitive processes. There is some evidence to show that the development of metacognitive processes differs according to sex. Veenman (2014) revealed that there is a pause in metacognitive growth at the age of 14−16 years, with a sex−age interaction. This pause occurs earlier in girls (13−14 years) than in boys (14−15 years), but girls subsequently overtake boys at around 16 years. The sex difference seems to persist beyond adolescence. In the case of university students, Downing Chan, Downing, Kwong, and Lam (2013) found that female participants perceived themselves to be better at strategies such as concentration, time management and study aids. However, there were no sex-related differences for self-testing. Moreover, Kizilcec et al. (2017) found that female students reported lower levels of planning, self-evaluation and elaboration, but scored higher than male students on seeking help, setting goals and task strategies.

Differences between female and male individuals can also be found in the writing domain. Mau and Lynn (2001) found that female college students scored higher than male students on tasks requiring writing skills. They also developed their reasoning abilities more, despite lower results at college entrance. This superiority of the female sex could be a consequence of personality traits, such as conscientiousness (Duckworth & Seligman, 2006; Mau & Lynn, 2001), and motivational variables, such as a greater interest in academic work and bet-

ter effort regulation (Fryer, Ginns, & Walker, 2016; Mau & Lynn, 2001; Meece, Glienke, & Burg, 2006).

Interactions between education variables and metacognition. As we mentioned above, there is a dearth of information about the interactions of education variables (e.g. educational background, learning domain, level of study) with metacognition. Nevertheless, if we adopt a sociocognitive approach, we can assume that education variables predict the development of metacognition in higher education. In particular, according to Bandura's social-cognitive learning theory (2002), environmental, personal and behavioural variables contribute to individuals' learning. Within this framework, Zimmerman (2008) explained that self-regulation results from the interaction between these three variables. Environmental factors could comprise specific and contextualized elements, such as task constraints and specificities, as well as more general factors, such as the learners' culture and school trajectory. Previous findings have indeed highlighted variations in the metacognitive processes of individuals from different cultures (Broyon, 2001; Marambe, Vermunt, & Boshuizen, 2012), with authors arguing that parental education and the nature of communication between parents and children could explain these differences. In the present study, we were interested in specific education variables related to the learners' experiences in higher education and in previous levels of education.

Even though there is not sufficient evidence about the contribution of education variables toward the development of metacognition in higher education, findings have mainly linked education factors to academic achievement. For example, Jia and Maloney (2015) found that learning domain plays an important role in course non-completion outcomes. Specifically, students enrolled on Bachelor of Health Sciences, Bachelor of Design, or Bachelor of Education courses were less likely to succeed in their first year than students enrolled on Bachelor of Computer Information Science or Bachelor of Engineering Technology courses. The authors explained these differences by arguing that some first-year programmes may be more difficult than others. Similarly, Beekhoven De Jong, and Van Hout. (2003) demonstrated that the different effects of learning domain on academic performance are a consequence of the number of scheduled hours during the academic year, the number of exams and the self-reported number of hours spent studying per week. Students who followed courses with a higher mean number of hours achieved better academic performances.

Another education variable explored in the present study was the level of performance at secondary school. There has been no research on how this factor might interact with metacognition in writing at university, although several studies have demonstrated that it is a factor for academic success at university. Cyrenne and Chan (2012) sought to determine the predictive power of college students' high school average, based on data collected over a five-year period. The authors tracked the students' performances, as reflected by their grade point average at university. Findings showed that high school average was a strong predictor of grade point average.

The clear and persistent effect of prior academic performance on success at university has also been demonstrated by Diseth, Pallesen, Brunborg, and Larsen (2010) and Jia and Maloney (2015). In particular, Jia and Maloney (2015) found that the risk of not completing their first year at university was lower among students who scored higher on their National Certificate of Educational Achievement, a national secondary-school qualification in New Zealand. This effect was especially striking among students with potential problems in literacy (reading and writing) and mathematics. In brief, prior academic performance is a variable that directly affects academic results at university, and this predictive effect is just as important as students' effort and their approaches to learning (Diseth et al. 2010).

