

**Title**

Integration of sex and gender in interventions by students in ergonomics

**Running head**

Ergonomics Training

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**Abstract**

This article aims to analyze the integration of sex and gender (s/g) by ergonomics students during their internship at the master's degree level, following training sessions on s/g issues in the workplace. This exploratory research used a descriptive mixed-methods design, encompassing evaluation of students' intention to use the content from the training (n=13 students), and a multiple case study (n=5 ergonomics interventions). The results show that while students found the training relevant, they only minimally integrated s/g in their interventions and when they did, it was primarily from an anthropometric and physiological perspective. In addition to discussing the training format limitations, the article discusses barriers to this integration: combining learning about s/g issues with learning about activity analysis is challenging; employers' and workers' organizations may be reluctant to

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approach s/g issues; and it is difficult for an ergonomist to integrate these issues when the employer's request does not specify it.

### **Practitioner Summary**

This article aims to analyze the integration of s/g by ergonomics students during their internships. Findings show that they only minimally considered s/g. The discussion examines s/g training, organizational obstacles to inclusion of s/g during interventions, and how ergonomists can consider s/g in their practice.

### **Abbreviations**

EI : ergonomic intervention

SGBA+ : Sex and Gender Based Analysis Plus

s/g : sex and gender

### **Keywords**

Ergonomics intervention; training; sex and gender integration; obstacles to s/g integration

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## 1. Introduction

Activity-centered ergonomics is a scientific discipline that aims to understand work in order to transform it (Daniellou, 2005; St-Vincent et al., 2014; Guérin et al., 2021). A holistic vision of work is adopted and transformations are geared to human, organizational and technical dimensions of work. This approach fosters the development of "enabling environments" that are designed to support individuals' and groups' power to act in workplaces (Falzon, 2014). Considering this aim, the purview of ergonomics goes beyond the physical layout of workplaces, extending to a wide range of considerations, such as health outcomes or performance issues, many of which can be influenced by sex and gender (s/g). There are many reasons for ergonomists to consider s/g. Workplaces are horizontally (among jobs) and vertically (among hierarchical positions) stratified along s/g lines. S/g division exists between jobs, among tasks performed within the same jobs, in exposures while carrying out the same tasks, and in health outcomes resulting from the same exposure (Messing et al., 2003; Habib and Messing, 2012; Côté, 2016). However, Quebec laws governing the prevention and compensation of occupational risks and physical and mental health problems do not include any need or obligation to consider sex and gender.

According to Johnson et al. (2007), "sex is a multidimensional biological construct that encompasses anatomy, physiology, genes, and hormones that together create a human "package" that affects how we are labelled." **Considering sex in ergonomics** means considering the biological, physiological, anthropometric, reproductive or metabolic (particularly in regard to toxins) differences between female and male bodies through the entire process of work activity analysis.

"On the other hand, gender refers to the socially prescribed and experienced dimensions of "femaleness" or "maleness" in a society and is manifested at many levels" (Johnson et al., 2007). **Considering gender in ergonomics** means considering social factors linked to gender, such as divisions of labor and influences on health and performance, throughout the entire work process (Laberge et al., 2017; Messing, Laberge et Riel, 2021).

It is difficult to fully differentiate sex and gender because feminine and masculine attributes (gender) are influenced by biological characteristics (sex), and, inversely, life experiences and socialization can modulate people's biological or physiological characteristics (Fausto-Sterling, 2005). To capture this interaction, we use the expression "s/g."

The theoretical framework of ergonomics stipulates that people at work implement different strategies, behaviors and actions that translate into gestures, postures, reasoning, social interactions, etc., that ultimately appear in their work activity. Work activity integrates physical, mental and social components and is influenced by workplace determinants of work organization such as tasks and requirements, conditions and means, social environments, including s/g relations, and cultural aspects specific to a trade, including, again, s/g dynamics. Workplace determinants can act as facilitators or inhibitors, meaning that they can offer the operational leeway for people to grow, learn, develop their health and be productive, or, on the contrary, they can be detrimental. In this model, collective aspects of work are also important because they influence people's empowerment and, therefore, their work activity (Caroly & Clot, 2004; Riel, 2015).

It can be a challenge to integrate s/g considerations into ergonomic interventions. On the one hand, even though horizontal and vertical divisions based on s/g can put people's health in jeopardy, requests for ergonomic interventions rarely mention s/g issues (Chappert et al., 2014; Riel, Saint-Charles & Messing, 2017). Also, ergonomists themselves have long since advocated for an approach that does not focus on individuals but rather deleterious or harmful work situations (Vézina, Chatigny & Calvet, 2016). An emphasis on s/g could appear to be an approach centered on the individual. However, s/g analysis can in fact be applied to ergonomic interventions in order to identify work situations that contribute to inequity and therefore to potential harm to specific groups (Laberge, Blanchette-Luong et al., 2020). Determinants of work activity can be found in corporate subcultures,

social norms and values that contribute to the institutionalization of gendered roles and relationships among women, men and non-binary people within an organization (Ashcraft & Mumby, 2004; Rutherford, 2014). S/g is an important factor to consider, alongside others, such as the social constructs of race, ethnicity, social class, age, and ability, using an intersectional lens (Crenshaw, 1989). Optimally, s/g analysis can contribute to a better understanding of differentiated risk factors and the distribution of health problems within a population of female and male, feminine and masculine, workers.

