Observational Learning of Junior Residents during Surgery:

Exploring Promoters and Barriers to Learning

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Abstract

Surgical observation is an integral part of surgical training. Junior residents, who have limited understanding of the procedure being performed, frequently engage in observation in order to gain exposure to surgical techniques. This limited experience, and the relative lack of guidance currently provided to them, might limit their ability to learn by observing. This thesis examines learners' perceptions of the value of surgical observation, the barriers to learning in the surgical environment, and the factors that facilitate learning within the context of the operating room. An intervention, employing predefined objectives in the form of sets of questions, was introduced and the impacts of this intervention in terms of junior residents' attitudes toward observation were explored. Two rounds of focus groups examined learners' perceptions: one before introducing the intervention and one after it. Transcripts from these focus groups were analyzed using a qualitative interpretative approach and focus group participants provided considerable insight into observational learning. Many barriers were identified, including logistical constraints and lack of guidance. The surgical culture, within which observation is perceived as less effective than performing the surgery itself, was also mentioned as a factor that impedes learning during observation. Following the intervention, participants felt more validated as learners in the operating room and appreciated having clear objectives when observing procedures. Participants did mention that their busy clinical obligations would likely limit their use of any educational intervention. It was also noted that interventions to promote learning through observation would have to be fully supported by their program to be used on a regular basis. In conclusion, many factors that impact learning during surgical observation were identified. While trainees felt that increased guidance for observation was helpful, the environment in which learning takes place would have to be optimized to facilitate junior trainees' learning.

Résumé

L'observation est un élément-clé de l'entraînement chirurgical. Les résidents juniors, qui ont souvent une compréhension limitée de la procédure en cours, occupent généralement un rôle d'observateur en salle d'opération. Leurs apprentissages sont souvent limités par leur manque d'expérience et le peu de consignes offertes par les membres de l'équipe. Le but de ce projet est d'explorer les bénéfices potentiels de l'observation chirurgicale du point vue des résidents juniors. Il vise aussi à identifier les facteurs limitant et aidant l'apprentissage durant l'observation chirurgicale. Une intervention, qui prenait la forme de consignes pré-définies, a été menée auprès des apprenants. Les impacts de cette intervention sur l'attitude des résidents par rapport à l'observation ont été explorés. Ce projet a inclus deux séries de groupes de discussion. Les transcriptions de ces discussions ont été analysées en utilisant une approche qualitative interprétative. Les participants ont identifié un riche contenu pouvant être appris durant l'observation chirurgicale. Cependant, plusieurs barrières incluant les contraintes logistiques, le manque de directives et l'environnement rendent les résidents peu enclins à poser des questions afin de mieux comprendre l'intervention chirurgicale. La culture chirurgicale rend souvent l'observation sous-optimale en associant le rôle d'observateur à une position d'incompétence technique. Après avoir pris part à l'intervention, les étudiants se sont sentis davantage impliqués comme apprenant en salle d'opération et ils ont apprécié avoir des directives clairs pour guider leurs observations. Par ailleurs, de nombreux freins ont été identifiés par ces derniers dont, entre autres, les horaires chargés du contexte clinique qui risquent, selon eux, de limiter l'utilisation de l'intervention. Ils ont aussi indiqué qu'une intervention de ce type devrait être encouragée par l'ensemble des personnes impliquées dans le programme de formation afin de pouvoir avoir un impact à long terme. Un changement de culture semble incontournable. En conclusion, plusieurs facteurs influençant l'apprentissage durant l'observation ont été identifiés. Offrir des instructions claires fut perçues comme utile pour les résidents juniors mais l'aspect social de l'apprentissage devrait aussi être pris en compte pour optimiser l'observation chirurgicale comme activité d'apprentissage.

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Statement of research problem

Current surgical training relies heavily on the operating room (OR) as the main venue for the teaching of operative surgical skills (Hauge, Wanzek, & Godellas, 2001). It is the environment where surgical residents learn the complex surgical operative skills and decision-making strategies required to safely perform procedures (Roberts, Brenner, Williams, Kim, & Dunnington, 2012). However, trainees actually spend only 6-14% of their residency hours in the operating room (Snyder et al., 2012). Various forms of work-hours restrictions also limit the time spent by residents in the operating room (Reznick & MacRae, 2006). In the United Kingdom, over the last 20 years, it is estimated that the amount of time spent in the operating room has dropped by 50% when compared to previous decades (Cassar, 2004). There is also increased scrutiny from the public regarding medical errors, appropriately limiting the independence offered to trainees (Pernar, Ashley, Smink, Zinner, & Peyre, 2012). Furthermore, increased awareness of the cost of training residents in the operating room, the limited resources offered by teaching institutions and the pressure on surgeons to improve their efficiency, increases the proportion of time residents spend observing rather than performing surgery (Bridges & Diamond, 1999; Pernar, Ashley, Smink, Zinner, & Peyre, 2012).

During the first years of surgical training, when learners are considered junior residents, most of the time in the operating room is spent observing surgery rather than performing it. Junior residents more often adopt the role of second assistant, a minor role in performing the surgery. Occasionally they hold retractors but more often they simply observe the procedure. Senior trainees or residents, who are more advanced in their training, are often first assistant, performing some of the surgery under supervision and actively assisting the operating or primary surgeon. In a recent survey of American trainees, 47% of first year residents felt that they were actively performing the surgery in less than 25% of the procedures (Snyder et al., 2012). Despite its high prevalence, little evidence exists regarding junior residents' learning occurring during surgical observation. At this point, research on intra-operative teaching has focused more on the 'first assistant', a learner who is generally more involved in the procedure. For example, a scale developed to measure the perception of the operating room as a learning environment contains mostly items relevant to an operative trainee but no elements that assess the operating room as a teaching venue for the observing assistant (Cassar, 2004). Moreover, studies on the perception of the operating room as a learning environment include hands-on teaching as a measure of intra-operative teaching but there is no evidence to suggest an optimal way to support learning for an observing trainee (Kanashiro, McAleer, & Roff, 2006; Skoczylas, Littleton, Kanter, & Sutkin, 2012). Other studies on the operating room as a teaching venue have focused on medical students. In a study on such students learning in the operating room, Lyon (2004) explains the key role the environment plays in learning: her findings indicate that students need to *trust* the learning environment as a safe place, where they can ask questions, be learners, and occupy a *legitimate* role. Playing an active role in the surgery is seen as conducive to learning by this group of learners but no suggestions are provided on ways to improve learning in those cases where students can only observe (Lyon, 2004).

In a recent article, Carlile (2012) summarized his experience as a surgeon educator, describing various stages of surgical proficiency among residents. The early stage is described as the period during which the learner is not ready to perform part of the surgery due to a lack of basic knowledge and skills. It is suggested that the learner should be enrolled in a process called "active observation." This form of observation is described as a combination of assisting, discussing, observing, questioning, demonstrating relevant anatomy and describing step-by-step during a procedure, in order to get the trainee to a stage where he or she could perform part of the surgery. The author concludes that, in his experience, this form of training is underutilized but useful and that more evidence is needed on its use and benefits for surgical training (Carlile, 2012).

The active observation described by Carlile would involve commitment, from both the trainee and the surgeon, to describe the surgery and point out anatomical details. Though this may be the optimal form of observation to improve learning for junior residents, it might prove challenging in the intra-operative context where surgeons are faced with multiples priorities. The first goal of the surgeon is to provide the patient with a safe and timely surgery; the task of teaching residents comes second (Moulton, Regehr, Lingard, Merritt, & MacRae, 2010; Scallon, Fairholm, Cochrane, & Taylor, 1992). These often conflicting demands have consequences for junior residents who are usually observing procedures. With the attending surgeon already facing challenges to safely and efficiently complete the surgical procedure *and* to teach the senior trainee, likely the first assistant, how to operate, he or she may be unable to address the teaching needs of a second, more junior learner with different learning needs and goals.

A study by Scallon, Fairholm, Cochrane and Taylor (1992) suggested that surgeons were less aware of the second assistant, likely an observing junior resident, and were therefore less likely to actively teach them in comparison to their first assistant. With their limited experience and peripheral role during procedures, junior trainees' learning is often further impaired by the challenge of following complex surgeries with which they are unfamiliar (Cope, 2012; Moulton et al., 2010). Trainees are simply expected to learn through observing but this can prove difficult as a result of limited guidance (Mayer, 2004) and a lack of understanding of key aspects of the procedure.

Preliminary work, in the form of interviews with senior residents and practicing surgeons, confirmed the perceived and potential use of observation in developing surgical skills in experienced learners (Raîche, in progress). During semi-structured interviews, a senior resident and two practicing surgeons explained how observation helps in creating a "tool box" of potential approaches to use later during surgery. They implied that considerable learning at their stage of development consists of watching experienced surgeons manage specific intra-operative situations. The resident and surgeons also stressed the fact that learners do not necessarily need to perform specific aspects of a case to learn and later apply new skills during procedures. Those preliminary interviews confirmed the potential of surgical observation as a learning strategy. Participants in those interviews also endorsed different views on surgical observation; depending on what stage they were at in their careers. The senior residents described observation as a positive learning experience but also a consequence of their incapacity to perform certain aspects of the surgery, echoing the description from Carlile (2012). These latter comments have a clear negative connotation; the trainee is associating observing with failing to perform the procedure. Those interviews highlighted the potential complexity surrounding observation as a learning activity.

In sum, given the evolution of surgical education and the recent decrease in opportunities for residents to perform surgery during their training, it seems more important than ever to optimize learning opportunities through observation (Pernar et al., 2012; Roberts, Williams, Kim, & Dunnington, 2009). One potential avenue for improving intra-operative education is to ameliorate the junior residents' learning experience when observing surgery. However, given the existing limited amount of evidence on this learner population and educational activity, a better understanding of the current situation is required before surgical observation can be improved.

Purpose of the thesis

This study is a first step towards improving surgical observation in novice learners. The long-term goal is to design learning aids to support junior residents during surgical observation. The findings presented in this thesis will contribute to the current literature by documenting the status of surgical observation as perceived by junior learners and by exploring the potential benefits and limitations of a first attempt at improving surgical observation.

Due to the very limited amount of evidence in the surgical education literature concerning junior residents and their learning experience in the operating room, it is necessary to start by getting a better understanding of their experience as learners. Initial questions to consider include: What are they missing? What is currently working for them? What goals are they trying to achieve? As well, the current status of observation as a learning activity within the surgical culture should be explored. Surgical training takes place within a specific culture and environment and it will be impossible to improve this activity without first gaining a robust understanding of the current challenges and opportunities present in the operating room milieu. Documenting current perceptions and the learning environment itself is seen as an important first step to ensure that there is a need to improve surgical observation as a learning activity. Throughout this thesis, the term "perception" should be understood to refer to the interpretation one makes of the environment, acknowledging that it is shaped by previous experiences, culture and expectations (Mayhew, 2009). An exploration of current perceptions was done to help align eventual interventions to learners' needs and the surgical culture.

After reviewing the literature, a theoretical framework was built to guide data collection and interpretation of the findings. The literature review revealed consensus across various educational models and theories surrounding the potential benefits of instructions to guide novice learners (Farmer, Buckmaster, & LeGrand, 1992; Jenstch, Bowers, & Salas, 2001; Kirschner, 2002; Mayer, 2004; Roberts et al., 2009; Rosen et al., 2010; Salas et al., 2009; Sweller, 2003). A set of instructions was designed to help focus the attention of junior learners on features previously identified by experienced surgeons. The development of these instructions represents a first attempt at supporting surgical observation as a learning activity. The intervention was designed to be simple to use and to address only the need to guide learners' attention during observation. Junior residents' feedback will help improve the intervention and guide larger implementation.

Due to a paucity of evidence on junior residents' learning during surgical observation, this study is largely exploratory, aimed at documenting and acquiring an initial impression of the situation. To assist in designing methods and interpreting results, a theoretical framework was used. It is presented in the next section. The framework guided the creation of links between the findings and the educational literature and provided a deeper understanding of the learning process. Following the theoretical framework is a review of pertinent literature on surgical education. It includes studies conducted in the surgical and medical contexts along with research from other areas. It provides a basic understanding of observational learning and potential strategies to support expertise transfer in the surgical context. The research questions and the methodological approach chosen to answer the questions are then discussed. Finally, the results, interpretation, and conclusion summarize the findings and explain how this thesis contributes to the literature.

Theoretical framework

Observational learning can be informed by a number of theories related to individual cognition and social interaction. A theoretical framework accounting for the influences of expertise development, apprenticeship and cognitive apprenticeship, discovery learning and cognitive load theory, and the elaboration likelihood model was formulated to guide the design of the intervention, the protocol for the focus groups, and the interpretation of the findings.

1. Expertise development

Expert decision-making and problem solving is critical to surgical performance and a number of models have been suggested to describe it (Flin, Youngson, & Yule, 2007; Moulton, Regehr, Mylopoulos, & MacRae, 2007). For example, one of the most commonly cited models in literature on surgical decision-making, Naturalistic decision-making, is a process shared by experts in various fields (Hall, Ellis, & Hamdorf, 2003b; Yule & Paterson-Brown, 2012). Naturalistic decision-making explains how experts make decisions in real-world, often high-stress situations such as the military and medical context (e.g., Ross, Shafer, & Klein, 2006). Conditions promoting the use of Naturalistic decision-making among professionals include "high uncertainty, inadequate information, shifting goals, high time pressures and risks" (Flin et al, 2007 p.235). Naturalistic decision-making often occurs in contexts of teamwork and organizational constraints. All those conditions are also usually found in an intraoperative context

(Flin et al., 2007). In experimental studies on classic decision-making, the expert is expected to generate many potential solutions through effort by fully reflecting on a situation in order to select the optimal solution to a problem. In contrast, the Naturalistic decision-making approach assumes that experts must make decisions in an uncertain environment within a limited time. These situations promote less analytical thinking and more automated responses. Evidence supporting the prevalence of Naturalistic decision making by experts in complex and high-stress situations have shown that experts usually use pattern recognition to devise a potential solution to a problem, validate it by mental simulation, then apply it (Ross, Shafer, & Klein, 2006). Authors exploring intra-operative decision-making have generally adopted Naturalistic decision making to describe surgical decision-making (Flin et al., 2007; Hall et al., 2003b; Moulton et al., 2007; Norman, Eva, Brooks, & Hamstra, 2006; Yule & Paterson-Brown, 2012).

A second key concept in expert decision-making is situational awareness, which is often described as the basis of expert decision-making, and, more importantly, the basis of Naturalistic decision-making (Endsley, 2006). Situational awareness is defined by three key elements. The first is the accurate perception of the aspects of a situation, second, comprehension of the meaning of the situation and, finally, projection of what is likely to happen in future (Endsley, 1995). Considerable research has made a connection between situational awareness and expertise in problem solving in complex, real-world situations, indicating that experts appear to have greater situational awareness than novices (Crandall, Klein, & Hoffman, 2006; Endsley, 2006; and Moulton et al., 2007). These differences have important consequences for how novices respond within a situation. For example, novices can quickly become overloaded by the amount of information contained in a complex situation (Ross et al., 2006). As experts have described in complex mental models, they can manage large amounts of new information (e.g., symptoms, physical findings, test results) comparatively easily, given that they understand the relevant features of a task (Sweller, 2003). In contrast, novices must exert considerable effort to fully process information using domain-general reasoning and classic decision-making strategies. Novices and experts also focus their attention on different aspects of situations and prioritize the information to be processed differently (Norman et al., 2006). In general, experts not only perceive more information, they perceive it more efficiently, thereby capturing more relevant information, and processing it more efficiently (Ross et al., 2006). Understanding the meaning of the information presented in the system and projecting the potential results of an action requires experience and it is in this area that novices are prone to erroneous interpretation (Endsley, 2006).

To conclude, expert surgeons tend to use Naturalistic decision-making to make appropriate intra-operative decisions, a process that is based on adequate situational awareness. To promote surgical expertise, it is necessary to foster good situational awareness, which is linked to one's ability to perceive a situation adequately (Endsley, 2006). Novices often impede their ability to perceive a situation adequately by their limited attention span and lack of structured mental models to help them manage large amounts of information (Ross et al., 2006). Authors suggest that it is possible to hasten expertise development by providing learners with training, highlighting key elements to include in their mental model (Crandall et al., 2006; Endsley, 2006; Lajoie, 2009). Two challenges arise when developing these kinds of interventions: getting experts to provide the explicit cues used to build their mental models and providing learners with an educational experience that promotes development of a mental model that includes the desired cues (Crandall et al., 2006; Moreno, 2006).

2. Apprenticeship and Cognitive apprenticeship

A second theoretical framework that is relevant to this thesis is Apprenticeship and Cognitive apprenticeship. Surgical training in North America has its foundations in the model proposed by William Stewart Halsted in 1889. This model includes the progressive responsibility that is linked to prolonged immersion in the clinical environment (Halsted, 1904). The model has been described as an apprenticeship, defined as "a situation in which a learner works intensively with an expert to learn how to accomplish complex tasks" (Ormod, Saklofske, Schwean, Andrews, & Shore, 2008). Lave and Wenger have studied apprenticeship in multiple contexts (1991). In their description, this form of training includes not only an emphasis on skills transfer but also the development of a professional identity linked to those skills. Apprenticeship has been used as an instructional strategy for centuries, in many different domains including surgery (Collins, 2006; Kerr & O'Leary, 1999; Lave & Wenger, 1991; Reznick & MacRae, 2006). The goal of this teaching strategy is to transfer the situated expertise of the master to the apprentice (Ormod et al., 2008). Since learning occurs in the context where the newly acquired skills will be used, apprenticeship offers the advantage of making the learning concrete and immediately applicable for the apprentice (Liu, 2005). The content learned through an apprenticeship is specific to a particular domain and the concept of apprenticeship includes the notion that knowledge must be used in real situations (Liu, 2005).

Many elements are critical to successful apprenticeships. For example, apprenticeship involves relationships with the other members of the community of practice and progressive responsibility. The trainee should be validated as a learner and useful member of the community (Lave & Wenger, 1991). Communities of practice are key elements in apprenticeship. As a group, members share an identity and are responsible for defining competency among themselves as well as their culture (Wenger, 2000). Communities of practice represent the environment where learning happens, as well as the rules that govern this environment and the behaviors that are accepted and expected from its members.

Second, apprenticeship works well for tasks that are readily visible and concrete, where the immersion of the learner in the environment should provide a complete understanding of the skill being studied. Lave and Wenger (1991), explain that a large portion of learning happens while the apprentice is watching the master; however, the apprentice also learns from their contact with other individuals performing related tasks within the training environment.

Interaction with members of the community of practice described in the preceding two paragraphs allows the apprentice to observe the behavior and skills of the community. Surgical observation, for example, has been an intrinsic part of surgical apprenticeship for more than a century (Reznick & MacRae, 2006). Interestingly, again, the first descriptions of apprenticeships concerned tangible tasks that could easily be understood by a learner's observation (Collins, Brown, & Holum, 1991). However, surgical skills also involve coordinating a number of sensory-motor processes with non-technical skills, such as diagnostic reasoning and clinical decision-making, that are more difficult to observe (Hall, Ellis, & Hamdorf, 2003a; Yule et al., 2008). Despite being difficult to observe, non-technical skills are critical elements in the development of surgical expertise but it is not clear whether observation is an effective means of learning less concrete and more cognitive surgical skills.

One solution to the difficulty in observing non-technical skills is an instructional model called "Cognitive Apprenticeship" (Collins et al., 1991). The goal of cognitive apprenticeship is to teach 'internal skills', defined as cognitive and metacognitive strategies that are not readily visible to novices (Alger & Kopcha, 2010). In professional training, this approach is primarily focused on the teaching processes used by experts to handle complex tasks (Collins, 2006;

Farmer et al., 1992). According to Lajoie (2009), by mapping the processes used by experts and making them visible and easier to access by novices, cognitive apprenticeship should hasten the development of expertise in complex professional domains. In this context, mapping processes used by experts means getting experts to describe the mental processes or cues they use to make decisions and the mental models they use to recognize normal and abnormal (Lajoie, 2009). Mapping the processes used by experts can be done in several ways such as formal interviews, focus groups, discussion through simulation, and case reviews (Hoffman & Lintern, 2006). This approach has been used in a number of different formats to teach various types of professional skills (Farmer et al., 1992). The main difference between traditional apprenticeship and cognitive apprenticeship is the necessity on the part of the expert to externalize his or her cognitive process and knowledge. This emphasis on cognitive processes and heuristics aims at providing principles to learners, leading them to develop generalizations that can be applied in different contexts (Collins, 2006; Collins et al., 1991; Dennen & Burner, 2008; Farmer et al., 1992).

An example of a cognitive apprentice framework is described by Collins et al. (1991). It describes the content to be taught, the method used, the sequencing, and the sociology related to learning (Collins et al., 1991). It can be used as a template for instructional design and was used to create the intervention used in this thesis.

Table 1 presents a summary of cognitive apprenticeship as a tool for designing educational intervention. It is used to summarize the following paragraphs and briefly illustrate the various components. The next section provides details of the components of instructional design that use cognitive apprenticeship principles.

Table 1: Principles for designing cognitive apprenticeship environments (Collins et al, 1991 p. 14)

CONTENT types of knowledge required for expertise
Domain knowledge subject matter specific concepts, facts, and procedures **Heuristic strategies** generally applicable techniques for accomplishing tasks **Control strategies** general approaches for directing one's solution process **Learning strategies** knowledge about how to learn new concepts, facts, and procedures
METHOD ways to promote the development of expertise
Modeling teacher performs a task so students can observe **Coaching** teacher observes and facilitates while students perform a task **Scaffolding** teacher provides supports to help the student perform a task

Articulation teacher encourages students to verbalize their knowledge and thinking **Reflection** teacher enables students to compare their performance with others **Exploration** teacher invites students to pose and solve their own problems
SEQUENCING keys to ordering learning activities
Global before local skills focus on conceptualizing the whole task before executing the parts **Increasing complexity** meaningful tasks gradually increasing in difficulty **Increasing diversity** practice in a variety of situations to emphasize broad application
SOCIOLOGY social characteristics of learning environments
Situated learning students learn in the context of working on realistic tasks **Community of practice** communication about different ways to accomplish meaningful tasks **Intrinsic motivation** students set personal goals to seek skills and solutions **Cooperation** students work together to accomplish their goals

2.1 Content

The content taught by cognitive apprenticeship encompasses more than domain knowledge. Domain knowledge includes facts, rules and processes that can usually be found in textbooks. It is recognized as necessary for expert performance but insufficient on its own. Instead of focusing mainly on content knowledge, cognitive apprenticeship also aims at teaching *heuristics*, the rules of thumb or tricks of the trade that are used by experts to quickly solve problems, *metacognitive skills*, monitoring strategies used to assess the progression of a task and *learning strategies,* what experts use to improve their skills, either while performing tasks or in a specific context (Collins, 2006; Farmer et al., 1992).

2.2 Methods

Cognitive apprenticeship employs different teaching methods: *modeling,* in which the learner observes expert performance and develops cognitive model related to the task; *coaching,* where the expert watches the trainee perform a task and offers hints, reminders, challenges and feedback; *scaffolding,* which refers to methods the teacher uses to support the learning of the student; *fading,* when experts become less and less involved in the process, leaving more autonomy to the trainee; *articulation,* which is when the learner is asked to express his or her thought process and problem-solving strategy to get feedback from the teachers, *reflection,* aimed at guiding the student to monitor his or her own cognitive process and to compare it with that of experts and, finally, *exploring,* when the trainee has enough experience to develop new problem-solving strategies and techniques to apply in uncommon situations (Collins, 2006; Collins et al., 1991). Articulation and reflection are not usually present in traditional apprenticeship; their role in cognitive apprenticeship is to validate the rules and principles developed by students (Collins, 2006). The interplay of the different methods included in apprenticeship should lead learners to develop self-monitoring skills and to integrate knowledge and experience in a way that fosters expertise (Collins et al., 1991).

2.3 Sequencing

Sequencing of learning activities is another major component of instructional design. Collins recommends progressively increasing the complexity of presented cases (2006). This approach should help the learner feel challenged with the task at hand but not overwhelmed. It has been suggested that learners should be presented with situations that are progressively less defined. Well-defined situations include circumstances for which a single appropriate course of action has been defined by the profession. Situations are moderately defined when two or more options exist for their management and a consensus exists on how to select the most appropriate one. Ill-defined situations include all those situations that “cannot be dealt with as responsibly and adequately as a well-defined or moderately well-defined situation is handled” (Farmers et al., 1992 p. 45). Moreover, the level of risk embedded in situations should progress as the learner gains experience (Farmer et al., 1992). Diversity of proposed tasks is also believed to be necessary to provide learners with an opportunity to test the rules and principles they have developed during the previous activity (Collins, 2006). Finally, Collins insists on the importance of exposing novices to global tasks before learning the specifics. Developing a cognitive roadmap in which to anchor learning is seen as necessary for the learner to develop self-monitoring skills. Knowing how one task fits into the global picture helps in understanding what endpoints should be sought in a specific task (Collins, 2006).

2.4 Social context

Apprenticeship as a form of situated learning (Lave & Wenger, 1991) requires that the sociology associated with it be considered (Collins, 2006; Dennen & Burner, 2008; Reznick & MacRae, 2006). The culture helps to motivate learners and provide an environment that promotes the development of situated expertise. The expert used as the model has a key role in apprenticeship. The learner must identify with the model, and the expert must be available enough to create a meaningful relationship with the learner. Ideally, the expert would be able to articulate the reasons for their particular course of action from a variety of experiences, to maximize the transfer of knowledge and experience. The various sources of information help to create knowledge that is generalizable and flexible (Farmer et al., 1992). It is important in an apprenticeship framework to provide learners with activities that are embedded in real-life situations, with immediate and concrete application, as this is when learning occurs best. Developing communities of practice comprised of novices and experts engaged in the same practice is also important as it creates a sense of ownership and inter-dependency. The goal of the communities of practice and the situated learning is to generate intrinsic motivation in the learner, as well as a sense of cooperation among learners in the same community (Collins, 2006; Dennen & Burner, 2008).