In France, there is also evidence that academic experiences in secondary school determine academic success at university (Morlaix & Suchaut, 2012; Perret, Berthaud, & Benoist, 2013). The high-school diploma track followed in high school appears to be the strongest determinant of grade point average at the end of the first semester at university. In particular, the authors found that pupils with a *science* high-school diploma achieved the best academic performances. To gain a better understanding of the peculiarities of these education variables in the context of the present study, we briefly describe some relevant features of the French education system.

Objectives and Hypotheses

Based on these empirical data and theoretical considerations, we aimed to conduct a correlational study in order to analyse the interactions between metacognition in writing and variables such as individuals' sex and education background. In particular, we set ourselves the following research aims. As we mentioned earlier, the factors that interact with the metacognition in university students have so far received very little attention from researchers.

Furthermore, the contribution of individual factors (e.g. sex) and education variables (e.g. educational background, learning domain and level of study) on self-reported levels of metacognitive processes in writing has yet to be studied. We therefore set out to answer the following research questions:

- Is the sex of university students a predictor of the levels of self-reported metacognitive processes involved in the planning of writing? (RQ1)
- Is educational background (type of high-school diploma) a factor determining differences on the the metacognitive processes self-reported by university students? (RQ2)
- Are learning domains a factor determining differences in the self-reported metacognitive processes related to the planning of writing in a university context? (RQ3)

The questions relating to education variables seem particularly relevant in a French context of highly specialized secondary studies that determine essential aspects of learning in HE, such as the choice of learning domain and students' academic performances. On the strength of our literature review, we formulated the following three general hypotheses:

- Sex is a relevant predictor of the metacognitive processes engaged in the writing of university students. More specifically, being female positively affects self-reported levels of metacognitive processes (H1);
- Type of high-school diploma determines differences on the metacognitive processes engaged in writing at university. French students' scores therefore differ according to their high-school diploma track, with the *general* track being linked to the highest self-reported metacognition scores (H2);
- At university, learning domain (the course in which the student is enrolled), and level of study (first year vs. third year) determines differences in the students' self-reported level of metacognition in writing. In particular, the students enrolled in domains where the learners are supposed to engage in more intense writing practices (i.e. Literature and Language or Social and Human Sciences) will self-report the highest scores on metacognition (H3).

Method

Participants

Participants were 1501 first-year and third-year students enrolled in different learning domains. Initially, 1519 students filled in the questionnaire, but we removed 13 participants

because they failed to provide essential information (e.g. age, sex or high-school track) and 5 other participants because they had a foreign high-school diploma that was not comparable to the French high-school diploma. Table 1 sets out the sample's characteristics. The students were contacted in their classrooms, which were randomly selected, and they filled in the questionnaire on a voluntary basis. The researchers briefly explained the aims of the study and informed them that their participation would not affect their course results or grades. The participants were reassured that the data would be anonymized and their identities would not be revealed in any publications resulting from the research.

Table 1. *Demographic and educational characteristics of the sample (N = 1501)*

Variables	***n (%)***
Age in years	
Range	18−20
Mean (SD)	19.34 (2.28)
Sex	
Male	433 (29)
Female	1068 (71)
High-school diploma track	
Vocational	42 (3)
Technical	167 (11)
General	1292 (86)
Domains of study programme	
Human and Social Sciences	466 (31)
Language and Literature	313 (21)
Law and Economy	436 (29)
Sciences	286 (19)
Level of study	
First year	925 (62)
Third year	576 (38)

The sample was overwhelmingly female (71%), reflecting the statistically significant increase in the number of women attending French universities in recent years. Women make up 58% of the university student population and constitute a large majority (70−74%) in domains such as Language and Literature and Human and Social Sciences (MENSR, 2016). Furthermore, our students were mostly enrolled in Human and Social Sciences or Law and Economics programmes. In all, 86% of participants had a *general* high-school diploma, and 62% were in their first year of study at university.