This article presents the results of a study led by the "GESTE<sup>2</sup> for knowledge translation" team. GESTE's aim is to evaluate the relevance of considering s/g in knowledge translation interventions in occupational and environmental health. Because of the influence that s/g has on work and its execution, we suggest that integrating s/g into ergonomic practices should be taught as part of ergonomists' basic training. In Québec, this training is based in activity-centered ergonomics (St-Vincent et al., 2014; Guérin et al., 2021). Note that, to become a certified ergonomist in Canada, students must have completed undergraduate studies in a relevant field (e.g. industrial relations, rehabilitation sciences, physical activity, engineering), and then complete a master's degree and a certification process. The present article explores the uptake of s/g concepts and practices by ergonomics students exposed to specialized training sessions developed by the GESTE team.

The specific objectives of the present study were to 1) ascertain students' assessment of the relevance of the s/g training, 2) identify students' vision of and the meaning they attribute to "integrating s/g" in an ergonomic intervention (EI), 3) describe how students integrated s/g in their EI, and 4) explore barriers to considering s/g for ergonomics students.

## 2. Methodology

### 2.1 Research context

In Québec, two universities offer two-year master's programs in ergonomics, both based on the activity-centered approach to work analysis developed in French-speaking countries (Daniellou, 2005). The programs offer similar courses, and both require a one-year EI internship in a company. In both programs, the EI is defined as proposed by St-Vincent et al. (2014): *EI takes place within a given context, at a given time, with a view to transforming work situations to improve them in accordance with health and efficiency criteria. Ergonomic intervention involves the implementation of an organized system of actions carried out in interaction with the key players in the organization.*

Student EIs took the general form common to ergonomic interventions, in five steps defined by St-Vincent et al. (2014): 1) analysing the company request for the intervention, 2) conducting preliminary investigations of the work situation and the principal actors, 3) analysing a chosen, specific work situation and making a preliminary diagnosis, 4) moving from the preliminary diagnosis to an action plan (prioritisation of potential transformation projects), 5) conducting transformation projects. Steps 3 and 4 include many hours of observations of the work process in situ, whose conclusions are validated by discussions with the observed workers and their colleagues.

The process implies technical and social methods and strategies. On the one hand, there are tools that ergonomists use and develop to analyze work activity (technical methods and strategies). On the other, there is what ergonomists do to position themselves strategically with respect to workplace stakeholders in the decision-making process (Falzon, 2004). This latter, social dimension of the EI is an important part of the general training. Professors spend significant time developing this skill and companies that take on students are informed that students must and will develop an influential role at the decision-making level.

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<sup>2</sup> French acronym for "Gender, Environment, Health, Work and Equity"

## 2.2 Research design

The present exploratory research project used a descriptive mixed-methods design, simultaneously combining quantitative and qualitative methods and encompassing two complementary elements:

- (1) Descriptive quantitative evaluation of students' intention to use the content from the training, based on a questionnaire.
- (2) A multiple-case study (Yin, 2014), in which each case corresponded to the EI carried out by ergonomics students in a workplace. The qualitative data derive from interviews conducted with students and professors.

This project received ethics approval from the *Comité institutionnel d'éthique de la recherche avec des êtres humains* (ethics board) at UQAM (certificate number: 2442\_e\_2018). The language used by all participants at all times was French.

## 2.3 Co-development of training sessions with universities

Preliminary content for the training sessions was put together based on recommendations from the Canadian Institutes of Health Research (CIHR) (i.e., [Sex and Gender-Based Analysis](#)), the project lead's (ML) scientific experience (Laberge, Vézina & Saint-Charles, 2012; Laberge & Caroly, 2016; Laberge, Tondoux, Camiré Tremblay, & MacEachen, 2017; Laberge et al., 2020), previous research by GESTE team members (Vézina, 2010; Chatigny et al. 2014a; Côté, 2016; Messing, 2021) and intervention approaches developed by the entire research team (Laberge et al., 2016; Chatigny et al., 2014a and b). Researchers contacted professors at both universities to offer s/g training to their students. The training opportunity (themes, ways of engaging with the material, teaching tools, etc.) was discussed in meetings and through email exchanges, and professors were provided with opportunities to react and make suggestions to ensure that the sessions were coherent with the rest of the program.

To summarize, the training began with general definitions of the concepts of sex and gender and their interrelationships. In this part, sex and gender were not considered as variables, but as complex multidimensional constructs related to personal characteristics or gendered social determinants that influence work activity. Then, for each step of the ergonomic process, examples of ways to integrate sex and gender were given. For instance, the training includes illustration of how sex and gender influence the s/g division of jobs, tasks, working conditions, exposures and effects on occupational health and safety. These illustrations were extracted from studies by leading ergonomists and researchers who have analysed gender and work activity, such as Florence Chappert, Céline Chatigny, Julie Côté, Marie Laberge, Karen Messing, and Nicole Vézina. Research data were used to illustrate different mechanisms thought to be useful for understanding why s/g is important to consider in ergonomic interventions. Finally, it is important to mention that the proposed way of integrating s/g touched on both technical and social dimensions of interventions.

The training sessions were given by the principal investigator (ML) at both universities. Two sessions were given in each university: two hours at the beginning of the internship and 90 minutes at the preliminary diagnosis stage (mid-internship). The first session provided a general introduction to the inclusion of sex and gender in interventions, as described above. The second session reinforced content from the first session and provided suggestions on how to integrate s/g into the final steps of an EI. The second session ended with a round-table discussion about students' own experiences in their internship. In both sessions, interactive presentations were illustrated through case studies, videos and discussions.