3. Discovery learning and cognitive load theory

A third framework relevant to this thesis is Discovery Learning, primarily because it describes how surgical observation has been framed thus far for junior learners (Cope, 2012; Snyder et al., 2012). Cognitive load theory, on the other hand, explains the limitations of this form of learning (Mayer, 2004). Discovery learning is a teaching strategy in which the "learner is not provided with the target information or conceptual understanding but must find it independently and with only the provided material" (Alfieri, Brooks, Aldrich, Tenenbum, 2011, p. 2). The potential advantages of discovery learning include improved knowledge retention, better attitude towards learning and more meaningful learning (Lee & Anderson, 2013). Pure discovery learning or minimally guided discovery is based on the principle that people learn better when they find essential elements for themselves and build their knowledge on their own experience (Kirschner, Sweller, & Clark, 2006). It assumes that every learner learns differently and brings a different set of experiences to the learning environment, and that they should be provided with learning opportunities that allow for individual knowledge construction (Lee & Anderson, 2013). In a review of the topic however, Kirschner et al. (2006) indicated that empirical evidence suggests that students learn more efficiently when provided with instructions on the method and the objectives of the learning sessions. Among the risks of pure discovery are frustration on the part of learners, confusion leading to misconceptions and more time needed to acquire skills (Kirschner et al., 2006; Lee & Anderson, 2013). During surgical training, the modeling phase of the apprenticeship, including surgical observation, occurs in a context that has been described as discovery learning (Snyder et al., 2012). The pure discovery learning that happens at an early stage in surgical training might prevent residents from maximizing potential benefits from their time spent in the operating room (Cope, 2012).

In order to explain the challenges faced by junior residents, one can compare guided and pure discovery learning. In his review on discovery learning, Mayer (2004) explains how *guided discovery*, a learning model in which the instructor helps the trainee to focus his attention on learning objectives, is more efficient than *pure discovery*. Guided discovery might play a role by ensuring that the learner is successfully “selecting relevant incoming information” (Mayer, 2004 p. 17). It also helps to ensure that the mental framework created by the learner after the experience includes the critical elements that were intended to be transmitted by the experience (Mayer, 2004).

Based on the idea that guided discovery might be a better option than pure discovery for junior learners and understanding that the main difference when comparing guided discovery with pure discovery is the instructions provided, it is relevant to explore the role of instructions. In the context of this thesis, instruction is defined as “specific guidance about how to cognitively manipulate information in ways that are consistent with a learning goal” (Kirschner et al., 2006 p. 77). In a review of the role of instructions in learning, Lee and Anderson (2013) explain the expertise reversal effect, which is defined as the impact of experience on the usefulness of instructions. Evidence suggests that experts learn better when provided with less instruction, and novices when provided with more detailed instructions to reach learning goals (Lee & Anderson, 2013; Sweller, 2003). To help novices draw appropriate conclusions, Kirschner et al. suggested combining experience with sufficient instructions to scaffold the learners. Among the strategies suggested to render learning more efficient is the “worked example”, a teaching strategy in which learners study the reasoning of an expert in solving a problem (Sweller, 2003). In Kirschner et al (2006), “worked example” represents an illustration of the role of instructions in learning. Worked examples are also present in the literature on cognitive apprenticeship in the form of expert explanation of their cognitive processes (Collins, 2006). Worked examples are particularly useful with novices (Lee & Anderson, 2013). In a review of 108 studies comparing discovery learning and teaching strategies involving some form of instruction, Alfieri et al found that instruction was associated with better learning outcomes, the most effective method being the “worked example” (Alfieri et al., 2011).

To better understand how and why worked examples are useful as a form of instruction, one can examine the cognitive load theory. It supports the superiority of guided discovery over pure discovery for novice learners. It describes how working memory is a limited resource that can manipulate only a few elements at a given time (Kirschner, 2002). In order to process complex information it is necessary to store declarative knowledge and heuristics in the long-term memory, through the creation of schemas. Schemas are mental models used to store complex information in the long-term memory. They evolve with time and experience and reflect learner understanding of a topic (S. P. Marshall, 1995a). Long-term memory is seen as an unlimited resource. In cognitive load theory, learning is defined as a change in the schemas kept in long-term memory.

Among other findings, the cognitive load theory and its description of schema can explain the role of experience in learning. Schemas have many roles. They store declarative knowledge but they also help in triaging new information. "The central executive function" of schema is used by Swellers (2003) to explain the role played by previous knowledge and skills to triage new information and make sense of new concepts. It is suggested that existing schemas create a framework that guides the acquisition of new information. This explains the potential role of experience in learning. If it is assumed that experience leads to the development of the schema, then more experienced learners will have enough guidance from their existing schema to process new information adequately. Before the creation of an initial framework, pertinent information is believed to be selected randomly and attempts at creating a schema are made through mental simulation or trial and error. Concepts are tested, and accepted or rejected, depending on the outcomes (Sweller, 2003).

Cognitive load theory also informs instructional design by describing various sources of cognitive load and their role in the learning process. Specifically, three types of cognitive load have been described. First is the *intrinsic cognitive load*, which represents the content being learned. It is stable and is unlikely to be diminished by instructional design. The second type of cognitive load, the *extraneous cognitive load,* is dependent on the instructions. It includes all tasks and distractors that use working memory resource without increasing learning. For example, trainees trying to define their own objectives, or trying to come up with a creative solution to a problem already solved by experts are believed to be using their cognitive resource for tasks irrelevant to their learning. Finally, *germane cognitive load,* includes information processing that leads to schema building that does not deal directly with content, rather it is related to metacognitive skills. Increasing the germane load of learning activity, by having trainees articulate their thought processes, has been shown to increase performance on transfer tasks (Moreno, 2006).

4. Elaboration likelihood model

A fourth theoretical framework to be discussed is the Elaboration likelihood model. It explores the relation between motivation, attention, and information processing. It is relevant to this thesis because the theories explored thus far can inform instruction design but instructions are only part of the complex puzzle of learning. The role of the learner in the process is also critical (R. Kusurkar, 2012; R. A. Kusurkar, Ten Cate, van Asperen, & Croiset, 2011). For instructions based on cognitive load theory and apprenticeship to help impart expertise, trainees will need to process information to ensure good learning outcomes. They will have to actively process elements transmitted to them by the modeling surgeon to include those elements in their existing schema (Sweller, 2003). The theoretical and empirical evidence presented so far considers a number of broad concepts, mostly related to information delivery to trainees. However, a number of studies suggest evidence for more specific sets of processes, which can inform training. One such model used to examine decision-making in the context of communication is the elaboration likelihood model (ELM) (Petty & Cacioppo, 1986). While developed in the context of persuasive communication, it provides a general framework of factors that allows us to process information presented by others (Evans, 2008).

In education, information processing is desirable since it is usually associated with stronger conviction and concepts that are less likely to change over time (Petty & Wegener, 1999). Information processing and integration can be linked to the concept of germane load, described in the cognitive load theory as critical in schema acquisition (Moreno, 2006).

The two main assumptions of the elaboration likelihood model (Petty, Kasmer, Haugtvedt, & Cacioppo, 1987) are that:

1. Learners will engage in information processing to the extent to which they are motivated and have the ability to process information.

2. There are two information-processing pathways or systems. These two systems are described as the peripheral and the central routes and are analogous to discussions on System 1 and System 2 (Evans, 2008).

Peripheral, or System 1 processing, relies on heuristics and simple cues, for example, using the frequency of a message to assume its validity (Petty et al., 1987). Another example is the impact of the person delivering the information. Experts expressing their opinion tend to activate less processing because it is generally assumed that they are trustworthy. This system require relatively less cognitive investment (Evans, 2008).

The central or System 2 processing, implies detailed and effortful processing of information (Chaiken & Stangor, 1987). Using this system, learners would carefully consider new information and integrate it into existing schemas, based on relevance and objective evidence of correctness. It is considered a more analytical process. It is believed that this more involved process leads to more durable change in belief (Kuldas, Bakar, & Ismail, 2012; S. P. Marshall, 1995a). Therefore central processing should be promoted by educational intervention aimed at creating durable learning (Chaiken & Stangor, 1987).

Following the model described by Petty et al, one concept that might promote central processing is related to increasing learner motivation (Petty et al., 1987). Many factors that have an impact on motivation are described. One factor that increases the motivation to process information is the information's relevance to the learner (Chaiken & Stangor, 1987). The more relevant the information the more processing the learner will be willing to do. Other factors include sense of responsibility, accountability and the opportunity to discuss the topic with another person. An increased number of sources delivering the same message also increases the likelihood of this information being processed, as does presenting the information in a rhetorical or a written format. Information that is partially incongruent with previous belief tends to be scrutinized more than information completely in line with previous knowledge. Need for cognition, defined as an individual's tendency to enjoy thinking and seek cognitive understanding of situations, tends to be associated with increased processing of information (Petty & Cacioppo, 1986; Petty et al., 1987; Petty & Wegener, 1998).

The second element presented by Petty et al., (1987), the ability to process information, is also influenced by many factors that can limit the extent to which learners can engage in effortful processing (System 2 processing). The ELM assumes that learners need to have attention available in order to process information, as well as prior knowledge to direct their attention to critical features of a situation. For example, distraction and physical discomfort will diminish the amount of information processed because cognitive resources are allocated elsewhere. Repetition of the same information, as well as a slower pace in delivering a message, increase a person's ability to process information (Petty & Wegener, 1998). Prior knowledge has two different effects on processing. First, it tends to give people the ability to process more information by giving them enough skills or background information to be able to process new information effectively. Alternatively, motivation can be diminished when someone is under the impression that he or she possess complete understanding of a topic (Petty & Cacioppo, 1986).

Chaiken and Stangor (1987) describe other factors that have an impact on how new information is processed. The primary goal of a participant in any activity will determine the system that he or she activates to judge incoming information. For example, if someone tries to be correctly aligned with a social group, they will activate less processing than if they trying to find the truth for the sake of correctness. Also, sufficient information to make a judgment might not be available in the message. In this case, an eventual learner would have to use heuristics and simpler cues to assess the information's validity.

5. Summary

The four models discussed in this section influenced the design of the intervention and the data collection, as well as the interpretation of the findings to better understand observation as a learning strategy for junior learners. First, the expertise theory, by providing information on the various differences found between experts and novices, helped define both the content to be taught and the cognitive skills to promote with the intervention. Specifically, situational awareness skills were found to be critical in expert performance, serving as the initial step toward efficient Naturalistic decision-making. An intervention to hasten the development of situational awareness would be relevant in this context. Second, the apprenticeship framework offered a lens with which to better understand the potential value of observation in the learning process. The cognitive apprenticeship model, on the other hand, underscored some challenges present in the current training model: the necessity for operating surgeons to explain their thought processes in order for a junior learner to access this critical content. Third, the pure discovery model was presented, as it is believed to be the most prevalent way of teaching in the operating room. Limitations of this teaching strategy, shown through the cognitive load theory, support the use of instructions designed to help learners to direct their limited attention resource to relevant elements. The cognitive apprenticeship framework and the cognitive load theory both offer guidance for the design of the intervention. Combining their suggestions, an intervention consisting of instructions to help orient learners' attention through observation was designed. Lastly, the Elaboration Likelihood Model offers a framework to analyze factors that affect information processing from the learner's point of view. This analysis is critical for understanding the potential role of the intervention and identifying elements that could be modified to promote learning.

Surgical literature review

This brief literature review presents studies relevant to this thesis. Most studies were conducted in surgical education but evidence from other fields is also presented to support the choice of intervention, the interpretation of the findings, and to illustrate the place of this thesis in the current literature.

1. Intraoperative learning

Surgical training has been seen as an apprenticeship for decades (Reznick & MacRae, 2006). As such, the apprenticeship theory helps explain some of the components of surgical training, particularly in the intra-operative context. For example, Lave and Wenger (1991) suggested that the "master-apprentice relationship was diagnostic of apprenticeship" (p. 33) underscoring the critical role this relationship has in promoting learning. As shown by Cassar in 2004, the quality of the operating room as a teaching environment is closely related to the relationship between the surgeon and the trainee. Lave and Wenger (1991) also discussed legitimate *peripheral practice,* defined as an important component of apprenticeship in which the learner has to play a significant and accepted role in the organization while learning. Peripheral practice is linked to the concept of community of practice, with the learner initially adopting a role at the periphery. With increased experience, knowledge and credibility within the group, the learner can assume a more important or central role in the community. The importance of legitimacy was underscored by both surgeons and trainees in the qualitative work of Lyon (2004) on the operating theatre as a teaching and learning environment. In this study, it was felt that the attending surgeon was responsible for the role played by the student; if the surgeon included the trainee on his team, others in the operating room would follow suit. Lave and Wenger (1991) also presented the important social component associated with learning in this model. Those characteristics are present in surgical training, as illustrated by the literature on the hidden curriculum, in which the role of the trainee as a peripheral member of the team and the social interactions are well illustrated (Hundert, 1996; Ozolins, Hall, & Peterson, 2008). Furthermore, studies on the operating room as a learning environment show that learning is influenced by factors other than the relationship between the trainee and the surgeon. Learning in the operating room can vary, depending on the specifics of the procedure, the trainee's level, and the personal philosophy of the attending surgeon (Lyon, 2004; Mayer, 2004; Moulton et al., 2010; Roberts et al., 2009; Scallon et al., 1992).

Of note, only one article was found to specifically address the learning of the second assistant, a role usually played by a junior resident (Scallon et al., 1992). The second assistant rarely assumes an active role; most of the time, this team member is holding a retractor or watching the surgery. In the apprenticeship model, the second assistant would be in the modeling phase of learning. In a study by Scallon et al (1992), an external observer was introduced in the operating room to monitor the educational interactions that occurred during surgery. The surgeons and all trainees involved in the case also completed questionnaires regarding their perceptions of the learning experience (first and second assistant). Generally, surgeons felt they were giving more teaching to the second assistant than what the residents perceived. The authors also concluded that much time spent in the operating room was not used for valuable teaching.

Authors have tried to address what is perceived as a lack of structure regarding intra-operative teaching (Pernar, Breen, Ashley, & Peyre, 2011; Roberts et al., 2009). The BID model proposes that the trainee and the attending surgeon choose objectives before the case (**B**riefing), followed by relevant intraoperative teaching (**I**ntraoperative teaching) and then a short feedback session at the end of the case (**D**ebriefing). This teaching method was found helpful by both the surgeon and the trainee, mainly because it helped focus attention on one specific aspect of the procedure (Roberts et al., 2009).

2. Observational learning and modeling

Surgical observation corresponds to the modeling stage of the apprenticeship model (Stalmeijer, Dolmans, Wolfhagen, & Scherpbier, 2009). Observation can be defined as directing one's attention to a particular aspect of a situation in order to get a better understanding of its reality (Savoie-Zajc, 2000). No study specifically dedicated to junior residents and surgical observation was found.

In an effort to determine what conditions make observation an efficient teaching strategy, Jenstch, Bowers and Salas (2001) studied the impact of instruction design on observational learning for pilots. In the study, 59 pilots with varying levels of experience were asked to observe behaviors and to record whether these were positive or negative. They showed that observation improved with the precision of the instruction given before the task, the experience of the participants, and the type of behavior presented. Negative behaviors were recognized more than positive ones and behaviors shown with their consequences were also associated with higher rates of recognition (Jenstch et al., 2001).

A review of observational and demonstration-based learning, published in 2010, describes various instructional designs that can be used to make demonstration-based training more efficient. It explains that the efficiency of this type of learning was linked to the content demonstrated and the instruction given with the demonstration (Rosen et al., 2010). A study of medical students noted that learning experiences during modeling was largely influenced by the amount of explanation given by the physicians. Students noted that verbalization of the mental process and explanations helped them to model the procedure, while in the absence of explanation, they merely imitated the physician's movements instead of understanding the purpose of their actions (Stalmeijer et al., 2009). According to Taylor and Care (1999), modeling should be explicit enough to allow the trainee to build a "conceptual framework." Currently, attending surgeons are responsible for most "instructions" given during observation (Stalmeijer et al., 2009).

3. Experts' knowledge elicitation

In a cognitive apprenticeship context, the first step in delivering instructions is for surgeon educators to make their cognitive processes understandable to learners. This challenge is very relevant in surgery where the attending surgeon faces multiple and simultaneous demands: the need to provide the patient with an optimal and timely surgery and the need for residents to receive an engaging learning experience (Cope, 2012; Moulton et al., 2010; St-Martin, Patel, Gallinger, & Moulton, 2012).

Another challenge faced by experts in many domains is the difficulty they have explaining their thought processes (Crandall et al., 2006; Moulton et al., 2007). It is suggested that experts develop decision-making strategies that allow them to accurately manage considerable information through script creation or pattern recognition, using a form of automaticity to make decision (Flin et al., 2007; Moulton et al., 2007). The efficiency of these processes resides in their automaticity, in the fact that they don't require conscious processing to be accurate (Flin et al., 2007). This automatic decision-making is helpful to experts in Naturalistic situations but renders the transmission of components of expert decision-making skills more difficult (Crandall et al., 2006). Moulton et al (2007) reviewed the literature on expertise, attention and situational awareness and conducted interviews with surgeons to explore the components of surgical expert judgment. One aspect they discovered was that experts seem to be unaware of some of the cognitive processes involved in judgment. Boreham (1992) also describes the difficulty that experienced practitioners have in explaining their decisions, even when directly questioned during performance (Boreham, 1992). In order to teach cognitive skills it is necessary to make them explicit. Different options have been suggested in the literature. Moulton et al. (2007) suggested field observation, which could provide information on the manifestations of judgment. Other groups suggested that "think aloud" sessions might be useful for understanding what experts were thinking in action (Hoffman & Lintern, 2006).

To produce teaching material that can be adapted to different contexts and reduce the effects of automaticity, it has been suggested rule codes be used (Salas et al., 2009). Rule codes are simply the rules underlying a specific behavior. For example, it is more beneficial to learn formulae to guide math problem resolution than to learn the solution to each problem. Teaching those rules would be more useful than teaching the actual specific behavior related to a situation because they allow for generalization. Considering that those rules are not visible, it is necessary to find a method that will allow experts to explain their thought processes.

"Cognitive task analysis (CTA) is a family of methods used for studying and describing reasoning and knowledge," (Crandall et al, 2006 p. 3) that allows experts to explain their underlying rules. It has been used mainly to help transfer cognitive skills from experts in Naturalistic contexts to novices. Different forms of cognitive task analysis have been used to understand expert thinking in many fields. It has been shown to be useful as a base for instructional design in the military, in nursing, in business and in firefighting (Crandall et al., 2006). In medicine, it has been used to help teach many procedures. A study comparing the results of CTA vs. traditional explanations in colonoscopy showed that experts described no more than 50% of the critical steps of the procedure when using traditional explanations. CTA was helpful in enabling surgeons to break down every step in simple tasks and decisions to help novices understand the procedure (Sullivan et al., 2008a). CTA has been used to elicit experts' cognitive processes in central venous catheter insertion, open cricothyrotomy, Nissen fundoplication, appendectomies and cholecystectomies (Smink et al., 2012).

4. Experts cognitive skills

In order to guide the learning of cognitive skills related to surgery, it is necessary to better define this construct: how it is that surgeons ensure that each procedure progresses safely, the cues used as a basis for those decisions, and the patterns and heuristics used to process information and take action. Various cognitive skills are used while performing surgeries. Several authors have used different lenses and designations to study the cognitive processes that occur. As Moulton et al (2007) describe it, cognitive skills remained ill-defined and different labels have been used interchangeably, creating confusion around this construct. Klandall, Klein and Hoffman (2006) recommend a classification of the cognitive skills used by experts in a Naturalistic context. Models used by experts include: *mental models*, rich representations of situations that allow them to connect different aspects of situations; *perceptual skills,* which provide them with more information about a situation and make them aware of subtle cues; *sense of typicality,* which helps the expert to quickly know when something is following its usual path or if a situation requires special attention; *routines,* that are varied enough to cover most situations normally encountered and provide baseline strategies with which they can address most problems; and, lastly, *declarative knowledge,* which includes theoretical knowledge but also other rules and processes that can be used to help solve complex problems.

Given that cognitive skills used by surgeons are variable, depending on the context and the procedure (Moulton et al., 2007), it is more feasible to design an intervention specific to one procedure. Laparoscopic cholecystectomy is a relatively common surgical procedure performed by most general surgeons. Learning the cognitive skills associated with its safe performance would be relevant for trainees. Also, complications following cholecystectomies have been linked to cognitive errors (Way, Stewart, Ganter, Liu, & Lee, 2003), making this procedure an interesting starting point from which to study cognitive skills transfer among surgeons.

5. Summary

This section begins by presenting evidence supporting the need for further research on junior residents as learners in the operating room. Our current understanding of the operating room as a learning environment is based on observational studies, theoretical descriptions of apprenticeship and qualitative studies on medical students. Many factors that can influence learning have been identified, the relationship between the trainee and the operating surgeon being the primary one. Second, observational learning has been studied in different fields and the available evidence supports the use of instructions to guide learning of junior learners. Third, in order to create instructions, it is necessary to elicit what experts use as cues to guide them in their decisions, a process that can take many forms. Because of its flexibility and good results in medical education, cognitive task analysis was seen as an appropriate option. Finally, the cognitive skills used by experts were described; they represent elements to keep in mind when designing the intervention, as they all come into play with the situational awareness skills and decision-making that characterizes experts.

Research Questions

The overarching goal of this research is to improve surgical observation as a learning activity for junior residents. Specifically, it aims at informing future interventions, to help junior residents learn more relevant elements when they observe procedures in order to hasten development of their surgical expertise. Based on the frameworks previously described, this project aims at exploring how surgical observation can help in developing situational awareness among trainees in the context of a cognitive apprenticeship, keeping in mind the principles of the cognitive load theory which explains how attention is a limited resource that should be guided through instructions, especially in novices. The Elaboration likelihood model will help to further understand the learner's perception of observation as a strategy and how the intervention is perceived.

For this project, three questions were selected to explore the learning that occurs during surgical observation, from the perspective of junior learners. They are:

1. What is the perception of junior surgical trainees on the educational value of surgical observation?

This question was chosen to get a better understanding of the current situation of surgical observation. It was answered in the spirit of a needs assessment. Put simply, this question could have been: From the learner's point of view, is there a problem with surgical observation? Before trying to improve upon an activity that has been implemented for decades, it is necessary to gather more information about its potential utility and limitations. This question was chosen to inform on the potential of surgical observation as a learning activity, as well as to understand its limits as seen from the learner's perspective. Surgical observation takes place within an environment and a culture, and its role in global surgical training needs to be documented. This information will help inform future intervention by providing insight into key elements that may need improvement.

2. What factors make surgical observation an efficient or inefficient learning experience, according to junior residents?

The first question addresses the potential utility of observation and its limits in the surgical culture. This second question provides information on factors that make this activity useful or challenging for learners on a daily basis. Again, this project aims at improving surgical observation and identifying factors outlined by learners that will help tailor educational activities to their needs. By collecting information on what helps or hinders learners while they are observing procedures, it may be possible to promote or mitigate those factors.

3. What factors can promote or compromise the use of instructions during surgical observation?

The theoretical framework and literature review used to guide this project strongly suggest that instructions are the key to learning for novices during observational learning. Given that some guidance and instruction is already taking place, it was decided to explore the effects of an increased level of instruction on surgical observation. This was a simple intervention, aimed at improving one aspect of this activity but it was felt that it could be used as a first step. By examining factors that promote or compromise the use of instructions, the goal was to explore whether this type of intervention is feasible and sustainable in the current clinical environment. It was assumed that the perception of improved learning would be seen as a factor in promoting the use of instructions.

Methodological Approach and Research Design

This research project explores surgical observation as a learning experience for junior residents. First, junior residents participated in focus groups to determine their opinions on the current educational value of surgical observation, as well as on the barriers to and facilitators of learning during surgical observation.

An intervention based on the principles of cognitive apprenticeship was introduced, in an attempt to guide observation and improve their experience of surgical observation.

After participating in the intervention, residents again took part in a focus group, to discuss the effects of the intervention on their learning during observation.

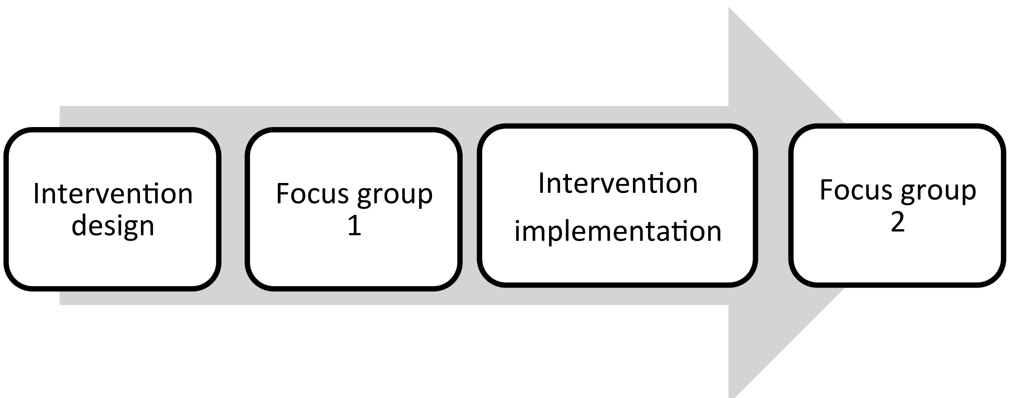


Figure 1. Design overview

1. Intervention design

Following the principles of cognitive apprenticeship, elements proposed by Collins, Brown and Holum (1991) were used to design an intervention relevant to surgical observation. The intervention's construction is presented using the instructional design model suggested by Collins et al, including *content* elicitation, *methods* chosen among modeling, coaching, scaffolding, fading, articulation, reflection, *sequencing* of the intervention and *expected sociological impact* (Appendix A).