Instruments

We measured the students' metacognitive processes by means of a questionnaire constructed by authors of the present study. This consisted of 15 items probing three dimensions: conditional metacognitive knowledge (MCK; 6 items), covert or personal self-regulation (CSF; 4 items), and environmental self-regulation (ESR; 5 items). Participants were asked to identify the extent to which a given strategy or type of knowledge reflected their planning writing processes. More specifically, they had to rate the frequency of each situation that was described on a 7-point Likert-like scale ranging from 1 (*Never*) to 7 (*Always*). For the purposes of data processing, we summed the raw item scores for each dimension to obtain three factor scores.

Before analysing the data, we examined the validity and reliability of the instrument following two steps. First, we ran an exploratory factor analysis (common factor approach) with an oblique rotation method (an interrelationship between the metacognitive components was assumed). One part of the participants (497 students) was randomly selected in order to run this exploratory factor analysis. This analysis indicated the existence of three factors, each of which had item loadings from -.81 to.79: MCK had an eigenvalue of 3.95 (corresponding to 23.27% of the explained variance); CSF had an eigenvalue of 2.51 (corresponding to 14.81% of the explained variance); and ESR had an eigenvalue of 1.58 (corresponding to 9.33% of the explained variance). MCK comprised items pertaining to personal knowledge about the use of specific writing methods, taking account of task requirements and the genre of the text to be produced. CSF contained items relating to strategies used by the writer to regulate his/her cognitions or emotions during the planning of writing. ESF measured the use of social resources (peers, tutors, teachers, etc.). Table 2 sets out the items of the questionnaire with the results of the exploratory factor analysis.

Table 2. *Questionnaire: metacognitive components, item loadings, factor eigenvalues, % of variance and alpha coefficients*

Metacognitive component	Items		Eigenvalues	% var	α
Metacognitive conditional knowledge (MCK)	I know how to find ideas to write about	.67	3.29	23.68	.80
	Before writing, I know the formal characteristics of the text I have to construct	.60			
	I know which writing strategies to employ depending on the kind of writing assignment	.76			
	I know how to adapt my writing strategies to the requirements of the writing task	.79			
	I know how to decide if it is necessary to change my writing strategies to meet task demands	.78			
	I repeat in my head the ideas to write about while I am reflecting about how to organize my text	-.55			
Covert self-regulation (CSF)	I connect my ideas with keywords that flow into my head before writing	-.77	2.42	16.20	.65
	I make a mental checklist of all my ideas before starting to write	-.81			
	I let my knowledge about the topic flow before starting to write	-.60			
	I ask someone to read the plan of my text in order to make sure it is clear	.75			
Environmental self-regulation (ESR)	I use a text plan that someone recommended to me	.63	2.34	10.49	.70
	I discuss with my peers in order to identify the ideas I will write about	.68			
	I question the prof./evaluator of my text to find out his/her expectations	.57			
	I show my prof./evaluator a draft of my text to get his/her advice	.70			

Second, we performed a confirmatory factor analysis (CFA) to test the factor structure found in the first step. The rest of the participants in the study (498 students) constituted the data for the CFA. The model had a good fit with the data. We selected the following absolute fit indexes: comparative fit index (CFI), normed fit index (NFI; also known as the Tucker−Lewis index, TLI), root mean squared error of approximation (RMSEA), goodness-of-fit index (GFI), and parsimony goodness-of-fit index (PGFI). A value of at least .90 is held to be acceptable for CFI and NFI (Bentler, 1992), and a value below or equal to .06 is acceptable for RMSEA (Hu & Bentler, 1999). Moreover, values greater than .50 and .90 are acceptable

for GFI and PGFI, respectively (Byrne, 1998; Gefen, Straub, & Boudreau, 2000). Taking into account the values we obtained (CFI = .897, NFI = .854, RMSEA = .063, GFI = .935, PGFI = .678), we can consider that the model presents a good fit to the data in relation to the aforementioned accepted value. Moreover, the Cronbach's alphas were .80, .65 and .70, respectively. Following Nunnaly (1978), an alpha coefficient between .62 and .92 is considered as an acceptable level of reliability.