## 2.4 Study participant recruitment

Seventeen students (ten from University A (UA) (five self-declared women and five self-declared men) and seven from University B (UB) (all self-declared women) and five professors (two self-declared women at UA and two self-declared men and one self-declared woman from UB) were enrolled or involved in the university programs. Two students did not finish their internship (one from each

university, including one who left before the last class). Each of these students were asked to join one or more of the following groups:

**Group 1** was composed of all the students from these two cohorts to whom we distributed a questionnaire to be filled out anonymously at the end of the last class (ten at UA and six at UB). At UA the questionnaires were distributed and collected in class. All ten students present returned a completed questionnaire. At UB, students left with the questionnaires after class. Researchers sent two reminders for the questionnaires and three of six sent them in. In total, 13 students responded to the questionnaire. Due to the anonymous nature of the questionnaire, responses in this group cannot be linked to the data from the qualitative study, and gender of questionnaire respondents was not identified.

**Group 2** consists of five volunteer students (one woman and one man from UA and three women from UB, all of whom finished their internship) who participated in a longitudinal follow-up of their intervention during the entire academic year. They were recruited during the first training session on s/g.

**Group 3** was composed of the five professors who supervised students from the two programs.

## 2.5 Data

The 13 participants in **group 1** filled out an anonymous questionnaire inspired by the 12-Item Theory-Based Instrument for continuing professional development (CPD) developed by Légaré et al. (2014) and adapted to the context of the present study. This tool was developed to study continuing professional development in health domains and included the following themes: beliefs about capabilities, social influence, beliefs about consequences, moral norms, and intentions. Considering the confidentiality requirements and the small sample size, no sociodemographic questions were asked.

The EIs conducted by the five participants in **group 2** form the units of analysis in the multiple case study. The EIs were subject to a longitudinal follow-up using several sources of data from the EI documentation, as well as semi-directed interviews conducted with students and professors. Documentation kept by ergonomists conducting EIs, sometimes referred to as EI traces, (Albert, 2018; Bellemare et al, 2001) “bear witness to intervention implementation, process development and the nature of relationships that emerge during implementation” (our translation, Rouat et al., 2019, p. 11). They could be coursework or documents submitted to the company where the intervention took place. Three individual, semi-structured interviews per student, lasting 90 minutes each, were carried out at the following points in time: 1) in the weeks following the first s/g training session, 2) after submitting the preliminary diagnosis to the company (which occurred after the second s/g training session) and 3) after the students' final presentation, given at the end of their internship. Table 1 presents the themes discussed in each of the interviews with group 2. All interviews were recorded and transcribed verbatim.

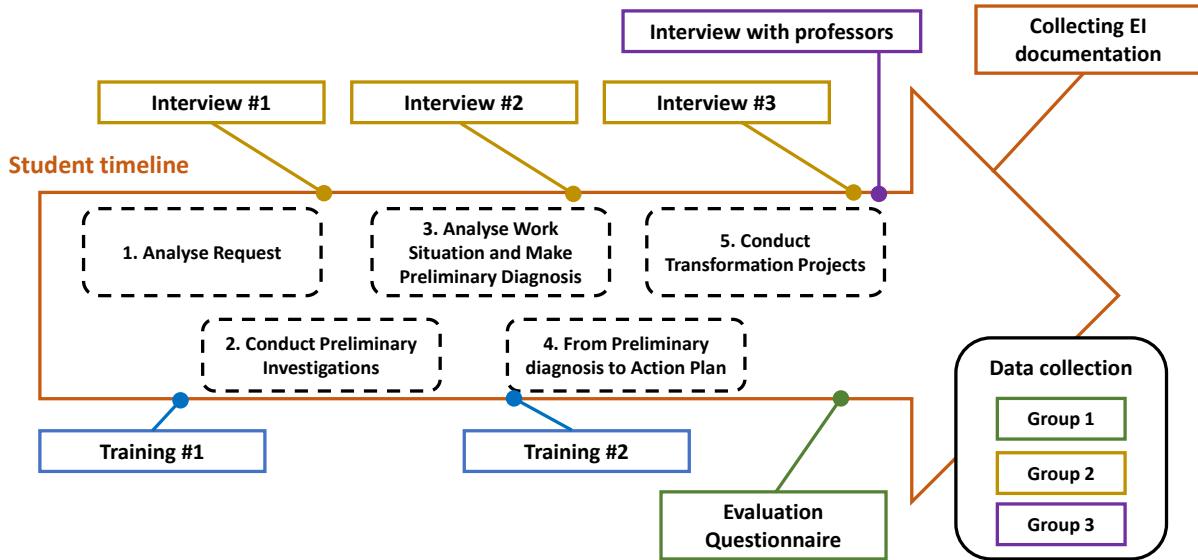
**Table 1.** Themes for the individual interviews with students from group 2

	Interview 1 <sup>1</sup>	Interview 2	Interview 3
Themes	Description and gendered composition of the company, request, participatory structures, issues and challenges during the intervention, stakeholders, jobs	Agreed-upon assignment, work activity analyses carried out, preliminary diagnosis, action plan, relationship with representatives, worker profile, organizational chart, issues and intentions with respect to integrating, or not, s/g	Feedback on the preliminary diagnosis, transformation project description, feedback on the intervention, perceived s/g issues, opinion of integrating s/g

<sup>1</sup> During this interview, no direct questions on s/g issues were asked, but the interviewer did ask for the gender composition of the workplace and interviewees were aware of the purpose of the study.

Individual, semi-structured interviews with the professors in **group 3** lasted about 90 minutes and were held at their university about two months after the students' final presentations. Themes covered included the value of adopting a s/g sensitive approach in ergonomics, their overall impressions of the cohort's uptake of s/g analysis, their opinion on the training of future ergonomists, the facilitators and barriers to integrating s/g in EI internships, and their views on the various EIs completed by the students (the five in group 2).