1.1 Content

The content of the intervention is based on a CTA. It was used to identify and describe the heuristics, visual cues, and patterns experts use to make decisions during a laparoscopic cholecystectomy. The CTA was conducted using the Critical Decision Method proposed by Crandall, Klein and Hoffman (2006). This method uses a series of semi-structured interviews in which incident-probing questions are used to have experts explain what they are thinking, what cues they look for, and what heuristics they use during task performance (Appendix B). This method has been successfully used to help transmit procedural skills in medicine and in other domains that require complex skills such as the military, weather forecasting and firefighting

(Smink et al., 2012; Sullivan et al., 2008b). The method suggested by Crandall, Klein and Hoffman explains how to collect and analyze data.

1.1.1 Participants to CTA. A key informant sample technique was used to choose the participants to be interviewed, using the criteria described by Marshall (1996). Four experts participated in the CTA. They are recognized for their knowledge and their status as leaders in the community of practice. They were chosen for their expertise in laparoscopic cholecystectomy, diverse backgrounds, interest in teaching (willingness), and their recognized communication skills (communicability). They had no bias towards one approach or another (impartiality) (M. N. Marshall, 1996a). They were contacted directly by the investigator in an informal meeting during which the purpose of the study was explained, as well as details on its method and approach, their potential role and the interview process. Following this meeting, the investigator asked for their consent to participate.

The first expert is a pioneer of laparoscopic surgery in Canada, and has taught laparoscopic surgery for more than 20 years. He has been a surgeon in many academic centers across the country and has taught laparoscopic courses around the world. He is considered an expert in the field. The second expert is a surgeon who trained and works in Quebec City; he has formal training in laparoscopic surgery and a Master's degree in the medico-legal aspects of medicine; he did his thesis on laparoscopic surgery. He has been practicing for 15 years. The third expert is a hepato-biliary surgeon at the University of Ottawa, with more than 30 years' experience. He trained before the advent of laparoscopic surgery but learned this procedure while in practice. The fourth expert is also a hepato-biliary surgeon at the University of Ottawa, and has been in practice for seven years. He has a Master's degree in medical education and participated in the design of this study. Crandall et al (2006) recommend that experts be selected for their expertise, as well as other criteria. It is important that experts be actively engaged in practice at the time of the CTA, to obtain information on their current situated expertise. CTA was originally developed to explore the thought processes of experts as a replacement to thinking aloud during performance. As such, it is important that experts involved in the process be immersed in their domain of performance, to avoid distortions from recall of distant memory. All interviewees were in practice at the time of interview and were available for repeated interviews, another factor identified as critical by Crandall et al (2006).

1.1.2 Interview protocol (Appendix B). The interview protocol was designed and discussed with one general surgeon, one orthopedic surgeon and one psychologist member of the research team. The protocol was tested with the first expert and modifications then made. All interviews were conducted alone with the expert, with the investigator taking notes and recording the discussion. Five semi-structured interviews were conducted with each expert, each lasting between one and two hours. A preliminary interview was used to select a case and to obtain a first detailed description. During the second interview, the table generated from the analysis of the first interview was reviewed and completed and then used as a support, to deepen understanding of the procedure. Two additional interviews were conducted, during which video recordings of cholecystectomies were reviewed to allow experts to explore and analyze various situations and help identify common errors and possible complications. Finally, a fifth meeting was used to reach an agreement on the analysis, using tables created from the interviews as a basis for discussion.

1.1.3 Data analysis and presentation. The recordings were directly analyzed without transcription, as suggested by Crandall, Klein and Hoffman (2006). The goal of those interviews was to answer specific questions. The objective was to identify the visual cues upon which experts base their surgical decision-making. In the context of this study, it was not relevant to look for other emerging themes. With this in mind, a data analysis grid was constructed using the method suggested by Crandall, Klein and Hoffman and discussed with the research team (Crandall et al., 2006). It was used to analyze the audio recording of the data. The interviews using video recording were analyzed, by listening to the recording while simultaneously reviewing the video since experts' comments were related to the specific intra-operative situations presented on screen. One interview was analyzed twice to ensure that no new information emerged from the second analysis. The interviews were conducted with the four participants over the same period. Findings from a discussion with one expert were used to inform the interviews conducted with the others. All interviews were analyzed concomitantly with the data collection process, in order to make sure that the experts agreed with the findings throughout and to allow for potential clarification of their points of view. Also, this iterative process allowed participants to give their opinions on any disagreement with the experts. The completed analysis grid of the CTA was presented to the experts twice during the process to make sure they agreed on the content. Part of the analysis involved monitoring new ideas, to the point of saturation, at which time the CTA process was stopped. The experts identified similar landmarks and heuristics. In light of their different backgrounds and experiences, it was decided that data saturation had been reached by the end of the process. No new information was found and it was felt we had reached the goal of the interviews: to identify the visual cues and heuristics used by experts to conduct cholecystectomies (M. N. Marshall, 1996b).

1.1.4 Questions creation. Open-ended questions on the visual cues and heuristics that influence decision-making during cholecystectomies were generated, to be used as instructions to support surgical observation.

The tables describing cognitive skills were reviewed, as was the video material used for the interview, to search for key elements. Initially, questions were generated without considering a limit in number; the goal was to capture all essential elements from the CTA. Initially, 79 questions were created. These were reviewed and discussed by the experts. Those considered redundant were eliminated and the formulation improved. The experts confirmed that all key aspects of the procedure were covered. Two junior residents reviewed the questions to finalize the formulation and to acquire feedback on relevance to their training. Questions were then grouped into five categories representing key aspects of the decision-making process that occurs during cholecystectomies. The five categories were chosen by the research team and validated by the experts.

1.2 Sequencing.

According to Collins and his model of cognitive apprenticeship instructional design, sequencing includes aspects linked to ensuring that the learner feels challenged but not overwhelmed. The level of complexity of the tasks should increase as the learner progresses. The instructions should include situations that are both well-defined and less defined. Diversity in the proposed tasks is necessary, to provide learners with opportunities to test the rules and principles they developed in the previous activity. Finally, it is necessary to expose novices to global tasks (Collins, 2006).

When considering these elements, the length of the surgery, the questions' complexity and the novelty of the intervention, it was decided that each resident should receive five questions before a surgery. This number was considered optimum to allow the instructions to cover several aspects of the procedure and so as not to overwhelm residents with too many points on which to focus.

The number of cholecystectomies a junior resident can be exposed to during a 3-month period was reviewed, using case logs and discussions with residents. The number varied. After discussion with the research team we decided to create 8 bundles of questions. It was felt that the residents should be exposed to many different sets of questions for different surgeries, to keep them engaged and to offer opportunities for them to test their new understanding and heuristics. It was assumed that it would be possible for participants to be exposed to the complete set of bundles. Also, enough questions to cover all critical aspects of the procedure were included.

Forty questions were used in the final intervention. A Delphi method was used to select those questions that would lead to the greatest understanding of the key elements essential for safely performing a cholecystectomy. "The Delphi method is an iterative process to collect and distill the anonymous judgments of experts using a series of data collection and analysis techniques interspersed with feedback" (Skulmonski, Hartman & Krahn, 2007 p. 2). The construct of surgical cognitive understanding is poorly defined so a Delphi method was chosen because it was developed to foster consensus among experts in areas of uncertainty (Cuhls). A group of ten experts with expertise in hepato-biliary surgery, laparoscopic surgery or surgical education was used. This sample size was chosen based on availability. The sample size was considered feasible for this process and available resources. Rounds of surveys were conducted until 70% agreement was reached regarding the 40 best questions. During each round, the experts were asked to choose the 10-20 best questions from the list. Questions that received 70% or more of the votes deeming them useful were kept (de Villiers, De Villiers, & Kent, 2005). Questions not identified by any experts were rejected. Only one round was necessary to reach consensus using this criteria.

As the context for the intervention was associated with real clinical cases a diversity of activities was ensured. Real cases also allow the trainee to have regular access to the global procedure in order to build a framework to which new learning may be added. The use of real clinical cases for this intervention also ensured a variety of levels of defined situations. Intraoperative situations have varying levels of definition (Moulton et al., 2007). Both the questions used as instructions and the cases observed were variably complex. Using real cases could have resulted in the intervention not becoming progressively more complex and ill-defined but the advantages (global tasks available, participating in actual social context, Naturalistic) were felt to outweigh this disadvantage.

1.3 Methods.

This intervention is aimed at rendering the modeling phase of the learning of junior residents more efficient. It also includes elements of articulation, as trainees are asked to verbalize elements of the decision-making process.

Trainees were asked to answer five of the 40 questions during each observation of a laparoscopic cholecystectomy. The questions were designed to guide the trainees' observation and help them model key elements of a cholecystectomy. The questions were uploaded onto a web-based platform, which trainees could access with a password. They had access to a particular group of questions before and after each laparoscopic cholecystectomy and were then asked to write their answers on the website. The use of the intervention by the trainee was recorded.

1.4 Sociology.

To keep the learning situated, the intervention took place in the operating room during actual cases. Cultural immersion is believed to help motivate learners and provide an environment that promotes development of situated expertise (Collins, 2006; Lave & Wenger, 1991). However, during the initial focus group residents identified the operating room as a milieu that could impede learning. This intervention was designed to help them feel more like part of the team and to give them insight into the surgeons' focus and those factors associated with decision events in the operating room. It is well recognized that the surgeon plays a key role as a model but they also validate the presence of the trainee (Lyon, 2004). However, trainees can have difficulty establishing a relationship with the surgeon; this intervention was designed to help them to feel better situated in the environment and to give them topics to discuss with the surgeon that were known to be relevant to experts in the field. This intervention was designed to help the learner to integrate within the community of practice earlier on in their training, by providing them with a new tool. The main goal of this project was to improve the learning experience of junior residents during surgical observation; their integration within the community of practice is one way of achieving this. Also, by underscoring the role surgical observation plays as a learning activity, residents' motivation and engagement could improve. It should be noted that no intervention was conducted with the surgeon to ask them to integrate the junior learner in their team. Surgeons were aware that trainees might come to observe surgery but were not given any insight regarding the project or its goals.

2. Focus groups

2.1 Instruments and procedure.

At the beginning of the first round of focus groups, information regarding participants' demographics and characteristics were collected using a questionnaire.

Junior residents involved in the study were asked to participate in a focus group before and after implementation of the intervention. The goal of the first focus group was to explore the opinions of junior residents regarding surgical observation, its use and any difficulties it might pose. The first round of focus groups also verified that the intervention planned was relevant to their needs. The goal of the second focus groups was to explore trainees' reactions following the intervention and to gain a deeper understanding of surgical observation and its limitations (Appendix D: Focus group protocol -FG1, Appendix E: Focus group protocol –FG2).

Focus groups were held at the University of Ottawa in the facilities of the Academy for Innovation in Medical Education (AIME). A moderator, with experience in conducting focus groups and qualitative methods, was recruited through AIME; they also participated as a member of the analysis team. This moderator was external to the training program, and so provided a 'safe environment' for trainees to openly discuss their opinions about the tool and surgical observation. The confidentiality of the process was emphasized to participants in order to make junior residents as comfortable as possible. Each focus group included 3 to 6 residents, an observer and the moderator.

Themes for discussion were piloted with two junior residents likely to be involved in the study, to confirm that learning during surgical observation is a relevant topic for discussion, and that they were comfortable discussing it. The focus group protocol was developed with the help of the moderator and the final version was piloted with two residents who were not involved in the research before the first focus group. All residents participating in the study were asked to participate in the focus groups. Eight focus groups were held, four before the intervention and four following it. Questions were open-ended, and direction was determined by the independent moderator. Partial analysis of the data from the first focus group was used to inform the protocol of the second group and this iterative process continued throughout the first round. This iterative process was again used to ensure we asked relevant questions and probed areas yielding the richest data. The first three focus groups included residents in their first and second years of training. After analyzing data from those three groups, their answers were found to be homogeneous but it was unclear if this was due to complete exploration of the topic (saturation) or a selection bias of a homogeneous sample. To reduce concerns of homogeneity, three trainees in their third year of training (research year) were also included. These trainees did not have more surgical experience but had spent more time in the surgical milieu.

During the second round of focus groups, questions revolved around the feasibility of the intervention and its effect on the learning experience. The results of the analysis of the first round of focus groups also informed the second round. Questions linked to what trainees identified as difficult were included, as well as probes regarding the impact of the intervention on those impending factors.

2.2 Instruments justification.

Qualitative methods were used for this study because its aim was to explore a construct that is not well defined (Morgan, 1997). This work was done through a qualitative interpretive approach. Surgical observation as a learning experience for cognitive skills has not been studied specifically and the goal of this thesis was to improve understanding of the phenomenon, identify barriers to learning, factors that make it useful, and the perceptions of learners.

Focus groups were used for this study because this type of data collection is useful for achieving a better understanding of group processes and norms (Bloor, Frankland, Thomas, & Robson, 2001). Since surgical learning is rooted in its social context, the design of any intervention to potentially improve it must consider the contextually specific social rules. The sample chosen for this study includes a group of participants that have a relationship with each other, as they are involved in the same demanding residency program. This had an influence on their participation in the focus group, as the group dynamics were already established prior to the discussion. Authors have mentioned that groups with a pre-existing relationship can be better for the discussion of sensitive topics, as the comfort level of the group as a whole may be better. Learning during surgical observation could be perceived as a sensitive topic because residency training is a learning context with high expectations regarding the results, from the trainee, the trainers and the general population. Discussing potential flaws in their own training could make residents uncomfortable (Bloor et al., 2001). The focus groups in this study were conducted with participants with a relatively homogenous background and level of interest; all were general surgery residents in the same program. Fern (2001) suggested that such a homogenous group could be very useful in generating group consensus and for eliciting commonalities that justify behavior in a particular group. Since the ultimate goal of the research was to develop an intervention that could be used by junior residents at large, it was important to identify ideas shared by the group rather than those of a particular individual. Since the construct is ill-defined, it was also crucial to witness the vocabulary that the participants and moderator developed during the discussions.

The number of participants within each group is important in focus groups. Since it was expected that junior residents would be eager to talk about their learning experiences, it was important to keep the groups small enough to give every participant enough time to express an opinion (Bloor et al., 2001). Finally, it was felt that four groups would be sufficient for a first exploration given the resources available for this project in terms of participants, time frame and research staff availability (Morgan, 1997).

2.3 Participants in focus group.

The project was held in the General Surgery residency program at the University of Ottawa. Observational learning has been shown to be influenced by the experience of the trainees (Jenstch et al., 2001). Since this project was aimed specifically at getting a better understanding of junior residents' experience, only junior residents were included in the study. Also, because the intervention is procedure-specific and based on principles of self-motivation and situated learning, it was implemented only with residents who are training to eventually perform cholecystectomies. This left a fairly small group of junior residents from which to sample. However, since this study was designed as a feasibility study (and proof of concept) only a few residents were needed. This was a convenient sample. The addition of another group with slightly more experience, the junior residents in their research year, was an attempt at purposeful sampling, an attempt to find outliers to enrich the data with their points of view or to confirm the previous findings (M. N. Marshall, 1996b).

2.4 Recruitment.

Junior residents were asked to participate in the study after ethics approval from the Ottawa Health Sciences Network Research Ethics Board (OHSNREB) (Appendix C: Ethics approval). Participants were recruited via an e-mail inviting them to participate. An information session was also held after one of their teaching sessions. The participants received information on the research project and their potential role in it. The principal investigator answered questions. A written consent approved by the Ottawa Health Sciences Network Research Ethics Board (OHSNREB) was submitted to them and explained as well.

2.5 Data Analysis

2.5.1 Team of analysts. Three analysts were involved in the analysis. The principal investigator was such an analyst, having finished general surgery training five years ago and being involved in teaching residents at an academic center. The second member of the team is a research assistant from AIME. She has many years' experience in qualitative research in medical education, making her an ideal candidate to moderate and lead focus groups. The third member of the team has completed a Master's in medical education and combines the role of research assistant and program coordinator for the University of Ottawa Surgery Program. People on the team were chosen because of their diverse backgrounds and experience. All members have been immersed in the medical context for many years and they understand this culture. Only one member of the team has been involved in surgery and the operating room as a learning and social environment. The research questions and the purpose of the study were discussed with team members before the first analysis meeting.

2.5.2 Justification. Content analysis was used for this project because the aim was to acquire understanding of an issue that was not directly observable: the cognitive involvement of junior learners during surgical observation, its perceived role as a learning activity, and elements that promote or limit learning in context. Content analysis is defined as a "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes and patterns" (Hsieh & Shannon, 2005 p. 1278). It focuses mainly on the study's subject and context and tends to describe situations (Graneheim & Lundman, 2004). A conventional inductive approach was used, in which data were used as the main source of themes, allowing findings to emerge from it (Kondracki, Wellman, & Amundson, 2002). The goal was "to provide knowledge and understanding of the phenomenon under study," (Downe-Wamboldt, 1992, p. 314). Qualitative content analysis is used when there is little or no theory on which to base the analysis. It describes a phenomenon but also links it with its context. This method was chosen because the goal was to get a better first understanding of the phenomenon, as reported by the residents.

2.5.3. Process. A specialized firm, previously used by AIME, transcribed the focus groups' discussions. A recording of a randomly chosen focus group was compared with the transcription to ensure accuracy.

A content analysis was conducted using the method suggested by Van der Maren (1995). Both the latent and manifest content were analyzed. The transcripts were first read to get a global sense of the data. The first transcript was then used to establish an initial provisional list of themes. This list was based on the data linking it to the research questions and existing theories. It was established during an analysis meeting. It was then used to code the second transcript and adjusted to reflect all the data. The two other transcripts were coded with minimal change to the coding system. The material was then coded again, using the coding system developed. Every member of the analysis team coded all the material; the final coding was discussed at the analysis meeting. Any disagreements among coders were discussed and resolved through consensus.

The coding process included dividing the material into "sense units" with sequences of the original material and the context surrounding it. Sense units are defined as sections from the original material that contain a specific meaning, after being extracted from the original transcript, and can be used for coding purposes (Van der Maren, 1995). All transcripts were divided into sense units and then attributed codes. The sense units were coded using themes previously identified and defined. Themes were defined and listed in a document made available for future reference. Examples were provided in the document, which was amended following each coding session. All coding documents produced and the minutes of the coding meetings were kept to build a record of the decisions made during the process and their justifications.

Once all the material from the first round of focus groups was coded, it was put in *NVivo* to facilitate further analysis (NVivo 10 for Mac, QSR International, 2014). After coding the material initially, certain themes (building the story, what, approach, preparation, interpretation of the tool) contained a variety of sense units. The material included in those themes was re-coded during a team meeting, to ensure better understanding of the data.

The initial coding system was used to develop the second focus group protocol. Results of the analysis were discussed between both the analysis team and the research team and the findings compared to existing theory.

2.5.4. Trustworthiness. The model proposed by Lincoln and Guba (1985) was used to ensure the trustworthiness of the results. It included the notion of *credibility*, which is the truth-value or how certain the researcher is that the findings represent reality in the context of the study, considering the participants and the method used. *Transferability* refers to how much the findings could be applicable to another group, in a similar context. The level of possible transfer should relate to the level of similitude between the two contexts. *Dependability* refers to the probability that another researcher would reach the same conclusions, were the project replicated in the same context. *Confirmability* refers to the absence of bias in the study and the neutrality of the research process (Graneheim & Lundman, 2004; Krefting, 1991).

2.5.4.1 Credibility. It is not possible to separate the findings of exploratory research from its context (Van der Maren, 1995). To ensure credibility, it is important that researchers have a good understanding of the context related to the research. The analysis team, even if not involved directly in surgery has been working in medical education for many years. Also, the four different focus groups, each lasting one hour, were conducted to ensure that all participants could express their points of view. We tried to limit the extent to which the residents would feel social pressure to answer a certain way by having the focus groups conducted by people from outside the training program. It was also emphasized during the focus group that the process was anonymous and would have no impact on their training. Different aspects of surgical observation were addressed during two different sessions (rounds of focus groups). Questions were reframed, and examples were used to ensure every topic was discussed enough so that the patterns found would be relevant.

After coding the initial three focus groups, we reached data saturation with no new themes emerging. In an effort to ensure there was sufficient data to make credible interpretation, we proceeded with another focus group. Analysis of this fourth group confirmed the original findings.

One aspect of credibility is the concept of reflexivity, in which researchers analyze their own values and preconceptions and consider their potential impacts on the study. For example, I am a general surgeon with five years in an academic environment where I train surgical residents. I think that surgical observation as a learning activity has generally been a lost learning opportunity that should be better exploited. The main purpose of this study is to improve surgical observation as a learning experience. The current changes in medical education, work hours restriction, and the increasing level of complexity of cases done in academic centers creates a need to make training more efficient. These beliefs make me want to find ways to improve trainees' learning. Also, I was a junior resident eight years ago, which makes it possible for me to identify with them but also difficult not to see the situation through my own lenses of senior trainee or surgeon. My own context and beliefs, as well as the knowledge I had from reviewing literature relevant to this topic, have colored my analysis. I was conscious of those factors as the project was conducted. The implication of a research team and a research analysis team, with their variety of backgrounds and experiences, helped to validate the findings.

Triangulation is a powerful strategy to enhance credibility of findings. In this study, there was triangulation of data sources as trainees with different experiences participated in the focus groups. Also, the findings from this study were compared with preliminary work done in the form of interviews. Eventually we could proceed with individual interviews to triangulate methods but for feasibility issues, it was not done during this project. It would also be interesting to replicate this study in another training program, to compare findings in a different context. Triangulation of investigators was important for the study's credibility. The research team included a psychologist PhD with many years' experience in medical education, an orthopedic surgeon with a Master's degree in medical education, a general surgeon with a Master's degree in education, and a PhD in measurement, assessment and evaluation; the methods and the findings were discussed with them regularly. The analysis team was described above and all members contributed equally.

The credibility was also enhanced by finding coherence in the data. All data was considered in the analysis and discordant elements were kept as part of the analysis and discussed by the research team. We made sure that the final interpretation took into account the points of view of all participants. Because the same people were interviewed twice on different occasions, it was possible to include questions about areas of disagreement of variability during the second round of focus groups, thereby increasing the probability of understanding the source of variation.

To ensure that the findings accurately represented the reality experienced by the participants, we proceeded with a member check at the end of the analysis. The results were submitted to two trainees and discussed with them to ensure they agreed with the findings. These trainees were selected for their insight and interest in this area of research. The moderators from the focus group mentioned them as potential candidates for an interview.

The study's findings were also discussed with a colleague not involved in the project directly but with similar research interests. She has completed a PhD in medical education using qualitative methods to assess learning in the operating room. The methods and findings were discussed as a form of peer review.

2.5.4.2 Transferability. This study was conducted in the specific context of the University of Ottawa General Surgery program. As programs all inevitably have their own culture and teaching style, learners' experience may be unique and differ from those of residents in another program. All residents at appropriate learning levels in the program were invited to participate, which increased the likelihood of a representative sample. The issue addressed in this study, junior residents' learning during surgical observation, is a phenomenon common to general surgery programs across North America, and based on an apprenticeship model with progressive involvement in the operating room (Reznick & MacRae, 2006). Depending on the similarities in context, operating room culture, size of the program and residents' demographics, findings from this study will be more or less applicable.

*2.5.4.3 Dependability and confirmabilit*y. To ensure consistency, an expert in qualitative research in medical education was consulted during the study's design and analysis to ensure use of proper methods. Findings were also discussed with her. Notes were kept regarding the decisions made during the analysis and study design.

After the analysis, 50 participant quotes, randomly chosen from the coded transcripts, were coded independently by the 3 coders. Using *NVivo* coding comparison query, the inter-rater reliability was found to have a kappa of 0.55 and a 91% agreement.

Results and interpretation

Throughout the iterative process of data analysis, multiple code and themes were created and amended during coding meetings. After the analysis, coding trees were used to answer the research questions and the codes regrouped under themes linked to the research questions and existing theories. For each focus group round, a list of code was created. Those final coding maps are presented in Appendix (Appendix F: Coding tree for first focus groups. Appendix G: Coding tree for second focus groups).

After the analysis, the findings were displayed in a diagram explaining globally how residents describe their learning process (Figure 2). The goal of this learning process is for the learner to create a *schema* that accurately represents a particular surgical procedure. This schema should contain all relevant declarative knowledge, as well as the heuristics necessary to perform a procedure. The schema should be used to anchor their procedural decision-making. The figure describes a process involving several sources of knowledge, or *inputs,* including surgical observation, to gain a better understanding of a surgical procedure. Learners must be *motivated* to learn in order to process the available information, be willing to make a mental effort. Before new information is included in the mental representation of a procedure, residents need to pay *attention* to this element (e.g. a new piece of declarative knowledge or new trick to improve surgical efficiency). It needs to be encoded and included in the schema. This attention requires an element of selection; it is assumed that it is not possible or desirable for a learner to pay attention to everything that is happening during surgery. In this context, residents try to identify and encode relevant information in the available sources. If this selection process is not supported by previous knowledge or instructions, it happens randomly and is therefore error prone. Attention and motivation are critical in making observation a source of elements to include in the schema. Without attention or motivation, there is limited information processing and limited change in the pre-existing schema; the result is therefore limited learning.

Participants described many factors with an impact on this process, which is represented in the results. The content of the boxes in Figure 2 represent themes taken directly from transcript analysis. They represent sources of potential knowledge and other factors with an impact on learning during observation. Given that schema building is an iterative process with many interrelated factors, the figure uses interlocking circles to illustrate the relationship between what is available in the environment to learn and the factors that impact the learner who is processing those opportunities to enrich their schema. The development of this representation of the results is linking the participants' description of their learning process with the work of Sweller on Schema Acquisition and Cognitive Load Theory, as well as the work of Petty et al (1987) on the Elaboration Likelihood Model (Petty et al., 1987; Petty & Wegener, 1999; Sweller, 2003).

