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[1]Le ministère de l'Éducation, du Loisir et du Sport (MELS) a changé de nom pour devenir le ministère de l'Éducation et de l'Enseignement supérieur (MEES).

[2]Le 1er janvier 2016, la Commission de la santé et de la sécurité du travail (CSST) est devenu la Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST).

ABSTRACT

A number of studies have shown that limited job experience, which often applies to young workers, is associated with an increased risk of occupational injury. Among young workers, those most likely to injure themselves at work are youth who dropped out of school without a high school diploma, those who perform manual labour and those who have documented learning disabilities. In 2007–2008, the ministère de l'Éducation, du Loisir et du Sport (MELS) set up a training program for semiskilled trades (TST) addressed to young people considered to be more at risk of sustaining an employment injury. In this program, students aged 15 to 17 took part in work placements of 375 hours spread over one school year.

In Québec, the *Act respecting industrial accidents and occupational diseases* defines an industrial accident as "a sudden and unforeseen event, attributable to any cause, which happens to a person, arising out of or in the course of his work and resulting in an employment injury to him." This study focuses on unforeseen events experienced by the students during their traineeships. The unforeseen events could be either totally new events or familiar ones whose occurrence is unpredictable. An unforeseen event disrupts the normal working day of a trainee and may under certain circumstances result in an incident or even a workplace accident. In fact, an unforeseen event can be intrinsically a health and safety risk for a trainee, for example, a trainee dishwasher in a restaurant who injured his hand when he broke a glass he was washing. Variations in the trainee's activity caused by the unforeseen event also cause risks. An example of that is a trainee printer's assistant who burned himself when trying to restart a film-sealing machine that had stopped working a few minutes before. To deal with unforeseen events, trainees must implement strategies that may be more or less adapted to the situation, depending on their experience.

The goal of this research is to identify and categorize the types of unforeseen events that occur, their immediate causes, the strategies observed to deal with them (both individual and collective), and to document the consequences of the work activity, such as loss of time and risk of injury. To do this, observational data taken from video sequences gathered during the previous research on nine trainees over two days of their traineeship were analyzed (T1 et T2). These nine trainees worked in diverse sectors of activity: commerce, industry and food services. The conceptual framework used for these analyses is the model of the work situation focusing on the individual at work, which is used in ergonomics.

The research results showed that the nine students were faced with various types of unforeseen events, related to the sector of activity of the business in which they were doing their traineeship and the type of task they were performing during the observations, in proportions that were quite similar at the beginning (T1) and at the end of the traineeship (T2). They encountered a total of 554 events during these two days. Almost 10% of these unforeseen events caused losses of time and about 19% of them involved risks for the trainees' health and safety. Over half of the events that had the potential to cause an accident were associated with certain work contexts of three of the trainees, i.e., the woodworker, the inventory clerk in a household appliance and electronics store and the butcher's assistant. The results indicate that these three students had to handle heavy objects. Among all of the types of unforeseen events observed, handling difficulties are in fourth place, but they were in first place in unforeseen events associated with a risk of accident.

In addition, the action or the work technique used by the trainee is often called into question in unforeseen events that may be associated with a handling activity. This helps to establish links with the numerous studies that have shown that the handling know-how of experts develops with experience.

To deal with these unforeseen events, the students were able to use individual strategies only, collective strategies only or both. However, in most cases, they took the initiative of implementing individual strategies. They tried to find their own ways of dealing with the situation alone, instead of asking for help. Thus, they tried to resolve problems caused by unforeseen events, performing additional tasks to fix an error. Only the three students (printer's assistant, butcher's assistant, and cook's assistant) who benefited from a richer social environment used more collective strategies proportionally than the others. These collective strategies were mainly initiated by their co-workers, who gave them training after an unforeseen event to help them complete the task. The occurrence of an unforeseen event thus constituted a learning opportunity.

Several suggestions could be made to organizations using the results of this study:

- Analyze certain categories of unforeseen events that can increase the risk of accidents, in order to suggest preventive mechanisms to deal with them;
- Provide novices with learning opportunities that gradually increase the level of complexity and sources of constraint;
- Enrich workplace training by simulating unforeseen or sudden but credible situations that provide trainees with the opportunity to implement adapted strategies under supervision and with feedback;
- Specifically analyze the handling tasks that novices may have to carry out and adopt training strategies;
- Consider the importance of motor skills in learning during training, and plan ways to encourage the transmission of useful knowledge for learning skills and efficient operating methods;
- Pay special attention to people in the workplace who could pass on their work-related knowledge, thus contributing to the development of reflexive skills.

The results of this research will be integrated into a project to establish occupational health and safety learning tools for TST students. These tools will complement training material for both the teachers responsible for implementing them, the students, and the companies that receive and train them.

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CNESST :	Commission des normes, de l'équité, de la santé et de la sécurité du travail [Quebec occupational standards, equity, health and safety commission] (formerly the CSST)
IRSST :	Institut de recherche Robert-Sauvé en santé et en sécurité du travail
MELS :	Ministère de l'Éducation, du Loisir et du Sport (Québec government department of education, recreation and sport)
MSD :	Musculoskeletal disorder
OHS :	Occupational health and safety
PPE :	Personal protective equipment
TST :	Training in a Semiskilled Trade

1. INTRODUCTION

In 2001, the Commission de la santé et de la sécurité du travail (CSST) launched its youth action plan to improve the employment injury prevention rate in young workers aged 15 to 24. Since then, the frequency of employment injuries in Québec has been in constant decline, especially with respect to young people. Nevertheless, in 2012, approximately 11,500 young people were injured in the workplace (CSST, 2013). Young workers who have dropped out of school before getting a high school diploma, who have learning difficulties and who work in manual jobs remain particularly vulnerable to employment injuries, mainly because of the jobs that they do and the fact that they often lack experience (Gervais et al., 2006; Breslin, 2008; Breslin and Pole, 2009).

In 2007–2008, the ministère de l'Éducation, du Loisir et du Sport (MELS) implemented a training course for semiskilled trades, entitled *Training for a Semiskilled Trade* (TST), addressed to those young people considered most at risk of sustaining an employment injury (MELS, 2008). In the program, the students have the opportunity of learning an unspecialized trade through a vocational integration placement of 375 hours over a school year. The 129 trades targeted are mainly manual and are in the ministry's list of semiskilled trades (MELS, 2014). Several of these trades correspond to the low skill jobs that the majority of adolescents and young adults do during their school years (e.g., grocery store clerk) (Laberge et al., 2011). These are jobs with manual tasks that have known risk factors, such as handling or use of chemical products (Laberge et al., 2010). According to Smith and Mustard, (2007) only one worker in five receives occupational health and safety training during his or her first year at work and this training is often not provided by businesses that carry out activities involving high occupational health and safety (OHS) risks.

The results of previous action research (Laberge, 2011) showed that, during a traineeship, TST students regularly experience new, variable, atypical or unforeseen situations without necessarily having the appropriate means to deal with them. Sorock, et al. (2001) demonstrated that the use of defective or new equipment and the execution of unfamiliar tasks increase the risk of injury. The *Act respecting industrial accidents and occupational diseases* defines an industrial accident as "a sudden and unforeseen event, attributable to any cause, which happens to a person, arising out of or in the course of his work and resulting in an employment injury to him." An unforeseen event thus constitutes a source of risk to the occupational health and safety of students in traineeships. Students must learn to manage this type of situation, however, because it could occur during traineeships or in their future jobs. Nevertheless, questions persist, especially with respect to understanding how work experience is constructed through unforeseen events. It is therefore important to document the strategies of novices when they face unforeseen or atypical events during their traineeships in semiskilled trades and with respect to the learning conditions in the workplace.

The conceptual framework used in this research, like the previous action research, is the model of the work situation, focusing on the individual at work (suggested by Vézina in 2001 and adapted by St-Vincent et al. in 2011). In this conceptual framework, the occurrence of an unforeseen event is interpreted according to the determinants of the activity being carried out, the strategies used to deal with it (regulation of the work activity) and the consequences for health

and productivity that stem from it. In this research, unforeseen events are considered as learning opportunities, but ones that could become risky situations in terms of occupational health and safety, depending on the conditions and context of the work being performed.

This research aims to

- identify and categorize the types of unforeseen events, their immediate causes (which may be due to the work context or to the characteristics of the person involved in the activity), in addition to the responses and strategies observed in the learning situation (activity), whether individual or collective;

- understand what this means in terms of risk of injury and consequences on productivity (loss of time).

This study will make it possible for avenues to be suggested to improve training on this aspect of skills development, particularly in terms of conditions that will foster the health and safety of novice workers.

2. STATE OF KNOWLEDGE AND RESEARCH

2.1 Youth and Occupational Health and Safety

Among the injuries most frequently suffered by young workers under the age of 24 are sprains, injuries caused by overexertion, fractures, cuts, burns, bruises and lacerations (Runyan and Zakocs, 2000; Jackson, 2001; NIOSH, 2004; Zierold et al., 2004; Breslin and Smith, 2005; Zierold and Anderson, 2006; Breslin et al., 2007; Walters et al., 2010; CSST, 2013). The industrial sectors with the highest risks of injury for young workers are those where young workers are found in large numbers and where accidents are frequent (such as commerce, accommodation, food services, manufacturing, healthcare and social assistance), or where young people are injured more often than older workers, even though they are not necessarily present in large numbers (such as forestry, fishing, mines, transportation and storage, construction, business services and services related to buildings) (CSST, 2013).

What are the reasons young people are injured at work? Breslin et al. (2007) carried out a systematic review of quantitative studies that measured a causal relationship between certain risk factors and employment accidents affecting young people. They showed that employment-related factors (type of job, presence of risk factors, experience, workload and pace) are more important than individual factors (gender, age, personality). Breslin and Smith (2010) question studies that predominantly attribute the risk of injury to developmental factors (maturity, growth). On the basis of numerous convincing scientific results, they explain that these young people are more often employed in types of jobs and working conditions that are known to involve an increased risk of occupational injuries.

Although the rate of occupational injuries in young people has dropped since 2000, certain groups of young people remain more susceptible to injuries in the workplace. These include the youngest workers, aged 15 to 19, who are no longer in school and who are working full-time (Gervais et al., 2006; Breslin, 2008), and those with learning disabilities (Breslin and Pole, 2009). According to Godin et al. (2009), the risk of occupational injuries is, in fact, higher among young people who did not graduate from high school. The Institut de la statistique du Québec also indicates that workers with a higher education level proportionally incur fewer injuries at work (accidental injuries and repetitive strain injuries) (Camirand, 2013). The main reasons given in the literature relate to different working conditions among people depending on their educational level. A study by Breslin (2008) revealed, however, that these differences persist even after controlling for certain employment-related variables (job category, hours worked).

Most workplace accidents occur during the first month on the job (Morassaei et al., 2013). In fact, whether the worker is young or older, the risk of injury is four to five times higher during the first month on the job than after one or more years (Breslin and Smith, 2006). Many young people change jobs frequently and therefore often find themselves in the situation of being a new employee (Godin et al., 2009). Nevertheless, only a minority of youth say that they worry about workplace accidents, as revealed by the results of a survey sponsored by the Association of Workers' Compensation Boards of Canada (AWCBC) and Ipsos-Reid (Legault-Faucher, 2005). In addition, it appears that young workers do not always report their occupational injuries to the

CSST (Ledoux et al., 2008; Vézina et al., 2011; Laberge et al., 2011), which suggests that the numbers of young people who have sustained an occupational injury could be higher than what the official statistics reveal.

2.2 Occupational Health and Safety and Unforeseen Events

In terms of occupational health and safety, young workers are at greater risk for many reasons, which have been extensively documented by Salminen (2004), Breslin et al. (2006, 2007, 2008, 2009, 2010), and by Laberge and Ledoux (2011). Among others, an important factor in explaining this vulnerability in youth lies in their limited work experience (Breslin and Smith, 2006). In the scope of this study, the accent will be on coming to a more comprehensive understanding of the relationship between experience and OHS, by studying the observable conditions and strategies deployed when an unforeseen event occurs for students learning an unspecialized trade. Before dealing with this question, the term "unforeseen" must be defined.

2.2.1 Variability at Work and the Notion of the Unexpected (Unforeseen Events)

St-Vincent et al. (2011) defined variability as: "[e]verything that produces changes in the work, whether anticipated or not, and that affects people's ways of doing things. The variability between people that can be seen in their activity is also present in a single individual, who changes over time." Here, the term covers the following types of variability:

- inter-individual, meaning among workers;
- intra-individual, meaning the changes in an individual's condition over time (level of fatigue, for example);
- work situations.

Guérin et al. (2007) perceived two categories of variability in working situations:

- "normal variability, due to the type of work performed." This category includes seasonal variations in volume of production and client demand, and the range of products and services offered by a company. Variations of this kind are in part predictable, but how they affect workers may be "more or less expected […] more or less brutal, and their consequence on production operations may be foreseeable to a greater or lesser extent." (Guérin et al., 2007);
- "incidental variability, such as a poorly finished part which cannot be assembled, a tool which breaks…" This second type of variability, which is not predictable, is close to the Larousse dictionary (2014) definition of *aléa* (unknown quantity, uncertainty), in the sense of a usually disadvantageous unexpected turn in the course of events, related to an activity or an action.

According to Perrenoud (1999), who studied the issue of managing the unexpected in the context of learning, "the unexpected is always related to a concrete subject and cognitive processes that are simultaneously situated in the context of the activity, social relationships, and the physical framework, and limited by the operators' knowledge and know-how, the information they possess, and the physical and psychosociological conditions under which they think and act: stress, fatigue, pressure, risk, conflicts, etc." [free translation]. According to the author, there are two types of unforeseen events:

- First type: expected events, but for which the moment of occurrence is unknown. These are called relative unforeseen events;
- Second type: unusual events.

2.2.2 Unforeseen Events and Disruption in the Course of Action

An unforeseen event corresponds to a disruption in the normal course of action, as described by Leplat (2011): "the course of the action can be interrupted by an internal (distraction, memory failure, etc.) or external event (an exceptional obstacle, a more urgent task to be performed, etc.). This is referred to as a disruption." [free translation]. The author explains also that this disruption can have diverse consequences. Either the operator interrupts his or her activities and then starts at the same place as before the disruption, or the action following the disruption is different than the normal course. The disruption in the normal course of action and its consequences is represented in Figure 1, below.

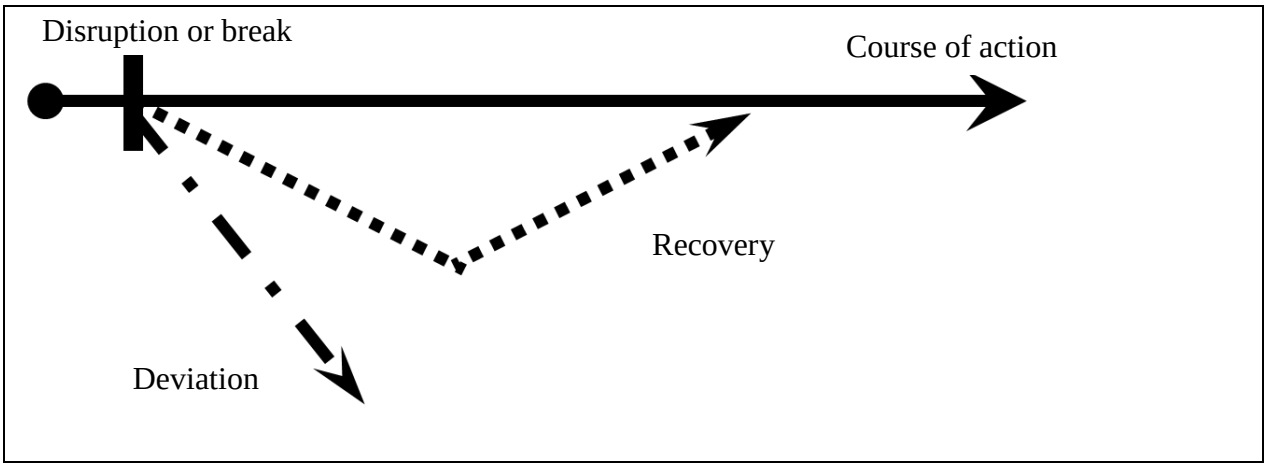

Figure 1 – Representation of disruption in the normal course of action, according to Leplat's model in *Mélanges ergonomiques : activité, compétence, erreur* (2011)

The unexpected event, as a disruption, may force the operator to change the action that he or she was initially going to perform. Leplat (2011) uses the example of a driver who changes his route to go from home to the workplace because there is roadwork being done on his normal itinerary.

The notion of variation plays an essential role in studies of accidents. Leplat (2011) mentions, for example, the method of analysis of accidents developed by France's research and safety institute,

the Institut national de recherche et de sécurité, which can be summarized as follows: *If everything had gone as it normally does, there would not have been an incident or an accident.* In that case, the analysis will mainly consist of searching for the sources of the accident in the variations of the situation (Leplat, 2011). In the context of working situations, unforeseen events such as power outages and equipment malfunction "oblige the operators to change their operating methods to re-establish the situation and to reach the objectives set, despite the obstacles." (Noulin, 2002, free translation). This variation in the activity, which consists of reaching the initial goal by another way, is called recovery. It can be compared to the mechanism of (self) regulation. (Leplat, 2011). In fact, St-Vincent et al. (2011) defined self-regulation in work as "a process of ongoing adaptation to varying work requirements and working conditions and to the worker's own personal variability." For the authors, "the self-regulation process interacts with the activity through the development of operating methods and strategies adapted to various work situations and adapted to variations in the person's condition" (St-Vincent et al., 2011).