Figure 1 summarizes the various steps of the study.



**Figure 1.** Timing of the intervention and data collection from three groups of participants.

**Figure 1 Caption:** Visual timeline of both typical EI and study design

**Figure 1 Alt Text:** Illustration of parallel timeline of main steps of an ergonomics intervention (EI) (1-Analyse Request, 2-Conduct Preliminary Investigations, 3-Analyse Work Situation and Make Preliminary Diagnosis, 4-From Preliminary diagnosis to Action Plan, and 5-Conduct Transformation Projects) and key steps of this study design (training sessions, interviews with students, interview with professors, evaluation questionnaire, and continuous data collection of EI documentation).

## 2.6 Analyses

Students' assessment of the s/g training and their intention to use what they had learned were evaluated by compiling questionnaire responses (objective 1). We grouped scores into categories (see footnote of Table 2). The multiple case study was made possible by triangulating several sources of data collected from groups 2 and 3 (objectives 2 to 4). These data were triangulated using intervention monographs that grouped together all information on the same EI, with a particular focus on integrating s/g. Monographs (compiled by researchers) are a method of choice in case studies. Monographs gave a description of the context and reconstructed the EI, using several sources of documentation (reports, field notes, EI results according to transformation projects, etc.) and participant statements. They create a mosaic of information with (or from) all types of sources, mainly observations but also interviews, logs, reports, schoolwork, photos, etc. The technique allows the researcher to capture all traces of the participants' actions and uses triangulation to make sense of specific questions to be answered. In this study, three of the present authors (ML, MC and MI) read and analyzed such traces of the EI, as well as the transcribed interviews. This analytical work brought insights about ways in which sex and gender were integrated at each stage of the EI. (Yin, 2014; Eisenhardt, 1989; Leplat, 2002; Albert, 2018; Huberman & Miles, 2002).

## 2.7 Limitations of the study

For ethical reasons as well as partnership constraints, it was not possible to randomize students between two groups to evaluate the impact of training on s/g concept and practice uptake in EIs. One of the requirements of participatory research is a "negotiation" of the terms of the study (Bergold and Thomas, 2012). In this study, our partnership with professors of two universities required a concerted effort to harmonize our content with the approaches and knowledge already offered. One of the conditions imposed by this partnership was that it was not possible to offer two different training sessions to explore differences in uptake. Further, the quantity and complexity of tasks and knowledge students are required to integrate in their EIs would have made it impossible to ascertain whether the differences observed between the two groups were in fact due to the s/g training. That said, the qualitative interviews offered a rich understanding of the impact of the s/g training.

## 3. Results

We first present the students' assessment of the s/g training and then outline their use of knowledge and practices from the training during their EI.

### 3.1 Training assessment (group 1)

Table 2 shows that the students from both universities gave a generally positive assessment of the s/g training. It was deemed useful, of high quality and complementary to the other classes taken in the program. Items that were particularly positively received related to ethics (item 4), perceived usefulness (item 6) and perceived benefits (item 9) of such an approach. Most students who responded to the questionnaire revealed that they hoped to make use of the ideas learned in their future work and that they were confident that they would be able to do so. However, as item 1 shows, for several students, this favorable assessment did not translate into applying the concepts learned during their EI internship. They admitted to having undertaken few intentional actions to ensure that s/g be considered in their EI. Furthermore, they suspected that few of their peers had done so (item 13).

**Table 2.** Questionnaire results (n=13) (adapted from the 12-Item Theory-Based Instrument for continuing professional development (CPD) developed by Légaré et al., 2014)

Item	Question	Frequency of scores *			Mean
		1 - 3	4	5 - 7	
1	As part of my internship, I took specific steps to ensure that I integrated some of the principles of Sex and Gender-based Analysis	7	2	4	3.2
2	In my future practice, I intend to integrate the principles of Sex and Gender-based Analysis	3	2	8	4.5
3	With the training I received, I am confident that I will be able to integrate the principles of Sex and Gender-based Analysis in my future professional practice	1	3	9	4.8
4	I consider it ethical to integrate the principles of Sex and Gender-based Analysis to an EI			13	6.5
5	Integrating the principles of Sex and Gender-based Analysis is difficult/easy for me	3	5	5	4.2
6	In general, I think that integrating the principles of Sex and Gender-based Analysis in an IE is useless/necessary		2	11	5.8
7	I believe I would be able to integrate the principles of Sex and Gender-based Analysis in an EI		4	9	4.9
8	Care should be taken to ensure that all ergonomists are adequately trained to be able to integrate the principles of Sex and Gender-based Analysis		2	11	5.6
9	In general, I think that integrating the principles of Sex and Gender-based Analysis in an EI would be harmful/beneficial to me		1	12	5.9
10	The two s/g sessions are complementary to the courses received in the rest of the master's program		1	12	5.9
11	I learned concepts that I had not seen in other courses		2	11	5.8



Item	Question	Frequency of scores *			Mean
		1 - 3	4	5 - 7	
12	The two s/g sessions are relevant to my general training as an ergonomist			13	6
		0-40	41-60	61-100	
13	To the best of my knowledge, the proportion (%) of other students who integrated principles of Sex and Gender-based Analysis in their own EI is	12		1	N/A

\* Items 1, 2, 3, 4, 7, 8, 10, 11, 12: 1 to 3 = disagreement, 4 = neutral, and 5 to 7 = agreement;  
 Item 5: 1 to 3 = difficult, 4 = neutral, and 5 to 7 = easy;  
 Item 6: 1 to 3 = useless, 4 = neutral, and 5 to 7 = useful;  
 Item 9: 1 to 3 = harmful, 4 = neutral, and 5 to 7 = beneficial.