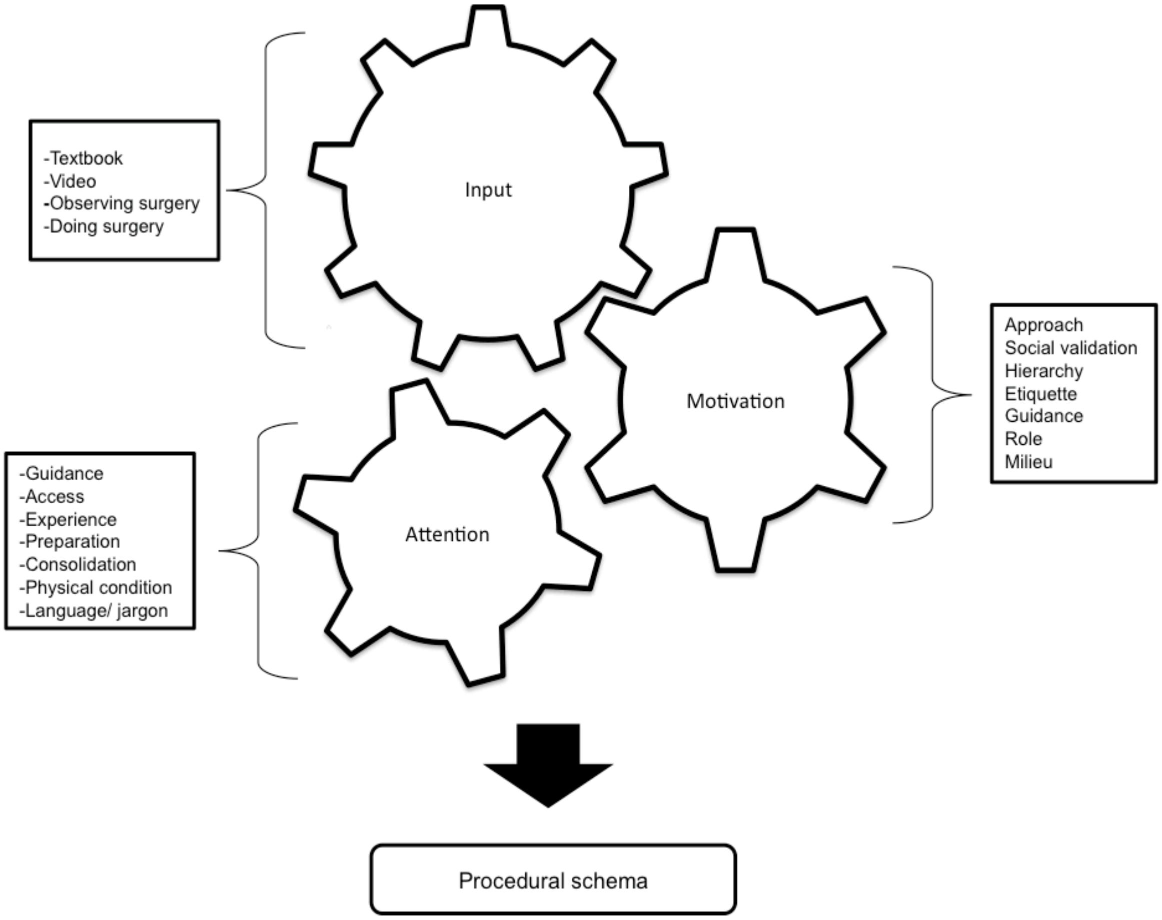


Figure 2. Global learning process

Based on the global analysis, all the research questions were adequately addressed in learners' responses. The results section will be divided by research question.

1. What is the perception of junior surgical trainees on the educational value of surgical observation?
2. What factors make surgical observation an efficient or inefficient learning experience for junior residents?
3. What factors can promote or compromise the use of instructions during surgical observation?

A diagram presents themes and codes that answer each question. A bar diagram was made for each theme to present the number of sense units referring to it. Then each theme and code is presented, with relevant citations from the focus group transcripts. A short interpretation is presented for each theme. The first two questions were answered using data from the first round of focus groups. The third question was answered using data from the second focus groups. A table summarizing the questions and themes that answer those questions is presented first to guide the reader.

Table 2: Summary of questions and findings for each research question. (Codes used in the results section are **bold** in the table)

1. What is the perception of junior surgical trainees on the educational value of surgical observation?	
Approach (29 sense units) -General perception regarding observation.	Surgical observation is perceived as having a role in learning operative surgical skills. It has **specific benefits** that differ from other learning modalities (textbook, atlas, videos). It is especially useful as a **first step** when learning a new procedure to build an initial framework. However, there is common agreement that observation is a **second choice**: performing the surgery is seen as the best way to learn operative skills. In the same vein, according to participants, observation can only get you so far. There is a clear **limit** to possible learning through observation and it is necessary to have other learning modalities such as performing surgery to achieve surgical proficiency.
Role in schema building (34 sense units) -Perceived role of observation in the global process of learning surgical skills.	Participants described an iterative **process of learning** in which observation has a role. This process of learning surgical procedure includes the use of different learning modalities to revisit and enrich procedural schema to create a complete mental model for each procedure. The role of observation is **different from other sources**. For example, it provides validation for anatomy knowledge and clinical correlation for theoretical knowledge. It also offers a unique chance to integrate previously acquired knowledge. Since surgical observation happens in the clinical environment, trainees benefit from a **variety of experiences** that allows them to compare management strategies for intra-operative issues in order to include the most successful ones in their schema.
Content (34 sense units) -Possible content learned through observation	Participants identified many elements of content potentially learnt through observation. Some are concrete and visible: **anatomy**, **instrument** use and name, **steps of the surgery**, **normal and abnormal** clinical findings, anatomical variance, and **operating room set up** including patient positioning. Some are more cognitive elements: **what not to do** in certain situations; how to avoid complications; what decision led to a complication; special **tricks** used by a surgeon to make surgery more efficient; and special anatomical landmarks and pitfalls. Finally, participants mentioned being able to learn how to behave in the **operating room milieu**, the social rules, the surgeon's role in this environment, and how to create a good working climate.
2. What factors make surgical observation an efficient or inefficient learning experience for junior residents?	
Motivation (168 sense units) -Factors that impact how motivated or engaged residents feel about certain cases	To be able to learn, residents need to be motivated to process information. Residents explained how **guidance** and interaction with senior members of the team helped them stay motivated during the surgery and be drawn into the operation. They also mentioned the importance of the **role** they have in the surgery for them to be engaged in the process. The operating room **milieu** with its many occasionally conflicting priorities, its **etiquette** and unwritten rules, as well as the **hierarchy** prevailing in the operating room among the surgical team but also among the other professional groups were other factors mentioned as frequently preventing residents from feeling comfortable in asking questions or voicing concerns. Finally, their **approach** to observation, their personal perception of how useful this activity was, is also having an impact on how much learning happens during this activity.
Attention (184 sense units) -Factors with an impact on the level of	The quality of the **preparation** they go through before observing a surgery was identified as having a large impact of what they could learn during the procedure. Preparation helped them focus their attention on relevant features of the surgery and gave them a framework to help them follow the surgery. They also mentioned

attention during a procedure, how they distribute their attention, the amount of mental processing happening around a specific procedure		the importance of their **level of experience** in how they were able to select relevant elements to pay attention to. Residents also mentioned that reviewing the case after the fact, discussing it, and taking personal notes or debriefing, a process called **consolidation**, was useful in identifying relevant learning points in a procedure. Explanation or **guidance** from senior members of the team was the most valued form of instruction to guide attention. Finally, residents mentioned other factors that impact their level of attention. They need to be able to see and hear what is happening during the surgery, or to have **access** to relevant information about the intra-operative situation. Also, they need to be able to understand the **jargon and language** of the surgical team and they need to be in a **physical condition** that allows them to learn.
3. What factors can promote or compromise the use of instructions during surgical observation?		
Factors related to cognitive apprenticeship (58 sense units)	Facilitators	Participants mentioned that instructions given before observation had helped them feel more **validated** in their role as learner in the operating room. It also provided them with a **common frame of reference** with the surgeons. They mentioned being able to use those questions as conversation starters because they felt that these would be relevant to the surgeon. Also, they recognized that the format of the instructions with questions was forcing them to **articulate** their understanding of surgery because they had to formulate an answer. This articulation was seen as a beneficial feature, a form of consolidation as described in the first focus group. Residents also mentioned that those instructions were useful because they were **different from other sources of learning**. They were covering aspects of the procedure not covered in textbook or video; it made them look at things with a different perspective.
	Barriers	Participants mentioned that the instructions were not providing them with **feedback**. Residents mentioned that they would have liked to have answers to the question or liked to be able to discuss the questions with senior members of the team. The lack of feedback was limiting what they were able to learn with the intervention. The intervention took place without explicit support from the program. Residents mentioned that support from the program would be necessary for the intervention to be used consistently. Instructions **needed to be legitimate** and included in the mandatory daily activities. Finally, participants did not feel that the instructions were enough to overcome challenging work **atmosphere**. They said that even using those instructions, it was difficult to learn if the atmosphere was tense.
Factors related to cognitive load theory (85 sense units)	Facilitators	Residents found the breakdown of different steps useful. The **deconstruction** of the procedure in the instructions helped them gain an understanding of the subtleties of each step. They also said that the intervention helped to **focus** their attention on relevant elements during the procedure, so that observing surgery became more **structured** with a framework to guide them. Residents also mentioned that this kind of instruction would likely help junior learners to improve their technical skills because they would have a better understanding of key elements relevant to surgery. This impression that those instructions could accelerate technical skills acquisition was called **quick star**t.
	Barriers	Some residents saw the level of difficulty of the questions contained in the intervention as a barrier. Some mentioned there was **too much material** included in the questions; some mentioned that the questions were **too easy**. Participants in all focus groups mentioned that the instructions on their own were not enough to reach surgical proficiency, that they were **one part of a process**, including observing surgery, studying around cases, and performing surgery. Finally, residents mentioned **needing prior knowledge** to get the most out of this activity; that it would be impossible to learn from those instructions without a basic understanding of the steps of the surgery and relevant anatomy.
Factors related to elaboration likelihood model (49	Facilitators	There was general agreement that the intervention was fairly **easy to use,** both in terms of time needed to complete it and its format. Participants appreciated that the instructions were making them reflect more on the procedure they were observing, to try to gain a deeper

sense units)		understanding of it. By **increasing reflection**, it was felt the instructions were beneficial. The instructions also made some residents study more around cases, trying to find answers to questions. This **increased action** was also seen as useful.
	Barriers	On the other hand, residents mentioned some **technical difficulty** with the website displaying the questions which would limit their use of the intervention long term. Also, some residents misunderstood the role of the instructions and how they were to be used, which would limit their use of it. Residents found that the benefits of the instructions on their skills as an observer were **transient**. Residents did not see an improvement in their motivation or attention after the end of the project. Residents also pointed out that those instructions were just **one more thing to do** in an already busy schedule. They felt other clinical duties would limit the use of those instructions. Also, some elements included in the instructions were felt to **not be applicable** to some cases limiting the usefulness of some questions. Finally, residents realized that the instructions needed processing, that they were improving learning only if they were associated with a part of cognitive investment and mental processing from the learner point of view, which was similar to other sources of learning available to them. The **need for processing** was seen as a barrier to consistent use of those instructions.

1. What is the perception of junior surgical trainees on the educational value of surgical observation?

This question provides information on the current state of surgical observation from the learner's point of view. It was used to understand the potential role of this activity in surgical training and to explore its current limitations. The perception junior residents have regarding observation can be divided into three main themes: approach, role in global learning, and content (Figure 3). The general approach or attitude on this activity includes baseline perception and feelings regarding this activity. This is relevant because it is necessary to start by understanding junior residents' perception since it has an impact on motivation. It is influenced by the surgical culture and by previous personal experiences as trainees (Figure 4). Secondly, the act of observation has a role within the larger process of learning surgery and participants discussed its potential utility and the reasons why it is considered a learning activity (Figure 5). Finally, junior residents described the content that can potentially be learnt by this activity; it is discussed in this section to illustrate potential perceived benefits (Figure 6).

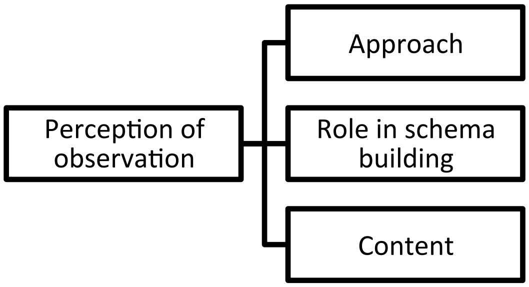
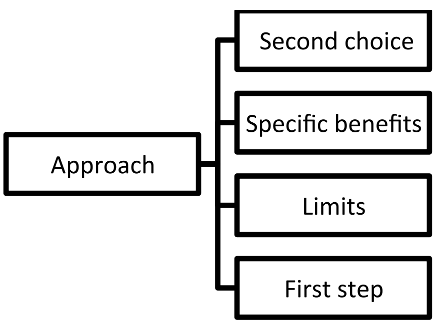


Figure 3. Perception of observation

1.1 Approach

This theme covers the content related to the general attitude of the participants towards surgical observation - their perception of it as a learning activity. How is surgical observation perceived within the junior residents' culture? How do they approach surgical observation?



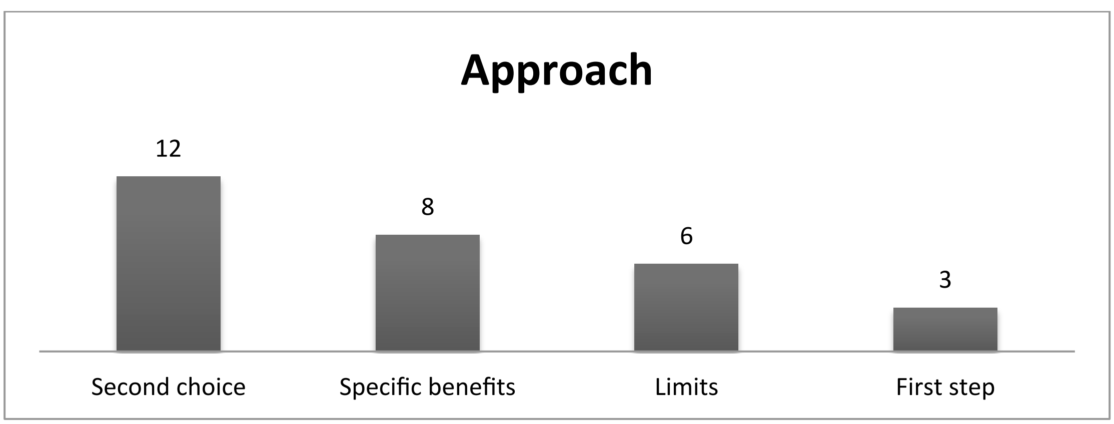


Figure 4. Approach (29 sense units)

1.1.1 Second choice (12/29). Residents mentioned that observation was generally perceived as a *second choice* learning activity. They would rather be actively involved in the surgery than just observe it. For most, greater learning is achieved by doing rather than by observing. Some participants even mentioned a negative stigma regarding observation.

Citation:

M1: The public thinks watching an operation is like on Grey's Anatomy, they think it's really cool; it's not always cool. So there is a stigma as you get along in your residency that if you're someone who's watching you're probably someone who's not at the level they should be at. So eliminating the stigma of having to watch an operation could be beneficial.
Mod: Right. That's interesting, because I mean talking about the way you've been discussing, or about it being a graduated thing, then you know, people should be watching until… All the way along until you're the pilot, sort of.
M1: Yeah. But there is a stigma.
Mod: There is, okay. That's interesting.
M2: And the nurses know that.
M1: And the nurses know that.
F1: Oh yes.
M1: And its self-fulfillment, there are residents who get to fifth year and unfortunately are known as watchers because they have been deemed not at their level, and it's a negative… You don't want to be one of those people.

1.1.2 Limits (6/29). This code included mention of the limitations of observation as a learning activity. It included a sense unit describing that many factors needed to be in place for surgical observation to be effective and citations of the perceived limitations of observation as a learning activity. Residents mentioned that there has to be a part of tissue and instrument manipulation to learn how to perform surgery. Residents implied that without having attempted to do the surgery and manipulate tissue, it is more difficult to learn just by watching. Factors necessary for surgical observation to be efficient will be described in the next section (research question 2).

Citation:

M3: I think for me observing gets you only so far, like from the beginning you can observe how the lights are put, how the patient is positioned, how they drape, how they enter the abdomen, how they see the anatomy. But actual surgical technique, I think you have to have your hands in there so that your mind can build a connection; this is how it feels, this is what I did, this is what I did wrong and this is how I need to get better next time. So just observing itself will only get you so far.

1.1.3 First step (3/29). This code was used for sense units describing surgical observation as a first step in learning a new procedure, one that allows surgeons to familiarize residents with a new procedure. Many mentioned that they would not be comfortable actively doing the procedure the first time they were in contact with it. There is a classic saying in medicine: "See one, do one, teach one," and residents mentioned it as a way to explain that observing at least one procedure is an integral part of learning a new surgery.

Citation:

I think at some points also it's more within your comfort zone. When you're seeing something that you haven't seen, or there's a procedure that you've never done before and operationally you've never done before, you know, I would personally like to have the opportunity to watch it being done in a setting where I'm directly with the Surgeon, right. Rather than I come on with a new Surgeon, he assumes I've already done this, and then he says, go ahead do it, right. I would… So that's certainly one setting where I, you know, there's great benefit in seeing it.

1.1.4 Specific benefits (8/29). Learners also recognized that surgical observation has a role that differs from other learning modalities such as reading textbooks, watching video of surgical procedures or performing surgery.

Citation:

M2: For myself I like to watch how they do something, their particular technique, and I try to, you know, appreciate that and then internalize it and think, okay they pulled this way in that direction during this part of the operation, I'm going to try that next time. So I, observation has allowed me to pick up on maybe some of the subtle things that you might not be able to do if you were just instructed to do it with the tools in your hands.

Interpretation approach. Residents seem to have mixed feelings regarding their general attitude towards surgical observation. On one hand it is perceived as an essential first step in learning surgical procedure, but it is also seen as a second choice in terms of learning activity, and most participants would rather be doing the surgery than observing it.

Many limitations were described by participants, who said that "observation can only get you so far." Within the context of an apprenticeship, it is not surprising that residents are eager to move on towards the active doing part of the surgery. As junior members of the community of practice they value activities that are associated with better integration in the community (doing the surgery). Also, they see a stigma associated with members of the group who remain at a junior stage of development (residents who are still observing at the end of their training) (Lave & Wenger, 1991; Reznick & MacRae, 2006). *Modeling* is an integral element of apprenticeship, and residents recognize it as such, as the first step in learning a new activity, when the procedure is observed and internalized. They also recognize the more active part of the process (*coaching* and *scaffolding*), when learners are performing procedures under supervision and receiving feedback. Practice and feedback are key to becoming proficient (Lave & Wenger, 1991; Norman et al., 2006).

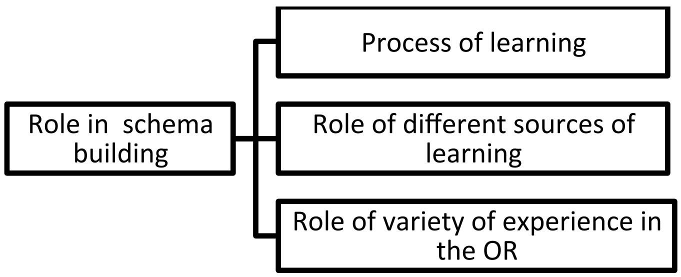
When looking at schema development theory, their perception of observation as a first step can be seen as an attempt at building an initial framework to develop a procedural schema using the available features of a given example. Marshall (1995) explains that it is possible to learn the initial component of a schema using abstract rules or knowledge (in the surgical context, what can be learned from a surgical atlas) or a concrete example. Both modalities are efficient but their use depends on the learner preference. She also demonstrated that a combination of approaches is the best way to teach as it optimizes learning (S. P. Marshall, 1995b). Schema theory explains that for schema to be enriched it needs further experiences; different modalities and experiences can be integrated to render a schema as complete as possible (Sweller, 2003). New rules must be tested, either through mental simulation or through concrete application, which is likely what residents are describing when they say observation can only take you so far. At some point, it is necessary to test the schema to confirm its usefulness.

The approach to observation is important when designing an intervention to improve it as a learning activity. It gives an idea of how relevant this activity is to them. This intervention is trying to promote reflection and improve the way residents process information after observation, a process that depends on motivation, which is itself linked to how useful this activity is perceived to be (Petty & Wegener, 1999).

1.2 Role in building schema

While discussing the role observation plays in learning, residents explained their learning process (Figure 2) and how they make sense of intra-operative situations. They described a process of integration of multiples sources of information including textbook, videos, surgical performance and observation. This process seems iterative, as they revisit their ideas and knowledge of each encounter with a procedure. Discussions surrounding how participants are constructing their knowledge and building a mental model or schema for a procedure are grouped under the theme: *building the story*. It was felt that residents were building a story for every procedure, including progressively complex information. Observation was seen as part of this process at different points. First, it was described as a source of input of likely elements to include in the mental model. It was also described as an aspect of the processing of new elements.

As residents watched surgery, they compared their schema with what was happening, making connections between the different sources of learning (Figure 5).



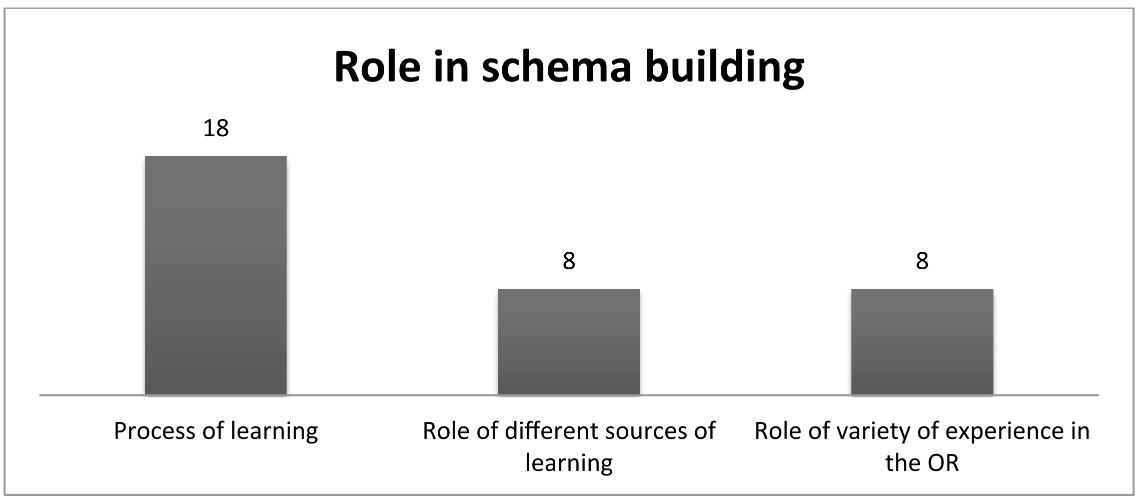


Figure 5. Role in schema building (34 sense units)

1.2.1 Process of learning (18/34). This code was used whenever a sense unit described how connections are made between different ideas and sources of knowledge. Participants described learning as an iterative process that involves reviewing previous knowledge with a progressive deepening of understanding.

Citation:

F2: And once you've read about something you have sort of like a framework of understanding and then in the situation real time, where you're there, you're like just piecing things into the empty spaces of that understanding. So you're like, it's like in my mind it's like a tree and like you're just kind of filling out all the leaves to understand the whole picture of it. Like that takes time and you kind of like spiral upwards to like learn more as you revisit each procedure or situation.

1.2.2 Role of variety of experience in the operating room (8/34). When learning new procedures, participants described how they used the witnessing of different occurrences of the same procedure under different circumstances to enrich their knowledge. These descriptions were grouped under this theme.

Citation:

M2: Like because I think out of what you observe every time there are only, there's probably a smaller percentage that you can apply. So let's say you observe 100% of what someone else does, then maybe in your own procedure next time you would probably only apply like 50% of it. But you know when you go back to it and then you observe more and you apply more of that, you know, that 50% expands.

So yeah, that's the ceiling effect that we were talking about earlier as well, so you keep going back after you apply something you learned, you get better and better, you pick up different things, so. Definitely I think observation has a role in that.

1.2.3 Role of different sources of learning (8/34). This code was used when participants discussed the specific role of different sources of learning. They found specific uses for video reviewing, participation in surgery, observation, and textbook reading.

Citation:

F1: I think too like in terms of preparing, you see the surgery, you focus on a couple of things and then you often go back and read like about the surgery again many many times, it's not like you read it once and you're an expert. And then the next time you see the surgery you sort of consolidate like a different part of the surgery's knowledge, or you read in the textbook and then you pick up something in the textbook that you missed the first time because it was sort of like way above you.

And so there's always that interaction between like the readings or the YouTube videos and what goes on in the OR, and your understanding of it, so that develops too like every time you see a surgery, especially if it's like during normal working hours.

Interpretation schema building. The process of learning described by all participants can be linked to schema acquisition theory (S. P. Marshall, 1995a; Sweller, 2003). This theory describes how learners construct schemas. Initial encounters with a procedure lead to the development of an initial schema that is then used to store information and heuristics in long-term memory. Any other experience relevant to this procedure helps to refine the schema. The theory also includes the notion that different learners will derive different elements from the same experience and that the same learner, at a different point during knowledge building from another, will generate a different kind of learning from the same experience.

The creation and adaptation of previous conceptions following various experience is also described in expertise theory. It is thought that experts have frameworks and use patterns that help them make sense of situations and that those frameworks are progressively enriched with experience and expertise (Crandall et al., 2006; Norman et al., 2006).

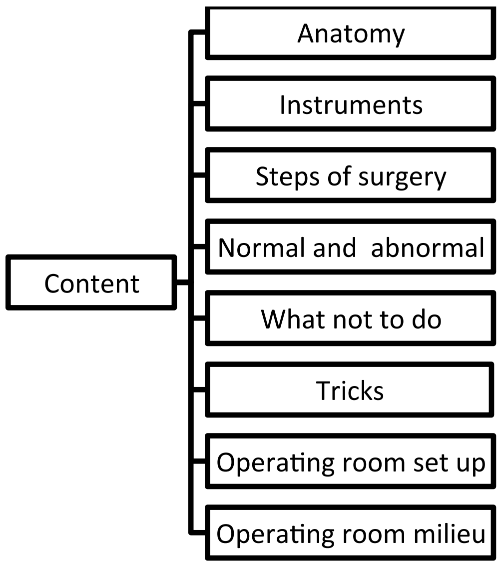
Finally, in the cognitive apprenticeship framework, the learner uses *articulation* and *exploration* to generate new rules, describe and validate them with their teacher (*articulation*), and then test them in new situations (*exploration*). Those two activities are described in the cognitive apprenticeship framework as key to learning consolidation, but the steps were not initially described in the classic apprenticeship framework. However, to integrate new cognitive constructs, it is felt that articulation is needed to ensure that the knowledge and heuristics built by the learner are adequate and that the rules generated by previous experience align with the teachers' rules (Collins, 2006). Developing relevant schema is seen as key to achieving mastery.