2.2.3 Workplace Accidents and Unforeseen Events

Québec's *Act respecting industrial accidents and occupational diseases* defines an industrial accident as "a sudden and unforeseen event, attributable to any cause, which happens to a person, arising out of or in the course of his work and resulting in an employment injury to him." In Québec, 85,523 industrial accidents were recorded in 2012, and 11,517 of them involved young workers aged 24 or under, representing 13.5% of all accidents (CSST, 2013). All these accidents are costly to businesses, workers and the society as a whole.

Sorock et al. (2001) showed that the use of defective or new equipment and the performance of unfamiliar tasks increase the risk of injury. In 2008–2010, an action research project led to the development of tools to assist learning about OHS. It revealed how young students with learning disorders are received and integrated into the workplace, in the scope of a co-op program. In particular, the study revealed that the students regularly faced new, variable, atypical or unforeseen situations (Laberge, 2011).

2.2.4 Unforeseen Events and Workplace Traineeships

This study focuses on unforeseen events experienced by TST students during their workplace traineeships. With respect to the previous definitions, unforeseen events could

- belong to one or another of the two categories of working situation variability, i.e., *normal variability* or *incidental variability* (Guérin et al., 2007) ;
- events that the trainees may expect but for which the occurrence is unpredictable, or totally new events that the trainees must cope with (Perrenoud, 1999).

Unforeseen events disturb the normal course of trainees' work and constitute a disruption in their activities. An unforeseen event may, in some circumstances, lead to an incident or a workplace accident. In fact, an unforeseen event can be an inherent risk to the health and safety of the trainee, for example, a dishwasher in training at a restaurant who injures his hand when a glass

he is washing breaks. The risk could also be due to variations that the unforeseen event has caused in the trainee's activities. An example of this type of situation is that of a printer's assistant in training who burns himself when trying to restart a film-sealing machine, which had broken down a few minutes before.

To deal with unforeseen events and to regulate their working activities, trainees implement strategies that may be more or less adapted, depending on their experience of the situation.

On the other hand, for the trainee, the unexpected can also become a learning opportunity. Therefore, the next part of the review of the literature will examine the construction of the experience and learning through unforeseen events.

2.3 Unforeseen Events and Learning

2.3.1 Incidental Learning

Marsick and Watkins (2001) define what they call "incidental learning" as unintentional learning that is a byproduct of some other activity. It is an informal, generally unstructured type of learning, closely linked to the situation at hand, and is indispensable from the constructivist learning perspective. (Jonnaert et al., 2004). For novices, the occurrence of an unforeseen event can result in incidental learning, as it changes the course of the normal activity and obliges the use of unintentional strategies, which can contribute to learning a trade. Often, the strategies used by novices are based on trial and error and may not be appropriate to the situation. This can sometimes be costly in terms of lost time or health risks (Chatigny, 2001). However, some of these strategies may be effective, and be directly integrated afterward.

2.3.2 Novices' Strategies for Managing the Unexpected

Marcel (2004) studied the different ways that novice and experienced teachers manage the unexpected. In that study, the author submitted a questionnaire with 24 educational situations in which expert and novice teachers were faced with the unexpected. The teachers were asked to choose how they would deal with a given situation from among several options. Significant differences were seen between how novice teachers and experienced teachers would managed unforeseen events. Marcel noted that a characteristic of novice teachers was a lack of confidence. The results also showed that whatever the type of unforeseen event that occurred, the novices scrupulously attempted to respect the framework that they had established in the preparation of their class. They stuck to what they had intended to do before the unforeseen event occurred. To the contrary, the experienced teachers showed more flexibility, and their management style was characterized by their ability to adapt to the constraints and resources of the situation.

The strategies developed and their implementation by novices thus differ considerably from those with more experience. For Perrenoud (1999), a person may adopt different strategies to deal with two types of unforeseen events, which the author detailed:

- in the case of *relatively unexpected events*, the skill consists of the construction of a prepared response, implemented by adapting it at an opportune moment;

- in the case of unusual events, the skill consists of improvising an adequate response. In the latter case, the improvisation is based on the subject's experience, previous training and on the resources at hand.

The author explains how the mastery of unforeseen events corresponds to a higher level of competence and appears to be one of the challenges of situational learning (Perrenoud, 1999).

The two types of unforeseen events documented by Perrenoud (1999) refer to two categories of situations identified by Vergnaud (1990, cited by Perrenoud, 1999):

- « categories of situations for which the subjects have in their repertoire the skills required to immediately deal with the situation, at a given time in their development and under certain circumstances »;

- « categories of situations for which subjects do not have all the skills necessary, meaning that they must spend time thinking and exploring, and which involve hesitation, failed attempts, and eventual success or failure ».

Thus, for novices, unforeseen events they consider "unusual" occur frequently, but gradually, as they gain experience, these events become "relatively unexpected." In this process, strategies are implemented, at first randomly, which then gradually become refined as the repertoire of responses adapted to situations is constructed, in particular to protect their health at work when unforeseen events occur. This is what a number of researchers have defined as the protective role of experience (Cloutier et al., 2005; Cloutier, 1994; Gonon, 2003; Avila-Assunçao, 1998; Millanvoye and Colombel, 1996; Gaudart and Weill-Fassina, 1999).

2.3.3 The Unexpected and Motor Skills

Among the components of strategies that differ between experts and novices, several researchers have highlighted disparities in manual and proprioceptive skills. Ouellet (2009) explains that, through their dexterity, experienced workers are able to deal with diverse situations with many levels of complexity. Based on the work of Bernstein, Latash and Turvey (1996), and Bril and Roux, the author defines « dexterity as being how well an individual is able to rapidly and successfully perform a motor task. As dexterity is expressed through its interaction with changes in external conditions, one of its essential characteristics is that it is always related to the outside world. (Ouellet, 2009, p. 43). »

For semiskilled trades, which require the performance of numerous manual tasks according to the prescribed reference system of skills (Laberge et al., 2010), building strategies presupposes the development of the operators' motor skills. Here it is more a question of manual dexterity as defined by the Larousse dictionary (2014): *the skilfulness of the hands in the execution of something*. These motor skills improve with experience, with repeated practice of the same task and with the practice of new tasks. Chassaing (2004) discusses the results of experimental studies comparing novice workers to expert workers as follows: "novices' movements are haphazard, jerky, and they change them according to the result they get. Experts' movements are more stable and uniform, enabling greater speed. Experts have a range of fine movements at their disposal" [free translation]. The different ways that novices do things compared to experts,

mainly characterized by more fluid gestures by experts and more jerky movements by novices, were also demonstrated in research on garbage collectors (Denis et al., 2007).

A number of researchers (Vézina et al., 1999; Denis et al., 2007; Ouellet and Vézina, 2008, 2009) have explained the relationship between motor learning, regulation of the work activity and the increased presence of risk factors in the development of musculoskeletal disorders. These studies suggest that the development of working conditions and training content that encourages the acquisition of practical skills would enable workers to work effectively while protecting their health at work.

This research was initiated in order to understand how and how often unforeseen events occur during the traineeships of TST students and what it means in terms of risk for the health and safety of trainees. There was a particular focus on the strategies implemented by students to solve the problems caused by unforeseen events. As the traineeships were in semiskilled trades, the research mainly looked into strategies requiring motor skills.

2.4 Research Objectives

The objective of this research was to analyze the strategies adopted by novices, alone, or in cooperation with their co-workers during unforeseen or atypical situations.

The main objective was to identify and categorize the types of unforeseen events that occur, their immediate causes and the responses and strategies observed in learning situations in semiskilled trades and finally, their impacts on OHS indicators and productivity.

The specific objectives are as follows:

1) Draw up an observation table of unforeseen events that applies to various work contexts according to three categories of variables: typology of unforeseen events, immediate causes and strategies used to deal with them (individual and collective);

2) Analyze unforeseen events that occur during the learning of a trade in a genuine traineeship situation, according to observable indicators developed in the first sub-objective (e.g., dropping the merchandise);

3) Analyze the immediate causes (determinants) related to the unforeseen event, according to the observable indicators developed in the first sub-objective (e.g., presence of an obstacle that caused the operator to lose his balance);

4) Analyze the individual (initiated by the student) and collective (also involving peers in the workplace who are working with the student) strategies used when unforeseen events occur, according to the observable indicators developed in the first sub-objective (e.g., changing their way of doing things to solve problems on their own or asking a co-worker for help);

5) Document the consequences of the working activity, such as lost time (consequences on productivity) and the risk of injury (consequences on health).

These results have practical applications because they can be integrated into the development of strategies to prevent occupational injuries in young workers.

3. METHODOLOGY

3.1 Context

An action research project carried out in 2008–2010 on the conditions of reception and safe and competent workplace integration of TST students identified several aids for and obstacles to learning OHS (Laberge, 2011). This action research took place in two schools in different regions in Québec, which were chosen with the help of project partners, one in an urban setting and the other in a semi-urban setting. They received 87 TST students, 64 boys and 23 girls at the start of the project, over the 2008–2009 school year. In order to build a reasonable sample to illustrate diverse situations (trades and enterprises in which traineeships took place), 31 students were selected. Among them, a subsample of nine students was selected for more detailed workplace analyses; these were students whose employers consented to the researchers taking videos. (Laberge, 2011). These nine students were filmed on two separate occasions, at the beginning (T1) and at the end (T2) of the traineeship, throughout complete work shifts (representing between five and six hours per day).

This study provides a second analysis of observation data taken from the video sequences of the nine student trainees. During the primary analysis of the data, the first coding system enabled us to identify various types of difficulties encountered by the trainees, especially unforeseen events. In this study, a more systematic analysis of these difficulties, when they involved unforeseen events, was carried out.

3.2 Theoretical Framework

The conceptual framework used in this research, as in the previous action research, is the model of the work situation, focusing on the individual at work (proposed by Vézina in 2001 and adapted by St-Vincent et al. in 2011). In that model, an occupational injury is considered to be the result of an imbalance between the demands of work and the ability of individuals to deal with them, related to an insufficient margin of manoeuvre. According to this theory, the physical, mental and social activity of an operator in a situation is influenced by individual and environmental factors, which are called the determinants of the activity. In addition, the work activity of the operator will have consequences on his or her health, safety and ability to meet production demands. Thus, the work activity, characterized by the implementation of various strategies, is a response to the determinants of work and will result in a certain balance between the person’s health and productivity. Given that conceptual framework, the occurrence of an unforeseen event is considered in light of the determinants of the work in play, the strategies deployed to deal with it (regulation of the work activity) and the resulting health and productivity consequences (see Figure 2).

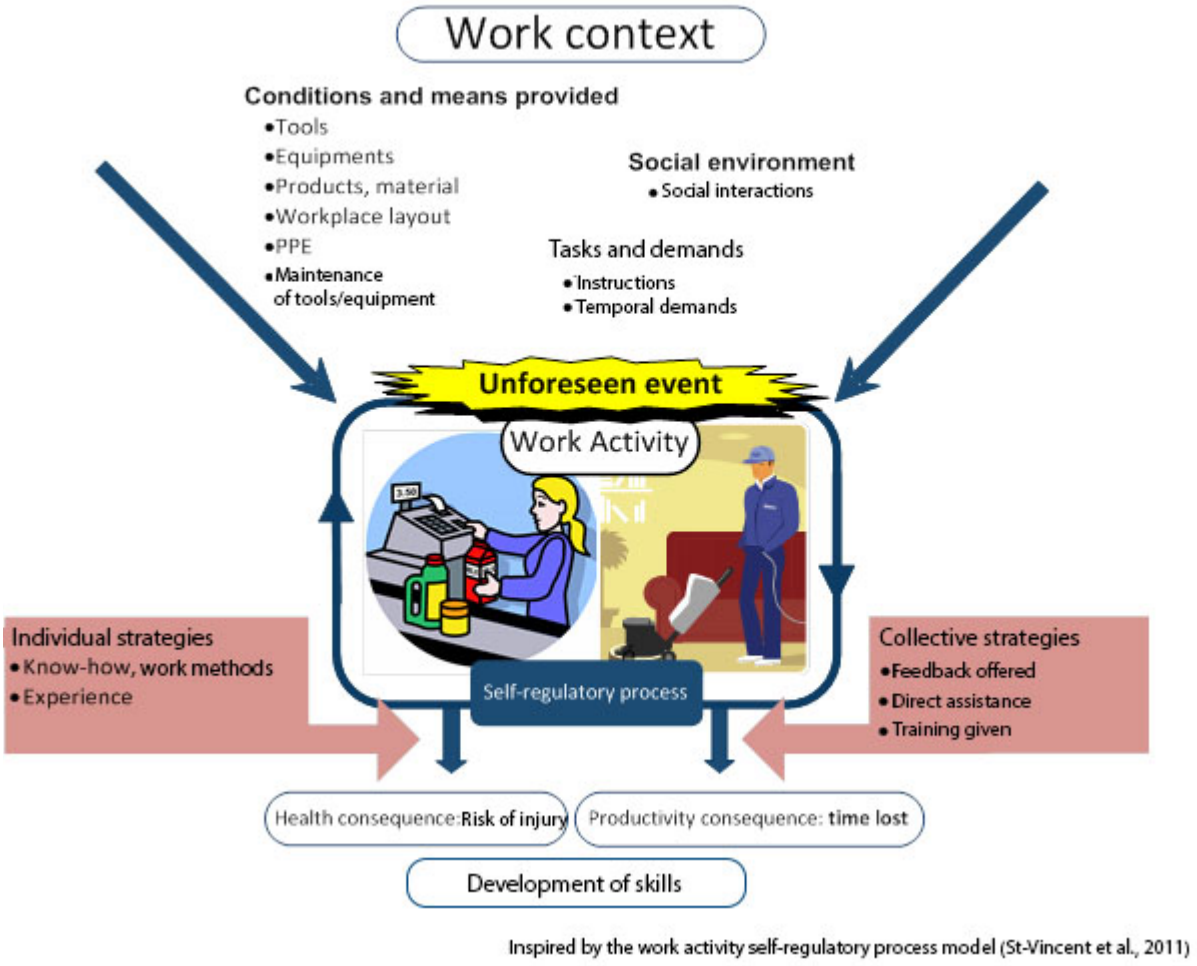

Figure 2 – Model of the work activity regulatory process adapted to the unexpected

3.3 Participants

The nine students were selected to represent a variety of workplaces from among the businesses that received trainees and agreed to participate. These are different-sized enterprises from a variety of industrial sectors. Thus, six students from school 1 and three students from school 2 participated in the detailed study.

The participating students and their training environment are presented in Table 1 below.

Table 1 – Description of participants and their training environment

Student	Gender	Age on September 30, 2008	Job title	School	Business size	Business
1	Male	16	Woodworker in wood product manufacturing	2	Large enterprise	**Sawmill**: This company specializes in wood processing: manufacturing construction materials. The enterprise receives raw material, checks it, and sends it off to the relevant departments to be processed according to customer orders. The student works in the beam-cutting department.
2	Male	16	Welder's assistant in a welding shop	2	Very small enterprise	**Steel mill**: In this company, the workers process steel. Depending on their positions, they cut, weld, brush paint or grind steel. They manufacture steel products such as waste containers, according to the customers' orders. The student works in the container-manufacturing workshop.
3	Male	16	Printer's assistant in a printing plant	1	Very small enterprise	**Printing plant**: In this company, the essential tasks of a printing plant are carried out: printing, reproduction and finishing (binding, folding, brochure, etc.). The student carries out operations on various machines, with the exception of binding.
4	Female	16	Clothing store inventory clerk	1	Multinational chain store	**Retail trade**: Retailer selling athletic products such as sports clothing, accessories, and shoes. The student works throughout the store.
5	Male	15	Drugstore inventory clerk	1	Large national chain store	**Retail trade**: Drugstore franchise that mainly sells prescription drugs but also everyday food products and cosmetics. The student works throughout the store; some days he works in the drug aisles and other days in the food aisles.
6	Male	16	Drugstore inventory clerk	1	Large national chain store	**Retail trade**: the same as student #5
7	Male	16	Electronics store inventory clerk	1	Large national chain store	**Retail trade:** Electronics and household appliance retailer. The products sold by the company range from small electronics to large appliances (televisions, refrigerators). The student performs stocking duties throughout the store and in the warehouse.
8	Male	16	Butcher's assistant	2	Large national chain store	**Retail trade:** Rural supermarket that has kept a "grocery store" atmosphere with several services: butchery, bakery, pastry shop, delicatessen, etc. The student works in the butchery.
9	Male	15	Cook's assistant	1	Small enterprise	**Restaurant**: French bistro-type restaurant, open at noon and in the evening. The student works in the kitchen.

3.4 Material

We were able to gather a total of 79.5 hours of video in the training environments of the nine students. Each of these adolescents was observed and filmed twice during his or her traineeship: at the beginning (T1) and at the end (T2) of the traineeship, with six months between the two video sessions. A complete day of work for these students corresponds to the same number of hours as a school day, i.e., five hours for school 1 (six students) and six hours for school 2 (three students), and they worked two to three days per week. Thus, on average, the first day of observation took place around the 12th day of the traineeship (minimum: 9 days; maximum: 15 days) and the second day of observation took place on the 46th day of the traineeship (minimum: 32 days; maximum: 55 days), corresponding to an average of 60 hours worked in T1 and 240 hours in T2 (for a traineeship to be validated, 375 hours had to be worked). The same scenario was applied to all the students, except for one, who was not filmed until the end of the traineeship (T2), because the company he was working for did not have the authorization from its head office at the time of the first observation (T1). For that student, only the data gathered in T2 was used.