### 3.2 Multiple case study: Students' vision of, implementation strategies and obstacles to integrating s/g in their work (groups 2 and 3)

Even though students were interested in doing so, the questionnaire data demonstrate that they were less confident that they knew how to concretely integrate s/g considerations in their interventions. This result also emerged from the multiple case study analysis that we present here. Table 3 briefly summarizes the five monographs that constitute the material for this analysis.

#### 3.2.1 Students' vision of and the meaning they attribute to "integrating s/g" in an EI

Two main elements emerge from students' vision of how to consider s/g. **First**, integrating s/g seems to represent above all a consideration of anthropometric, morphological or physical differences between women and men (biological sex) and these factors are taken into consideration only if they are believed to exacerbate work challenges. **Second**, other factors such as work experience, qualifications, expertise, or job description, were considered more important to consider than s/g, or possible interactions with s/g.

For example, AS1 highlights that considering anthropometric, morphological or physical differences between women and men is important:

*I don't think I touched on s/g that much, except for the [height of the] table. For that, I looked at the smallest person, who was a woman, and the largest, who was a man. (AS1, woman)*

This vision of s/g is not surprising, considering that even a professor shared the same idea (from the other university):

*I'm more of an expert at the biomechanical level, the anthropometric level, with musculoskeletal disorders (MSDs). (...) I'd say that gender [mostly becomes an issue] at the anthropometric level, strength, physical exertion. (P4, woman)*

Several students suggested that considering s/g was random or accidental, as illustrated by the following passage:

*The barrel has almost 45,000 feet of wire (...) so I only saw it being changed two or three times at most. And it just so happened that it was women who were moving it those times. (BS3, woman)*

Student AS1 observed that some EI phases are more conducive for considering s/g. According to her, it is easier to do during transformation projects than earlier on:

*[Integrating s/g] that would be more likely in the solutions phase. You know, making sure that the solutions I propose are not just for women (...) or just for men. Like my adjustable table, we took into consideration the tallest man. (AS1, woman)*

Students' visions of integrating s/g seem to involve aspects linked to biological sex more explicitly than to gender. Thus, factors such as qualifications, experience or expertise are seen as important to consider but are dissociated from gender. For example, the student working in art restoration noted that men and women do not carry out the same tasks and are not assigned to the same works, but she believes this reflects a personal choice made during academic training, as illustrated in the following quote:

*The [artwork] conservators are spread out over seven workshops as a function of their training. So, if they had decided to do their master's on paper artwork, they can't work in the sculpture workshop. (...) you're at school, you decide, you say to yourself, "what's my passion? Is it wood? Textile? I think its X." (BS4, woman)*

Finally, we note that more systemic s/g issues related to power, decision-making (operational leeway) and gendered hierarchies, either horizontal or vertical, at the workplace were not mentioned, directly or alluded to, by any of the students or professors.

## Integration of sex and gender in ergonomic students' interventions

**Table 3.** Summary of students' EI context

	University A			University B	
EI Code	1	2	3	4	5
Student Code	AS1 – woman <sup>1</sup>	AS2 – man <sup>1</sup>	BS3 – woman <sup>1</sup>	BS4 – woman <sup>1</sup>	BS5 – woman <sup>1</sup>
Company	Farm and restaurant industry	Pharmaceutical industry	Non-profit adapted company	Government agency	Private assisted living facility
Sector	Agriculture	Production of pharmaceuticals	Industrial subcontracting, cable and harness manufacturing department	Conservation and restoration of artwork	Care and welfare services
Position	1. Cooks 2. Clerks at a snack bar 3. Christmas tree harvesters	1. Workers at merchandise delivery 2. Health and Safety Committee members 3. Workers at product preparation (weighing ingredients)	Workers: 1. cutting electric wires 2. splicing electric wires 3. putting together electric harnesses on panels	Conservators of: 1. paper artwork 2. wooden artwork	1. Patient attendants
Gendered composition of the population <sup>2</sup>	Significant gendered division of labor, positions 1 and 2 exclusively W <sup>3</sup> and position 3 exclusively M <sup>3</sup>	40% of workers are W. M primarily choose positions 1 and 3 and W choose 2.	Approx. 50/50; little information on the population given; several employees have disabilities of multiple types	24 W and 6 M in total; only one M in the targeted positions	70% W; little information on the population observed
Goal agreed upon	Improve overall working conditions for the three positions using a list of irritants evoked by workers	Analysis of the three positions and improvements to equipment (1, 3), training (2), procedures (1,2,3) and reorganization of workspace (3)	Understand and reduce constraints associated with the three positions considering the abilities of the workers and by improving workspace accessibility	Identify, evaluate and reduce the physical, mental and social burdens of conservators	Reduce physical, cognitive and psychosocial requirements while transferring residents, as a function of workers' experience and employment status

<sup>1</sup> (self-declared)

<sup>2</sup> As presented by students in their reports

<sup>3</sup> W-women; M-men

3.2.2 Ways of integrating s/g in EIs

Table 4 summarizes the actions proposed in the training sessions that were implemented by students as they integrated s/g into their EI. Information comes from the coursework and documents analyzed and interviews with participants.