The iterative process of schema building and validation is described in many learning theories and participants described it in all the focus groups, in varying levels of detail (18 citations describing the learning process). There was consensus that previous experiences are used to create knowledge and that rules and laws are generated using both multiple experiences and sources of learning. This finding underlines the role that observation can have in learning surgery but it must be integrated in the larger process of sense making.

As each learner is at a different stage in his or her training, results of any intervention to improve learning will likely vary from one to the next. Multiple factors, including motivation and level of understanding of the procedure, will likely have an impact on the educational outcomes of the intervention.

1.3 Content

This theme includes the content that can be learned during surgical observation. The residents mentioned several aspects (Figure 6): the concrete and visible, the technical and cognitive, and the cultural and social aspects of the role of the surgeon.



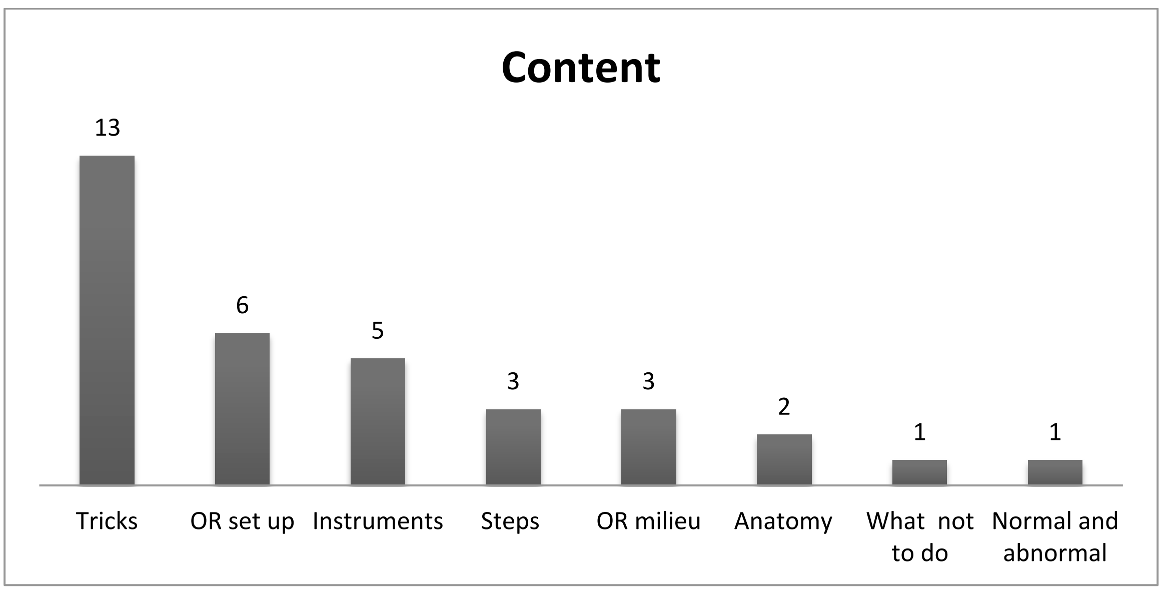


Figure 6. Content (34 sense units)

1.3.1 Anatomy (2/34). This code groups all mention of anatomy learning: its clarification, comparison of clinical anatomy and description made in atlas.

Citation:

Mod: Right. Is there anything do you feel that's different about learning from a book or a video, well you're saying you don't really watch them yet. But if learning from an atlas or a book versus actually being there in the OR, can you sort of talk about the differences?

F3: Oh yeah, it looks totally different, right; a book is clear and colour coded (laughter), and clear, right.

F2: You don't have like the animation of like… It's hard to see the whole picture sometimes.

F1: And three-dimensionally, you can't capture that in the book.
Mod: In a book, okay, yeah.
F1: And like a nerve is not yellow in the body.
F3: Yeah, exactly, right, everything is red

1.3.2 Instruments (5/34). This code includes learning the names of the different instruments and their uses.

Citation:

F1: …the step, just even basic OR familiarity in terms of etiquette, in terms of what are the names of the instruments, because we're never ever taught what the names of the instruments are, you just kind of pick it up as you go along. Even how do you set up the bed, how you prep the patient, you learn a lot of basics without realizing it.

1.3.3 Steps of surgery (3/34). This code was used for sense units that describe how they can learn the different steps of a surgery by watching and how it consolidates the knowledge gained from textbooks on surgical steps.

Citation:

Mod: Yeah I guess what's there, what are the possibilities to learn through observation?
F1: You can also just learn the general steps of a procedure, start to finish.

1.3.4 Recognition of normal and abnormal (1/34). This code covers the description of observation as a way to gain a better understanding of individual variance, both in terms of normal anatomy and pathologic findings. Observation can be used to create a bank of situations to use later when identifying a presentation as normal or abnormal.

Citation:

But then from the opposite standpoint, it's good to observe because like you recognize normal and you recognize abnormal. Even colonoscopies, as much as GI you want to be doing them, there's things that you can gather from observing, just like a normal, what it's supposed to look like and that when you do it and you see something abnormal, then you recognize that.

1.3.5 What not to do (1/34). Some residents mentioned that they have used observation to recognize techniques leading to poor outcomes. Some described reviewing what happened before a complication, trying to avoid repeating those same decisions when operating.

Citation:

M1: And you can learn just as well from watching someone do it properly as you can from someone doing it poorly. And I hadn't realized that until I saw someone do it poorly (laughter).

But you can watch a Surgeon, an experienced Surgeon operate very well and you think, wow that's really easy, then you watch a learner and you're like, oh okay, not as easy as it looks, as I thought it once was. So watching I think is important in learning the steps, learning the movements, learning what to do, and what not to do.

1.3.6 Tricks (13/34). This code was used to classify mention of complication management, specific techniques and pearls learned while watching surgery. Many residents mentioned that observation allowed them to learn how to react in the event of problems. They also mentioned learning more specific strategies to make surgery efficient. Residents said that surgeons should explain their thought processes so residents could understand more. Those explanations were generally perceived as useful.

Citation:

F2: If you read before you can, you know, it depends on the level you're at but I think we're, most of us are at the level where it's like you can read the basic anatomy and the basic steps but it's the little small things, it's the little tweaks and things we make to do it easier and to make it a little more smooth for that matter. And you only really only pick that up by observing, but you need to be very engaged in thinking, oh yeah they just, you know, they flipped the gallbladder around, or that was like a cool move they did with their instrument, etc.

1.3.7 Operating room set up (6/34). Several mentions were made of the many details to learn on operating room set-up including patient positioning, light set-up, draping. Those sense units were grouped under this code.

Citation:

F2: I think it's what you make of it because you can learn a lot of different things, there's more than just… I don't know, there's so many things to be learned for a surgical resident, like even just the practical things about how to get the OR set up so you can like watch how your senior resident sets up the table, sets up the patient.

1.3.8 Operating room milieu (3/34). This code covers mention of interaction between different team members and how the atmosphere in the operating room is created. It was also used when residents described how they learn about their role and that of other team members while observing surgery.

Citation:

And the other thing I thought of is that there's so much communication that happens in the OR that's not necessarily… I mean you can't put it in a textbook, right, but how do you communicate with the Anaesthetist, how do you… Like what's going on, how is this person creating, like *fostering a good environment, how are they fostering a negative environment? All this stuff you can only pick up and you can observe a lot of that without even realizing it, subconsciously.*

Interpreting content. Participants described several key interrelated elements that could be learned during surgical observation. The content described by participants covers all areas of surgical expertise, from anatomy and instrument knowledge to communication skills. Thirty-four citations mention different aspects of the content learned during observation. This underscores the potential of this learning activity. It is interesting to contrast these findings with those in the first theme. Even if observation can lead to learning useful content, it is perceived as a relatively inefficient teaching strategy when compared to actively doing surgery.

It is interesting that the residents mentioned technical aspects (instruments, anatomy, and technique), cognitive strategies (tricks) and social elements (operating room m ilieu). Surgical training includes developing a professional identity, even if this is not an explicit component of the curriculum (Lingard, Reznick, DeVito, & Espin, 2002; Mahood, 2011). Participants recognize that certain behaviors and interactions are expected of them and that, initially, they observe before becoming active members of the community. This is in agreement with the social learning theory of apprenticeship, recognizing that learning a trade usually includes learning attitudes and social behaviors associated with members of this community (Lave & Wenger, 1991).

The technical elements of surgery are usually visible and easy to understand simply by observing them. However, residents identified other aspects of the environment and procedure that are more subtle or difficult to see. Participants recognized that subtleties and invisible elements were key to surgical performance but mentioned that this content was inaccessible to learn without guidance. They are eager to learn the decision-making process from their teachers, which agrees with earlier descriptions of surgery as a cognitive activity (Hall et al., 2003b). Participants mentioned that teachers should make their cognitive process visible to them for it to be understood, which agrees with Collins' work on cognitive apprenticeship (Collins et al., 1991).

Interpretation of question 1: What is the perception of junior surgical trainees on the educational value of surgical observation?

This first question was chosen to assess the current state of surgical observation for junior residents. The goal of this question is to compare participants' experience with theoretical models presented earlier. It was also used to explore the hypothesis that surgical observation has more potential as a learning activity than what is currently exploited by junior residents, as suggested by Carlile (2012). The findings tend to align with cognitive apprenticeship, cognitive load theory and elaboration likelihood model. Participants also confirmed that while a rich content could be acquired through observation, it is often a suboptimal learning activity.

Participants described surgical observation as a useful learning activity. It is understood that a rich content can be learned through observation and that this activity has a role in learning, as do many other potential sources of knowledge and expertise. Junior learners confirmed the potential of this activity.

However, they also mentioned that this activity was associated with negative feelings. Many described feeling frustrated on having to observe procedures instead of perform them. It is interesting that even though they understand the potential value of this activity, residents wished that it was not as prevalent in their residency.

This negative view of surgical observation can be understood better when viewing it through two different theoretical lenses. First, from a social learning theory perspective, it is not surprising that junior residents are eager to perform a key role in surgery, to be the primary surgeon, the person at the center of the community of practice. Being the person performing surgery, the primary surgeon, implies a level of skill close to that of practicing surgeons and trainees are eager to reach that stage. The role of operating surgeon is also associated with recognition by the other members of the team (Lave & Wenger, 1991). The current context of limited time for training and less exposure to technical skills because of work hour restrictions adds to residents' feeling of pressure to be the primary surgeon (Reznick & MacRae, 2006). The negative stigma associated with observation will have to be considered when implementing interventions that attempt to optimize learning. Trainee motivation will likely be impeded if they perceive this activity as less valuable than performing surgery (Petty & Wegener, 1999).

Second, when considering the schema acquisition theory, prior knowledge and experience are key in selecting relevant information to include in the schema. Junior residents described having difficulty following surgeries that lack explanations or instructions. Following the model proposed by Swellers (2003), insufficient previous knowledge can be compensated for by detailed instructions. In other words, if residents are not able to learn from observation because they don't have enough experience to identify the key elements needed to further their understanding of a procedure, guidance provided by more senior members of the team can compensate. This idea is also present in studies on observational learning (Jenstch et al., 2001).

Another idea to consider is that residents could maximize what they can learn with their current knowledge base, perhaps reaching a point where observation is not as useful for them. Some mentioned a ceiling effect because they miss the important part of attempting to perform the surgery when they observe a procedure as a junior resident. Actually doing the surgery would provide a new source of information to include in the schema and the opportunity to test rules and hypothesis derived from previous experience.

Understanding the potential of surgical observation and its current limitations, it is possible to devise an intervention to optimize it. To make this activity more useful, it is possible that residents need more instructions based on the experience of expert surgeons, but adapted to their current level of expertise. Those instructions might be challenging to develop, given that each resident is at a different stage in their schema acquisition. From a social learning theory, junior residents would benefit from being validated in their role as a junior learner in the operating room.

2. What factors make surgical observation an efficient or inefficient learning experience for junior residents?

This question addresses factors that have an impact on surgical observation from the learner's point of view. It is necessary to first identify those factors before implementing an intervention because they can then be targeted specifically.

From the general understanding of schema creation for a procedure (Figure 2), factors with an impact on observation as a learning activity can be divided into those with an impact on *motivation* during procedure and those with an impact on *attention*. These categories are derived from the elaboration likelihood model, which explains that motivation and attention are necessary for information processing. Since this project aims at understanding the factors that prevent or facilitate information processing for residents during surgical observation, using those categories provides a useful framework. It is understood that this is an integrated process and that most factors have an impact at different levels. Factors were classified as having impact on motivation or attention, depending on what was felt to be their strongest affinity with one category. This thesis is studying one source of information or input, surgical observation. It is considered to be constant.

For observation to lead to a better understanding of a procedure, learners must actively be trying to learn. They need to be convinced that observation is a valuable source of information (motivation). However, participants emphasized that just being motivated is not enough; they also need to figure out what element is important in the display. They need to pay attention to elements relevant to them at their level of training. Different factors and strategies have an impact on their level of engagement or motivation and on their capacity to select relevant elements from the display (attention) (Figure 7).

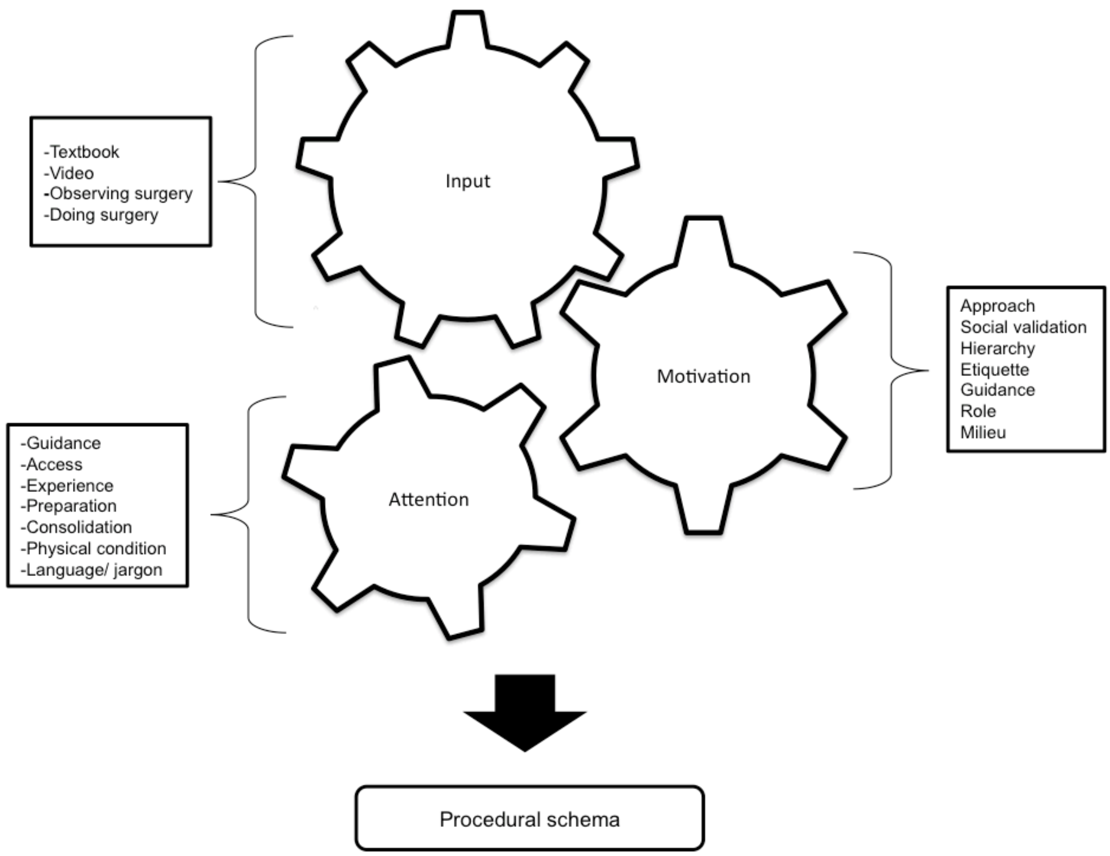


Figure 7. Factors that impacting surgical observation

2.1 Motivation

Fifty-five citations describe the importance of actively trying to learn and stay motivated during observation in order to make it a useful learning activity. Many describe this active involvement as a critical step. They explained that their learning is a direct outcome of their attitude and level of engagement in a procedure. Many factors were mentioned as having an impact on motivation. They are described in this section. Of note, learners' general approach to observation has an important impact on their level of motivation; this was discussed in section 1 so will not be discussed here. We should also remember that motivation and attention are interrelated; many factors have an impact on both. For presentation purposes, they were categorized and are presented only once.

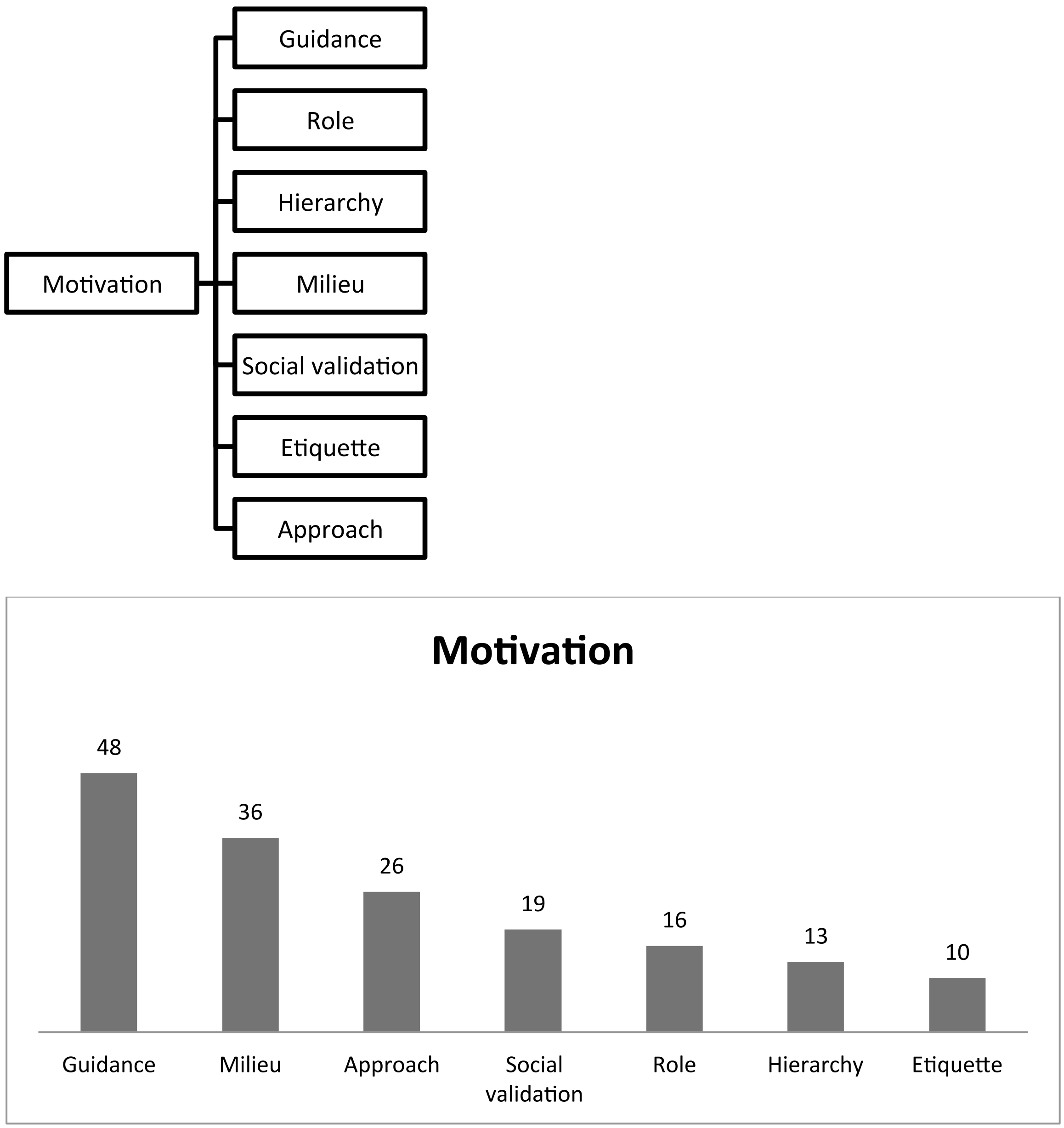


Figure 8. Motivation (168 sense units)

2.1.1 Guidance (48/168). Residents frequently mentioned how important they felt it was to get guidance from the senior member of the surgical team, a more senior resident or a staff surgeon. The preferred form of guidance varied but included direct questioning, pointing at anatomic details, verbalizing thought processes, and setting objectives for the case. It was also recognized that not all surgeons do guiding tasks with the same intensity. Residents mentioned that this could occasionally cause them discomfort, especially when they don't know the answers to questions from surgeons. Guidance was mentioned as an important factor in keeping residents motivated but also for pointing out important elements from the case to be remembered (attention).

Citation:

F2: Occasionally (laughs), it really does depend because if you can't see anything but your staff is like asking you all kinds of questions, you're engaged because you're thinking about the answers to his or her questions and how that applies to the situation. You're being drawn in to the surgery.

2.1.2 Role (16/168). Residents mentioned being more motivated in the surgery when they played a more active role. They felt their improved motivation was leading to more learning. The sense units with this idea were grouped under this theme. The task could be as simple as holding a retractor or cutting sutures but it was felt that engagement was proportional to the role.

Citation:

M1: I found that certainly as a medical student, if I didn't have a hand in on something I focused a lot less and paid less attention. And as soon as I put my hand in on something, doesn't matter if it was a retractor or if you're just got your hand on the bowel keeping it out of the way, all of a sudden you're engaged, you're part of the operation. So absolutely a big part of being engaged is having at least one hand in there, so yeah.

2.1.3 Hierarchy (13/168). This category was used for sense units that describe the importance of hierarchy and relationships in the operating room. It includes instances that describe the usefulness of more senior people advocating for junior residents. It also included a description of the importance of friendships and long-term relationships to facilitate teaching.

Citation:

Mod: It sounds like the relationships you have with the others around you are pretty vital.

M2: It is very vital, yeah. I would say particularly in those situations, if you have had a chance to work with the senior and you've developed a rapport or a relationship with them, then getting *into the OR and these learning environments will be a much nicer process. It will be more well received, there will be a… Like [Name 7] said, you'll be advocated for and, so it's nice.*

2.1.4 Milieu (36/168). This category was used for sense units describing the role of the atmosphere in the operating room and the milieu as a learning environment. It includes surgeons' moods, logistics, distraction, expectations, fear of being judged, and the concept of a safe learning environment.

Citation:

M2: Yeah so the person there can affect the whole teaching environment, right, and it can even affect the other learners in the room, let's say a Nursing student or an Anaesthesia resident or student. You know if you have this angry Surgeon who's just nasty and doesn't give you any time for teaching and isn't pleasant about it, it definitely hampers everyone's learning.
Mod: So the attitude of the staff, or the Chief Surgeon or the main Surgeon, makes a huge difference.

2.1.5 Social validation (19/168). The category was used when residents described how important it was for them to feel welcome on their team, to be recognized and acknowledged by the group. The operating room is a multidisciplinary environment that can be overwhelming. Their role in the operating room needs to be validated for them to feel comfortable asking questions, or to be able to fully engage in learning.

Citation:

So just by somebody saying, "Welcome, my name is Dr. So and So, today we're doing this, if you have any questions let me know." Like it just makes you feel, okay, I'm not in the way or if they are tell me.
F1: I'm supposed to be here.
F2: Yeah, like it's okay that I'm here.
Mod: So even just that small acknowledgement makes a difference?
M2: It's permissive for learning, essentially, right, it then allows you… Yeah, like you are allowed to be involved and you're there, you're a participant and they've acknowledged you and it's a permissive effect essentially that… You know, so you're going to be way more engaged and not feel out of place.

2.1.6 Etiquette (10/168). The intraoperative context is governed by implicit rules that must be learned and followed by all members of the surgical team. Sense units that discuss those rules and how they regulate operating room behavior are included under this category.

Citation:

Mod: You're sort of intimated that sometimes, there might be something to do with timing for asking a question?

M1: Oh yeah, certainly during higher pressure situations you don't want to ask questions, you know, if there's active bleeding you don't want to ask what vein is that bleeding (laughter)? And you can tell when they're, you know if they're moving a little quicker and they're asking for the instruments quickly, don't bug them with a question.

Mod: There's something about reading the situation properly I guess, yeah.

Interpreting motivation. Many factors are mentioned as having an impact on motivation. Guidance or the instruction given by surgeons is most frequently mentioned as having an impact. The milieu, atmosphere and feeling of being validated as an authentic member of the team are next.