These observations were interrupted by breaks, with the average recording time of a work shift being 4.8 hours for T1 and 5 hours for T2. Table 2 recapitulates the duration of recording for each young person. For T1, approximately 38 hours of observation were analyzed and for T2, slightly more than 41 hours.

Table 2 – Students participating in observations in the training environment

Student	Duration of recordings analyzed (in hours)	
	T1	T2
1 = Woodworker (M)	4.7	6.0
2 = Welder's assistant (M)	5.1	1.6**
3 = Printer's assistant (M)	5.2	5.0
4 = Clothing store inventory clerk (F)	3.9	4.3
5 = Drugstore inventory clerk (M)	4.4	4.6
6 = Drugstore inventory clerk (M)	4.2	4.6
7 = Electronics store inventory clerk (M)	0*	4.4
8 = Butcher's assistant (M)	5.2	5.3
9 = Cook's assistant (M)	5.4	5.6
Mean	4.8	5.0
Standard deviation	0.55	0.61
Total	38.1	41.4

H: Male F: Female

* Observation of subject 7 in T1 was done with pencil and paper, as the company had not yet consented to us taking video. It was excluded from the mean and the standard deviation for T1.

** Subject 2 was excluded from the mean and the standard deviation for T2 because he was not observed over a complete shift.

According to the students and the company, the work shift was different at the beginning (T1) and at the end of the traineeship (T2). Table 3 summarizes the context for each student during the two days of observations. For student 7, the T1 shift does not appear in the table, because he was not filmed.

Table 3 – Description of work shifts according to student

Student	Details of the context during the observation days
1 Woodworker in wood product manufacturing	The trainee's tasks depend on demand in terms of production. In T1 and T2, he was assigned to piling up the beams at the end of a wood processing line (beams weighing from 150–200 lb. in T1 and 30–60 lb. in T2), the work pace was rapid and the environment was noisy. The work posture was standing position with frequent moving. In T1, the pieces of wood were lifted by two people, while in T2, the pieces were mainly lifted by one person.
2 Welder's assistant in a welding shop	The tasks of the trainee depended on demands in terms of production. In T1, he mainly worked at a metal sheet cutting machine, sometimes alone, sometimes with his supervisor. In T2, he was mainly working alone on welding parts of steel wheels. He performed more varied tasks in T1 than in T2. In both cases, he worked in standing position the entire shift, but moved around more frequently in T2.
3 Printer's assistant in a printing plant	In T1 and T2, he carried out similar jobs, responding to printing orders from various clients, often from electronic documents. His work was performed at various workstations: computer, printer, packaging, paper cutting. His tasks included layout, printing, cutting, packing, maintenance and handling. The owner, his traineeship supervisor, was often with him and was generous with his advice. The nature of orders could be quite complex, especially in T2. Work was performed mainly in standing position for printing and packaging, but in sitting position when he was at the computer. In both T1 and T2, he frequently moved around between the different workstations.
4 Clothing store inventory clerk	In T1, she stocked merchandise in the warehouse and on the store floor with her supervisor. In T2, the store was busier; she stocked merchandise in the morning and served customers in the afternoon. Sports shoes are the big sellers; selling them involves finding the right sizes in the back of the store, with time constraints. Shoes are stored on high shelves (which require using ladders/stepladders). There are two to five employees present at a time, depending on the time of day. She always worked in standing position, with frequent moving around. Some tasks were more static, such as folding, a task she did more in T1.
5 Drugstore inventory clerk	In T1, he stocked non-prescription drugs with another trainee (student 6). The products were extremely varied, but looked similar; finding where they were supposed to go appeared difficult. In the afternoon, the trainees put price tags on the shelves, which required scanning and printing the prices with a computer system that often malfunctioned. As the trainees did not have an employee code to use the scanner, they had to ask other employees. In T2, this trainee would stock drugs alone in the morning; he helped a co-worker in the food section, and in the afternoon, he stocked (faced) shelves. He always worked in standing position, with frequent moving around, except for the tasks of posting prices and stocking (facing) shelves, which were more static.

Student	Details of the context during the observation days
6 Drugstore inventory clerk	In T1 in the morning, he stocked non-prescription drugs with his trainee co-worker (student 5). In the afternoon, he was alone stocking non-perishable food and beverages (larger and heavier products, with expiry dates), which required frequent visits to and from the warehouse (on the second floor) or the refrigerated storeroom. He also posted prices on the shelves. In T2, he did the seasonal reorganization of merchandise in the food section with his supervisor. He always worked in standing position with frequent moving around. Furthermore, in T1, he often had to use the stairs to get to the storeroom.
7 Inventory clerk in an electronics store	In T2, he did most of his job in the warehouse with his co-workers, unloading merchandise from a truck, sometimes very large household appliances. He then finished his work shift by stocking electronic products and installing antitheft equipment. He mainly worked in standing position with frequent moving around. In the warehouse, he was able to sit to place the merchandise on a mobile shelving unit.
8 Butcher's assistant in a supermarket	In T1, he placed fish and previously cut meats in Styrofoam containers. For a long stretch, he also molded balls of chopped suet to be frozen and sold as bird food in the winter, a physically demanding task. This required trips back and forth in the cold storage room. In T2, he was involved in cutting and trimming meat. Most of the time he worked alone, but in constant proximity with other co-workers. In both T1 and T2, he worked in standing position. When he was doing food preparation, his position was relatively static at a workstation (the same in T1 as T2), while he moved around when he had tasks in the store or the cold storage room.
9 Cook's assistant in a restaurant	In both T1 and T2, he helped prepare dishes for lunch under the orders of the chefs and other cooks. He also participated in plating the meals and in cleaning up the work area. Work was done in standing position, the pace was sustained and there was no break during the day. The complexity of tasks progressed between T1 and T2. In T2, he assisted in receiving food orders, which required movement in the stairways, as the cold storage units were situated on the second floor. In T1 and T2, he did vacuum packing, a task carried out in an out-of-the-way room on the second floor. That task was more static.

The students carried out different tasks in T1 and T2. Moreover, the T2 period began on the 46th day of the traineeship, after 240 hours of work. In the equivalent of full-time, this would correspond to about seven weeks, which means that the students were still novices in T2. These two factors limit the possibility of performing comparative analyses between T1 and T2.

3.5 Data Analysis

By using the theoretical framework presented previously, which corresponds to a model of the work situation focused on the individual at work, the following categories of observables were accepted:

1. unforeseen events;
2. immediate and observable causes;
3. strategies used as a result (individual and collective);
4. consequences on production, particularly in loss of time;
5. risks with respect to occupational health and safety: in particular, accident risks or musculoskeletal disorders (MSDs).

The details of the various types of event, cause, strategy, consequence and risk in terms of OHS are found in Table 5 below (categories of observables and descriptors).

In particular, for the description of unforeseen events (first category of observables), before viewing the data, some articles were examined to identify how other authors have characterized unforeseen events related to OHS. Among others, Sorock et al. (2001) determined categories of new or atypical situations to explain the risk of injuries to the hands, such as using equipment or material that did not work properly, performing unfamiliar tasks or being under time constraints. In this study, the analyses dealt with work observation data and not data from questionnaires, but some categories were inspired by those identified by Sorock et al. (e.g., broken down or incompatible equipment, being rushed). As the database was not the same (a questionnaire instead of video sequences), it was necessary to define the descriptors according to new observables, i.e., the new variables of observations defined in the scope of the study.

During the action research described previously, the protocol used to code the observations of the trainee students included the following categories of observables: tasks performed, difficulties encountered, movements, work position and interaction with other people at work (Laberge, 2011). The analysis of difficulties was carried out using Captiv software. This is a multiuse video data processing software program used to build a protocol and to code various categories of observables recorded over time. It was thus possible to find the time codes for diverse types of previously coded difficulties, of which several corresponded to unforeseen events (e.g., material damage). To draw up the observation table, the researchers analyzed some 20 randomly selected events that had been previously coded in the category of “difficulties encountered.”

Coding of data took place in three stages. First, all of the material was viewed (79.5 hours) to enable the selection of all the unforeseen events. For each event, the student, the period (T1 or T2) and the time code were compiled.

A second phase of coding enabled identification of the causes and strategies used by the students at the time of the initially coded unforeseen events. These observables were defined in part from the literature (e.g., collective compared to individual strategies) and in part through induction, meaning that they emerged after watching the material.

The third step coded the loss of time and presence of occupational health and safety risks. It was found to be of interest to distinguish the risk of accidental MSDs from other types of accidents because of their significant incidence in the statistical data set (in youth under 25 years of age, 24% of these injuries are back injuries and more than one in three is caused by a reaction of the body and by exertion) (CSST, 2013). For obvious reasons, this study focused on accidental MSDs (and not industrial diseases), which correspond to the majority of cases accepted by the CSST, and almost all cases in young workers.

On the basis of this coding, quantitative processing (frequency, proportion) was carried out according to prior qualitative analysis (categorizing events and strategies developed, description of context).

To ensure the consistency and reliability of coding, the main coder had to self-assess his/her level of confidence as to the accuracy of his/her assessment from 0 to 100%. When the confidence rating was deemed lower than 75%, an opinion was requested from a second coder. The two coders had to come to a consensus to determine the final coding. The results are represented in Table 4.

Table 4 – Number of events that required consensus by both with respect to each category of observables

(N events = 554)

Class of observable	n	%
• Unforeseen event	46	8.3
• Cause	67	12.1
• Strategy	33	6.0
• Lost time	0	0
• OHS risk	36	6.5

Table 5 – Categories of observables and associated observation criteria

Observable category	Definition	Possible value	Observation criteria
Unforeseen event	This definition includes both types of unforeseen events detailed by Perrenoud (1999) 1- relatively unexpected events 2- unusual events The occurrence of the event had to be sudden and difficult for the observer to anticipate.	1. Collision (structure, object, person)	The trainee is struck or trapped by an object, moving or not, with or without an intermediary.
		2. Object slipping/falling (object that falls or is dropped by the trainee)	An object falls on the ground (from the student's hands or a structure close to the student).
		3. Difficulty in handling	The object is instable in the trainee's hands (almost fell, hard to hold or hang on to).
		4. Unstable load	Unstable product with respect to its external structure.
		5. Difficulty in handling equipment because of the product/equipment interface	The problem comes from an interface that is not adapted to the equipment, product or material (equipment is adapted to another product).
		6. Failure of an action, error, rejection because of poor quality	When the student makes a mistake or a product is rejected because of poor quality. This rejection was identified by an observable indicator such as • A supervisor or co-worker who notifies the trainee of the error; • The trainee recommences the task; • The trainee puts the product in the garbage after the inspection.
		7. Tripping, falling	When the student falls, slips or loses balance.
		8. Looking for a product or person	When the student does not find the person, the product, the material or storage space he/she is looking for: he/she shows signs of hesitation, goes back and forth or asks someone.
		9. Difficulty in handling personal protective equipment (PPE)	The student finds it difficult to put on or keep his/her PPE on (takes it off, puts it back on).
		10. Equipment (or machine) failure or shutdown, inadequate equipment	The equipment (or the machine) used by the student stops working, seriously malfunctions, or is not adapted to the task being performed.

Observable category	Definition	Possible value	Observation criteria
Cause	The cause is that which seems the most evident during the observation, depending on the chosen event. When the observer could not discriminate between two meaningful causes to explain an event, both causes were coded.	1. Being rushed	The student appears to be in a hurry (running, walking or moving rapidly).
		2. Being disturbed or interrupted	An external event (signal) or a person (supervisor, client) interrupts the student's task.
		3. Equipment (machine)	The cause is related to the equipment (bad design, not available, maintenance…).
		4. Material, products (unusual, new, missing, misplaced, badly designed)	The cause is related to the material (wood, fabric, metal, etc.) or the product being held (box, canister, carton, etc.) In other words, the design or the properties of the material or product could be at fault.
		5. Work action or technique	The cause is related to an inappropriate working technique (experience) and apparently not attributable to an external condition (layout of the workplace, organization of work, etc.).
		6. Inadequate or badly designed PPE	Personal protection equipment (PPE) does not correspond to the student's characteristics (too big or too small, for example).
		7. Layout of the work space	The workspace is badly designed or set up; few counters and shelves; the student does not have equipment adapted to the task at hand.
		8. Cluttered work area	The work station is cluttered, there are obstacles on the ground and/or around the trainee (merchandise, equipment)
		9. Impossible to determine a cause (or other causes)	

Observable category	**Definition**	**Possible value**		**Observation criteria**
Strategy	A strategy is what the trainee uses to perform his/her job and especially to deal with unforeseen events. These are "choices, operating methods, that a person adopts, depending on her personal condition, to achieve an objective and adapt to the characteristics of the work situation" (St-Vincent et al. 2011). A trainee can thus implement several strategies for a single event.	Strategy initiated by the young people	1. Continue working	The student continues the activity as if nothing had happened.
			2. Repeat the operation	The student repeats the operation the same way, trying again with the same movements.
			3. Attempt to solve the problem	The student tries to find a solution by changing the method.
			4. Perform an additional operation	The event requires an additional step (unexpected, additional). This step is not intended to resolve a problem, but is an inherent consequence of a problem (e.g., cleaning up after spilling a product).
			5. Request assistance	When a student asks for assistance from a co-worker, a supervisor or another person.
		Strategy initiated by others	6. Receive assistance	When a co-worker, a supervisor or someone else takes the initiative to help the student without the student asking.
			7. Receive training	When someone offers advice or shows the student how to resolve the situation or to avoid re-experimenting.
			8. Receive a comment	When the supervisor or the co-worker has a reaction and/or a positive or negative comment (that's not right, that's good…)

Observable category	**Definition**	**Possible value**	**Observation criteria**
Lost time	Loss of productivity associated with the unforeseen event	- Yes - No	When the incident takes more than a minute to resolve. When the incident takes less than a minute to resolve. It is an arbitrary choice, but one that the two principal investigators agreed upon, mainly because that duration reflected a significant loss of time, while being realistic in coding it given the amount of material to be analyzed.
Risk of accident (OHS)	The unforeseen event and/or the strategy implemented afterward by the trainee may be the origin of OHS risk	- Risk of accidental MSD - Risk of other types of accident - No observable risk	1. Risks of accidental MSD: this category was coded on the basis of the known observable risk factors for accidental MSDs. These risk factors are essentially as follows: • Adoption of a risky posture, such as flexion or twisting of the torso in an extreme range of motion; • Use of excessive force during handling, observable by: the facial expressions of or comments made by the trainee; the trainee's posture when he/she handles a load (e.g., a trainee's torso in extreme extension to be able to pull a pallet truck); the low speed in which a load being handled is moved or the distance over which the load is moved (e.g., the trainee is only able to move a pallet loaded with merchandise with his manual pallet truck a few centimetres); the stability of the load being handled (e.g., when the trainee must manipulate it several times before successfully carrying it); the dimensions of the load being handled (e.g., the trainee has his/her arms outstretched to carry the crate, the pile of merchandise on the pallet is higher than the trainee's head). While this portion of the input was not part of the detailed observation table because it is not the subject of this research study, the coder has expertise in identifying MSD risk factors because she is a trained ergonomist. She had to make an overall assessment to determine whether the strategy caused such a risk factor. 2. Other types of accident risks: • Fall from a height; • Fall at the same level (student tripped or slipped, obstacle in the way); • Falling object: an object falls on the student or very close to him or her; • Jamming/crushing by an object or a machine (e.g., when the student's hands are inside a machine while working on it); • Cut: use of a sharp object, which could be associated with a product that is difficult to handle (e.g., a package of frozen sausages or crab legs); • Burn: contact with hot material (for example: an oven or a thermosealer).

4. RESULTS

4.1 General Data

4.1.1 Events

The first screening of the video sequences enabled us to code all of the events that occurred. In total, 554 events were identified for the nine participants. Below, Table 6 presents the various types of events that the nine trainees were faced with, as well as their frequency.

Table 6 – Number and frequency of events observed for the nine students

Event	Number (N)	Frequency (%)
Object slipping/falling	142	25.63
Failure of action, error, rejection due to poor quality	97	17.51
Inability to find a product or person	96	17.33
Handling difficulty	75	13.54
Inappropriate product/equipment interface	45	8.12
Equipment failure/shutdown, inadequate equipment	44	7.94
Difficulty handling PPE	29	5.23
Collision	12	2.17
Unstable load	9	1.63
Tripping, falling	5	0.90
Total	554	100.00

The four most frequent events (below) represent 74.01% of all those experienced by the nine students:

- *object slipping/falling;*
- *failure of action, error, rejection due to poor quality;*
- *inability to find a product or person;*
- *handling difficulty.*

Object slipping/falling events were observed the most frequently, 25.63% of the time.

In differentiating between the events that occurred in T1 and those that occurred in T2, it appears that for all of them, the number is evenly divided between the two periods, as illustrated in Table 7. However, there are differences for the *object slipping/falling*, *handling difficulty*, *equipment failure/shutdown* and *difficulty handling PPE* events. As the number of days of traineeship in T2 is still relatively low compared to the whole life course (an average of 46 days of traineeship) and the work contexts were different between T1 and T2 for several trainees, it was not possible to study the effect of learning. For the other results, all of the unforeseen events

were therefore taken into account in a single database, regardless of whether they occurred in T1 or T2.