The questionnaire also elicited information about respondents' demographic and education variables: sex; high-school diploma track; level of study; and learning domain.

Procedure

The students completed the questionnaire in their classrooms. They were invited to participate in the present study on a voluntary basis and signed a consent form. This form presented the research's general aim and asked for the students' consent to obtain personal information (high-school diploma track, years of study in higher education) registered through the Statistical and Inquiry Office of the university. Prior to this procedure, a declaration form was submitted by the researches to the data protection officer of the institution. It specified the various modalities for ensuring the ethical treatment of personal data. In particular, the manner by which the data would be anonymised was explained.

The questionnaire was administered collectively, and students spent 10-20 minutes answering all the questions. The period between September and October was selected for the administration of the questionnaire.

Data Analysis

We adopted three approaches to analyse the data. In the first stage, descriptive statistics were used to a) illustrate the participants' characteristics in relation to the demographic and education variables, and b) look for differences on each of the metacognitive dimensions in terms of demographic and education variables. In the second stage, we ran an analysis of variance (ANOVA) to identify the variables (education and demographic factors) that determined differences between the students' metacognitive processes of planning for writing. In the third and last stage, regression analyses allowed us to precisely establish whether students' demographic and educational traits predicted the metacognitive characteristics of their plan-

ning. For the all-of-data analysis, we used the Statistical Package for the Social Sciences – SPSS.

Results

First Stage: Descriptive Data and ANOVA Results

Table 3 sets out the mean metacognition scores according to the individual and education variables we considered. Because the data relative to metacognition scores were not normally distributed (Shapiro−Wilk for MCK $W = .89$, $p < .05$, CSF $W = .89$, $p < .05$, and ESR $W = .89$, $p < .05$) they were log-transformed beforehand in order to ensure normal distribution. We found that women's self-reported scores were higher than the men's for all three metacognitive dimensions. An independent *t* test showed that this difference was statistically significant for both MCK, [$t(1, 1499) = -2.44$, $p = 0.015$, $d = -0,14$], and ESR, [$t(1;1499) = -5.72$, $p = 0.000$, $d = 0.33$].

Table 3. *Mean scores for self-reported metacognitive components according to sex and education*

	MCK		CSF		ESR	
	M	***SD***	***M***	***SD***	***M***	***SD***
Sex						
Male	27.89	(5.31)	19.82	(3.78)	15.84	(5.11)
Female	28.55	(4.56)	20.21	(3.76)	17.52	(5.18)
High-school diploma track						
Vocational	24.71	(4.55)	19.45	(3.58)	17.29	(7.10)
Technical	26.83	(5.12)	19.43	(3.76)	16.09	(5.31)
General	28.68	(4.68)	20.21	(3.77)	17.15	(5.12)
Learning domains						
Human and Social Sciences	27.76	(4.70)	19.85	(3.77)	16.88	(5.19)
Language and Literature	28.07	(4.70)	20.19	(3.84)	16.41	(5.30)
Law and Economics	29.10	(4.73)	20.39	(3.73)	17.11	(4.93)
Science	28.53	(5.02)	19.96	(3.74)	17.86	(5.49)

Students with a *general* high-school diploma scored the highest on the MCK and CSF dimensions. When we carried out one-way ANOVAs to compare the three high-school diploma track groups on each of the metacognitive dimensions, we found that the self-reported MCK [$F(2, 1498) = 24.20$, $p = 0.00$, $\eta 2 = 0.03$] and CSF [$F(2, 1498) = 3.83$, $p = 0.02$, $\eta 2 = 0.00$] scores of students with a *general* high-school diploma were statistically significantly higher than those of students with a *vocational* or *technical* diploma (Table 3). It should be

noted that students with a *vocational* or *technical* diploma had the same self-reported CSF scores, while students with a *vocational* or *general* diploma had very similar ESR scores. However, students with a *vocational* diploma had significantly higher self-reported ESR scores than the other two groups, [$F(2, 1498) = 3.11$, $p = 0.04$, $\eta 2 = 0.00$].