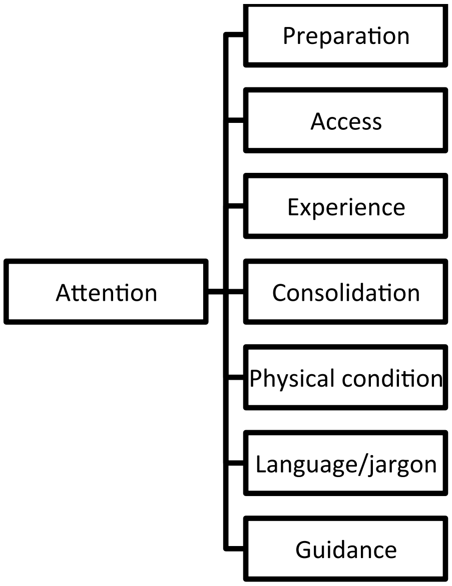
Several factors mentioned under this theme can be linked to the cognitive apprenticeship theory. The importance of feeling validated as a learner, of being given a useful role as part of the surgical team, is clearly outlined by Lave and Wenger in their description of apprenticeship (Lave & Wenger, 1991). The key role of the surgeon as "master" in the operative context is also found in other descriptions of apprenticeship. It is well recognized that as role model in this context, the 'master' surgeon transmits not only knowledge and technique but also culture. Being accepted by surgeons is critical for the trainee to feel welcome in the community of practice. In regards to the cognitive apprenticeship theory, many mentioned how important it is for senior team members to share thought processes and provide instructions to guide observation. The instructions could take the form of questions or simply pointing out certain aspects of the procedure but trainees mentioned how this keeps them focused and helps them identify important content.

Participants also mentioned needing to be motivated to learn from the procedure. They mentioned strategies that they can use to stay more engaged but there was consensus that there is a limit to what a resident can do on their own. The environment and how safe they feel as learners both play a critical role.

These findings can also be linked to the work of Petty and Wegener (1999) in which a model is developed to explain how various factors impact the way people process information. They explain that relevance of the content is one of many factors with an impact on motivation and the intensity with which new information is processed. Various sources of motivation have also been identified by Meyer (2000), sources that can be linked to comments made by the trainees. According to Meyer, the first, *accuracy* motivation, comes into play when residents intrinsically want to learn to improve their understanding of a procedure; this motivation can be increased with increased level of responsibility. It can be linked to the importance of the role as discussed by participants. Second, *defensive* motivation, describes how people try to retain their existing schema, being reluctant to change existing perceptions. This can explain why guidance from a trusted source is so critical to motivation. Trainees described lacking motivation when they were uncertain of the relevance of certain information. They would rather not learn than include wrong heuristics in their schema. This type of motivation also includes how people generally try to protect their self-perception. Trainees also mentioned the concept of a safe learning environment or milieu, and how they were not as motivated when they felt unsafe. They specifically described how they hesitate to ask questions that could improve their learning if they felt that the question would reveal their ignorance or lead to humiliation. The final concept within the same model is *impression* motivation. This motivation type deals with social interaction and how information processing can have an impact on relationship. Many factors mentioned by residents fall under this type, the importance of being validated as a learner, as well as the role of hierarchy and etiquette in learning. Generally, residents want to be accepted by the team and tend to act in a way that meets expectations. If their role as active learner is not made clear to them during a procedure, they tend to behave like an assistant only, trying to be useful and not asking questions, even when it would help their learning (Meyer, 2000).

2.2 Attention

This category groups all themes that describe strategies used by learners to decide which procedural element or new piece of information should be selected for inclusion in their schema. It is considered essential to efficient observation and residents described instances when they felt they could not learn because they did not know what they were supposed to learn or could not access key information. One hundred and eighty-four citations describe the role attention plays and the factors that increase or decrease its level. This category includes preparation, which has been further analyzed since it is an aspect that was targeted by the intervention. It also includes what happens after surgery to consolidate learning, the role of experience, the importance of having access to information, and the impact of physical condition and distraction on learning. It includes the role of guidance in selecting relevant information, a theme presented in the previous section (Figure 9).



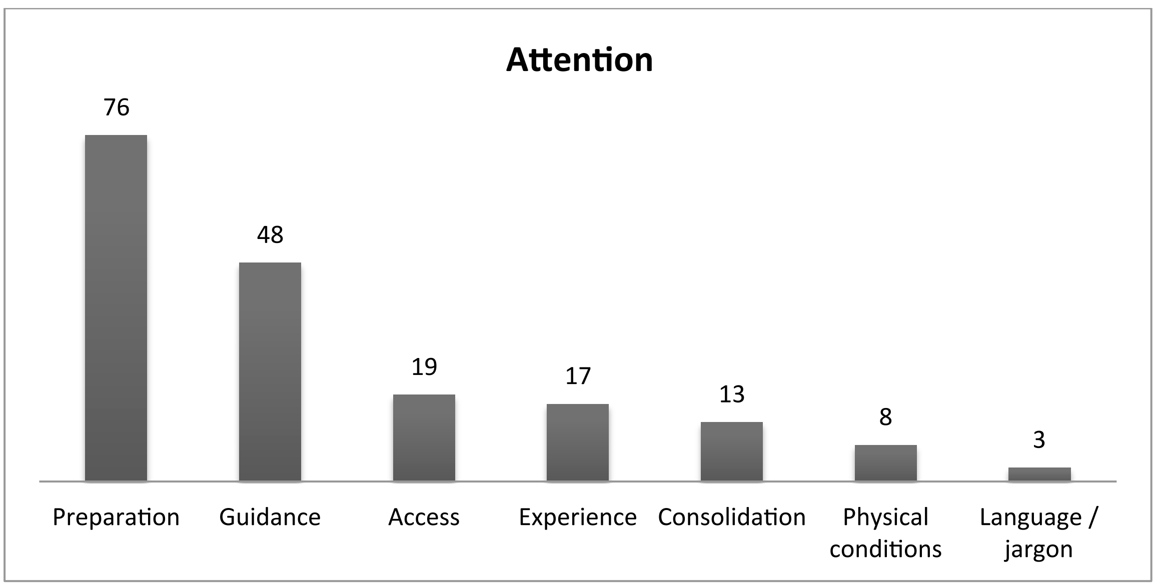
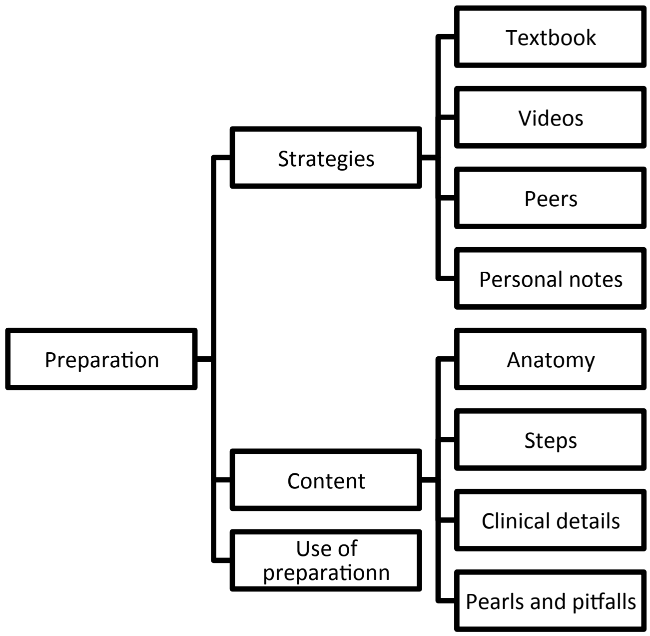


Figure 9. Attention (184 sense units)

2.2.1 Preparation (76/184). This theme covers the strategies used by residents to prepare for surgical observation. It includes the resources used and the content they are trying to learn (Figure 10). This theme was further analyzed because the intervention was aimed at improving preparation. It was felt that having a better understanding of what trainees were doing now to prepare for observation could help in the design of an intervention to optimize it.



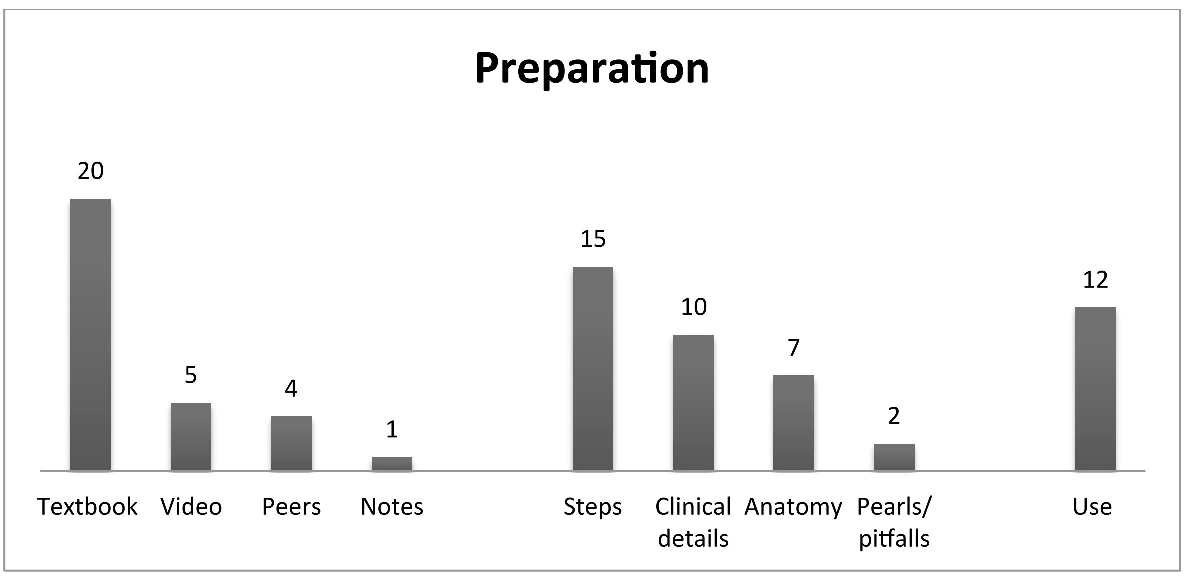


Figure 10. Elements of preparation (76 sense units)

2.2.1.1 Strategies (30/76). This theme includes the various strategies used by residents to prepare before observing a surgery. It includes individual strategies as well as interactions with colleagues. Most residents said that they used textbooks, general surgical textbooks, anatomy atlases or technical atlases to prepare for surgery. Residents also indicated the use of instructional videos. Participants of the focus groups mentioned episodes in which a more senior colleague helped them prepare for a surgery, either by reviewing the surgical plan or by providing information about a surgeon's particular preferences for a procedure. One participant mentioned using personal notes made during previous procedures to prepare.

Citation:

… like I remember as a junior resident seeing a procedure at, like a LIFT procedure I've never seen, I've never done. I couldn't read about it, it was not in my textbook, so I remember like just Googling a video and coming up with an approach step by step and building my anatomy on it.

2.2.1.2 Content (34/76). This code was used for sense units in which residents describe what they were trying to learn when they prepared for surgery. Seven sense units described residents looking for anatomy landmarks. Most also described learning about the specifics of the procedure or the broad steps of the surgery they were about to watch. Ten sense units describe the importance of knowing specifics about the patients having surgery. Useful information identified by participants included past medical history, past surgical history, surgical indication, and history of the present condition. Finally, residents mentioned that they were looking for more specific risks of complication or intraoperative strategies when preparing for surgery.

Citation:

M2: Well as mentioned before, ideally you review the anatomy, and you should be comfortable with knowing what you'll be doing from start to finish; what tissues they'll be going through, what you might run into, what things you have to be cautious of, that sort of thing.

2.2.1.3 Use of preparation (12/76). This was used to code the sense unit that mention the benefits of preparing for surgery. Generally, residents felt they learned more from observation if they were prepared, if they knew the patients and the surgery better. Preparation was felt to help them be more engaged in the surgery and was also helping them to formulate appropriate questions during or after the procedure.

Citation:

M1: Yeah it's like [Name 3] said, you're only going to get out of watching what you've, what you know to look for. Like if you're well prepared and you are aware of what's happening, you're going to learn. If you're woefully unprepared and you just show up in an Operating Room…

2.2.2 Access (19/184). This category includes sense units that describe the importance of being able to see the surgical field well and to hear conversation clearly between the surgeon and the assistant to benefit fully from the experience.

Citation:

F1: So sometimes if we're doing a big incision, a laparotomy and we have to look deep inside the belly, as the second or third assist you're often retracting backwards, so you're not actually looking in, you're pulling back. And then you have no idea what's going on in the surgical field because your role is to retract, so you don't know what your staffs are doing or what they're seeing, and you have no vantage point.

2.2.3 Level of experience (17/184). Residents mentioned that they were able to learn more from observing as they gained in experience. Actually performing the procedure was identified as an important factor, but general experience also had an impact. They felt that the previous experience helped them identify which areas to focus on more. It helped them understand what to learn next and what their objectives for a specific learning experience should be.

Citation:

M2: And it's interesting you bring up the ceiling effect because I find there is kind of a ceiling effect but there are different, but the ceiling is different as you go through your training. So like at any one observation or surgery perhaps you can only sort of observe or learn up to a certain point, you go back to practice, you know, you get some opinions about how you're handling things and you incorporate what you've learned. And then next time you observe your ceiling is different. So for sure, every, any single observation there is a ceiling effect, but that changes over time as well.

2.2.4 Consolidation (13/184). This theme contains categories related to what can be done after a surgery to gain as much as possible from the experience. Useful strategies as well as barriers are described. Strategies include dictating the case, debriefing with the attending physician, taking notes, asking questions and personal reflection. Barriers include mention of what is limiting the use of consolidating strategies. The most commonly mentioned factors are time pressures and other clinical obligations.

Citation:

F1: I was trying to get into the habit of like trying to remember… After a case sitting down and trying to remember the key steps and just making note of what the key steps were and the different materials that were used and stuff. I haven't been doing that as much lately, but. It's a good effort (laughs).
Mod: You've tried to at times, yeah?
F1: Yeah. And it's been really good actually, like it's helped me solidify things, but I don't necessarily always have the time to do it.
Mod: Why do you think that's helpful? I mean you said to solidify…
F1: I think it just helps because… It's all repetition, so like if you read about it before, you see it, and then you think back and then you review it again, then you kind of learn the procedure three different ways then, and so it just kind of helps stick it in your mind.

2.2.5 Physical conditions (8/184). Learning is an active process and the learner must pay attention. Certain physical conditions can affect a learner's ability to learn during observation. Sense units such as being hungry, tired, or sick, were grouped under this category.

Citation:

F3: Also, like I don't know, just pain, fatigue, headaches, you know, all the usual kind of stuff, a little distracting.

2.2.6 Language/ jargon (3/184). The intraoperative context has its own specific and specialized language. It must be learned as part of the residency. This poses limitations on what can be learned by junior trainees, who must first understand the language before they can possibly understand the content being transmitted.

Citation:

Or they're using a completely different lingo, right. So that's another huge factor is, you know, the vernacular, the lexicon of the different specialities… As a medical student you don't have an appreciation for all the words that they're using, right, even as a junior sometimes you go onto a new service and you don't know what that special stapler is called or what that special this, that and the other thing is. And so you're lost sometimes in the jargon, the medical jargon specific to that OR, for example.

Interpretation attention. According to the elaboration likelihood model (Chaiken & Stangor, 1987) attention is key to information processing. As a result, factors that allow trainees to focus their attention on relevant information are likely to have an impact on the amount of learning that occurs during a given learning activity.

Four different theoretical models support the use of instruction to guide attention and optimize learning. Studies on observational learning have shown that instructions given before the demonstration renders the activity more efficient (Jenstch et al., 2001). Mayers (2004) explains how learning is more efficient if it happens within a context of guided discovery. Similarly, Collins (1991), in his description of cognitive apprenticeship, describes how explaining one's thought process is key to efficient learning. The role of instructions and previous experience is also described in the cognitive load theory (Sweller, 2003). It is not surprising that guidance, preparation and consolidation, mechanisms used as a surrogate to instructions, were factors most frequently mentioned as having impact on attention (137/184).

Instructions can take many forms. The most obvious is guidance from senior team members, the ideal form of instruction from the residents' point of view. However, if instruction is considered in a broader sense of available resources to help in selecting what relevant information to pay attention to, then preparation and consolidation have similar roles. During preparation, reviewing different sources of information, residents are finding key elements for each procedure; they define their own objectives then create an initial schema. After surgery, when reviewing what occurred, learners can also select relevant information to include in their schema.

As seen in previous studies, more experienced learners can learn more from observing than novices (Jenstch et al., 2001). Also, experienced learners don't need as much guidance to identify key elements in a situation. Participants in the focus groups described this effect of experience as presented in studies on observational learning and example-based learning (Jenstch et al., 2001; Kirschner, 2002). They explained the impact of repeating the same procedure, as well as the impact experience has on their training progress over the years. This phenomenon is also described by Swellers in his work on cognitive load and schema creation. The premise is that working memory is limited and learners need to be guided so they know what they should pay attention to and what is important to integrate into their schema. Experience and previously acquired knowledge can replace instructions (Ahn, Brewer, & Mooney, 1992). Too many instructions can impede learning in those with more experience because their working memory is used to understand unnecessary instructions instead of to process new information (Sweller, 2003). Existing schema act as instruction, helping learners select information that is relevant to improved understanding.

By putting the findings from this section in a cognitive apprenticeship perspective, trainees highlight the key role guidance plays given in an example of *modelling,* as described by Collins (2006). It explains how this phase of apprenticeship is made more efficient if the master makes the mental processes involved in decision-making explicit and accessible to the learner. However, trainees also described the operating context as a complex environment with multiple priorities. Lave and Wenger (1991) described the limitations of apprenticeship in this context of multiple priorities and time pressure. Many participants mentioned that they understand that surgeons are not always explaining their every move and that the ultimate priority of the operating room team is to provide patients with good care. This was described by Moulton et al. (2010) when discussing the multiple tasks faced by teaching surgeons when operating.

Strategies described in the consolidation theme, dictations, personal notes, discussion with the surgeons, are examples of *articulation* (Collins, 2006), which is described in the cognitive apprenticeship theory as a strategy that allows the learner to validate content learned previously and to promote reflexion. It should allow the learner to compare the heuristics they use with those used by the expert. It is the final step before including new information in the mental model, validating it as relevant. In the context of intra-operative learning, pressure from the clinical environment seems to limit the use of this strategy.

When described by Petty and Wegener (1999), the concept of *attention* also includes the idea of being able to process information. Using this concept, themes of physical condition and access were included in the attention section. Trainees must be able to see critical elements in order to integrate them; they also have to understand the content of the conversations between different team members. This understanding can be limited by the use of technical terms. Finally, they must be physically able to process new information.

Interpretation of question 2: What factors make surgical observation an efficient or inefficient learning experience?

The aim of this question was to identify factors that could potentially be impacted by an intervention to improve surgical observation as a learning activity and to explore the link between residents' experience and theoretical models previously used to describe learning.

Participants identified many factors that can have an impact on learning during observation; the most frequently mentioned were guidance, preparation and milieu. The first two refer to a need on the part of the resident to have specific goals when they observe surgery, to have a good understanding of where to focus their mental energy and what could be a learning objective for the procedure. The prevalence of the milieu theme underscores its importance in residents' learning, how vital it is for them to feel validated as team members.

Factors described by participants can be interpreted using theories and models from the theoretical framework. Some are closely related to cognitive apprenticeship, others to the cognitive load theory and still others as part of the elaboration likelihood model (Collins et al., 1991; Farmer et al., 1992; Petty et al., 1987; Sweller, 2003).

When considering the cognitive apprenticeship theory, participants describe the importance of an environment that is conductive to learning. The milieu, which includes all stakeholders in the operating room, as well as logistical constraints, must encourage junior residents in their role as learners. Surgical team members must make room for junior learners. As expected, the role of senior team members was considered critical. They seem to have several roles: to validate and welcome trainees, and to keep them motivated during the procedure and include them in conversations or by asking questions. Finally, and maybe most importantly, they seem to hold the keys to learning since they must show their thought processes in order for the junior learner to access it. This key role is well described by Farmer et al (1992) and Moulton et al (2010). The surgeon's ability to share these thought processes with the observing junior resident is challenged by a variety of factors. Surgeons tend to pay more attention to the senior learner; more interactions occur between attending and first assistants than between any other members of the team (Scallon et al., 1992). The attending assistant is responsible for most learning interaction and the first assistant the closest person in the room, both from a physical point of view as well as the point of view of expertise. Interactions between people of similar expertise are likely to be easier (Lyon, 2004). A surgeon's thought process is often automated, which makes it difficult to explain (Crandall et al., 2006). Additionally, their priority, more than teaching, is to perform surgery in a safe and timely manner (Moulton et al., 2010). Guidance is critical to learning but with current operating room constraints frequently limiting it, it would be beneficial to supplement guidance with an intervention to optimize observational learning.

Other factors related to cognitive load theory were also described as having an impact on the intervention. First, learners described how difficult it is to understand unfamiliar procedures; they were seeking structure on which to anchor their learning. Many described how preparation before surgery, using textbooks or video, could help provide structure. This structure is similar to an initial schema, a framework to guide observation. Swellers (2003) described how existing schema are used to filter new information, referring to it as the "central executive" function. "A Schema, acting as a central executive, coordinates information. It indicates which information can be ignored, which is significant, and how elements of significant information relate to one another" (Swellers, 2003 p. 227). In this context, the role of experience is easier to understand. Previous experience leads to richer schema, which act as a better central executive, making learning more efficient. The consolidation described by the learner also helps to encode new information, a process of articulation and reflection described as leading to improved learning (Kirschner, 2002). An intervention aimed at improving learning will have results limited by the constraints of cognitive load and by the various levels of trainee expertise. It would likely prove challenging to provide trainees at various levels of their educational development with instructions that would be similarly helpful to them all. One might anticipate a variable response, were similar instructions provided.

Finally, when considering the elaboration likelihood model, certain factors will have an impact on learners' ability and motivation to process information. Their role in the procedure, level of involvement and responsibility in relation to the situation will promote deeper processing of information. They also need to be placed in conditions that are conducive to learning, where access to pertinent information is possible. Logistical considerations such as the ability to see or hear useful elements, understand the technical jargon, and physical condition will have an impact on the learning that is possible in any given procedure (Petty & Wegener, 1999). An intervention is unlikely to be efficient without sufficient motivation and ability on the part of the learner to pay attention.

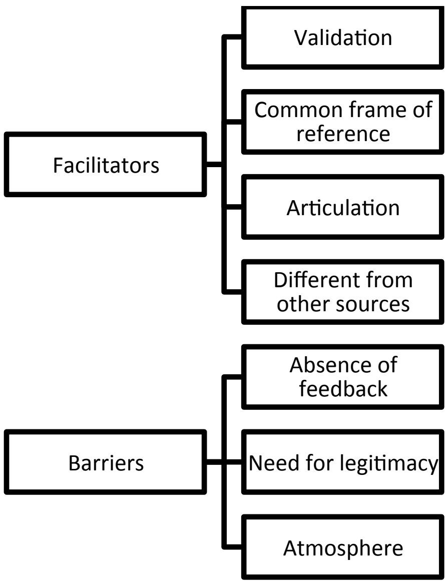
3. What factors can promote or compromise the use of instructions during surgical observation?

This last question was designed to assess the usability of instructions to support surgical observation. This thesis was not designed to directly assess the impact of instructions on learning. However, while answering this question, learners' perceptions of the use of instructions and their potential facilitators and barriers were uncovered. The information gleaned in the second round of focus group could inform improvement. Also, residents identified specific aspects of the learning experience that were augmented by the intervention, specifics that should be included in an eventual evaluation tool.

To answer the research question, it was assumed that factors that facilitate use of the intervention and those elements identified as improving the learning experience would promote the use of instructions. On the other hand, elements identified as difficult to deal with, not improved by the intervention, or requiring extra work, were classified as barriers to the use of instruction. Using the structure from previous sections and described in the theoretical framework, factors will be grouped together based on their relationship to three theories: cognitive apprenticeship, cognitive load theory and the elaboration likelihood model.

3.1 Factors related to cognitive apprenticeship

Knowing that surgery is being taught in an apprenticeship framework, it is interesting to look at potential promoters and barriers to the use of the intervention, from a social learning and cognitive apprenticeship perspective. Factors linked to the impact on the community of practice and the role of instruction as a medium to support articulation and scaffolding (two known steps in the cognitive apprenticeship framework), were grouped under this theme (Figure 11).



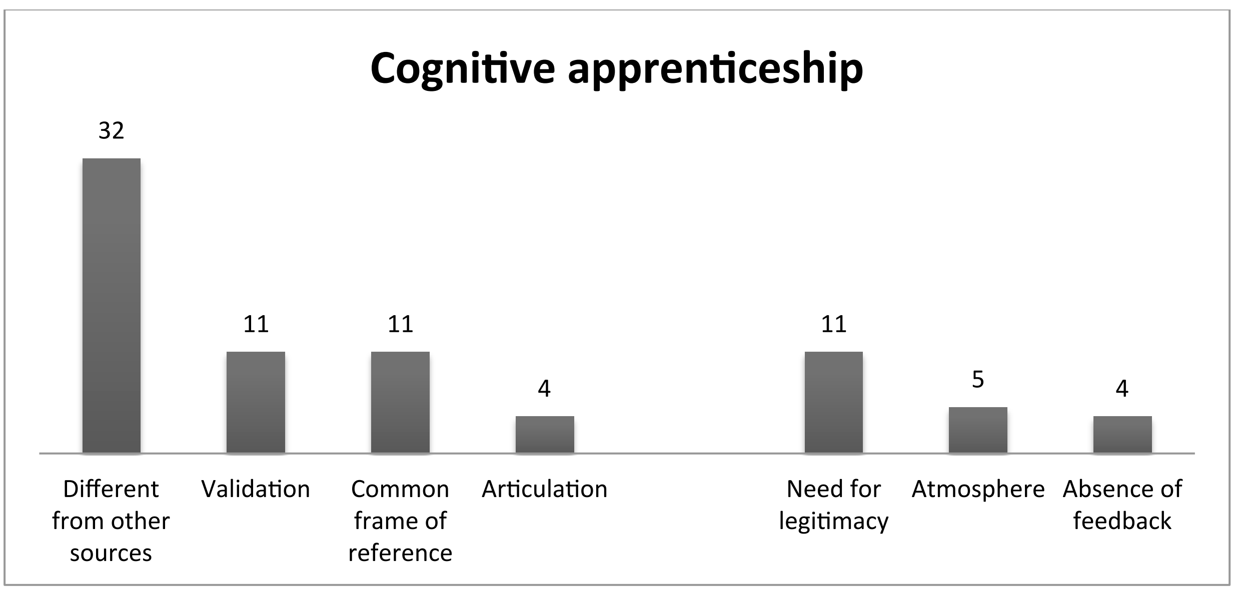


Figure 11. Factors related to cognitive apprenticeship (58 sense units)

3.1.1 Facilitators

3.1.1.1 Validation (11/58.) This theme was used when learners described how the instructions validated observation as a valuable learning activity. Some described it as eye-opening when they discovered how much information could be gained through observation. They described a change in their approach with some saying it had a lasting impact.