Table 7 – Distribution of events observed for the nine students in T1 and T2

	Number of events (N)		
Event	**T1**	**T2**	**Grand total**
Object slipping/falling	55	87	142
Failure of action, error, rejection due to poor quality	49	48	97
Inability to find a product or person	51	45	96
Handling difficulty	50	25	75
Inappropriate product/equipment interface	27	18	45
Equipment failure/shutdown	16	28	44
Difficulty handling PPE	11	18	29
Collision	5	7	12
Unstable load	5	4	9
Tripping, falling	3	2	5
Grand total	**272**	**282**	**554**

4.1.2 Causes

The total number of causes was 565 for the nine students, which is higher than the number of the events. When the observer could not differentiate between two meaningful causes to explain an event, both were entered. For example, student 7 worked as an inventory clerk in an electronics store and unpacked merchandise. To open the cardboard boxes he used a box cutter. Because he had no other place to put it, he placed the cutter on his thigh, and it fell on the ground. For that *object slipping/falling* event, two causes were coded: *work action or technique* and *workspace layout*. The coding of the two causes for the same event occurred 11 times, which represents almost 2% of events. Table 8 presents the number and frequency of each cause, independently of events.

Table 8 – Number and frequency of the causes identified for the unforeseen events that the nine students experienced

Cause	Number (N)	Frequency (%)
Material, products (unusual, new, missing, misplaced, poor design)	249	44.07
Workspace layout	118	20.89
Work action or technique	109	19.29
Equipment (machine)	37	6.55
Inadequate or badly designed PPE	30	5.31
Impossible to determine a cause (or other causes)	12	2.12
Cluttered work area	5	0.89
Being disturbed or interrupted	3	0.53
Being rushed	2	0.35
Total	565*	100.00

* The number of causes is higher than the number of events, because an event could be due to two causes and/or it was not possible to isolate a single cause during coding.

The *material, products* category constitutes the most common cause observed for the nine students. In fact, 44.07% of the events were due to causes of this type. The causes for which the number is higher than 100, i.e., *material, products, workspace layout, work action or technique,* represented more than 84.25% of the causes.

Three types of causes were rarely observed:

- *cluttered work area (0.89%).* This category was coded when the trainee's workspace was constrained by the presence of merchandise or equipment, or when the circulation areas were cluttered. For example, the trainee working as an inventory clerk in an electronics store had to change the direction of the pallet he was handling to avoid striking obstacles (crates, pallets) in the warehouse;

- *being rushed (0.35%);*

- *being disturbed or interrupted (0.53%).*

The *being rushed* and *being disturbed or interrupted* causes are more difficult to observe directly in the video sequences. To identify them more precisely, self-confrontation with the students should have been conducted, so they could verbalize their impressions about the various unforeseen events that they had encountered during the observations, immediately afterward. Unfortunately, this post-observation confrontation could not be carried out during this study, because the analysis of the video sequences to identify the events was performed in 2012 using the material that had been gathered for the previous action research, which ended in 2010.

4.1.3 Strategies

The total number of strategies for the nine students was 604. The total is higher for strategies than those for events because several strategies may be implemented to deal with a single unforeseen event. The strategies identified are those that occurred immediately after the

unforeseen event. Table 9 presents the various strategies used by the students, their number and frequency.

Table 9 – Number and frequency of the strategies implemented by the nine students following unforeseen events

Strategy			Number (N)	Frequency (%)
Strategy initiated by the young people	Individual	Perform an additional operation	195	32.28
	Individual	Continue working	109	18.05
	Individual	Repeat the operation	95	15.73
	Individual	Try to solve it	93	15.40
	Collective	Ask for help	39	6.46
Strategy initiated by others	Collective	Receive training	51	8.44
	Collective	Receive help	13	2.15
	Collective	Receive a comment	9	1.49
		Total	604*	100.00

* The number of strategies is higher than the number of events, because one trainee may use several strategies to deal with a single event and/or it was impossible to isolate a single strategy during coding.

The strategies can be organized according to two types of categorization:

- strategies initiated by the young people compared to those initiated by others:
  - the strategies initiated by the young people are the strategies that the students undertook themselves;
  - strategies initiated by others: in that case, the person who takes initiative for the strategy could be the supervisor in the workplace or another co-worker.
- individual strategies compared to collective strategies:
  - individual strategies correspond to strategies that the student initiated on his or her own;
  - collective strategies involve the student and at least one other person, such as the supervisor or a co-worker.

Table 9 shows that, in most cases, the trainees implemented individual strategies to deal with unforeseen events on their own initiative. In fact, the frequencies of the four individual strategies initiated by the young people reached 81.46%.

For statistical purposes, the strategies were grouped into individual strategies and collective strategies. This lowers the total number of strategies initially identified, because a student may have used one or more individual strategies and/or one or more collective strategies for a single event. For each of the 554 events, the presence (1) or the absence (0) of an individual strategy or a collective strategy was thus identified. Table 10 presents the number and frequency of the grouped strategies.

Table 10 – Number and frequency of individual and collective strategies

Individual strategy	Number (N)	Frequency (%)
0	93	16.8
1	461	83.2
Total number of events	554	100.0
Collective strategy	Number (N)	Frequency (%)
0	444	80.1
1	110	19.9
Total number of events	554	100.0

Table 10 shows the distribution of strategies implemented by the students for each event and how they sometimes combine individual strategies with collective strategies. Thus, to deal with 554 events, the students used

- individual strategies 461 times, and they used these individual strategies exclusively for 444 events;
- collective strategies 110 times and they used these collective strategies exclusively for 93 events;
- both individual and collective strategies for 17 events.

4.1.4 Occupational Health and Safety Risks

The consequences of events on trainees were recorded in two categories:

- consequences to the students' health and safety, meaning the OHS risks to which they were exposed when the unforeseen event occurred;
- consequences on productivity, which corresponds to the time lost because of these events.

The OHS risks include accidental musculoskeletal disorders (MSD) and other accident risks. The unforeseen events with OHS risks were identified and are presented in Table 11.

Table 11 – Number and frequency of events associated with accident risk (N total events=554)

Accident (not including MSD)		MSD		No observable risk	
Number (N)	Frequency (%)	Number (N)	Frequency (%)	Number (N)	Frequency (%)
53	9.6	52	9.4	449	81

The observation revealed that 53 events presented a risk of accidents that did not include MSDs, and for 52, there was a risk of an accidental MSD. In total, there were 105 events in which risk of accident were identified, representing approximately 19% of the events. The risk of accident could be the consequence of

- the event itself. For example, the *tripping, falling* event is associated with the risk of falling at the same level, or the *handling difficulty* event, corresponding to excessive effort, is associated with risk of MSD, as in the case of student 7, an inventory clerk who was handling heavy loads with a manual pallet truck in the store's warehouse;

- the strategy chosen by the trainee to deal with the unexpected. That was the case in 22 of the 105 events identified. This situation could occur, for example, when a student works with dysfunctional equipment (*equipment failure/shutdown* event*)*. There is a risk of injury when a student tries to solve a problem (*attempt to solve* strategy). Examples include the case of student 6 attempting to free a cardboard box stuck in a compactor, and student 3, a printer's assistant, who burned himself when pulling out plastic stuck to the metal rod of a thermosealer that was not working properly.

It is also possible that the strategy used by the trainee can increase exposure to risk even if it was not initially the cause, for example, when the trainee uses *continue working* or *repeat the action* strategies after an event that could cause OHS risks, such as *handling difficulty.*

According to the strategy chosen, OHS risks can also differ within the same unforeseen event. An example of this was when the butcher's assistant was unable to separate frozen sausages in packages. He dealt with this unforeseen event in T1 and T2, but his strategy to deal with it changed from the first to the second period:

- in T1, he left the sausages in their box and tapped the full box against the counter to separate the sausages: risk of crushing his fingers between the box and the counter, risk of back and arm pain because of the excessive force used to handle the box;

- in T2, he held a package in his hands and separated the sausages one by one using a thin bladed knife: risk of cutting himself on a sharp object.

4.1.5 Time Losses

Table 12 presents the number and frequency of events that result in time losses, i.e., more than one minute of interruption in the action related to the event. Almost 10% of the events caused time to be lost in responding to the unforeseen event and resolving the associated incidents.

Table 12 – Number and frequency of events causing time losses

Time loss	Number (N)	Frequency (%)
No (event resolved in under a minute)	499	90.1
Yes (event resolved in over a minute)	55	9.9
Total	554	100

4.1.6 Summary of General Data

The nine students dealt with various types of unforeseen events in their traineeships in quite similar proportions at the beginning (T1) and at the end of the traineeship (T2). Almost 10% of these unforeseen events caused losses of time and approximately 19% involved OHS risks.

To deal with these unforeseen events, the students could use only individual strategies, only collective strategies, or both. Thus, in 80.1% of events they only used individual strategies, while in 16.8% of events they only used collective strategies.

Given the diversity among the students and the work contexts in the traineeship environments, an analysis of the events observed for each student was also carried out.

4.2 Analysis of Data Student by Student

4.2.1 Events per Student

Student 5, an inventory clerk in a drugstore, experienced the greatest number of unforeseen events (128) while student 4, an inventory clerk in a sports clothing store, faced the fewest (20), as shown in Table 13.

Table 13 – Distribution of events per student

Students	Number of events (N)
Student 1 – Woodworker	44
Student 2 – Welder's assistant	39
Student 3 – Printer's assistant	63
Student 4 – Clothing store inventory clerk	20
Student 5 – Drugstore inventory clerk	128
Student 6 – Drugstore inventory clerk	79
Student 7 – Electronics store inventory clerk	52
Student 8 – Butcher's assistant	95
Student 9 – Cook's assistant	34
Grand total	**554**

The distribution of events per student according to the various categories of events is presented in the table in Appendix A of this report. The main results are detailed here.

Although the *object slipping/falling* category of unforeseen events was the most commonly observed among all of the students, the analysis of events per student reveals a wide variety in the distribution of these events. In fact, this category of events was mainly noted for trainee 8, who worked as a butcher's assistant, and trainees 5, 6 and 7, who worked as inventory clerks. One of the main tasks of inventory clerks is taking products to the sales area, which means that objects are handled numerous times, and there is thus a greater risk of them being dropped.

As well, the *inability to find a product or person* event was frequently observed with the inventory clerk trainees (especially 4, 5 and 6). In fact, the task of arranging the stock on the sales floor requires that the inventory clerk knows where it is to go. This often means that the trainees have to search, because the location may regularly be changed or not indicated on the sales floor.

The *failure of action, error, rejection due to poor quality* events were principally noted for students 8 and 9, who worked in the food industry, and for students 2 and 3, welder's assistant and printer's assistant, respectively. These are two sectors of activity in which the quality requirements are the most well defined and well known, and these requirements could be relatively rigorous for novices, which could increase the risk of error while learning.

Events in the *equipment failure/shutdown* category were noted for students 3 and 7, whose tasks required them to work with machines. Student 3, a printer's assistant, mainly worked with printers, a thermosealer and a cutter. Student 7, an inventory clerk in an electronics store, used a portable scanner.

Events from the *handling difficulty* category were specially observed for students 1, 3 and 9, and in higher proportions for students 1 (38.6%) and 9 (35.3%). Student 1 was a woodworker, student 3 was a printer helper, and student 9 was a cook's assistant.

For student 1, the difficulties were mainly related to the dimensions and weight of objects to be handled. For example, he had to carry beams that were several metres long, to move beams on the ground by pushing them with his feet, and to position metal trestles (on which the beams were then laid) by pushing them with both hands.

For student 9, most of the unforeseen *handling difficulty* events in T1 occurred when he was cutting up crab claws, a task that he was performing for the first time. In T2, these events were related more to carrying objects when a food product order was received, which he had to put in the refrigeration units situated one floor above the kitchens.

The *difficulty handling PPE* events were observed for four of the nine students, and mainly students 1 and 2, who did their traineeships in the wood- and metal-working industries, respectively. Student 1 replaced his helmet and cleaned his safety glasses several times. He also repositioned his high-visibility vest and laced up his safety shoes. Student 2, who performed welding tasks, had to put his gloves and welding mask back on several times. For both trainees, this was equipment loaned to them by the employer and did not necessarily fit them properly.

4.2.2 Strategies per Student

Depending on the events encountered, the students implemented only individual strategies, only collective strategies or both. Figure 3 presents the types of strategies used by each of the nine students and their respective frequencies. Each frequency percentage corresponds to the proportion represented by one type of strategy compared to all of the strategies that a student implemented.

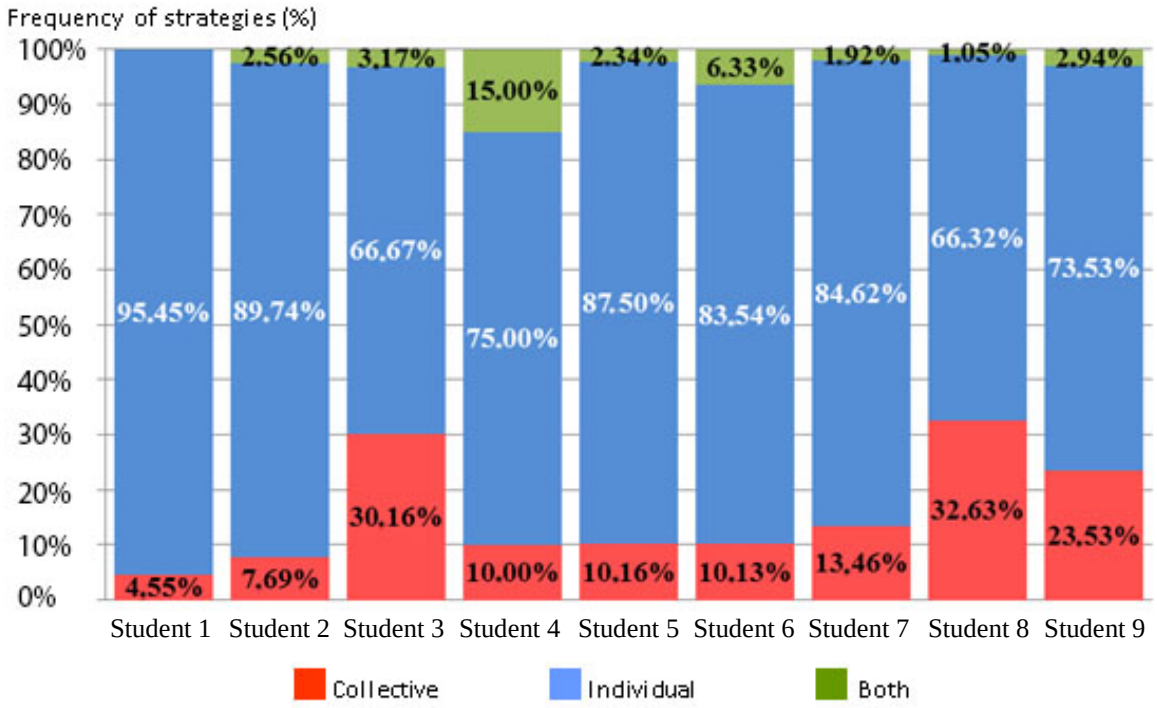

Figure 3 – Proportion of individual strategies and/or collective strategies implemented by each student

The students mainly used individual strategies. With the exception of students 3, 8 and 9 (the printer's assistant, butcher's assistant and cook's assistant, who all worked closely with their co-workers in the same workspace), the students implemented only individual strategies in over 75% of the cases. This can be explained mainly by the fact that the trainees usually worked alone.

An analysis of the various kinds of individual and collective strategies implemented by each student was also performed. Figure 4 presents the number of different types of individual strategies per student, and Figure 5, that of the different types of collective strategies per student.