Moreover, Law and Economics students scored higher on MCK than Human and Social Sciences, Language and Literature, or Science students. A one-way ANOVA showed that this difference was statistically significant [$F(3, 1497) = 6.46$, $p = 0.00$, $\eta 2 = 0.01$]. It should, however, be noted that the Language and Literature and the Science students' results were very similar. Tukey's Honest Significant Difference test tests revealed a statistically significant difference in scores between Law and Economics students and Human and Social Sciences students. There was also a statistically significant difference between Law and Economics students and Language and Literature students. Another difference concerned the ESR dimension where, as indicated in Table 4, the Science students had statistically significantly higher self-reported scores than the other three groups, [$F(3, 1497) = 4.11$, $p = 0.01$, $\eta 2 = 0.01$]. Turkey's HSD tests showed that Science students' and Language students' scores differed significantly. As for the CSF component, all the learning domains we considered had comparable self-reported scores (Table 3).

Second Stage: What Variables Interact with the Metacognitive Components?

We performed three separate, univariate ANOVAs for the whole sample ($N = 1501$), with the education and demographic factors as independent variable, and each one of the metacognitive dimensions as the dependent variable.

For the MCK component, this approach revealed a main effect of sex, [$F(1, 1499) = 12.31$, $p = 0.00$], with women scoring higher. We also found a main effect of learning domain, $F(3, 1497) = 3.15$, $p = 0.02$, with Law and Economics students scoring the highest, and Human and Social Sciences students scoring the lowest. Finally, there was a main effect of type of high-school diploma, [$F(2, 1498) = 15.60$, $p = 0.00$], in that students with a *technical* or *vocational* high-school diploma scored the lowest. For the CSF component, we only detected a statistically significant main effect for high-school diploma track, [$F(2, 1498) = 3.05$, $p = 0.04$]. In particular, having a *technical* high-school diploma negatively affected CSF scores, with this group of students scoring the lowest. By contrast, we observed several main effects

with respect to the ESR component. Specifically, there was a main effect of sex, [$F(1, 1499) = 18.76$, $p = 0.00$], with female students scoring the highest. Analysis also revealed a main effect of learning domain, [$F(3, 1497) = 5.45$, $p = 0.00$], with Science students having the highest self-reported scores.

Third Stage: Identifying the Determinants of Metacognitive Dimensions

We ran regression analyses to determine exactly how far the factors were determinants for the score obtained relative to the metacognitive dimensions (MCK, CSF, and ESR). In each case, the independent variables we entered into the regression were those for which the ANOVAs had revealed group-based differences on the metacognitive dimensions.

As shown in Table 4, sex continued to be a significant predictor of students' self-reported MCK scores. Being female was predictive of higher scores on this metacognitive variable. Moreover, two kinds of high-school diplomas, *technical* and *vocational*, were revealed to be statistically significant factors that determine variations of MCK, taking all other statistically significant predictors into account. It should, however, be noted that they appeared to be negative predictors, in that students with a *technical* or *vocational* diploma had lower MCK scores. This was more striking for the *vocational* high-school diploma (β = -0.142) than for the *technical* one (β = -0.066). Note, however, that the regression model (R2) indicated a weak contribution of these factors to self-reported level of MCK

Table 4. *Predicting students' MCK: relative contributions of previously established significant predictors*

Overall equation	**Adjusted R^2***	***F*** **	**Sig*** **	**Partial correlation**
	.04	11.70	.00	
Predictor	Beta	*t*	Sig	
Sex	.07	2.82	.07	.072
High school diploma track				
Vocational	-.12	-5.02	.00	-.127
Technical	-.11	-4.47	.00	-.112
Learning domain				
Language and Literature	.03	1.08	.28	.027
Law and Economics	.10	3.47	.01	.088
Science	.05	1.79	.07	.045

* R^2: Adjusted R-squared

** *F* corresponds to the variance ratio: intergroup variance/intragroup variance

*** *Sig* means the p-value or probability value

Regarding the CSF dimension, Table 5 shows that the *technical* high-school diploma was a (negative) predictor of this metacognitive variable. Students with a *technical* diploma had lower self-reported CSF scores than those who followed a different track at secondary school. However, the regression model (R2) showed a small contribution of the technical high-school diploma to the self-reported score of CSF.