Citation:

F1: Well that I could learn from just observing. Like I literally thought I was the retractor but now I feel like there's so much anatomy to be learned just by watching and keeping in mind the differences that you see. Whereas before I did this I just thought I was there for the sake of someone else knowing that I'm there and that made me a good resident. But this makes me realize that I need to be a good surgeon.
M1: But, you know, sometimes you're told, "All right, you're going to be retracting." And that's what you're told. You're told that your job here is to retract.
F1: Yeah.
M1: And so that's what you put in your mind. You're like, "Okay. I'm going to retract today." And by the end of the day you're like, "Oh I retracted really well."
F1: "I didn't move. I didn't move. I didn't even need to pee."
M1: But yeah, no, this was just a good reminder that even if you're retracting you can learn too

3.1.1.2 Common frame of reference (11/58). This theme groups elements that describe the instructions as an instrument for promoting discussion. This resulted from the proper formulation of questions in the intervention that used appropriate wording for the topic. Some said they were able to use this as an anchor for conversation. They felt more comfortable asking the questions because they felt they had been selected for relevancy. They also felt that the technical points highlighted were important enough to justify asking questions about them.

Citation:

Mod: What do you think it could do? Like how could it be helpful to streamline it? What do you think the steps might be or what…?
F2: Like just in summary all the things we've been saying. Like it would highlight the important technical points, it would make you think about active observation throughout and it would help you question the finer parts of the surgery that might not be intuitive or in a textbook and then you could ask the surgeon at the same time. So if they did it for multiple surgeries, especially at lower levels, observational learning in [Location 1] would be a lot better.

3.1.1.3 Articulation (4/58). The intervention asked trainees to write down answers to open-ended questions. This activity is an example of articulation as described in the cognitive apprenticeship theory. Trainees seemed to appreciate it as a way of consolidating their learning.

Citation:

M1: Yeah like the way that's… It's not… It's often not a… Like I said earlier like it's one of the strengths to not be too, too specific because then it really gives you some room to organize your own thoughts and then really force you to structure it. Just structure your answers and come up with the answers. And it's often… I like how the questions are not too closed so that, you know, it's a yes or no answer or there's a one right answer kind of thing. It's yes, yeah definitely you've got some freedom to structure your own answers and that's strength for sure.

3.1.1.4 Different from other sources (32/58). Many trainees found the intervention interesting because it introduced elements not covered in other sources of learning. They said that the content of the questions was different and oriented more to decision-making, safety issues and subtleties not explicitly found during surgery. Some questions dealt with anatomy landmarks and choice of instrument.

Citation:

M2: I like it that it actually, not only is it asking questions, but it's specific to a technique that is… Like that we should be familiar with. So it actually identifies an area that's very important. For example, B1 says, "How are the adhesions between a gallbladder and the duodenum taken?" and that's like… That's something that you don't often hear, talk about all the time in the OR and it's very good that it points that out for you.
Mod: Okay.
M2: Yeah, it just makes me realize that that's an area of focus.

3.1.2 Barriers

3.1.2.1 Absence of feedback (4/20). Participants in one focus group mentioned wanting to have the answers or at least an idea of the answers. They would have liked to compare what happened during the surgery with expert opinions on how to approach the procedure. No feedback was included in the intervention; it was suggested that learners could discuss their answers with senior members of the team but they did not do so on a regular basis.

Citation:

M1: Like how many clips were used? Some people use three, some people use five, some people use none. There's different surgeons that do things differently and if you're observing… Like if I was to do this twice and they happen to get the same surgeon both times and how many clips were to be used. And I then went and did it based on what I had seen thinking that what I'd seen was right, I might find out later that's actually wrong. So I think there's a role to have the correct answers taught.
Mod: Okay. Are you… What you guys seem to be almost saying is that it would be useful to have a range of different surgeons, experienced surgeons answer these questions and they'll always be available for you to view at some point.
F1: Yes. Mod: Yeah. Not necessarily the first time you use it but…
F1: No. Or like the… Or like just a consensus of like the experts who created these questions but not like… I can think of like different surgeons answering it differently.

Mod: Yes.
F1: And some may be wrong because that's not the procedure they do every day in their practice and, or some may overlook some stuff because they're so used to doing the procedure that like in their head they know they're safe but like by this are they really teaching us how to be safe? I don't know.
Mod: Interesting. Any thoughts on anything that could be improved?
M2: Just the answers. (Laughs)

3.1.2.2 Need for legitimacy (11/20). Many learners mentioned that the intervention would have to be made mandatory by the program for them to use it on a regular basis outside of a research project. Citations discussing the importance of having an initiative like this supported by the program were grouped under this theme, as well as remarks that the whole team would have to be involved in the process for an intervention like this to be effective.

Citation:

M1: I thought it was very helpful. I think that, you know, just… it is another one of those things where it's kind of like additional paperwork but this certainly serves a function and it would just be a matter of kind of changing the… kind of getting everyone on board and saying, oh, I'd like just five minutes… five to 15 minutes to do this after the surgery. Do you mind if I just step out for a minute or whatever? Not during the surgery, but let's say, afterwards. If you're supposed to dictate or do something on the ward, if it was kind of, you know, this is a tool that we all use. They would say, oh, yeah. The junior is going to step out for a couple of minutes and then take care of this and then they'll help us on the ward or come to the next surgery, whatever. I think that would make it a lot easier.

3.1.2.3 Atmosphere (5/20). It was mentioned that this intervention was not enough to transform the operating room into a more positive learning environment when the atmosphere was tense. In the first focus groups, the milieu was seen as an important factor. In the focus groups that followed the intervention, residents mentioned the role of the milieu but indicated that the intervention altered nothing.

Citation:

I don't know whether you had any experiences like that after having read any of the questions but could you see that maybe having something like this to focus on could allow you to get more out of a situation where perhaps the environment was negative or…?
F1: I'm going to have to say no to that one. Yeah. I don't think so. If it's stressful, it's stressful, you're not thinking about these questions, you're focused on the patient.
Mod: Right.
F1: Yeah.
M1: Yeah, I'd agree with her.

Interpretation factors related to cognitive apprenticeship. In the context of an apprenticeship, the milieu in which learning takes place is critical. As described by Lave & Wenger (1991), apprentices need to feel validated and legitimized in their roles as learners and the community of practice needs to support them. It is interesting that the intervention, though it changed the perception of some learners regarding observation, had limited impact on the milieu globally. The goal of this study was to examine the role of instructions in the context of surgical observation for junior learners. No other intervention was used to promote junior trainees' learning outside of those instructions; staff surgeons and senior residents were neither contacted nor involved in the initiative. It is not surprising that the general attitude of the team did not change but participants from the focus groups emphasized the importance of considering the global context when implementing an educational initiative. To make this intervention more effective, it would have to get buy-in from all stakeholders, including the learners themselves, staff surgeons and program administrators.

Some learners used the questions in the intervention to initiate conversation, appreciating the technical terms used. It was a goal of the intervention to get learners to engage more and ask more questions, to make them feel part of the team and validate their role as legitimate learners. Since the questions were based on cues used by experts to inform their decision-making process, they allowed junior learners an entry into the staff surgeon's mental process, helping them understand their concerns. The questions in the intervention also forced the leaners to articulate their thought processes. This is useful when acquiring cognitive skills as it gives learners an opportunity to share ideas. Articulation is an integral part of the cognitive apprenticeship model, one focus group participants appreciated (Lajoie, 2009). However, the absence of feedback in the intervention can be seen as an absence of scaffolding. In cognitive apprenticeship, experts supervise learners as they verbalize their newly acquired concepts, to ensure that rules and heuristics developed during the activity are appropriate, and correcting the learners as needed. The intervention did not foster scaffolding in this sense, and it would potentially limit its benefits as learners would likely not get optimal learning without a form of feedback (Farmer et al., 1992). Again, this study was looking at the role of instructions in observational learning. The potential role and optimal format for feedback would be something to consider at a later stage.

3. 2 Factors related to cognitive load theory

Cognitive load theory explains how appropriate instructions can decrease extraneous cognitive load and help learners focus on relevant elements (Moreno, 2006). Participants described many factors influencing their learning with the use of the intervention. Factors that helped in understanding procedures were grouped under promoters and aspects limiting learning were grouped under barriers.

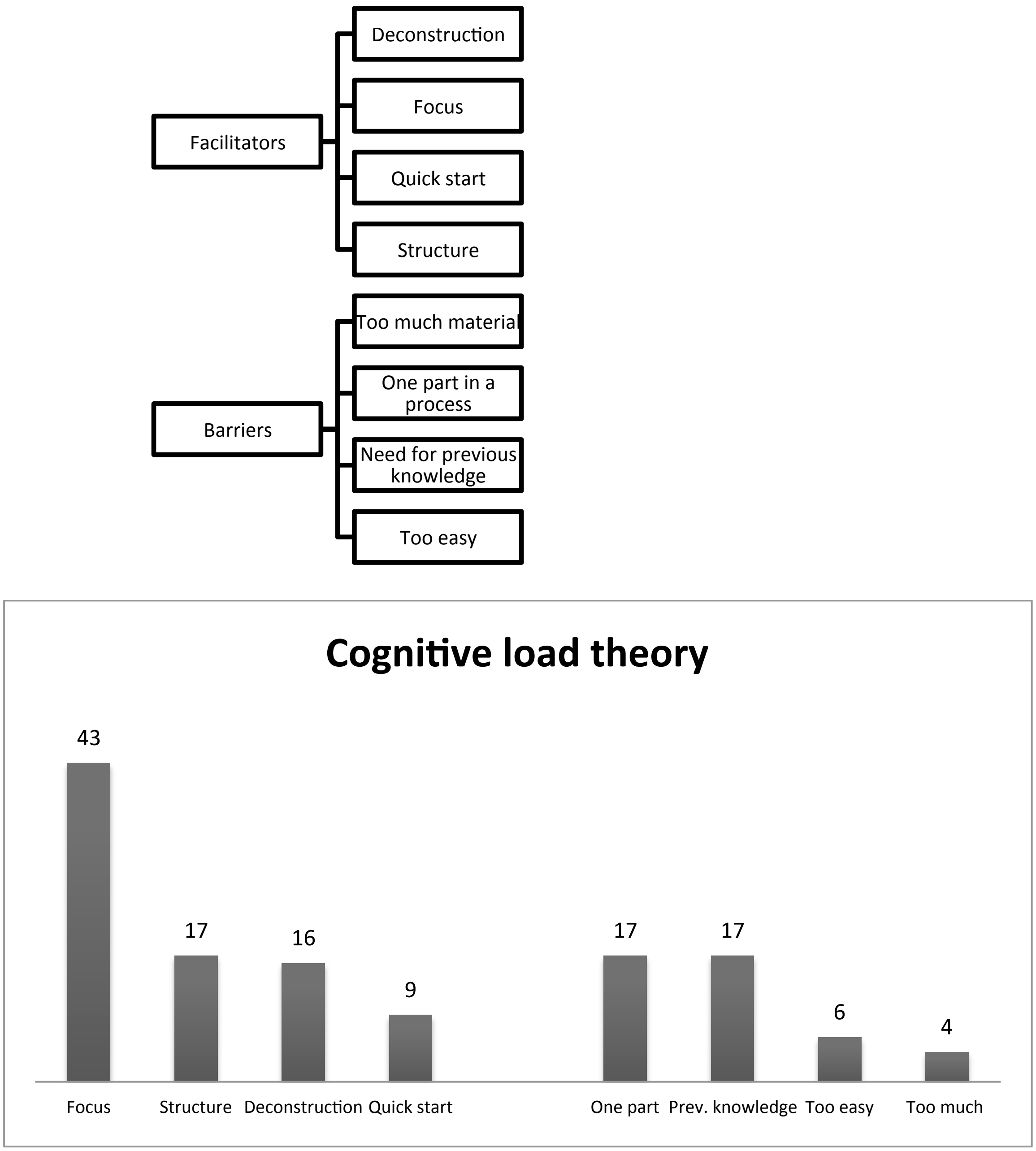


Figure 12: Factors related to cognitive load theory (85 sense units)

3.2.1 Facilitators

3.2.1.1 Deconstruction (16/85). This theme was used when participants mentioned an appreciation for the breakdown of certain aspects of the procedure in the intervention. They commented that the deconstruction made them look at the surgery another way, reconsidering previous concepts and occasionally reinforcing knowledge.

Citation:

M2: I think, looking at the questions, really like how-to de-construct some steps that I had kind of grown very used to and perhaps was overlooking some aspects because I've seen them over and over again. But the question sometimes breaks down the technique and separation was really done well and helped me re-focus a little bit and, as I said, de-construction was very helpful.
Mod: So sort of to help you get to almost to a deeper level of understanding.
M2: Yeah.
Mod: Yeah. Okay.
F1: Some stuff you knew that you're like, "I don't really know."

3.2.1.2 Focus (43/85). This theme was used when residents described the effect of the intervention as causing them to look at specific aspects, or focusing attention on a certain procedure. This was often described very positively. Many in the initial focus groups had mentioned feeling lost when watching surgery, unsure of what it was they should be learning.

Citation:

F1: I think so. I think they can help you focus on some steps when first, if you don't know the procedure at all or you're not prepared enough, then they give you at least, now instead of concentrating on the whole thing they give you like five things to look at.
Mod: Okay.
F1: Second, if you know the… You've seen too many of the procedures and you're kind of bored with the procedure; they give you something to review and focus more on. So I think they were good.

3.2.1.3 Quick start (9/85). Participants mentioned that this intervention would likely make it easier for junior learners to start operating. The intervention helped junior residents understand what they should be doing when they perform surgery. They thought that it would help them to become better operators more quickly.

Citation:

F1: I think you get better faster.
Mod: You get better faster.
M2: As a junior, yes.
F1: As a junior, yeah, you'd learn your stuff faster.

M1: I think that's the key. It brings you up to speed when you're actually doing the procedure. I don't think… I mean we said this in the orientation. I don't know if it says anything to actually improve your tissue handling, more your understanding of what you're supposed to be doing.
Mod: Yes.
M2: Yeah, exactly, totally. I think the perception would definitely improve. But yeah, the tissue handling part, like it won't train your hands, it will train your mind.

3.2.1.4 Structure (17/85). The intervention was occasionally described as providing a structure or framework to help learning. Since questions included in the intervention covered many aspects of the surgery; participants felt it provided structure to guide observation.

Citation:

M1: Yeah, as I kind of alluded to earlier, when I looked at the questions I try to formulate the answers beforehand and it definitely helps in, you know, to have a structure kind of going into the OR and seeing what was done and whether your answers were right or wrong or why it wasn't done in a way that you thought it was going to be done. In that regard it definitely helped.

3.2.2 Barriers

3.2.2.1 Too much material (4/44). Some residents explained that there were too many questions in each bundle used for the intervention, providing too many aspects on which to focus. Some questions were considered too broad, having too many possible answers.

Citation:

Mod: Yeah. Any suggestions to improve the questions?
F1: Less.
Mod: Yeah. Okay. We've got that one. So yeah, having three of them. And I think you suggested three different types as well.
M1: And just more directed.
F1: Sometimes a bit shorter too because like even though there's five, there's really like 12.
F2: Three questions within one.
F1: Do you know what I mean? Yeah.
Mod: And that's because it was just hard to focus, to retain it all and focus on it? Is that…?
F1: Well I just think it's a lot. Do you know like there's like three in one question so it's a lot. Your answer is a paragraph.
Mod: Okay.
F1: And I think it's a lot to focus on.

3.2.2.2 One part in a process (17/44). Many residents mentioned that this intervention was only one piece in a complex learning process. They explained that it was possible to get a better understanding of the procedure through the use of the tool, as long as it was part of a larger process. The learners would have to use textbooks to understand questions that were beyond their level and put questions to the surgeons to maximize any possible gain.

Citation:

F1: I don't know. Like I think they're… They make you an overall better surgeon. I think they would get you more to your goal but would like reading and looking at like how to be safe around a duodenum be enough compared to like having seen some and talked to surgeons about it like, some were difficult, some were not, some were handled in a way they shouldn't have maybe or like I think that made me more aware and that made me more careful around a duodenum like I don't know if… Well that question by itself would not be enough for sure.
Mod: No. Okay.

3.2.2.3 Need for previous knowledge (17/44). Many discussed the ideal timing of an intervention such as this one. There was general consensus that previous knowledge was necessary, and that a learner would have to have basic understanding of the procedure to be able to gain from the intervention. Inadequate knowledge could be addressed by referring to textbooks.

Citation:

M1: Yeah I think further the steps might… They're especially good for the people that already have seen the procedure. I think if I was going to see my very first ever Lap Chole, they wouldn't be helpful because there's… It jumps around enough that you wouldn't… You could easily get lost. Like if you just read these questions and said, "Okay. I need to go in and try to answer them based on what I'm seeing." Like if I didn't know that they were dissecting out the CBD because… Or the cystic duct and the CBD like when it says, "Where was the distal clip closest to the CBD on the cystic duct place in relation to Rouviere's sulcus," which is C3. I think if I didn't know enough to know what they were doing at each stage in the operation and I was sitting in the back just trying to figure out the answers, it would be not as helpful.

3.2.2.4 Too easy (6/44). A few participants felt that some questions covered aspects of the procedure that were already understood and that answering them would be a waste of time.

Citation:

I don't know, just very junior because you just intuitively know what you're doing and where the grasper is placed. It just seems like kind of a waste of your time. But for someone who's maybe never done surgery before and is just observing or just trying to first assist, I think that would really tune them in because it's easy to just watch and kind of be in oblivion until you're actually thrown to the dogs and you have to do it yourself, then you learn real fast.

Interpretation factors related to cognitive load theory: Cognitive load theory provides a framework to help design instructions that maximize learning. Basically, the intervention is instructions with which to guide observation; it is useful to look at its potential benefits and limits from a cognitive load theory point of view.

First, this theory suggests that working memory has limited capacity and that learning is maximized when working memory is used only to manage relevant information (S. P. Marshall, 1995a). The goal of the instructions given to participants was to point out key aspects of the surgery. It apparently worked; many mentioned that it had helped them to focus. This was an improvement as many in the initial focus group perceived the lack of guidance as limiting observation.

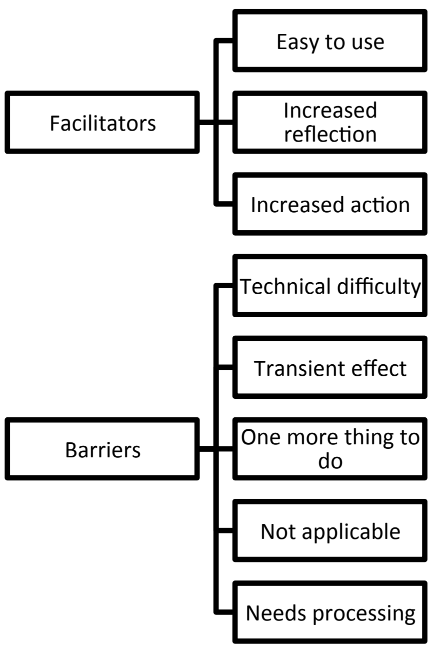
Because many variables must be considered at any given moment during a procedure, surgery is a highly interactive activity (Sweller, 2003). Because the questions covered only certain aspects of the surgery, it reduced the interactivity between elements. Learning various elements independently before putting them into context helps in learning (Moreno, 2006). When learners described how the intervention helped their learning, by breaking down or deconstructing the surgery, they were describing a process of decreasing interactivity, focusing attention on very specific elements before including them in a more complex schema.

This theory also recognizes that learning becomes easier through previously acquired schema (Sweller, 2003). Participants referred to this idea when explaining that the initial structure or schema provided by the instructions made their learning easier. It is also possible to link this concept with the idea that the use of such an intervention to develop cognitive understanding among junior learners could lead to faster acquisition of technical skills. However, it was also felt that initial knowledge of basic anatomy and broad steps were necessary to be able to use the instructions appropriately. There was general consensus that this intervention could help with one part of the complex schema acquisition process necessary to be able to safely perform a procedure but that it would not replace motor skills practice. Though designed to improve cognitive understanding of surgery, it was predictable that intervention would not be sufficient to develop total surgical expertise.

Another aspect of this theory is the uniqueness of each learner's schema (Moreno, 2006). This makes predicting instructional outcomes difficult. The intervention was the same for all residents. However some perceived it as too easy, while others felt it forced them to focus on too many procedural aspects. Designing instructions for multiple learners can be challenging as too many details can lead to redundancy effect and inadequate guidance can impair learning. If this intervention were to be implemented on a larger scale, it would be useful to plan on increasing the complexity of the questions to reflect learners' progress.

3.3 Factors related to the elaboration likelihood model

For this type of intervention to be effective in residents' learning, an information processing step must occur. Cognitive load theorists describe cognitive activity as necessary to the integration of relevant information, the *germane load,* as it is known. It is just as important in the learning process as the actual content that instructions try to impart (Moreno, 2006). The elaboration likelihood model describes a series of factors that determine how information is processed. Looking at the different elements mentioned by the residents it was possible to identify factors that would influence their level of information processing using the intervention (Petty & Wegener, 1999)



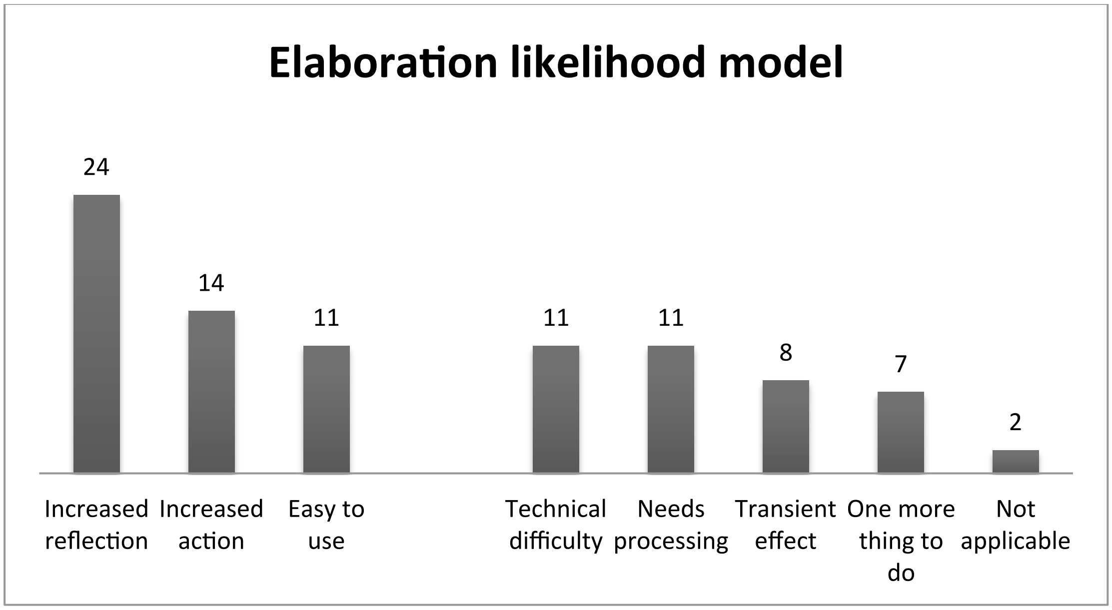


Figure 13. Factors related to the elaboration likelihood model (49 sense units)

3.3.1 Facilitators

3.3.1.1 Easy to use (11/49). Participants described how easy the intervention was to use. They generally liked the format and the fact it was accessible on their program's website and on their mobile devices.

Citation:

M1: It's very straightforward.
Mod: It's straightforward.
F1: Yeah. That it was on the iPad. I liked that, that you could do it on the iPad.
Mod: You liked it on the iPad?
F1: Yeah.

3.3.1.2 Increased reflection (24/49). Some participants described how the intervention increased the amount of reflection they put in to observation. This includes their motivation to process information while they were observing, but also before and after the procedure when they were reviewing the questions. This was generally seen as having positive impact on learning.

Citation

F1: I liked the one that made you review your anatomy but like very detailed. Like the one on Calot's node, I think it's F3 like what's in relation to the artery. Like this is not something like we discussed every day. So I like these questions that make you think about things more.

3.3.1.3 Increased action (14/49). The theme covers instances when participants described how the intervention made them do more to learn from observation. Some said that the intervention had made them research material and ask more questions. They said they were more engaged in their learning process.

Citation

M1: I usually brought it up before or after the surgery. And I actually found, even at my level, so we often get… I don't know there's a learning curve to everything and if your learning curve kind of flattens out after a while, you kind of need that extra kick in the right direction. And I found this was something like that where it allowed me to sort of get to a peak in a learning curve again where I was able to notice things that I hadn't noticed before, ask questions that I hadn't asked before.

3.3.2 Barriers

3.3.2.1 Technical difficulty (11/28). This theme covers the technical aspects that made use of the intervention challenging. It includes not understanding how to use the intervention, problems with passwords, and difficulty logging on to the website.

Citation:

M2: Not really. No specific questions. Just sometimes at the beginning that I wasn't sure that after I was finished a set of questions and suddenly I wasn't sure if it would take me to another set because it didn't show up exactly what it showed after that and I… To enter another patient I had to like re-log in again to be able to get another set of questions. So if I was doing more than one case I had to log in again to each one.
Mod: Okay. So a little bit…

3.3.2.2 Transient effect (8/28). When asked if the intervention had any lasting effect on the way they observed surgery, most participants said that the effect was transient. They did not transfer their change in attitude to other procedures.