**Table 4.** Actions taken to integrate s/g into student EIs\*

Actions aimed at integration		AS1	AS2	BS3	BS4	BS5	Tot
Actions taken in the context of report writing or coursework	Indicate the gender distribution of the company's overall workforce	X	X		X	X	4/5
	Indicate the gender distribution of (1) key stakeholders (members of different committees), (2) people observed or interviewed, and (3) positions observed	X	X	X	X	X	5/5
	Examine gender distribution of symptoms (pain, fatigue)	X					1/5
Actions taken during the EI within the company	Formulate an assignment that identifies at least one aspect related to s/g (e.g., examining a position considered 'feminine' even though the risks associated with it are less visible)	X	X	X	X	X	5/5
	Observe positions held primarily by women	X		X	X	X	4/5
	Observe women and men at the same job (if applicable)	X		X	X	X	4/5
	Identify risks specific to or influenced by s/g	X		X	X		3/5
	Carry out simulations with women/men or people with characteristics at the lower/upper limit of the parameter evaluated			X			1/5
	Recommend that the company carry out simulations with women and men				X		1/5
	Recommend equipment, models or standards for each sex separately, or that take into consideration the worker's sex	X			X		2/5
Total		8/10	3/10	6/10	8/10	5/10	

\* An X indicates that this action was noted at least once in academic work or interviews.

To integrate s/g into their academic work, students used a variety of strategies to render the s/g related dimensions of the study population visible. For the most part, students indicate the sex of the people they observed, with whom they interacted and who make up different committees. However, when students spoke more generally of a group of people, the gender composition was rarely described.

Here are some general elements that emerge from the results presented in Table 4:

- Students do not systematically specify s/g. Sometimes they do, often they do not.
- Students tend to specify s/g when the position is held by only one person.
- Initially, none of the requests from companies involved s/g issues, but after analyzing requests, all students formulated suggestions that could lead to considering s/g without explicitly naming it. For example, BS3 proposes to increase job accessibility to a wider population without specifying equity or recognition of women's work. Only AS2 has attempted to modify the request to better explore invisible risks in positions occupied by women, by making a part of this explicit, but his suggestion was refused by the company.

In addition, four of the student assignments involved positions held exclusively or predominantly by women. Nonetheless, these students did observe some men in these positions. That said, the students stated that this choice of observation was fortuitous, as highlighted in a previous passage (BS3).

AS1, BS3 and BS4 carried out comparative risk analysis between women and men in targeted positions for their assignments. AS1 observed that the repetitive wrist movements used by cooks, exclusively women, put them at risk, whereas among Christmas tree harvesters (all men) it was, instead, lumbar

extensions that put these workers at risk of developing MSDs. BS3 and BS4 observed differences in posture between women and men due to non-adjustable workstations.

Only BS3 intentionally carried out simulations to test solutions with women and men, which could have led to greater accessibility to the position, according to this student's professor.

*With the modifications she proposed to reduce the risk of mistakes, reduce standing, bending, handling issues, I think that, at least in terms of physical aspects, they'd favor the integration of women in the various positions. (P5, man)*

Finally, AS1 proposed adapted equipment for women and men in her recommendations ("female" model shoes, specific cutlery for each of the cooks, etc.) and BS4 proposed a suite of standards and guidelines for which anthropometric differences between women and men are considered.

### 3.2.3 Obstacles to integrating s/g in EIs

As mentioned above, no s/g issues were explicitly mentioned in company requests for interventions. In addition, students may have been resistant, afraid or embarrassed to discuss sex/gender issues, reluctance induced by their practicum social surroundings, possibly including their professors.

To improve accessibility to all jobs, AS1 mentioned having attempted to bring representatives to see how some stereotypes played out in the distribution of tasks, but she admits that she did not insist on the point, because she was embarrassed about being perceived as "too feminist". Thus, even those students who do consider s/g issues can feel uncomfortable about bringing them up explicitly.

Moreover, as mentioned above, students often considered factors such as age, experience, employment status, field of specialization or disability to be more relevant to their analysis than s/g. This posture may reveal a sort of hierarchy between the "authorized" factors that are considered to be part of sanctioned ergonomic analysis and those that are not.

Such reservations could be shared by professors, as illustrated by this passage:

*By giving a one-hour presentation on s/g, it's as if we're saying, among all the aspects you observed, we think this one is the most important. But if the assignment has no connection to that, they can't forget that there are other aspects that are also important. (P4, woman)*

Student AS1 expressed discomfort in taking up s/g or in attempting to apply an analysis that would be perceived as political or feminist, as opposed to scientific. In fact, she shared that when she talked about it with her boyfriend, he said: "This whole thing is so feminist! Could we just stop wanting to put women everywhere and be equitable, already?"

The fact that the training targeted novice ergonomists was perceived as another obstacle. Students are required to develop expertise in work activity analysis, while at the same time acquiring a sensitivity to the nuances of s/g.

*We had trouble [explaining the concept of individual task adaptations], whether it be with men or women... (P4, woman)*

A s/g lens was more often applied to the physical aspects of work than to the cognitive or social aspects. Professors deemed it "normal" that s/g was less prominent in analyses on cognitive load (as opposed to physical load).

*For both [students, including BS5] ... they were clearly interventions less focused on physical aspects, and much more focused on the cognitive. I don't know if it's because it was more at the cognitive level that we didn't look so much for differences between men and women (P4, woman)*

Participants also called into question the format of the training offered. Several students claimed that they had trouble applying the content of the s/g training because there were not enough reminders

during the course of the intervention. P2 (a man) suggested that the training should not be given too early because that "could lead to failure." The professors highlighted that the training was not well enough integrated into the rest of the program and the students expressed a feeling of being overwhelmed.

*We kept it [s/g] in mind, but sometimes we forgot (...). We were so concentrated on our projects (...) so maybe we thought about it a lot less. So maybe it would be good to have more reminders. (BS3, woman)*

Finally, several professors admitted that they themselves had little experience in applying s/g analysis, making it difficult for them to accompany students.