Table 5. *Predicting students' CSF: relative contributions of previously established significant predictors statistically significant differences on the self-reported metacognitive processes*

Overall equation	**Adjusted R^2**	***F***	**Sig**	**Partial correlation**
	.00	3.34	.03	
Predictor	Beta	*t*	Sig	
High-school diploma track				
Technical	-.06	-2.39	.01	-.062
Vocational	-.02	-1.11	.26	-.029

Finally, Table 6 shows that sex continued to be a statistically significant predictor of students' self-reported ESR scores. Being female was thus predictive of higher scores on this metacognitive component. Additionally, being enrolled on a Science programme was a statistically significant predictor of ESR when all other significant predictors were taken into account. These results should be minimized, taking into account that the contribution of factors to the self-reported ESR scores was very low. Table 7 summarizes these results, indicating the education and demographic factors that determined statistically significant differences on the self-reported metacognitive processes.

Table 6. *Predicting students' ESR: relative contributions of previously established significant predictors*

Overall equation	**Adjusted R^2**	***F***	**Sig**	**Partial correlation**
	.02	11.91	.00	
Predictor	Beta	*t*	Sig	
Sex	.15	6.03	.00	.019
Learning domain				
Language and Literature	-.03	-1.05	.29	-.027
Law and Economics	.03	1.22	.22	.031
Sciences	.09	3.08	.00	.079

Table 7. *Summary of the significant predictors of the metacognitive components*

	MCK	CSF	ESR
Sex	+		+
High school diploma track			
Vocational	-	-	
Technical	-		
Learning domain			
Law and Economics	+		
Science			+

Discussion

A central result of the present study concerns the identification of sex as an important predictive variable of the metacognitive components of planning in writing (RQ1). The data revealed that the women students self-reported the highest scores on two dimensions: MCK and ESR. Female superiority in metacognition has already been demonstrated in the case of children and adolescents (Downing et al., 2013; Kizilcec et al., 2017; Veenman et al., 2014). Our findings confirm that metacognition continues to be determined by individuals' sex beyond adolescence, particularly for writing. We can explain the interaction between sex and metacognition in the light of Duckworth and Seligman (2006), Mau and Lynn (2001), and Meece et al.'s (2006) findings, by considering motivational and personality variables that characterize the female sex, such as greater interest in academic tasks, especially those involving written communication (Fryer et al., 2016), and the conscientiousness trait. As they therefore found the practice of writing in a learning context easier, our female participants may have acquired further and more varied knowledge about the conditions for successfully performing writing tasks. They may have been able to anticipate their writing processes by searching for information about the reader's expectations and by asking their peers to critique their plan of the text.

Lastly, the present findings are coherent with previous research results (Downing et al., 2013; Kizilcec et al., 2017), showing that women and men may differ with regard to certain self-regulation strategies, but be quite similar for others. In our study, no female superiority was found for the CSR component, probably because in France teachers and tutors strong-

ly encourage pupils, girls and boys, to engage in brainstorming and actively search for ideas before they start writing (Gicquel, 1993). This environmental factor may explain the absence of a difference between the two groups in relation to covert self-regulation strategy.

Another relevant finding concerned the interactions between school background and the metacognitive components of writing (RQ2). The three metacognitive variables differed according to the kind of high-school diploma. In particular, students with a *technical* or *vocational* diploma self-reported the lowest levels of both MCK and ECR. In France, these high-school diploma tracks feature a more practical training, related to work in the real world. Their courses are less theoretical and abstract than those included in the *general* track, and there are far fewer writing activities. A pupil following a *general* track receives more hours of French teaching (4 hr per week) than a pupil enrolled in either a *technical* (3 hr) or a *vocational* (2.5 hr) track (French Ministry of Education website). In other words, the learning and teaching processes involved in *technical* and *vocational* training are less based on reflective practices, language skills and general culture than those in the *general* track.