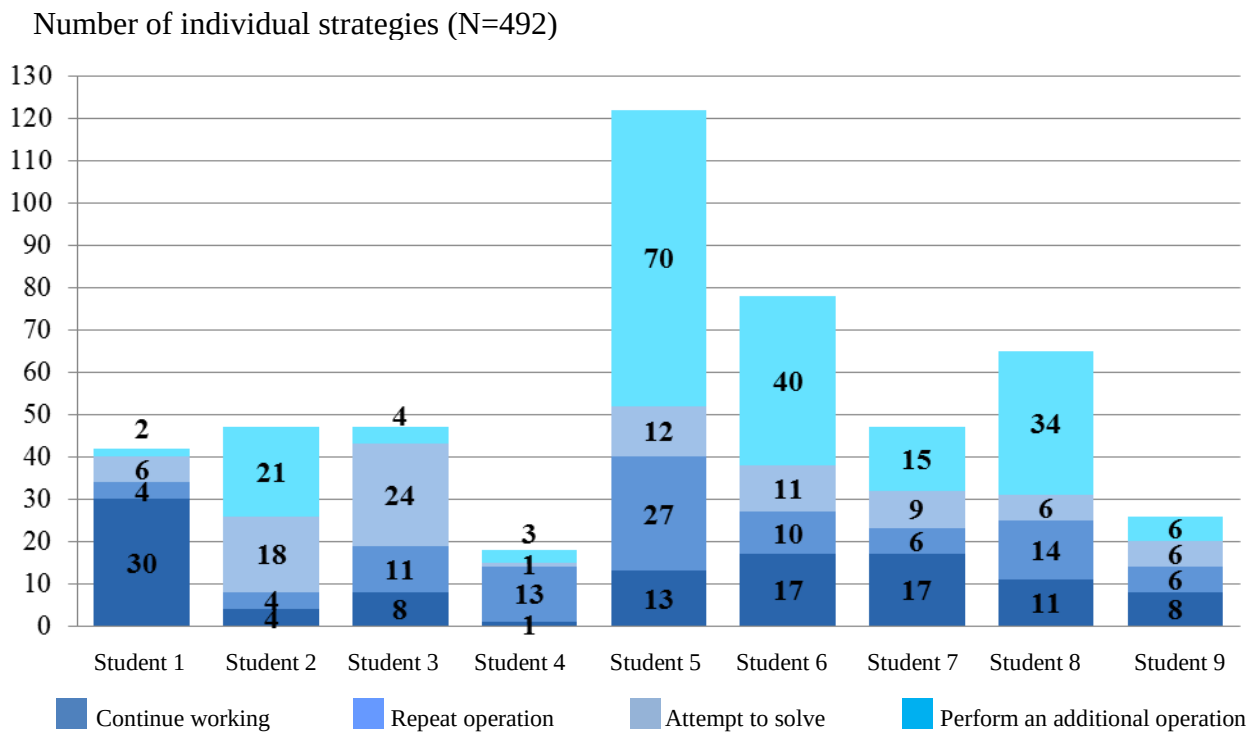

Figure 4 – Types of individual strategies implemented by each student (in numbers)

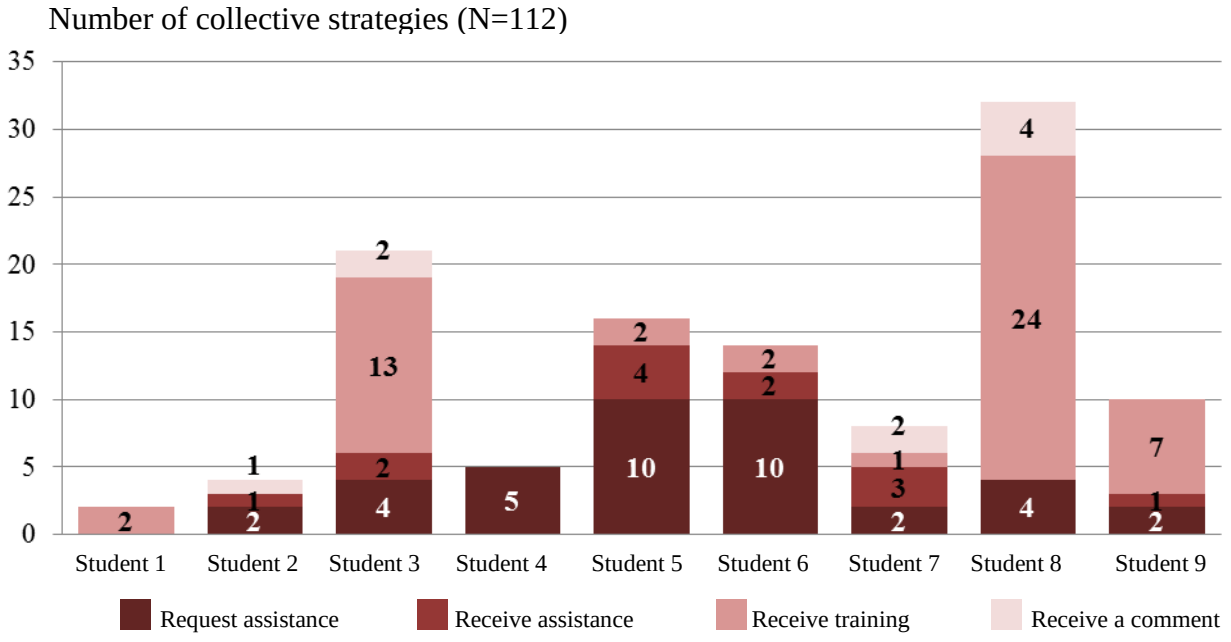

Figure 5 – Types of collective strategies implemented by each student (in numbers)

Students 5 and 6, who were both inventory clerks in the same drugstore, are those who used the highest number of individual strategies. It was also they who adopted the collective strategies of *requesting assistance* the most, although this number is much lower than that of individual strategies.

Students 3, 4, 8 and 9 used collective strategies in at least 25% of cases. However, the analysis of the type of collective strategies used by each student reveals differences. For instance, student 4 (inventory clerk) only used the *request assistance* strategy, while students 3 (printer's assistant), 8 (butcher's assistant) and 9 (cook's assistant), who worked in close proximity to their co-workers, had recourse to the *receive training* strategy most often. That strategy was initiated by the young person's co-workers, illustrating that experienced co-workers take the initiative of passing on their knowledge when they are in close contact with trainees and an unforeseen event interrupts their work.

Additional analyses were carried out to identify what types of events were associated with the *request assistance* and *receive training* strategies. Table 14 shows unforeseen events for which students implemented strategies of the *request assistance* type, while Table 15 illustrates which types of events trigger the *receive training* strategy for each student. In Table 14, it appears that requesting assistance was mainly associated with searching for a product or someone and it was a characteristic strategy of inventory clerks in a store. For two of the trainees, the printer's assistant and the electronics store inventory clerk, this strategy was also associated with a breakdown or malfunctioning of equipment being used. In the latter case, the equipment in question was a portable labeling printer used to mark the prices of products in the aisles. As this young trainee did not have an employee code, he had to ask other employees for their code to access the program that would enable him to record the prices to be printed. In Table 15, training was spontaneously offered when the student trainees made a mistake, or did not succeed in completing an action or finding a product. For example, one of student 5's co-workers came up to him and told him where he was to put the soup cans, because the student was in the wrong row, looking for the location of similar products. The three students for whom this observation is relevant were also those who worked more closely with other workers in the same area.

Table 14 – Distribution in numbers (N) of the *request assistance* strategy, according to event, for each student who implemented this type of strategy

Event / **Student***	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Welder's assistant	Printer's assistant	Inventory clerk in the store				Butcher's assistant	Cook's assistant
Handling difficulty				1				
Failure of action, error	1						2	1
Inability to find a product or person			5	9	6		2	1
Equipment failure/shutdown	1	4			4	2		
Total number of *request assistance* strategies per student	**2**	**4**	**5**	**10**	**10**	**2**	**4**	**2**

*Student 1 does not appear in Table 14, because he was not observed using the *request assistance* strategy.

Table 15 – Distribution in numbers (N) of the receive training strategy according to event, for each student who implemented this type of strategy

Event / Student**	1	3	5	6	7	8	9
	Wood-worker	Printer's assistant	Inventory clerk in a store			Butcher's assistant	Cook's assistant
Handling difficulty						2	1
Unstable load			1				
Failure of action, error	2	11		1	1	21	6
Inability to find a product or person			1				
Difficulty handling PPE						1	
Equipment failure/shutdown		2		1			
Total number of *receive training* strategies per student	**2**	**13**	**2**	**2**	**1**	**24**	**7**

**Students 2 and 4 do not appear in Table 15, because they were not observed using the *receive training* strategy.

4.2.3 The Occupational Health and Safety Risks for Each Student

The analysis of 554 events experienced by the nine students revealed that 105 events had an occupational and health and safety risk (OHS). However, the analysis by student revealed disparities in the distribution of OHS risk events as well as the type of risks to which the students were exposed. Three students were faced with an occupational health and safety risk more than 15 times when unforeseen events occurred. The young worker in a wood processing plant (1) regularly handled pieces of wood weighing more than 30 kg on his own and, during the observation, he was often exposed to the risk of his lower limbs being struck when he moved boards, either when rocking them with his feet, or dragging them on the ground on their edges. For the young electronics store inventory clerk (7), most events associated with MSD risks were related to extreme flexion of his torso when placing products on the lowest shelves, handling heavy loads when he was using a hand pallet truck or when he carried bulky crates. According to the observations, the young butcher's assistant (8) was also vulnerable to MSD risks. He had to handle very heavy and often unstable boxes of meat. He also had to make balls of chopped suet to be frozen and sold as bird food. To form the balls, he needed to apply pressure with both hands, and the video showed his workplace mentor telling him that he would soon feel pain in his forearms if he did too much without stopping. His body language confirmed that this task required an effort that could not easily be sustained. He was often in situations in which he risked cutting himself (close call) with his butchers knife, especially because sometimes he forgot to put his protective glove back on after removing it, and also because his cutting movements lacked fluidity. More complete results are found in Figure 6.

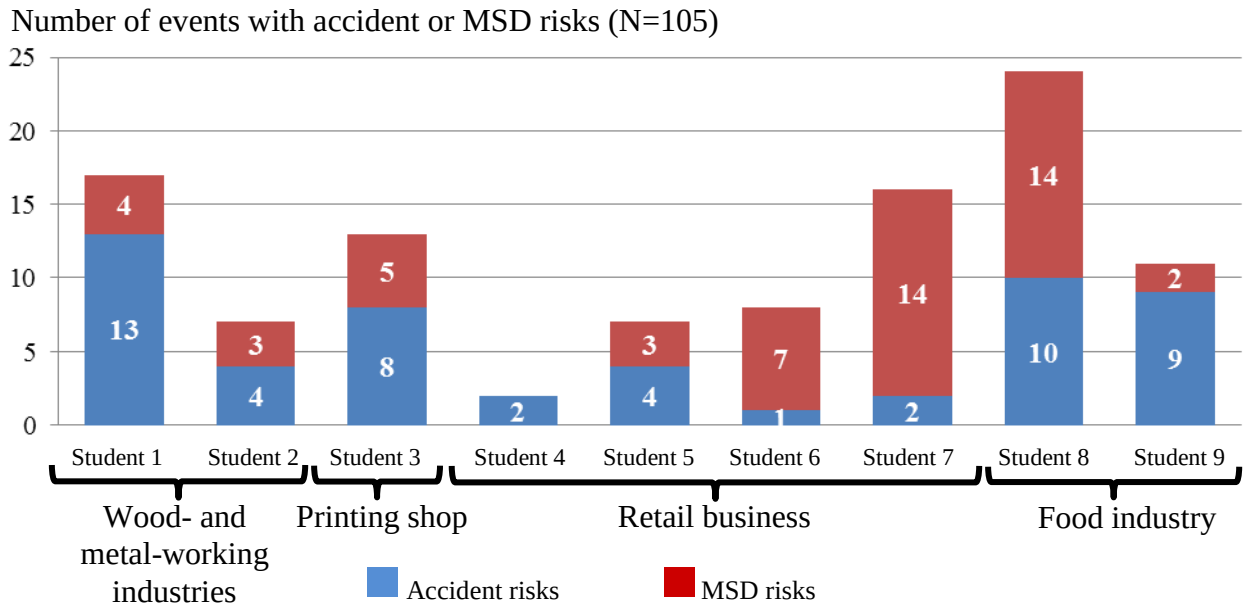

Figure 6 – Student by student representation of events with risk of diverse accidents or an accidental MSD

The events experienced by the nine students were mainly the risk of diverse accidents, with the exception of the young drugstore inventory clerks (6), the electronics store inventory clerk (7) and the young butcher's assistant (8), for whom the events with risk of MSD were more numerous. Both from the point of view of the types of OHS risks and the frequency of these risks, no trend could be discerned according to the sector of activity of the traineeship.

4.2.4 Summary of the Data Analysis by Student

The students experienced various types of unforeseen events during their traineeships, related to the sector of activity of the enterprise in which they were working and the type of task they were performing during the observations. Examples include the retail business students who dealt with the unexpected in the categories of *inability to find a product or person* (students 4, 5 and 6) and *object slipping/falling* (students 5, 6 and 7).

The nine students mainly used individual strategies to deal with the unexpected. The two collective strategies most often identified were those of the *request assistance* and *receive training* types.

However, the strategies of the *receive training* type concerned almost exclusively the printer's assistant and the two students working in the food service sector, and they were applied following the *failure of action, error* events. These are activity sectors in which the quality demands are the most often defined and known. They were also trainees who usually worked in proximity to their co-workers. When the trainees experienced failures or made errors, their co-workers took the initiative of providing training to help them reach the expected levels of quality.

The *request assistance* collective strategies were usually implemented following the *inability to find a product or person* and *equipment failure/shutdown* events, because the trainees were unable to deal with the problem on their own.

The strategies that the students implemented to deal with the unexpected depended on the type of event experienced and the presence (immediate or not) of their co-workers at the time the unforeseen event occurred.

The analyses of data per student also revealed that their exposure to OHS risks is variable. However, these analyses did not enable us to pinpoint a clear trend between the activity sector of the enterprises in which the students carried out their training and OHS risk to which they were exposed when the unforeseen event occurred. OHS risks appear specific to the context of each traineeship.

4.3 Unforeseen Events and OHS Risks

The preliminary results of the research revealed that, during the traineeships, the students dealt with diverse types of unforeseen events having varied consequences. Almost 19% of these events involved risks to the health and safety of the students. Analyses were performed to identify what types of unforeseen events carry the greatest OHS risks. Table 16 presents the distribution of events associated with OHS risks on the basis of the 554 events that were initially coded.

To summarize, the following describes what is shown in Table 16. It appears that 91 of the 105 unforeseen events that present OHS risks can be attributed to four categories of events. The analysis of the events reveals differences among the four categories:

- the *handling difficulty* category is the one in which the most OHS risk events occurred (in numbers). In addition, most of the events in that category entail OHS risks (44 events with OHS risks compared to 31 events without observable risk, or a relative frequency of 58.67%). The main OHS risks identified are those related to the efforts involved in handling heavy loads and the risks of being cut, for example, when the student had to slice through food items that were difficult to handle;

- Twenty-three events in the *inappropriate product/equipment interface* category present OHS risks, compared to 22 in which no risk was observed. The main risks come from the efforts exerted on equipment or material (exertion in folding cardboard boxes to make them fit into a compactor; striking boxes of frozen sausages against the counter to separate them) or difficulties in picking up objects with gloves (these could be food items or sheets of steel);

- *Equipment failure/shutdown* is the third category in which high numbers of OHS risks were identified. It corresponds to events in which the student did not have tools adapted to the task, such as the significant exertion required for a student to use a hand pallet truck to move heavy loads (he was not allowed to use the electric pallet truck). Also included in this category are events in which only a poorly functioning tool is available, such as the thermosealer in the printing shop that the student burned himself on when he was trying to understand why the machine was not working properly;

- The *failure of action, error, rejection due to poor quality* category was represented in nine of the events involving OHS risks. The risk types are quite varied in these cases and are contextual (e.g., the torso of the electronics store inventory clerk was in extreme flexion when he was placing products on a low shelf or attaching a cardboard box to a pallet; or one of the drugstore inventory clerks when he was handling a box on an unstable pile with his arms outstretched).

Table 16 – Distribution of events associated with OHS risks in numbers (N) and relative frequency of events with OHS risks (%)

Event	Number of events without observable OHS risk	Number of events with OHS risk	Relative frequency* of events with OHS risk (%)
Handling difficulty	31	44	58.67
Inappropriate product/equipment interface	22	23	51.11
Equipment failure/shutdown	29	15	34.09
Failure of action, error, rejection due to poor quality	88	9	9.28
Object slipping/falling	138	4	2.82
Tripping, falling	2	3	60.00
Inability to find a product or person	93	3	3.13
Unstable load	7	2	22.22
Collision	10	2	16.67
Difficulty handling PPE	29	0	0.00
Grand total	**449**	**105**	

*The relative frequency corresponds to the ratio between the number of events with OHS risks and the total number of events within each event category.

4.3.1 Causes of Events with OHS Risks

A cross-sectional analysis of causes by event for all of those with OHS risks was performed. Table 17 presents the results for the 91 events in the four main categories with OHS risks (*handling difficulty*, *product/equipment interface*, *equipment failure/shutdown* and *failure of action/error*). Table 17 shows that 92 causes were identified for the 91 events: a single cause for 90 events and two causes for one event.

The causes attributable to material or products were identified the most often and were mainly responsible for unforeseen events with OHS risks. The causes in the *work action or technique* category represented 16.30% of causes at the origin of the four categories of events with the most OHS risks. It is the only category of causes that could be directly associated with the trainees' actions. For the nine students, the main causes for the occurrence of 91 of the 105 unforeseen events with OHS risks were those related to the context of the traineeship and the work environment. This holds true for all of the 105 events with OHS risks (see Appendix B).

Table 17 – Causes at the origin of 91 events with OHS risks

	Cause									
	Work action or technique		Workspace layout		Inappropriate PPE		Equipment		Material, products	
Event	N	%	N	%	N	%	N	%	N	%
Handling difficulty	8		5		0		1		31	
Inappropriate product/equipment interface	2		0		2		0		19	
Equipment failure/shutdown	0		4		0		11		0	
Failure of action, error	5		1		0		0		3	
Grand total	15	**16.30%**	10	**10.87%**	2	**2.17%**	12	**13.04%**	53	**57.61%**

N = number of causes identified within each category of event | % = percentage that each category of causes represents compared to all of the causes for the 91 events.

4.3.2 Strategies Implemented to Deal with Events with OHS Risks

In order to complete the relative results of events with OHS risks, an analysis of the strategies implemented by the trainees to deal with these events was carried out. Table 18 illustrates the results of this cross-sectional analysis for the 91 events in the four categories identified previously, i.e., *handling difficulty*, *inappropriate product/equipment interface*, *equipment failure/shutdown* and *failure of action, error.*

For this analysis, the strategies are grouped according to whether they were individual strategies, collective strategies or both. As well, 91 strategies were used to deal with the 91 above-mentioned events. This analysis shows that the students mainly used individual strategies when they were faced with events with OHS risks, whatever the event category.