## 4. Discussion

Our first observation is that the participants confirmed that the s/g training responded to a need, was appreciated and was seen to be complementary to the rest of the ergonomics program. All students, albeit to differing degrees, integrated some of the suggestions offered during the training, for example, describing the gender composition of the worker population. Others carried out s/g disaggregated analyses, targeted positions that were held primarily by women, carried out simulations or made recommendations for all that took s/g into account. That being said, s/g was ignored in other situations where it could have been relevant, especially when hostility to s/g analysis was manifested or anticipated, or when other factors were perceived as taking precedence (experience for S1, disability for S3, area of specialization for S4, employment status and ethnicity for S5). Students did not fully appreciate the ways in which the other factors could intersect with s/g. Further, both students and professors often restricted "considering s/g" to looking specifically at work attributed to women, without necessarily reflecting on the mechanisms or the reasons behind a gendered division of tasks. This was also illustrated by the absence of statements related to gendered power differentials in interviews with participants. These results corroborate observations by Messing (2021).

A final point on students' characterization of worker populations is warranted. We observed that when students referred to a group of workers, they rarely deemed it necessary to describe the gendered composition of the population. However, when they described a particular person or position, they almost always noted the s/g of the worker. This is another indication that s/g is still seen primarily as an individual characteristic without systemic correlates, such as being the cause of or pretext for a division of tasks or for power differentials.

In terms of strategies, we observed at most ten strategies for considering s/g that were developed or partially developed by students, whereas the training had suggested a much wider range of strategies (e.g., considering the influence of job culture on risk factors, systematically taking into account gender composition of tasks or assignments in analyses, systematically assessing the impact of solutions on women and men according to a SGBA+ approach, adapting previous knowledge to a s/g framework).

The fact that students identified gender-based task distributions in workplaces without necessarily trying to analyze their workplace determinants limits possibilities for transformation projects. These topics are not easy to bring up with companies, especially in the context of a contractual relationship between ergonomists and their clients, when the clients are employers (Vézina, Chatigny & Calvet, 2016), and they are even harder to broach when the ergonomist is in training. How does one propose differences in treatment between women and men in a work collective without jeopardizing the cohesion necessary to ensure individual and collective health (Caroly and Barcellini, 2019)? How can observations of this nature be used by ergonomists in their interventions without endangering the indispensable alliance between practitioner and client (Vézina, Chatigny et Calvet, 2016)? The training offered to students suggested integrating these questions into the intervention at the social level, putting into place intervention strategies that enable the company to see for itself the challenges that arise from the inequities built into its own mission. However, this material seems to have been

particularly difficult for these ergonomists-in-training to integrate. The social dimensions of EIs are, indeed, some of the harder ergonomic concepts to learn. It is possible that adding transformation of s/g determinants to this already difficult construct is not immediately accessible to everyone.

Overall, students found the training interesting in principle (equity, social justice), but did not always see the relevance of bringing s/g considerations to the fore in their interventions. This conclusion is not surprising because the professors did not always see a benefit, either, nor did they feature knowledge related to s/g prominently in their teaching. Even more experienced and trained ergonomists can be easily distracted from thinking about social categories during an intervention (Messing et al., 2021).

The difference between the high Likert score (6.5) for the aspirational question on whether it is ethical to integrate s/g compared to several of the action-oriented questions that received more average scores, shows a dissonance between what practitioners new to the field would like to be able to accomplish and what they feel they are able to accomplish either based on their skills or the larger structural factors influencing their work. This gap between transformational values and the realities of practice has been noted in social work (Higgins, 2015) and has been referred to as the "ideal/real" gap by Jack and Donnellan (2010). If this gulf between what is taught and what is practiced persists, the risk is that of the emergence of a "hidden curriculum", missing important elements, but based on an "underlying culture" of practice (Higgins, 2015). If so, teaching students to engage in critical and reflective practice throughout their work can help them recognize and understand dissonances when they arise (Higgins, 2015). In other domains, such as engineering, educational research has shown that this kind of practice contributes to a practitioner's ability to close the gap between the need to gather information to understand a problem and the need to minimally understand the problem to gather relevant information (Adams et al., 2003).

For many students, their end-of-studies EI is the first time that they will carry out an intervention, and sometimes it is even the first time that they are in a workplace. Both ergonomics programs offer students several reflective tools to help them transforming certain preconceptions such as the meaning of work or offer them mobilization strategies for orienting an intervention. Faced with these complex tasks, student may see the construction/deconstruction of s/g issues as a significant challenge.

In summary, the following obstacles to integration of s/g analysis were encountered:

- s/g training was not accompanied by follow-up with regular feedback
- the researcher responsible for giving the s/g training was external to the program and was not involved in other training spaces within the programs
- the absence of reflective tools specifically addressing s/g considerations, combined with the other challenges of their first intervention may have caused students to "forget" to consider them.
- obstacles and objections to considering s/g were encountered in the workplace or feared
- the development of a critical view of s/g's influence may be outside the students' zone of proximal development, meaning that, despite their interest in the training, they may not yet be ready to undertake such analysis. (Wertsch, 1984)

These hypotheses are consistent with similar observations made in the larger field of professional development, to the effect that the success of training is strongly linked to learners' motivation to absorb and use knowledge from the training (Dunberry et Péchard, 2007) and also to the resources at their disposal that support them to apply what they have learned (Denis, 2016).