Considering that writing activities and theoretical learning are less of a priority in the *technical* and *vocational* tracks, we can assume that our students had had fewer opportunities to construct knowledge about strategies and different writing tasks in an academic context. Their limited writing practice meant that they had not been able to test enough strategies to monitor their cognitions when planning their writing tasks. Managing problem-solving situations and taking decisions is a precondition for developing metacognition (Bryce & Whitebread, 2012), particularly during writing. Thereby, the individual becomes awares of his/her knowledge and strategies needed to regulate the writing processes. However, we did not find any difference between the *vocational* and *general* tracks for scores on the ESR dimension, which may be in contradiction to what we have just argued. We can assume that this self-regulation strategy, which consisted here mainly of asking for help from peers or teachers in order to plan, is practised similarly across the different high-school tracks. Thus, the development of ESR seems to be less specific to a domain or learning task than the other metacognitive components considered.

The final education factor considered was learning domain (RQ3), our finding showing interactions between the Law and Economics and Science programmes and the metacognitive components. Students enrolled in one of the latter obtained the highest MCK scores. It

is important to point out that this domain mainly attracts students who followed a *general* track at secondary school, particularly the *social sciences and economics* stream. The fact that academic writing is extensively practised in the *general* track may explain the superiority of the students enrolled on a Law and Economics programme. The present results are consistent with Jia and Maloney's (2015) and Beekhoven et al.'s (2003) findings. These authors explained the interactions between learning domain and academic performance by arguing that certain programmes require considerable involvement from students (in terms of hours) in academic work per day and per week.

Finally, the Science domain was a factor inducing statistically significant differences on the ESR component. In the sciences, teachers probably encourage students to work together more during the learning process through pedagogic activities that have been traditionally named in France '*travaux dirigés'* (tutorials) and '*travaux pratiques'* (practicals) (Author, 2015). Both kinds of teaching practices are intended to promote the development of student autonomy through practical exercises or group projects.

Conclusions

The present study was intended to determine the interactions between sex and education variables (i.e. type of high-school diploma, learning domain, and level of study) with the self-reported metacognitive processes related to writing in HE. The data confirmed most of our hypotheses. First, participants' sex was a predictor of metacognition in writing (H1). The women students self-reported greater use of MCK and ESR strategies than the male students did, probably because women are generally more interested in academic writing than men. They could also encouraged by the cultural environment to practise writing in a more intensive and conscientious manner. Second, in accordance with our hypothesis, high-school diploma track determined statistically significant differences on the metacognitive dimensions (H2). However, further analysis showed that students having followed a *vocational* or *technical* track self-reported the lowest scores. We can surmise that the low priority given to reflective learning, writing practices, and theoretical content that characterizes these two tracks in French secondary schools, prevents students from developing metacognitive processes.

Third, concerning the interactions between the metacognition and the learning domain, we can confirm that this education variable induces specific variations in metacognition (H3).

However, results differed slightly from our hypothesis, given that the two learning domains where we assumed that students write more (Language and Literature and social and human sciences) did not have a positive effect on the self-reported level of metacognition in writing. By contrast, the Law and Economics domain determined variations in the MCK scores, doubtless owing to the students' secondary-school background. Similarly, the students enrolled in the Science domain obtained the highest self-reported levels of ESR strategies, doubtless because of all the collaborative learning these university students had engaged in since secondary school.

Limitations

Despite the contributions set out above, the present study had several limitations. For example, it only explored planning, thus neglecting other writing processes, such as revising. Future research should also adopt a broader approach to writing, in order to enhance current understanding of the different cognitive constraints of this complex cognitive activity.

Other limitations concern the methodology. Although metacognition is generally studied through questionnaires, it would be interesting to compare the data yielded by self-report inventories with online data. The latter would make it possible to explore the processes that are actually engaged, and not just those reported by participants.

In order to explore the question in relation to the factors that contribute to the development of metacognition among university students in greater depth, it seems necessary to consider family and personal characteristics, which we did not scrutinize in the present study. For example, parental education, family income and household composition may play an important role in the development of reflective processes. These factors certainly contribute to metacognitive development before students reach university.

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