Table 18 – Strategies implemented following the 91 events with OHS risks

Event Strategy	**Number of strategies (N)**	**Frequency of strategies* (%)**
Handling difficulty	**44**	
Collective strategy	2	4.55%
Individual strategy	42	95.45%
Inappropriate product/equipment interface	**23**	
Individual strategy	23	100.00%
Equipment failure/shutdown	**15**	
Collective strategy	1	6.67%
Individual strategy	13	86.67%
Both	1	6.67%
Failure of action, error, rejection due to poor quality	**9**	
Collective strategy	3	33.33%
Individual strategy	6	66.67%
Grand total	**91**	

*The frequency corresponds to the proportion of each type of strategy (individual, collective or both) within each category of events.

4.3.3 Protective Strategies ?

We investigated as to whether certain strategies played a protective role. We therefore reviewed all of the events in the four categories in which the most OHS risks had been identified: *handling difficulty*, *inappropriate product/equipment interface*, *equipment failure/shutdown* and *failure of action, error*. This corresponded to a total of 261 events out of the 554 that had been initially coded. Then we carried out a cross-sectional analysis of strategies per event, by analyzing the presence of OHS risks according to the strategy implemented for the 261 corresponding events (see Table 19). The strategies were grouped as individual strategies, collective strategies or both. The number of strategies is therefore equal to the number of events, or 261. For the four types of events previously identified, the students did not apply the same types of strategies. For the *inappropriate product/equipment interface* category, the students only used individual strategies, while for the three other types of events they also implemented or benefited from collective strategies.

OHS risks were observed most often in events in which the students used individual strategies. In fact, within the same category of events, the relative frequency of strategies associated with events entailing observable OHS risks is clearly less in the case of collective strategies:

- for *failure of action, error, rejection due to poor quality* events: 5.66% for collective strategies compared to 13.95% for individual strategies;
- for *handling difficulty*: 28.57% for collective strategies compared to 61.76% for individual strategies;
- for *equipment failure/shutdown*: 9.09% for collective strategies compared to 46.43% for individual strategies.

Table 19 – Strategies implemented to deal with the four types of event that involve the greatest OHS risks

Event Strategy	Number of strategies (N) without observable OHS risk	Number of strategies (N) associated with events with OHS risks	Relative frequency of strategies associated with events with OHS risks (%)
Handling difficulty (75 strategies)			
Collective strategy	5	2	28.57%
Individual strategy	26	42	61.76%
Inappropriate product/equipment interface (45 strategies)			
Individual strategy	22	23	51.11%
Equipment failure/shutdown (44 strategies)			
Collective strategy	10	1	9.09%
Individual strategy	15	13	46.43%
Both	4	1	20.00%
Failure of action, error, rejection due to poor quality (97 strategies)			
Collective strategy	50	3	5.66%
Individual strategy	37	6	13.95%
Both	1	0	0%
Grand total	**170**	**91**	

4.4 Unforeseen Events and Time Losses

Among the unforeseen events that students deal with, 55, or almost 10%, are at the origin of time losses, meaning that the students spent over a minute in restoring the previous situation following the occurrence of the event.

The results of the detailed analysis of 55 events at the origin of time losses are found in Table 20. The three types of events that led to the greatest time losses are *inability to find a product or person*, *equipment failure/shutdown* and *failure of action, error, rejection due to poor quality*, which correspond to a total of 53 events out of the 55 in which time losses were identified.

Table 20 – Events at the origin of time losses

Event at the origin of time losses*	Number (N)	Frequency (%)
Inability to find a product or person	19	34.55%
Equipment failure/shutdown	17	30.91%
Failure of action, error, rejection due to poor quality	17	30.91%
Difficulty handling PPE	1	1.82%
Inappropriate product/equipment interface	1	1.82%
Total	**55**	**100%**

*Only the events for which a loss of time was identified during the coding appear in Table 20.

A cross-sectional analysis of causes by event was carried out for the 55 unforeseen events at the origin of time losses. Table 21 presents the results for the 53 events in the three previously identified categories. Fifty-three causes were identified for these 53 events. The main cause of

lost time is attributable to material or products. In fact, searching for products in retail businesses often caused the young inventory clerks to lose a great deal of time. The second cause, *action or work technique*, was mainly associated with time losses for events in the *failure of action, error* category. In third place, the equipment was at the origin of most of the time losses when the unforeseen event corresponded to an *equipment failure/shutdown.*

Table 21 – Causes of 53 events causing time losses

	Causes									
	Work action or technique		**Workspace layout**		**Equipment**		**Being disturbed or interrupted**		**Material, products**	
Event	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**
Inability to find a product or person	1		9		0		0		9	
Equipment failure/shutdown	4		0		12		1		0	
Failure of action, error	9		0		0		0		8	
Grand total	14	**26.42%**	9	**16.98%**	12	**22.64%**	1	**1.89%**	17	**32.08%**

N = number of causes identified within each event category
% = percentage that each category of causes represents compared to all of the causes for the 53 events.

4.5 Work Action or Technique

Work action or technique is the only category of unforeseen causes that could be due to the students themselves, their know-how or their skills; the other categories mainly concern external elements such as the physical work environment or the social environment. In that category, the cause is related to an inappropriate work technique and apparently not attributable to an external condition. This type of cause was identified both for events with OHS risks and for events that cause time losses. The category was identified 109 times as the cause of unforeseen events. Table 22 illustrates the distribution of the *work action or technique* causes by type of event.

Table 22 – Events for which the *work action or technique* category of causes was identified

Event*	Number (N)	Frequency (%)
Failure of action, error	51	46.79
Object slipping/falling	29	26.61
Handling difficulty	11	10.09
Equipment failure/shutdown	6	5.50
Collision	4	3.67
Unstable load	2	1.83
Inappropriate product/equipment interface	3	2.75
Inability to find a product or person	3	2.75
Total	**109**	**100.00%**

* The *tripping, falling* and *difficulty handling PPE* events do not appear in Table 22 because no cause from the *work action or technique* category was identified for these events.

The causes in the *work action or technique* category were mainly identified for *failure of action, error* events (46.79%). It is the main cause of events of this type, as shown in Table 23. That category of causes was also associated with the *object slipping/falling* and *handling difficulty* events, but to a lesser extent: 26.61% and 10.09%, respectively.

The unforeseen events of *object slipping/falling* correspond to situations in which an object has fallen to the ground (from the trainee's hands or a structure close by). Cases in which the object appears to have fallen because of an action by the trainee (such as when a trainee was picking up boxes without stacking them properly and one of them fell on the ground) were categorized in the *work action or technique* category. For 8 of the 29 events that had *work action or technique* as a cause, a second cause related to the work context was also coded. For example, when the young trainee in the kitchen (9) was shelling crab claws, he cut them up with a knife that he wielded like a machete and he dropped several morsels of crab. A short time before he began this task, one of his co-workers had shown him how to do the job using the same knife. The qualitative analysis enabled the *material, products* cause to be coded as the second cause, given the particularities of the food product to be cut up. Another example is that of the young electronics store inventory clerk (7) using a box cutter to open the cardboard boxes he was unpacking before putting the merchandise on a rack. He was working in seated position, and after unpacking each box, he placed the box cutter on his thigh, as he had no place close by to put it, and the box cutter fell several times. In this case, the *workspace layout* cause was coded as the second cause. These three examples illustrate the diversity of situations that correspond to an event/cause pair of *object slipping/falling* and *work action or technique.*

The events categorized as being related to a *handling difficulty* were coded when the trainee had difficulties in holding an object in his hands or when the object was unstable, but without it falling on the ground. Among the events in which the cause was categorized under *work action or technique,* those in which the student was unable to use an appropriate handling technique for the product's characteristics were the most common. Several of these events were followed by or preceded by *object slipping/falling* events. This was the case when the kitchen trainee was shelling crab claws. Because of the difficulties he experienced in holding the claws and cutting them, morsels fell on the ground. The co-worker who demonstrated to him how to do it had to

repeat his movements twice before successfully cutting up one of the pieces of the claw, thus illustrating the dexterity required to prepare this type of food product and the difficulties experienced by novices in motor learning.

Table 23 – Causes identified for the 97 *failure of action, error* events

Cause	Number (N)	Frequency (%)
Work action or technique	51	52.58
Material, products	40	41.24
Impossible to determine a cause	5	5.15
Workspace layout	1	1.03
Grand total	**97**	**100**

A second analysis was then carried out to identify the strategies used by the students for the 109 unforeseen events in which *work action or technique* was identified as a cause. Table 24 presents only the results of this cross-sectional analysis of causes/event/strategies for the three categories of events previously identified: *failure of action, error; object slipping/falling;* and *handling difficulty.*

The results in Table 24 reveal that for the *failure of action, error* events, the strategies most often identified are, on the collective level, *receive training* (49.06%) and, on the individual level, *attempt to solve* (20.75%). In the first case, it was the co-workers who helped the students when they noticed errors being made by explaining to them how to resolve the situation and how to do it the next time.

For the *object slipping/falling* events, the students mainly used the individual strategy of *perform an additional task,* which, in most cases, consisted of picking up the object that had fallen.

For the *handling difficulty* events, the students mainly used individual strategies.

Table 24 – Strategies implemented following the three categories of events in which the category of *work action or technique* causes were most often identified

Event	Types of strategies implemented	Distribution of strategies by event	
		In numbers (N)	**In frequency (%)**
Failure of action, error (53 strategies implemented)			
Individual strategy	Attempt to solve	11	20.75%
	Repeat the action	4	7.55%
	Perform an additional task	3	5.66%
	Continue working	1	1.89%
Collective strategy	Receive training	26	49.06%
	Receive a comment	5	9.43%
	Request assistance	2	3.77%
	Receive assistance	1	1.89%
Object slipping/falling (33 strategies)			
Individual strategy	Perform an additional task	27	81.82%
	Continue working	4	12.12%
	Repeat the action	1	3.03%
	Attempt to solve	1	3.03%
Handling difficulty (11 strategies)			
Individual strategy	Continue working	4	36.36%
	Repeat the action	3	27.27%
	Attempt to solve	2	18.18%
Collective strategy	Receive training	2	18.18%

N = Number of strategies for each event category
% = Frequency of each type of strategy within each of the three event categories

5. DISCUSSION

The issue of controlling unforeseen events in the workplace is of interest to learning a trade, employment integration in general and the prevention of occupational injuries in particular. This study was able to build on several case studies and qualitative studies in ergonomics that had previously been identified in terms of hypotheses concerning OHS and young people and favourable learning conditions in a work situation. The analysis of quantitative data based on observations of the real jobs performed by nine TST students confirms that the occurrence of an unforeseen event cannot be considered solely as a risk to occupational health and safety, but also as an learning opportunity when conditions are favourable. This will be discussed in more detail in the following subsections, including the positive contribution of human resources in the student trainees' immediate environment. It will also show some of the difficulties that novices must overcome when learning a manual trade.

In this section we have emphasized certain results that build on the knowledge from other occupational health research studies. We will discuss the association between (1) accident risk and the occurrence of an unforeseen event, (2) the specific case of OHS risks and learning opportunities related to the activity of handling, (3) the development of know-how in a trade, and (4) collective control of unforeseen events, while putting the emphasis on the multiple learning contexts observed.

5.1 Unforeseen Events and OHS Risks

In Québec, an industrial accident is defined by its unforeseen and sudden character (AIAOD). In the scope of this research, the nine students were faced with various types of unforeseen events, in proportions that were quite similar at the beginning (T1) and the end of the traineeship (T2). For the two days of observation, they experienced a total of 554 events and 19% of these unforeseen events involved OHS risks. The unforeseen events with the greatest risks were caused mainly by badly designed products or materials, the trainees' actions or work techniques, or by defective equipment. These results support those of Sorock et al. (2001), which showed that risks of hand injuries are significant when workers carry out unfamiliar tasks, use dysfunctional equipment or adopt new or atypical working methods.

Sorock et al. (2001) also point to distraction and interruptions as risk factors in hand injuries. These two types of causes, *being rushed* and *being disturbed or interrupted*, had been identified as possible values in the "cause" category when the observation coding protocol was drawn up for this research, but they did not appear salient in the data analyzed. These types of causes are related to mental processes that are not easily observed.

The diversity of unforeseen events experienced by trainees can be explained by the activity sector of the organization in which their traineeships took place and the types of tasks they were performing during observations. The four workers who worked as inventory clerks in retail stores were mainly faced with events in the categories of *object slipping/falling* and *inability to find a product or person.* One of the inventory clerks' tasks is arranging the merchandise in the sales area (MELS, 2014), which requires searching for the location where the merchandise

belongs on the sales floor and then arranging the products, which could explain the occurrence of the two types of unforeseen events mentioned above.

The analysis of OHS risks, student by student, did not reveal a clear pattern in the sectors in which the trainees were the most exposed. However, the CSST data, which provide insight into the sectors in which youth aged 24 or under sustained the most occupational injuries, can clarify the research results. For 2012, the greatest number of occupational injuries occurred in the manufacturing and trade sectors, representing respectively 22% and 20% of injuries affecting youth in this age group; the accommodation and food services industry represent 10% of these injuries (CSST, 2013).

When OHS risks were targeted according to certain work contexts, three trainees had accumulated more than half of the events with a risk of accident (MSD or other) (woodworker, inventory clerk in the household appliance/electronics store and the butcher's assistant). The data from this research shows that all three students had to perform tasks involving handling heavy objects. It was therefore relevant to look more closely at events related to handling.

5.2 OHS Risks Associated with Handling

We feel it is worthwhile to discuss the issue of handling in more detail. The research shows that handling can be a source of injuries, particularly in young workers (Harkness et al., 2003). In fact, the highest rate of injuries among young workers falls under the vocational category of "handler" (19% of injuries incurred by young workers in Québec are in this category) (CSST, 2013). Among all the types of unforeseen events observed in this study, handling difficulties are in fourth place; yet they are rated first in unforeseen events associated with accident risk. Denis et al. (2011) caution against considering handling as a one-off activity with no regard to context. They stress the importance of referring instead to "handling activities," alluding to the various forms of and demands associated with this task, depending on the context. In our study, this is illustrated by the varied nature of unforeseen events that could be associated with handling activities: *handling difficulty* (N=142), *object slipping/falling* (N=75), or *inappropriate product/equipment interface* (N=45). The analyses made it possible to identify 262 unforeseen events in those three categories related to handling, or almost half of the unforeseen events identified (see Table 6). Among these 262 events, 71 of the 105 events held OHS risks (see Table 16).

The action or working technique of the trainee is often in question during unforeseen events that could be associated with a handling activity. In fact, 39.4% of unforeseen events in which the action or working technique of the trainee was identified as the cause came under one of the three categories related to handling (see Table 22). This corresponds to the findings of various studies, namely that the expertise of handlers develops with experience (Authier, 1996; Denis et al., 2011; Plamondon et al., 2010). The next section discusses this issue.

5.3 The Development of Know-How in a Trade

The unforeseen event encountered by a novice in a work situation can be seen as both a source of difficulties and as an opportunity for learning new skills.

For Mazeau (1995), competence (or skill) is defined as "the capacity of an individual or a group to effectively cope with a given situation. Competence consists of knowledge (formalized, transferable by teaching methods), know-how (most often acquired through imitation, and can be formalized with the support of experts), abilities (analyzable, acquired through experience and practice)" [free translation].

Leplat (1991) notes that an individual can acquire skills through diverse forms of learning: "This could be rationally guided learning, at school or in a training centre, or through instructions, which could entail learning through action" [free translation]. Learning through action therefore refers to the skills that the individual develops in a working situation when he or she performs specific tasks. Thus, a skill is always specific: "one is skilled in a task or a category of tasks" [free translation]. (Leplat, 1991).

In the scope of this research, it was not possible to see differences emerging between the unforeseen events that occurred at the time of the first wave of observations (a few days into the traineeships) and those reported after several months of training, or the progress of strategies in cases of unforeseen events (in T1, individual strategies counted for 79.0% of the strategies observed during unforeseen events, compared to 83.8% in T2). This can be explained by the fact that the traineeship contexts were different between the two waves of observations. Several students were not assigned to the same tasks (job enrichment for the inventory clerk in the clothing store; unfamiliar task for the drugstore inventory clerk because of the change in season), did not deal with the same type of client order (e.g., the printer's assistant), or were sometimes assigned to a completely different workstation (e.g., worker in a wood processing plant). Moreover, even during the second wave of observations, the numbers of hours and days of the traineeships were still relatively low, which leads us to hypothesize that the workers were not yet completely comfortable in the mastery of their trade. Laberge et al. (2012) showed that these young people, by the very nature of the traineeship, were rarely introduced to the global task (in reference to the work of Lave and Wenger, 1991) and remain restricted to peripheral participation. That is why they cannot develop all the knowledge necessary to deal with unforeseen events. Even in the development of a repository of events that are foreseeable but where the moment of occurrence is uncertain, which Perrenoud (1999) described as a relative unforeseen event, is not systematic for these students.

That said, our results contribute to a reflection on the role played by experience in strategies to control unforeseen events when we focus on two results in particular:

- the causes that were classified in the *work action or technique* category and their relationship with OHS risks or losses of time;

- self-regulation strategies compared to collective strategies, and their relationship with OHS risks; this last point will also be dealt with in the following section, on the issue of the group's contribution to learning and protecting health.

The *work action or technique* category is the only category of causes of unforeseen events that could be directly associated with the students' inexperience. In the scope of this research, these actions or working techniques were often related to the motor or proprioceptive skills of workers, in particular, of the young trainees working in the food service sector; knife handling was often

the source of the event, which backs up Ouellet and Vézina's conclusions (2008 and 2009) that motor learning is an essential component of learning a manual trade.