As we were developing the s/g training content in collaboration with professors from the two programs, we observed that they had some concerns regarding the evaluation of students' ability to integrate external information in their EIs. Professors did not want the quality of the ergonomic interventions to be called into question based on the integration, or not, of s/g considerations. In fact, they did not want students to systematically bring to the fore this dimension. From their perspective,

not taking s/g into consideration is an acceptable posture if the company is not disposed to accept it. Note that no student was sanctioned for failing to consider s/g, nor were professors asked to do so. Thus, the content of s/g training (which knowledge to include), harmonization of s/g analysis with other aspects of the project, prioritization of s/g when other considerations (e.g., age, experience, ethnicity or disability) seemed more relevant to the students, and the mentorship that this would require, were all questioned by the professors, albeit to differing degrees. We were aware of these reservations, and we clearly indicated to students that taking s/g into account would not be included in their evaluation. The professors admitted that they did not reinforce the s/g content in their ongoing accompaniment of students, even though some expressed an interest in eventually integrating it.

Considering the limited uptake of s/g in student interventions, we wonder whether the training offered was sufficient or well-placed during the professional development cursus. Several questions remain to be answered: Did the content respond to the needs of ergonomists-in-training? Were the length and frequency of sessions appropriate? How should these notions be integrated into the rest of the program? And, most importantly, what level of knowledge is necessary to ensure that future ergonomists are able to at least minimally take into account s/g in their initiatives to create more equitable working conditions for women and men and thus, better conditions for all? For example, clearly identifying the gender distribution in jobs is considered to be a basic element of s/g analysis, yet students did not apply it systematically. Why was it overlooked? We are led to examine the role of mentorship in encouraging students to develop a reflective practice that promotes the integration of s/g in interventions. This constitutes a theme to explore further: how to stimulate reflectivity among novice ergonomists.

### **4.1 Contributions of the study**

This study leads us to question the genuine possibility for ergonomists, especially those in a contractual relationship, to integrate s/g issues into their efforts to improve working conditions, let alone effect gender transformation in the workplace. The World Health Organization (WHO, 2011), lays out different levels of s/g integration in efforts to improve equity and health in organizations in a practical guide. The continuum starts at a baseline level where injustices are perpetrated and justified by recourse to stereotypes, going through various stages to a level at which deconstruction processes lead to transformations of gendered roles within the organization. To be able to question gendered dynamics, one first has to identify them, understand their underlying mechanisms, model them and communicate them to the company. This exercise requires several ingredients: knowledge, tools, the will to develop a reflective practice that highlights one's own unconscious biases and preconceptions, and commitment to engage in a truly transformational evolution with the company. It is particularly with respect to this last point that ergonomists can hit a wall (Chappert et al. 2014).

Indeed, transformation of s/g dynamics presupposes that one has clarity and agency regarding the structural determinants (standards, roles, relationships) of the studied system (WHO, 2011). It is essential to have the operational leeway as well as the legitimacy and knowledge to start a critical conversation about workplace drivers of inequality. The stance of integrating s/g questions into interventions is one that enlarges the practitioner's perimeter of action from performance and health in work situations toward a critical and political appraisal of the causes of gendered roles and relationships. This can be difficult to champion when operating in the context of a business/professional practice geared towards the client organization's self-defined short-term needs and benefits.

### **4.2 Future perspectives**

In the field of ergonomics, s/g continues to be invisible in comparison to other factors, such as age or experience (Messing et al., 2021). Yet s/g does not have to come into competition with other factors and, as one of our most basic and universal systems of categorization, should not be seen as an "optional" consideration. S/g is nested transversally in all other identity and positional factors, it is



present in all cultures, territories and spheres of activity (at and outside of work). Sex and Gender-based Analysis Plus (SGBA+), as promoted by the governmental office of Status of Women Canada, suggests that s/g should be taken into account *alongside* other relevant positionalities in all projects and programs, rather than in opposition to other factors that may seem more closely applicable to the analysis (Government of Canada, 2021).

SGBA+ training could eventually become part of the official accreditation process for ergonomists. This addition to the program could enable ergonomists to accept assignments reserved for Equity, Diversity and Inclusion (EDI) specialists. Many companies are currently expressing a willingness to emphasize EDI in their recruitment, staffing, training and even promotion and professional development processes. Offering such services would be innovative, yet valid in that it is compatible with the goal of ergonomic analysis, that is, to analyze work in order to transform it so as to preserve and promote the health of people and organizations. To this end, several strategies could be put forward, such as the development of a code of ethics for the profession, training for trainers, the development of reflective tools for the analysis of biases and preconceptions with a view to deconstructing them, and the development of ongoing professional training involving mentoring between experts and novices. The establishment of a community of practice, such as the ones developing within the technical committee "Gender & Work" of the International Ergonomics Association, could also contribute to this goal.

## 5. Conclusion

This research was directed to understanding how students integrated questions surrounding s/g in their interventions following training specifically on this topic. Despite positive assessments of the training, integration remained superficial, and manifested essentially as a depiction of differences (particularly anthropometric) between women and men. This finding is not surprising considering the significant challenges that more experienced ergonomists have faced while attempting to integrate s/g in their interventions (Messing, 2021).

This study has provided a number of indications for further research. First, the training format and ongoing involvement of professors could be improved. There is ample room for ergonomists to develop reflective tools to accompany the technical and social dimensions of an intervention focused on social justice and equity. Tools and ideas are also needed to overcome the resistance found among workplace participants, students and university professors. Finally, this study invites us to critically examine the role of ergonomists: Can they become social critics, while maintaining their expertise and mandate to improve working conditions? It seems to us that employers and others who request ergonomic interventions could be key to changing practices by welcoming the opportunity to concretely apply principles of equity, diversity and inclusion.

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