With respect to the links between the category of *work action or technique* and OHS risks, analyses revealed that it is the second type of cause associated with accident risk after *material, products*. These results concur with those of previous research on the comparison of the ways that expert and novice garbage collectors (Denis et al., 2007) and handlers (Plamondon et al., 2010) do things. In those studies, the authors showed that expert handlers more frequently performed their tasks in ways recognized as being safer (Plamondon et al., 2010) and adopted energy-saving strategies (Denis et al., 2007). These results may explain in part the very compelling findings of Breslin and Smith (2006), which demonstrated the much higher risk of novices injuring themselves during the first month on the job.

The strategies implemented following unforeseen events in the *handling difficulty* and *object slipping/falling* categories, for which *work action or technique* was identified as the cause, showed that the students tried to find adequate ways of doing things by themselves, instead of asking for assistance or taking advantage of a collective strategy suggested by a co-worker. They tried to work out the difficulties by doing additional tasks or repeating the action. It was only when an unforeseen event occurred that trainees changed how they were doing things, using new gestures. Chassaing (2004) also described these ways of learning new body movements by modifying them according to the result obtained.

This category of cause is at the origin of 26.42% of events that led to a loss of time, making it the second highest cause of lost productivity after *material, products* (32.08%). It provides a strong argument for businesses to invest in peer training, based on the transmission of workplace knowledge and on the development of reflexive skills.

5.4 The Group's Contribution to Learning and Health Protection

While the observations reveal that most of the students mainly used individual strategies when unforeseen events occurred, the detailed analysis of strategies revealed that students 3, 8 and 9 (printer's assistant, butcher's assistant and cook's assistant, respectively) used collective strategies proportionally more than the others, and these collective strategies were mainly initiated by their co-workers. Laberge et al. (2012) had previously shown that, overall, trainees who could count on the nearby presence of co-workers benefited more from the transmission of vocational skills and did better overall in their traineeships (job offers at the end of the traineeship). More specifically, in unexpected situations, the observations confirm that some young people were able to rely on or had more of a chance to benefit from the assistance of co-workers at critical moments when the activity was disrupted; these were the same young people described by Laberge et al. (2012) in the previous research study who had more supervision overall. In fact, the results of the previous research action carried out with the same nine students showed that students 3, 8 and 9 had the greatest number of interactions per hour with their co-workers. This amount of interactions per hour could be explained both by the close presence of co-workers to the trainee and as an indication of their availability to supervise and help the trainee perform the task and/or providing training.

The strategies of a collective nature observed in this study are not all on the same level. For instance, the *request assistance* (a strategy initiated by the young person) and *receive training* (a strategy initiated by a member of the group) strategies probably did not result from the same types of unforeseen events or the same contexts in the traineeship. The two trainees who were the least independent according to the overall appraisal of previous studies asked for assistance the most in unforeseen situations (the two drugstore inventory clerks). The three trainees who benefited from training when an unforeseen event occurred (the printer's assistant, the cook's assistant and the butcher's assistant) are those who benefited from a richer social environment as pointed out in Laberge et al. (2012). Two of these three trainees were more successful in their traineeships, and were offered jobs afterward, despite their poor educational qualifications (below secondary III).

With respect to the protective role of the group in terms of OHS, the analysis of the data revealed that recourse to the strategies involving the work group corresponds to a lower risk of accidents related to the occurrence of an unforeseen event. If one considers the four main types of events involving OHS risks for the nine students (*handling difficulty, inappropriate product/equipment interface, equipment failure/shutdown* and *failure of action, error*), it appears that the 91 events connected to them were mainly followed by individual strategies. However, when all of the events in these four categories are analyzed (N=261), the results indicate that injury risks are lower when the students implement collective strategies, whatever the type of event.

If we take a look at the causes of unforeseen events that give rise to individual or collective strategies, it is interesting to note that the strategies of the *receive training* type were implemented when the students were faced with the unexpected in the *failure of action, error* category, thus probably limiting situations involving OHS risks.

5.5 Suggestions for Preventing Occupational Injuries and Encouraging Situational Learning for Novices

In this discussion, we have seen that several sources of limitations, related, for example, to the handling or use of inadequate equipment, can represent an OHS risk. However, some resources in the workplace can become aids in learning a trade, for example, being surrounded by experienced workers who have the time to pass on their expertise. This study enabled the duality that characterizes the unforeseen event to be identified in terms of learning opportunity or accident risk. The research led us to revisit Leplat's 2011 model explaining disruption in the course of the action, which we adapted by integrating certain developmental consequences according to work conditions and people's characteristics, and modulated by the strategies implemented by the novices (see figure 7).

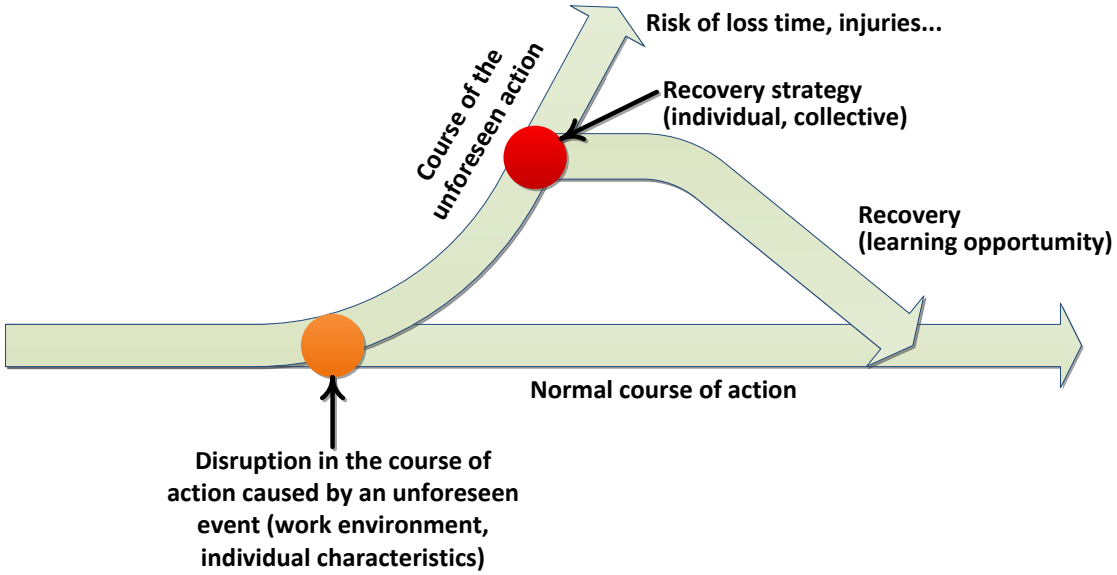

Figure 7 – Adaptation of the model representing a disruption in the course of action (Leplat, 2011) according to the results of this research

Several suggestions could be made to organizations using the proposed model and the results of this study:

- Analyze certain categories of unforeseen events that can increase the risk of accidents, in order to suggest preventive mechanisms to deal with them;
- Provide novices with learning opportunities that gradually increase the level of complexity and sources of constraint;
- Enrich workplace training by simulating unforeseen or sudden but credible situations that provide trainees with the opportunity to implement adapted strategies under supervision and with feedback;
- Specifically analyze the handling tasks that novices may have to perform and adopt training strategies, such as those suggested by Denis et al. (2011);
- Consider the importance of motor skills in learning during training, and plan ways to encourage the transmission of useful knowledge for learning skills and efficient operating methods, such as those recommended by Ouellet and Vézina (2009);
- Pay special attention to people in the workplace who could pass on their work-related knowledge, thus contributing to the development of reflexive skills.

More research is needed to develop and implement prevention strategies related to these issues.

5.6 Research Limits and Future Prospects

The main limitation of this research comes from the fact that the data was not initially collected with the intention of analyzing unforeseen events. The research design specifications did not establish the precautions that should have been taken to facilitate the quantitative analysis. For example, the sampling choice could have been restricted to a single trade to reduce the complexity of the variable contexts and the interpretation of results. It would have then been important to ensure that the trainees continued their traineeship at the same workstation and that the choice of days corresponded to the same types of assignments in T1 and T2. It would have also been relevant to film the experienced workers to compare whether the *OHS risks, time losses* and *strategies* variables could be related to learning and experience. This would have enabled us to go further in explaining hypotheses related to learning. However, the fact that no parameter was controlled has the advantage of representing the situation that the TST teachers experience with the students they supervise. These youth are found in all sorts of situations; the teachers must provide them with guidance, even though, in several of these environments, they have few points of reference. While the data in this study are imperfect, they provide a good illustration of the challenges of supervising these young people in a single academic program: many traineeship contexts, many young people, and many OHS risks. As well, the results of this study are different, but relevant, when compared to other studies on the same subject, i.e., the possible links between experience, learning and OHS risks. The originality of this research relates to the analytical perspective of this question: what happens when work does not proceed as anticipated? The choice of performing a quantitative analysis on uncontrolled observation data (real work, real environment) builds on and enriches the conclusions of other qualitative or more controlled research studies, such as, for example, the development of protective strategies in Cloutier et al. (2005) or the reduction in the level of occupational injuries at workstations (Breslin and Smith, 2006). In a further research study, it would be interesting to control for the task assignments between T1 and T2 in order to ensure similar work situations and to further examine the issue of learning over time.

Some limits are due to the analytical technique and coding. The observation of real work entails numerous challenges. First of all, it is not always easy to determine mutually exclusive and collectively exhaustive categories when characterizing the determinants of the working activity. In this research, it was sometimes impossible to decide between two causes because the incident appeared to be explained by a sequence of causes or by a simultaneous combination of two types of causes. The most convincing illustration of this difficulty can be found in the example of the young trainee in the kitchen who found it difficult to shell a crab claw, because it was very difficult to work with (even the experienced workers around the trainee struggled with this task) and he also lacked dexterity with his knife. In this example, every time the young trainee dropped the crab claw on the ground (*object slipping/falling*) the coded causes were attributed equally to *material, products* and to *work action or technique*. The results were therefore difficult to interpret and led us to this question: what best explains the risks facing novices: their personal characteristics (physical or intellectual abilities, skills, capacities) or the conditions in their surroundings? The importance of the role played by each of the different causes in the occurrence of an event is also touched on by Leplat (2011). For the author, a disruption in the course of action results from linking the subject's internal sources, such as *lack of competence*, with external sources, which rely on *technical and organizational conditions*. Thus, "each

interruption can be seen in both ways, with each assessed in light of the other." (Leplat, 2011 p. 96, free translation). To do this, the situation that led to the disruption should be analyzed and not solely the disruption itself (Leplat, 2011).

Along the same lines, there is general consensus that the occurrence of an unforeseen and sudden event, such as a workplace accident, is often multifactorial. The scope of the proposed analysis did not enable this complexity to be taken into account in the explanation of accident risks. The collection of data in this study was associated with the occurrence of observable events recorded at a certain moment, and to avoid making erroneous interpretations, the researchers were held to "immediate and observable causes." Thus, the reliability of data was preferred over the exhaustiveness of the analysis, which limits the interpretation of the data. Despite this, the information gathered appears relevant to us as an indicator of sources of difficulty. Moreover, it is based on real observable activity, which was also not systematically described in the scientific literature.

With respect to methodology, the activity cannot be uniquely described by what can be observed. Verbal reporting would have enabled us to confirm, deny, improve and qualify the analyses of causes and strategies. For example, self-confrontation interviews with the students would have helped us obtain information on the mental component of the activity, such as the reasoning that led to the choice of strategies. In the scope of the previous research for which data was collected, the researchers had completed their analyses through self-confrontation interviews, but the occurrence of unforeseen events was not included in the topics of the interviews at that time, because the analysis of unforeseen events was carried out afterward. Nevertheless, the data gathered for the previous research enhanced the knowledge regarding the contexts of the nine students and that made it possible to interpret several individualized results in this research.

Another limit to the research was the small sample of workers observed (n=9). In the original study, this choice was due to the type of research study design used; a case study based on a careful analysis of the activity of the student trainees in different traineeship contexts. It was then important to gather very detailed information on the contexts and the realities experienced by each student. The video data complemented the many other sources of data and enabled conclusions to be drawn through triangulation, which was not the case for this research. That said, a deeper knowledge of the various training environments of the students and the possibility of reviewing information from the previous research enabled certain data to be interpreted, such as, for example, the unforeseen events experienced by the young trainees in the drugstore; we learned about the complexity of the system for stocking merchandise on the shelves and the nature of products, which enabled us to decide on certain causes of events in the *object falling* or *unfound product* categories when the observer was uncertain of its code. Other than this detailed knowledge of contexts, to mitigate this limit related to sample size, it was decided to analyze all of the material and not to simply sample portions of the videos, as is often the case in this type of analysis. Thus 79.5 hours of video material were analyzed in their integrity and all of the unforeseen events filmed were examined, which had the advantage of having a significant number of occurrences for the analyses. As some of the young people are represented more in the sample of events analyzed (23% of the unforeseen events coded correspond solely to student 5), we added a differentiated analysis for each young person according to their traineeship context (section 4.2), which enabled a detailed analysis of certain unforeseen event scenarios.

With respect to the contribution of the group at work, Laberge et al. (2012) showed that some young people made more use of this type of resource. This study made similar findings. It would, however, be interesting to look more closely at the nature of this type of resource. In this study, the observables of *providing training* or *providing assistance* were catalogued, but the nature of the assistance or the training was not characterized. In future research, it would be valuable to delve more deeply into these dimensions of training and learning.

Finally, an important aspect of learning was not taken into account, given the nature of the data analyzed. In their analysis of the various types of training used in business, Verhaest and Omey (2010) showed that training "by doing," also called on-the-job training, was the most common in companies. For the authors, on-the-job training appears to be one of the most effective means of learning specific skills, but also general skills and those that are transferable to other trades, notably because of the time in which the novice worker "is training while on the job," because that corresponds to a large portion of his or her working time, at least at the beginning. To deal with unforeseen and atypical situations, the worker must be able to use the skills acquired in a "normal" situation or in an atypical situation of the same nature that occurred in the past. Pastré (1999) distinguished two types of skills: "incorporated skills, in which know-how is dependant on the action and its context, and explicit or explained skills, in which the subject's process of reflective analysis (conceptualization), results in a decontextualization of know-how, which makes the skill adaptable and transferable to other situations" [free translation]. Jonnaert et al. (2004) added with respect to explicit skills: "for someone to be able to adapt his/her skills to new situations, they must have been put into words, explained and conceptualized, while their meaning is preserved through the memory of the original situation" [free translation]. It is through this conceptualization that the person "recognizes, from one situation to another, a series of invariables that she or he identifies and adapts to the actions to be carried out. The person thus modifies the skills learned in a past situation and adapts them to the constraints and resources of the current situation" [free translation]. In our research, this part of the "explicit" skill was not analyzed but remains a subject that should be explored in more detail. To do so, using the combination of simple and crossed self-confrontation techniques applied to traineeships proposed by Laberge et al. (2014) appears to be an interesting approach. This combination of reflexive techniques could have a double usefulness. From the point of view of research, it would enable skills to be broken down into operational categories in order to develop training standards more consistent with the real demands of work. With respect to learning, it would allow the novice and the trainer to be more aware of which knowledge to use in a given situation.

6. CONCLUSION

Our research gave us a better understanding of the interactions between the learning situations and OHS risks, through a detailed analysis of what happens when an unforeseen event disturbs the normal course of the action. It added to the model of Leplat (2011), by suggesting some developmental consequences to disruptions of the course of the action. Lessons for preventing injuries and for training in the workplace could be learned, such as developing training situations that integrate the occurrence of unforeseen events, gradually increasing their complexity and the associated risks. The contribution of other workers appears essential, as other studies have also stressed. This research argues in favour of the development of rational training approaches with a social constructivist paradigm of learning that stipulates that individuals develop through experiencing situations surrounded by other people who can confront their preconceptions and enrich their repository of knowledge of the situation.

Theoretically, the description of causes and consequences of unforeseen events, in terms of regulation strategies and their impact on health and productivity enabled us to enrich the regulation model of activity that is widely used in ergonomics (Vézina, 2001; St-Vincent et al., 2011), by putting quantitative data to the test. Few previous research studies have used the model in that perspective. It suggests possibilities for better integrating the concept of regulation of the activity when choosing indicators to take into account in the statistical models used in quantitative research.

The research should continue in order to better understand the relationships between the unforeseen event, accident risk and the learning process, in particular, by comparing experts to novices and by carrying out longitudinal studies. It would be also relevant to do more specific analyses on certain activity sectors with high rates of injuries, to draw more targeted conclusions according to typologies of tasks.

The results of this research will be integrated into an OHS learning implementation project for TST students. These tools will accompany training materials, both for the teachers responsible for implementing them, and for the students and the companies that agree to receive and train them.

BIBLIOGRAPHY

Authier, M. 1996. *Analyse ergonomique des stratégies de manutentionnaires experts et novices,* Thesis, Université de Montréal, Montréal.

Avila-Assunçao, A. 1998. *De la déficience à la gestion collective du travail : les troubles musculo-squelettiques dans la restauration collective*. Doctoral thesis in ergonomy, laboratoire d'ergonomie physiologique et cognitive, École pratique des hautes études, Paris.

Breslin, F.C. and Smith, P. 2005. "Age-related differences in work injuries: A multivariate, population-based study." *American Journal of Industrial Medicine*, vol.48, no. 1, p. 50–56.

Breslin, F.C. and Smith, P. 2006. "Trial by fire: A multivariate examination of the relationship between job tenure and work injuries." *Occupational and Environmental Medicine*, 63(1), p. 27-32.

Breslin, F.C., Day, D., Tompa, E., Irvin, E. Bhattacharyya, S., Clarke, J. and Wang, A. 2007. "Non agricultural work injuries among youth. A systematic review." *American Journal of Preventive Medicine*, vol. 21, no. 2, p. 151-162.

Breslin, F.C. 2008. "Educational status and work injury among young people." *Canadian Journal of Public Health*, 99(2), p. 121-124.

Breslin, F.C. and Pole, J.D. 2009. "Work injury risk among young people with learning disabilities and attention-deficit/hyperactivity disorder in Canada." *American Journal of Public Health*, 99(8), p. 1423-1430.

Breslin, F.C. and Smith, P. 2010. "A commentary on the unique developmental considerations of youth." *International Journal of Occupational and Environmental Health*, vol. 16, no. 2, p. 225-229.

Camirand, H. 2013. "Qui sont les victimes de blessures en milieu de travail? Ce que révèlent les données de l'*Enquête québécoise sur la santé de la population, 2008." Zoom Santé*, vol. 40, January 2013, Institut de la statistique du Québec.

Chassaing, K. 2004. "Vers une compréhension de la construction des gestuelles avec l'expérience : le cas des "tôliers " d'une entreprise automobile," *Perspectives interdisciplinaires sur le travail et la santé*, 6-1 | 2004. http://pistes.revues.org/3280

Chatigny, 2001. " Construire des ressources pour l'apprentissage en situation de travail : une nécessité pour la santé et la sécurité au travail." Comptes rendus du congrès SELF-ACE – Les transformations du travail, enjeux pour l'ergonomie. Montréal, 2001.

Cloutier, E. 1994. "The effect of age on safety and work practices among domestic trash collectors in Québec." *Safety Science*. Vol.17, Issue 4. p. 291-308.

Cloutier, E., David, H., Ledoux, E, Bourdouxhe, M., Teiger, C., Gagnon, I. and Ouellet, F.2005. *Importance de l'organisation du travail comme soutien aux stratégies protectrices des auxiliaires familiales et sociales et des infirmières des services de soins et de maintien à domicile*. Report R-429. Montréal: IRSST, 277 pages.

Commission de la santé et de la sécurité du travail du Québec. 2013. *Portrait des jeunes travailleurs de 24 ans ou moins. Année 2012*. Montréal: CSST.

Denis, D., St-Vincent, M., Gonella, M., Couturier, F., Trudeau, R. 2007. *Analyse des stratégies de manutention chez des éboueurs au Québec - Pistes de réflexions pour une formation à la manutention plus adaptée*. Report R-527. Montréal (Québec): IRSST, 80 pages.

Denis, D., Lortie, M., St-Vincent, M., Gonella, M., Plamondon, A., Delisle, A., Tardif, J. 2011. *Programme de formation participative en manutention manuelle - Fondements théoriques et approche proposée.* Report R-690, Montréal: IRSST, 172 pages.

Gaudart C. and Weill-Fassina A. 1999. "L'évolution des compétences au cours de la vie professionnelle : une approche ergonomique." *Formation Emploi,* vol. 67, p. 47-62.

Gervais, M., Massicotte, P. et Champoux, D. 2006. *Conditions de travail, de santé et de sécurité des travailleurs du Québec.* Report R-449. Montréal: IRSST, 133 pages.

Godin, J.F., Laplante, B., Ledoux, E., Tsala Dimbuene, Z. and Vultur, M. 2009. *Étude exploratoire des parcours d'emploi en lien avec l'apparition des premières lésions chez les jeunes de 16 à 24 ans*. Report R-630. Montréal: IRSST, 74 pages.

Gonon, O. 2003. « Des régulations en lien avec l'âge, la santé et les caractéristiques du travail : le cas des infirmières d'un centre hospitalier français », *Perspectives interdisciplinaires sur le travail et la santé* 5-1 | 2003. http://pistes.revues.org/3336

Guérin, F., Laville A., Daniellou, F., Duraffourg, J. et Kerguelen, A. 2007. *Comprendre le travail pour le transformer. La pratique de l'ergonomie.* Lyon: Éditions du réseau ANACT. 318 pages.

Harkness, E.F., Macfarlane G. J., Nahit, E. S., Silman, A. J., McBeth, J. 2003. "Risk factors for new-onset low back pain amongst cohorts of newly employed workers." *Rheumatology* Volume 42 Issue 8, p. 959-968.

Jackson, L.L. 2001. "Non-fatal occupational injuries and illnesses treated in hospital emergency departments in the United States." *Injury Prevention*, vol.7, suppl I, p. i21-26.

Jonnaert, P., Barrette J., Boufrahi S. and Masciotra, D. 2004. "Contribution critique au développement des programmes d'études : compétences, constructivisme et interdisciplinarité." *Revue des sciences de l'éducation, Vol XXX, no.3, 2004, p.667-696.*

Laberge L., Ledoux, E., Thuilier, C., Gaudreault, M., Martin, J.-S., Cloutier, E., Auclair, J., Lachance, L., Veillette, S., Rozon, C., Gaudreault, M., Arbour, N., Bescou, S., Agenais, T., Hostiou, L. 2011. *Santé et sécurité des étudiants qui occupent un emploi durant l'année scolaire - Les effets du cumul d'activités et de contraintes de travail.* Report R-705, Montréal: IRSST, 147 pages.

Laberge, M., Vézina, N., Calvet, B. and Ledoux, E. 2010. "Le PFAE. Quelles sont les implications pour la SST ?" *Travail et santé*, vol. 26, no. 2, p. S7-13.

Laberge, M. 2011. *Accueil et intégration sécuritaire et compétente en emploi des élèves inscrits à la Formation menant à un métier semi-spécialisé du parcours de formation axée sur l'emploi*. Doctoral thesis in biology. Montréal: UQAM, 262 pages.

Laberge, M. and Ledoux, E. 2011. "Occupational Health and Safety Issues Affecting Young Workers: A Literature Review" *Work*, vol. 39, no. 3, p. 215-232.

Laberge, M., Vézina, N., Calvet, B., Lévesque, S., Vézina-Nadon, L. 2012. "Supervision of Apprentices in Semiskilled Trades: Program Stipulations and Workplace Realities." *Relations industrielles / Industrial Relations*, vol. 67, no. 2, 2012, p.199-221.

Laberge M., MacEachen E., Calvet B. 2014. "Why are occupational health and safety training approaches not effective? Understanding young worker learning processes using an ergonomic lens." *Safety Science* volume 68 (2014) p. 250–257.

Larousse. 2014. Édition en ligne du dictionnaire Larousse. http://www.larousse.fr/dictionnaires/francais-monolingue

Lave, J. and Wenger, E. 1991. *Situated Learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Ledoux, E., Bernier, J., Thuilier, C., Laberge, M. and Paquin-Collins, S. 2008. *Approche terrain pour rejoindre et sensibiliser les jeunes travailleur.* Report R-588, Montréal: IRSST, 118 pages.

Legault-Faucher, M. 2005. "Jeunes et prévention. Version réalité." *Prévention au travail*, volume 18, no 1, Winter 2005.

Leplat, J. 1991. "Compétence et ergonomie." J. Leplat and M. de Montmollin (dir.) *Les compétences en ergonomie* p.42-53. Toulouse: Éditions Octarès. 2001.

Leplat, J. 2011. *Mélanges ergonomiques : activité, compétence, erreur*. Toulouse: Éditions Octarès. 161 pages.

Act respecting industrial accidents and occupational diseases, R.S.Q., c. A-3.001.

Marsick, V. J. and Watkins, K. E. 2001. "Informal and Incidental Learning." *New Directions for Adult and Continuing Education*, Volume 2001, Issue 89, p.25–34. doi: 10.1002/ace.5.

Marcel, J-F. 2004. “Les pratiques enseignantes de gestion des imprévus.” *Psychologie & Éducation* no. 56, p.31-50.

Mazeau, M. 1995. “Acquisition, maintien et développement des compétences.” J. Leplat and M. de Montmollin (dir.) *Les compétences en ergonomie* p.89-93. Toulouse: Éditions Octarès. 2001.

Millanvoye M. and Colombel J. 1996. “Age et activité des opérateurs dans une entreprise de construction aéronautique.” R. Patesson (dir.) *Intervenir par l’ergonomie, XXXI*^{ème} *Congrès de la SELF*, Brussels.

Morassaei S., Breslin F.C., Shen M., Smith P. M. 2013. “Examining job tenure and lost-time claim rates in Ontario, Canada, over a 10-year period, 1999–2008.” *Occup Environ Med*.2013; 70: 171-178.

National Institute for Occupational Safety and Health. 2004. *Worker Health Chartbook*, Cincinnati (Ohio): NIOSH, 354 pages.

Noulin, M. 2002. *Ergonomie.* Toulouse. Éditions Octarès. 149 pages.

Ouellet S. and Vézina, N. 2008. “Savoirs professionnels et prévention des TMS : réflexions conceptuelles et méthodologiques menant à leur identification et à la genèse de leur construction.” *Perspectives interdisciplinaires sur le travail et la santé*, vol. 10, no. 2. http://pistes.revues.org/2251

Ouellet, S. and Vézina, N. 2009 “Savoirs professionnels et prévention des TMS : portrait de leur transmission durant la formation et perspectives d’intervention,” *Perspectives interdisciplinaires sur le travail et la santé* [online], 11-2 | 2009, put online November 1, 2009. http://pistes.revues.org/2388

Ouellet, S. 2009. *Acquisition d’habiletés motrices à la découpe de viande et prévention des troubles musculo-squelettiques : apport de l’analyse ergonomique à la conception de formations* . Doctoral thesis, Montréal, Université du Québec à Montréal, 569 pages.

Pastré, P. 1999. Travail et compétences : un point de vue de didacticien. J. Leplat and M. de Montmollin (dir.) *Les compétences en ergonomie* p.147-160. Toulouse. Éditions Octarès. 2001.

Perrenoud, P. 1999. “Gestion de l’imprévu, analyse de l’action et construction de compétences.” *Éducation Permanente*, 140-3, p.123-144.

Plamondon A., Denis D., Bellefeuille S., Delisle A., Gonella M., Salazar E., Gagnon D., Larivière C., St-Vincent M., Nastasia I. 2010. *Manutention Comparaison des façons de faire entre les experts et les novices*. Report R-663, Montréal: IRSST, 69 pages.

Québec, ministère de l'Éducation, du Loisir et du Sport. 2008. *Programme de formation de l'école québécoise. Enseignement secondaire, deuxième cycle. Formation préparatoire au travail et formation menant à l'exercice d'un métier semi-spécialisé.* Québec: Les publications du Québec, chapters 1 to 5 and 10.

Québec, ministère de l'Éducation, du Loisir et du Sport. 2014. *Répertoire des métiers semi-spécialisés*. Liste des métiers, année 2014-2015. MELS website: http://www1.mels.gouv.qc.ca/sections/metiers/index.asp?page=recherche&action=search&navSeq=1&type=all&cmp1=&cmp2=&cmp3=

Runyan, C.W. and Zakocs, R.C. 2000. "Epidemiology and prevention of injuries among adolescent workers in the United States." *Annual Review of Public Health*, vol. 21, p. 247-269.

Salminen, S. 2004. "Have young workers more injuries than older ones? An international literature review." *Journal of Safety Research* vol. 35, p. 513-521.

Smith, P. M. and Mustard, C. A. 2007. "How many employees receive safety training during their first year of a new job?" *Injury Prevention* 2007:13, p. 37–41

Sorock, G. S., Lombardi, D. A., Hauser, R. B., Eisen E. A., Herrick, R. F. and Mittleman M. A. 2001. "A Case-Crossover Study of Occupational Traumatic Hand Injury: Methods and Initial Findings." *American Journal of Industrial Medicine* vol. 39. p. 171-179

St-Vincent, M., Vézina, N., Bellemare, M., Denis, D., Ledoux, E., Imbeau, D, and Lapierre, J. 2011. *L'intervention en ergonomie*. Québec: Éditions Multi-Mondes. 360 pages.

Verhaest, D., and Omey, E. 2010. "The measurement and determinants of skill acquisition in young workers' first job." *Economic and Industrial Democracy*, 31(1), p.116-149.

Vézina, M., Cloutier, E., Stock, S., Lippel K., Fortin, E., Delisle, A., St-Vincent, M., Funes, A., Duguay, P., Vézina, S. and Prud'homme P. 2011. *Enquête québécoise sur des conditions de travail, d'emploi et de santé et de sécurité du travail (EQCOTESS*T). Report R-691, Montréal: IRSST, 656 pages

Vézina**,** N., Prévost**,** J., Lajoie, A., Beauchamp, Y. 1999. "Élaboration d'une formation à l'affilage des couteaux : Le travail d'un collectif, travailleurs et ergonomes," *Perspectives interdisciplinaires sur le travail et la santé*. 1-1 | 1999 http://pistes.revues.org/3838

Vézina, N. 2001. "La pratique de l'ergonomie face aux TMS : ouverture à l'interdisciplinarité." *Proceeding of SELF-ACE Conference* (Montréal, October 3-5, 2001).

Walters, J.K., Christensen, K.A., Green, M.K., Karam, L.E. and Kincl, L.D. 2010. "Occupational injuries to Oregon workers 24 years and younger: An analysis of workers' compensation claims, 2000–2007." *American journal of Industrial Medicine*, vol. 53, no. 10, p. 984-994.

Zierold, K.M., Garman, S. and Anderson, H. 2004. “Summer work and injury middle school students, aged 1-14 years.” *Occupational and Environmental Medicine*, vol. 61, no. 6, p. 518-522.

Zierold K. and Anderson H. 2006. “Severe injury and the need for improved safety training among working teens.” *American Journal of Health Behavior*, vol.30, no. 5, p. 525–532

APPENDICES

Appendix A. Analysis of Events per Student

The table shows the distribution of events that occurred for each student in number (N) and frequency (%); the proportion of each type of event was calculated with respect to all of the events identified for each student.

	Student 1		Student 2		Student 3		Student 4		Student 5		Student 6		Student 7		Student 8		Student 9		TOTAL	
Event	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**
Object slipping/falling	0	**0.0**	2	**5.1**		**0.0**	1	**5.0**	61	**47.7**	37	**46.8**	13	**25.0**	19	**20.0**	9	**26.5**	142	**25.6**
Failure of action, error	7	**15.9**	16	**41.0**	22	**34.9**	0	**0.0**	1	**0.8**	2	**2.5**	6	**11.5**	32	**33.7**	11	**32.4**	97	**17.5**
Inability to find a product or person	0	**0.0**	3	**7.7**	2	**3.2**	15	**75.0**	46	**35.9**	21	**26.6**	3	**5.8**	4	**4.2**	2	**5.9**	96	**17.3**
Handling difficulty	17	**38.6**	1	**2.6**	12	**19.0**	3	**15.0**	7	**5.5**	6	**7.6**	7	**13.5**	10	**10.5**	12	**35.3**	75	**13.5**
Inappropriate product/equipment interface	2	**4.5**	9	**23.1**	0	**0.0**	1	**5.0**	3	**2.3**	5	**6.3**	3	**5.8**	22	**23.2**	0	**0.0**	45	**8.1**
Equipment failure/shutdown	0	**0.0**	2	**5.1**	22	**34.9**	0	**0.0**	1	**0.8**	6	**7.6**	13	**25.0**	0	**0.0**	0	**0.0**	44	**7.9**
Difficulty handling PPE	17	**38.6**	6	**15.4**		**0.0**	0	**0.0**	0	**0.0**	0	**0.0**	2	**3.8**	4	**4.2**	0	**0.0**	29	**5.2**
Collision	0	**0.0**		**0.0**	1	**1.6**	0	**0.0**	3	**2.3**	1	**1.3**	4	**7.7**	3	**3.2**	0	**0.0**	12	**2.2**
Unstable load	0	**0.0**		**0.0**	3	**4.8**	0	**0.0**	6	**4.7**	0	**0.0**	0	**0.0**	0	**0.0**	0	**0.0**	9	**1.6**
Tripping, falling	1	**2.3**		**0.0**	1	**1,6**	0	**0.0**	0	**0.0**	1	**1,3**	1	**1.9**	1	**1.1**	0	**0.0**	5	**0.9**
Grand total	44	**100.0**	39	**100.0**	63	**100.0**	20	**100.0**	128	**100.0**	79	**100.0**	52	**100.0**	95	**100.0**	34	**100.0**	554	**100.0**

N = Number of events in this category for the student (or in total) | % = percentage of this event among those experienced by the student

Appendix B. Cross-sectional Analysis by Event for the 105 Events Entailing OHS Risks (total of 106 causes identified)

	Work action or technique		Workspace layout		Inadequate PPE		Equipment		Cluttered area		Material, products		Total	
Event	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**
Handling difficulty	8		5				1				31		45	
Inappropriate product/equipment interface	2				2						19		23	
Equipment failure/shutdown			4				11						15	
Failure of action, error	5		1								3		9	
Object slipping/falling	1		1								2		4	
Tripping, falling			1						2				3	
Inability to find a product or person			1								2		3	
Collision	1		1										2	
Unstable load	1										1		2	
Total	18	**16.98%**	14	**13.21%**	2	**1.89%**	12	**11.32%**	2	**1.89%**	58	**54.72%**	106	**100.00%**

N = number of causes identified within each even category
% = percentage that each category of causes represents compared to all of the causes for the 105 events entailing OHS risks.