Citation:

Mod: Can you say, though, how… this might be very hard to answer, but just can you get at what about it was… helped you to be more engaged?
M1: So I think that as a part of the process, it made me sort of actively think about what was going on and then actively reflective and think back what had happened and then the questions prompt some learning and some through process as well, right? So it gets you to kind of… rather than, you know, us memorizing things, it kind of gets us to engage, answer questions and kind of challenge what we know and I think that challenging process helps the learning process as well. So I think certainly, again, in that transient phase it was very helpful and I could tell that I was more active in the process, but then after that, it just went back to normal sort of however I kind of go through surgeries I guess.

3.3.2.3 One more thing to do (7/28). Among the factors many residents mentioned that would limit their use of the intervention outside of the research project was the fact that it was simply one more thing to do in a busy day. Comments referring to their schedules or the time it took to complete the intervention and logistical barriers to its use were grouped under this theme.

Citation:

F2: It was just one more thing to think about in the course of the day.
Mod: Right. Was it like an onerous thing to think about or…?
F1: I think you just sometimes… most of the time I forgot. I only did it once. I'm not going to lie.

3.3.2.4 Not applicable (2/28). Some residents felt that the content covered in the questions were not applicable to certain cases and that it would limit their use of the intervention.

Citation:

Mod: Okay.
F1: I think they were easy to understand but some of them didn't apply often. And there was a bunch of questions often in one question.
Mod: Right.
F1: A bunch of sentences in one question so I think that for usefulness as a true teaching tool, I think would be easy for the student to skip over if there's like four different question marks in the same question, they can kind of skip over one and just answer the ones that they want. Do you know what I mean? Instead of being like very, very direct, like this is the one question you can answer. Like there was a few that I didn't know and I would just kind of be like, "I'm just going to ignore that one and answer the other ones in the same question," so.

3.3.2.5 Needs processing (11/28). There was general agreement that the intervention was useful as long as it was used as a tool to improve learning. Participants in every focus group mentioned that the intervention on its own was not enough to improve the learning experience and that benefit was in direct proportion to the amount of work invested. Comments referring to the necessity to work with the tool were grouped under this theme.

Citation:

F2: So yes I would say that it did that if I used the tool properly which is like basically similar to reading before the case. Like you use these questions as a way to think through it while you're watching, right? And sometimes the tool could be used as if you just… You answer them really quickly but then you just fill them in after, right? So there's a difference between reading, thinking during and then filling them out after as compared to just reading them after. Like you still gain something from that but you don't gain the same thing.
Mod: Yeah. Yeah. So it's how you use the tool in a sense, makes a difference to what you get out of it is what you're saying?
F2: Yeah.

Interpretation factors related to the elaboration likelihood model. The elaboration likelihood model describes what factors influence how people process information. It also explains that a higher level of processing leads to a more durable change in schema.

Factors that promote higher processing of information include message repetition (Petty & Cacioppo, 1986). In the context of this intervention, the usability of the instructions plays a role in how often it could realistically be used. It was therefore important to create instructions that were easy to use and in a format that could quickly be understood by the user. This factor was highlighted by focus groups participants. If this intervention were to be implemented on a larger scale this would have to be taken into account.

The ability to process information has been linked to the capacity of attention in the elaboration likelihood model (Petty & Wegener, 1999). When trainees describe to this intervention as just one more task, they are describing a context replete with distractors, in this case clinical duties or other educational demands, which limits optimal processing of information contained in surgical observation. Many studies identify distractors as barriers to information processing (Petty & Cacioppo, 1986).

Motivation is included in the model as being key to information processing. It is understood that different factors can affect how motivated someone is to process information. The model includes the notion that higher levels of motivation should translate into more profound processing of the intervention. Higher motivation has been associated with better performance in medical school (R. A. Kusurkar et al., 2011). The intervention appears to have increased motivation, at least partially, since many participants described increased reflection and action when using it, and deeper information processing (Petty et al., 1987). However, participants also mentioned limits to their motivation to process information. They explained the transient effect of the tool and how they reverted to old habits following the research project. Active learning is a demanding activity requiring constant motivation. Participants also mentioned that the intervention alone was insufficient to produce learning, that it was more a support tool and that its benefits would be proportional to the amount of work invested. As such, it was similar to other sources of learning. The intervention does not supplant the need to process information. Rather it supports it by anchoring it on relevant information and by motivating the trainees to do it.

Interpretation of question 3: What factors can promote or compromise the use of instructions during surgical observation?

The goal of this question was to acquire a basic understanding of the potential instructions have for improving learning during surgical observation. The question also looks at what conditions would promote or limit use of an intervention to supplement current resources used, including guidance from senior team members, pre-case preparation using textbook and video, and consolidation following procedures via personal notes or team debriefing.

The reason residents should want to use the intervention is because of its potential to improve their learning experience when observing surgery. Improvement can occur at many levels. Given that they were provided with sets of questions to guide their attention, the most frequently mentioned positive impact was that it helped focus attention on the appropriate elements while observing surgery. Applying cognitive load theory, the intervention attempted to diminish the extraneous cognitive load, which is described as elements from the learning activity that use cognitive resources without leading to learning. By telling residents what they should be looking for, it prevented them from using cognitive resources to find their own objectives. This can be linked to the work-example effect described as ‘increased learning’, which occurs when learners are given solutions to complex problems (guided instructions) to study instead of being given only the problem to solve (no guidance). Swellers (2003) described how the solution helps the learner to integrate key elements instead of using precious attention resources to find ways of coming up with the solution. This type of instruction has been shown to lead to better performance on transfer tasks (Mayer, 2004). The questions used in this intervention were built using the cues and heuristics experts use in guiding their decisions. As such, residents were provided with the foundation for solutions that they could use to build their schema. Since each learner is at a different stage in schema building, it is not surprising that some felt the instructions were not appropriate for them.

In accordance with the elaboration likelihood model, by providing a relevant goal, motivation increased; learners also reflected more and became more active in the learning process (Petty et al., 1987). In a busy clinical environment setting, the ability to process information might be limited, despite learner motivation and an appropriate guiding tool. The participants suggested that were this activity mandatory, they would be forced to invest time and effort into it, yielding better results than having it available on a voluntary basis. Indicating that this intervention was simply another task, they put those instructions with the other resources available to them to improve their learning experience. Many residents in the first round of focus groups mentioned that they wished they had made better use of existing resources.

A more global impact of the intervention was that it helped change the perception of surgical observation for junior residents. Participants in the first focus groups mentioned the stigma associated with observation, how it was perceived as a second choice. However, residents in this group did describe the use of this intervention as eye-opening. This effect may have been heightened by the fact that it was done in the middle of a research project aimed at improving learning during surgical observation, further validating surgical observation as a learning activity. This further supports the importance of culture as suggested by social learning theorists (Lave & Wenger, 1991). Participants mentioned that the entire community of practice would have to support an initiative like this in order for it to be sustainable. It would have to be promoted by the more senior team members to be fully validated. Residents also mentioned the intervention's absence of a feedback modality. In the cognitive apprenticeship model proposed by Collins (1991), trainees get feedback from experts when building a mental model during the coaching and scaffolding phases of learning. This intervention attempted to optimize the modeling phase but feedback would likely promote more efficient learning.

To conclude, in order to maximize the potential gain from instructions given to improve learning during surgical observation, instructions would have to include enough elements to provide a framework for schema building, without overwhelming the learner with irrelevant information. Instructions would have to be usable enough to be used repeatedly and encourage motivation, so that learners would be willing to process information at a deep enough level to enrich their schema. The intervention would have to be supported by all stakeholders in the program and senior team members would have to provide feedback to trainees on their performance.

General interpretation

This study was conducted as a first step to improve surgical observation as a learning modality for junior learners. Considering that most of the time spent in the operating room as a junior resident is spent observing surgery, it is worth optimizing this learning activity (Snyder et al., 2012). Also, as a group, junior residents have not been extensively studied. Most of the research conducted on the operating room as a learning environment has focused on more advanced trainees or medical students (Lyon, 2004; Moulton et al., 2010; Roberts et al., 2009; Scallon et al., 1992). In this context, the findings from this research could be used to inform future intervention to improve surgical observation for junior residents.

The first research question, which asks about the perceived value of surgical observation, identified a vast content of technical, cognitive and social elements being imparted. Residents explained understanding the role of observation as a first, necessary step in achieving surgical proficiency. However, a culture that perceives observation as a second choice was also described. Residents would rather be performing surgery than observing it. Participants also mentioned a stigma associated with observation, some saying that they often felt their role as second assistant (role where they mainly observe without actively performing surgery) was purely to assist rather than learn. That stigma could limit what is learned through this activity. Junior residents' perception resonates with the model proposed by Carlile (2012). Residents felt that observation is useful mostly for trainees who are unable to perform the surgery but were eager to become proficient enough to do so.

The second research question was aimed at identifying concrete factors that have an impact on learning during observation. Various factors were identified, from the learner's physical state to the relationships among the various team members. The factor mentioned most was the key role preparation played before observing surgery. Gathering information about the steps of the procedure, the relevant anatomy, and the patient was seen as critical in the learning process, both to guide their attention and to feel engaged in the procedure. Also, the guidance provided by senior team members was perceived as the most valued source of learning. Residents felt that those interactions validated them both as learners and members of the team and provided them with learning points that they could not identify on their own. Finally, the intra-operative milieu, a fast-paced environment with rigid social rules and competing priorities, was seen as an important factor impacting possible learning.

The last research question addresses those factors that facilitate or limit the use of an intervention based on the findings of the first focus groups, the theoretical framework used to guide this research project, and the surgical literature review. The minimal amount of instructions currently provided to junior residents within the current context was seen as limiting what it is possible to learn. An intervention consisting of instructions in the form of questions to guide attention was introduced and the second focus groups discussed its potential benefits and limits, as well as its feasibility in the clinical context. Residents appreciated the structure provided by the intervention; it helped them focus their attention on relevant features of the procedures and promoted reflection and active learning. Also, some residents mentioned that the intervention made them realize the role observation plays as a legitimate learning modality that validated their role as a learner, even when not actively performing surgery. However, participants did mention that the busy clinical environment would limit the use of such an intervention and that it would have to be made mandatory by the program for it to be used consistently. They also said that it would still be challenging to voice questions in a difficult work atmosphere even if they were provided with a list of relevant questions regarding procedure.

The research findings were interpreted using the cognitive apprenticeship model, cognitive load theory, and elaboration likelihood model. The current study aligns well with these theoretical frameworks and contributes further to understanding the learning process from the trainee point of view. The challenges facing junior residents and the culture in which learning is taking place must be considered when designing activities, if the results of this project are ever to inform future potential interventions.

Limitations

1. General limitations

This study was an attempt to explore beliefs and perceptions residents have of a commonly used teaching strategy, surgical observation. As a teacher in the general surgery program where the study was conducted, the principal investigator leading this project could have biased the residents to paint a more positive picture of observation in general and of the intervention. To reduce this risk, two moderators not directly involved in the residency program conducted the focus groups; residents were also reminded the process was an anonymous one.

Also, having designed the intervention, a principal investigator's opinion of it tends to be favorable. This project was done on the premise that this intervention could help improve surgical observation and the principal investigator was involved in analyzing data from the focus groups discussions regarding the intervention's impact. To avoid having any preexisting beliefs bias the analysis, a team of 3 analysts was used and coding was done in team through consensus.

2. Limitations related to the intervention's design

The intervention was designed with the use of experts' cues and heuristics to help guide observation. It may have been more beneficial for junior residents to use instructions based on what senior trainees use to guide them in their operative performance, as senior residents are closer to junior residents in terms of expertise level. Participants needed to possess sufficient experience to interpret cues suggested by the instruction and include them in pre-existing schema. Perhaps the instructions attempted to guide their attention to details that they were not yet ready to assimilate in their schema because they were relevant to more advanced experts.

Also, the process of question formulation and selection was done using one round of experts. It is possible that involving residents in this process and choosing questions on increasingly complex intra-operative elements might have made the intervention more accessible.

Thirdly, the intervention was implemented for a 3-month period. Most residents used the instructions less than five times. This period was chosen after consulting with residents and asking them about previous experience with frequency of laparoscopic cholecystectomy. This is a limited exposure to the intervention and the opinion of the residents was based on their initial experience. To see more changes in the way residents observe surgeries, it might have been useful to have an intervention of a longer duration. This being a pilot study, this information will be taken into account in the design of future studies on this topic.

3. Limitations related to data collection

The choice to use a focus group as a data collection medium for the study was made because the goal was to find consensus. Also, the focus group format is thought to provide a more comfortable environment in which residents can share ideas rather than individual interviews. However, this data collection method has its own set of limitations. It is difficult to collect points of view from every individual on every question because of the discussion format. Adding individual interviews to the process could have been beneficial, but with 12-14 residents in each round, it was felt that we had a representative idea of beliefs and attitude.

This study also focused exclusively on the perception of the residents. For a more complete picture of what it is possible to learn, the opinions of staff surgeons and learners who are more advanced in their training would have proven interesting. More senior team members could have helped identify their expectations in terms of preparation of junior residents, as well as attitudes seen as helpful to derive the most from observation. They could also identify barriers limiting the amount of guidance they provide during surgical observation. This might be explored in future research projects.

This study was done with only one cohort of residents at one university. To understand the transferability of the findings, it would have been helpful to conduct this study on multiple cohorts or at multiple centers. The University of Ottawa's program is a medium-sized program with a culture similar to that seen in other training programs across the country; it is likely that participants painted a picture that will resonate with other residents. This study could eventually be replicated on a larger scale or a survey conducted across different programs to confirm the findings with residents elsewhere.

Not all residents who were invited to participate in the focus groups did so. This study was done with a convenience sample and it is possible that residents not present in the focus group could have had differing points of view. However, the sample that did participate in the focus groups was felt to be representative of residents involved in the training program, from both a skills and a demographics vantage point.

4. Limitations related to data analysis

As shown in the trustworthiness section of the method, the inter-rater correlation coefficient of the coders was relatively low at 0.55. This could be a reflection of codes not having been sufficiently defined in the coding book. Another factor to consider is the different background of each coder: one is a research assistant in medical education, one a program coordinator for the department of surgery, and the other a surgeon. Various levels of experience and training tend to have an impact on how coders proceed (Huberman & Miles, 1998). All the data was coded during coding meetings, and disagreements were resolved through discussion and consensus, making the low inter-rater reliability less relevant to this study. Each coder's opinion and perspective was considered during those sessions and efforts were made to capture all potential content in each citation. This method of coding should compensate for the relatively low inter-rater reliability.

The coding tree developed following the second focus group contained broad categories, which probably explains the low inter-rater reliability correlation. After a first pass in the transcript, each category was recoded again during coding meetings. Those transcripts contained varied data from the very technical usability of the tool, to the impact on the learning process during which residents reflected on their own methods of learning. Also, residents had divergent opinions on the impact of the intervention and, at the end of the process, based on the small sample size, it was unclear whether data saturation was achieved. Interviews with other participants could have helped confirm the findings. The member check done at the end of the analysis was used to ensure trustworthiness of the findings.

Future directions

A next step for this program of research would be to try to objectively determine the degree of learning that occurs with the use of the intervention. The intervention was designed to promote cognitive learning and hasten the development of surgical decision-making. To measure its effects, those constructs would have to be measurable. At this point, very few assessment tools exist to measure intra-operative decision-making and the available tools are labor intensive (Samuelson, Cadeddu, & Matsumoto, 2006). Another option would be to measure the impact of the intervention on residents' motivation. This is an intermediate step, as the current hypothesis is that the intervention would improve learning through increased motivation and better use of the attention resource of the trainees.

As mentioned, the addition of individual interviews with junior trainees and interviews or focus groups with other members of the surgical team could have enriched the study's findings. Additional data could either confirm the findings or suggest other views on the potential of surgical observation. The opinion of a larger sample of residents could also be collected through a survey based on findings from this study.

In light of the study's results, further work is also needed to clarify which level of learners would benefit most from an intervention such as this. There was agreement among focus group participants regarding the need for users to have previous knowledge and basic understanding of the procedure to benefit from this intervention. There was also disagreement regarding the level of difficulty of the questions used as instructions among trainees at the same level. Some considered them too difficult, others too easy. These findings suggest that more information should be gathered on factors that allow residents to use this intervention in a meaningful way.

Finally, more information needs to be obtained to ascertain the best way to deliver instructions to learners. There is a fine line between keeping trainees motivated and providing them with guidance to promote reflection and overwhelming them with instructions when they are already burdened with cognitive tasks. The optimal level of guidance might differ for each learner but it will be interesting to explore potential factors that impact the need for guidance.

Conclusion

The present study documents the perception and attitudes of junior surgical residents regarding surgical observation. In general, results of a content analysis suggest that junior residents hold a range of beliefs on the role of observational learning in the operating room. This research confirms the potential of observation as a learning modality but uncovered many limitations in the current context.

Factors that both facilitate and interfere with learning for junior residents were identified in an analysis of focus groups responses. Many participants mentioned the key role played by senior team members in their experience and the impact of the clinical milieu. Some factors mentioned would be difficult to modify; for example, it is unlikely that the intra-operative context will become less busy or that surgeons will fully explain their thought processes while they operate. Nonetheless, being aware of the importance of providing guidance to trainees to allow them to include relevant information in their schema can be useful. Also, knowing that the culture is so important in the perception and the motivation of residents, it will be important to ensure that any intervention aimed at improving surgical observation as a learning activity is endorsed by the program, as well as all the stakeholders involved in the residents' training (nurses, senior residents, training surgeons).

Finally, the use of instructions to guide observation was seen as a positive addition by most residents. The instructions' format could be modified to allow for more feedback and to support more reflection. Based on the results of this study, the instructions would benefit from the addition of progressively more complex cues used in decision-making, to provide a better ongoing learning opportunity as trainees progress. The findings also underscore the key role of the environment in the use of the intervention, both from a social validation point of view as well as in terms of creating an environment in which learners feel comfortable asking questions and dedicating time to their own learning.

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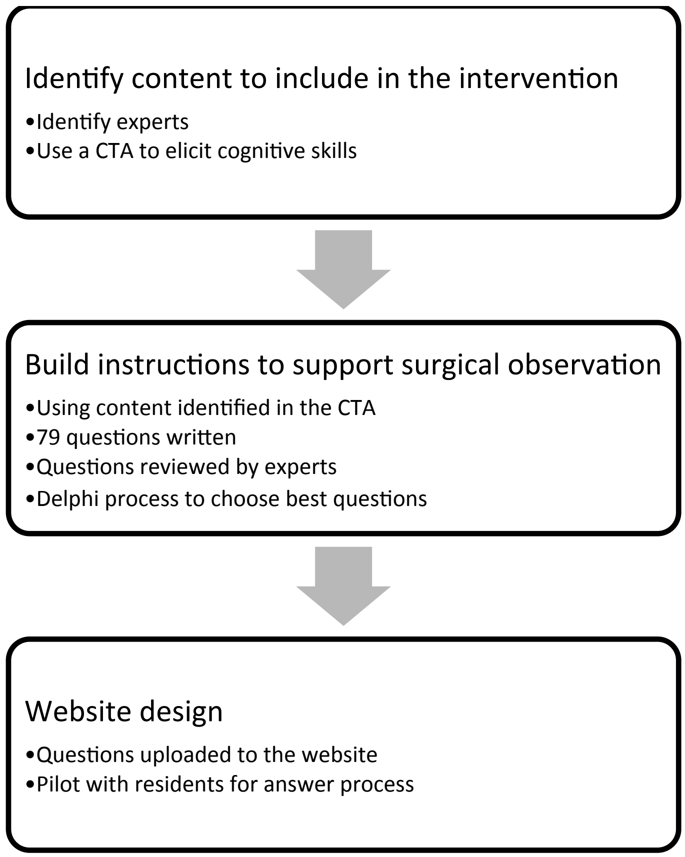
Appendix A

Intervention design



Appendix B

CTA protocol

Goal:

- Understand decision-making process of experts by asking them to describe a specific case
    - Cues and patterns that experts perceive
    - Rules of thumb devised by experts
    - Types of decisions they must make
    - Factors that render decisions tough
    - Factors in a typical case
    - Factors with rare cases

Procedure:

1. **Select a relevant case**

- Explain what you are looking for.
    - A case that is well remembered
    - Situations where the interviewee was decision-maker
    - Situations where the decision-making process made a difference in the outcome
- Ask for a brief outline of the complete case

2. **Describe the steps on a timeline and obtain a detailed description**

- Ask for a description using ordinal descriptors (step 1, step2, etc.)
- The point at which a major shift occurs in understanding the situation
- The point at which the situation could have been handled differently
- Find key points and steps (what happened, who did what, different roles)

3. **Deepening**

- Goals:
    - Figure out what the surgeon knew, how he knew it, what that knowledge changed in the course of the surgery
    - Find perceptions, expectations, goals, judgments, confusion and uncertainty

- Repeat the story to interviewee and request precision. "Do I have the sequence and details right thus far?"
- Ask for enough detail to allow first-year residents to be able to follow the thought process of the case. (What? Where? When? Who? Why?)
    - Surgical indications
    - Relevant clinical findings
    - Goal of the surgery
    - Unexpected events, what made it different
    - Perceptual cues
- Ask for cues and trigger in the decision making
- Mark the decision-making points on the timeline. Check if the expertise of the surgeon was key at turning points or if it is a decision easily made by most surgeons.
    - Look for moments when the surgeon said: "I just knew..." "My gut told me..." "It was obvious that..."
    - Look for what was surprising for the surgeon
- Use of probes to understand how the interviewee was making decision (Crandall et al, 2006 Table 5.3, p 79)
    - What were you seeing, noticing?
    - What information did you use to make this decision or judgment?
    - How, when, and from whom did you get this information?
    - What did you do with the information?
    - Were you reminded of a previous experience? What was it about that previous experience that seemed relevant to this case?
    - Does this case fit a standard or typical scenario? Is it a type of event you are trained to deal with?
    - What were your specific goals, objectives and the time? What was most important to accomplish at this point in the incident?
    - What other courses of action were considered or were available to you? How was this option chosen but others rejected? Was there a rule you were following in choosing this option?

- What let you know that this was the right thing to do at this point in the incident? How much time pressure was involved in making this decision?
- Did you seek guidance at any point? Why? How did you know to trust the guidance you got?

- Other probes
  - Why were you thinking (…)?
  - Why were you doing that (…)?
  - What would have made you do things differently?
  - What criteria did you use to make the decision?
  - How was this finding important?
  - What instruments did you use for that step? How did you choose the instruments you used?
  - How do you know that the surgery was a success? What were you looking for before closure?

4. What if… queries

- Goal:
  - Illuminate the expert-novice difference
  - Find possible places for errors
- Ask for hypothetical situations
  - Had a less experienced surgeon been in charge, what might have happened?
  - What errors would a novice have committed? Why?
  - Would someone with less experience notice what you noticed?
  - If (...) had been different, what would it have changed in your management (decision, action, plan, perception)?
  - What other knowledge, information, training, tool, technology could have helped in this case?

Shows props: videos, OR notes, diagrams, etc. Elicit surgeon's reactions.

5. Revision and (knowledge audit if needed)

- Tell the surgeon the story once more and/or send a written copy to the surgeon to check if every detail is well understood or if something is missing
- Ask if there is sufficient information to allow a junior resident to know what a surgeon is thinking about and looking for during a surgery.
- If not already in the data:
    - Can you tell me about a time when something just "popped out" at you before anyone else had seen it? How did it happen? What is the thing you most often notice before the residents?
    - Can you make a surgery more efficient? During which step do you see the performance of unnecessary moves most often? How does this happen?
    - How do you know a resident can safely do the procedure?
    - What has changed over the years in how you perform this surgery? What have you improved?
    - What makes you satisfied with the surgery you are doing? How do you know you are going to have to change what you are doing during a surgery?

Data presentation

Difficult cognitive task	Why it is difficult	What experts do to simplify it	What cues experts look for	Common errors
...				

Appendix C

Ethics Certificate

University of Ottawa Heart Institute / Institut de cardiologie de l'Université d'Ottawa

The Ottawa Hospital / L'Hôpital d'Ottawa

uOttawa

Ottawa Hospital Research Ethics Boards / Conseils d'éthique en recherches

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http://www.ohri.ca/ohreb

November 21, 2012

Dr. Stanley Hamstra
University of Ottawa
Faculty of Medicine
Academy for Innovation in Medical Education
451 Smyth Road, Room 2206
Ottawa, ON K1H 8M5

Dear Dr. Hamstra:

Re: Protocol # 20120417-01H **Exploring Cognitive Learning of Junior Surgical Residents in the Operating Room**

Protocol approval valid until - November 20, 2013

Thank you for the e-mail from Ms. K. Day dated November 21, 2012. I am pleased to inform you that this protocol underwent expedited review by the Ottawa Hospital Research Ethics Board (OHREB) and is approved to only recruit English-speaking particiants. No changes, amendments or addenda may be made to the protocol or the consent form without the OHREB's review and approval.

Approval is for the following documentation:

- Revised OHREB application received October 25, 2012
- English Intervention Cognitive Aid to improve surgical observation (76 questions) received October 25, 2012
- English and French classroom/e-mail announcements both received November 14, 2012
- English Information Sheet and Consent Form dated November 14, 2012

The validation date should be indicated on the bottom of all consent forms and information sheets (see copy attached). If the study is to continue beyond the expiry date noted above, a Renewal Form should be submitted to the OHREB approximately six weeks prior to the current expiry date. If the study has been completed by this date, a Termination Report should be submitted.

The Ottawa Hospital Research Ethics Board is constituted in accordance with, and operates in compliance with the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans; Health Canada Good Clinical Practice: Consolidated Guideline; Part C Division 5 of the Food and Drug Regulations of Health Canada; and the provisions of the Ontario Health Information Protection Act 2004 and its applicable Regulations.

Yours sincerely,

Francine F-A. Sarazin, Ph.D., C.Psych.
Vice-Chairman
Ottawa Hospital Research Ethics Board

Encl.

/cb

Appendix D

Focus group protocol -FG1

The focus groups will be held at the University of Ottawa and audio-recorded. They will be conducted with 4-6 residents at a time and include a moderator and an observer. Each focus group should last for 1-2 hours and will be held during regular working hours for residents.

A week before the focus group, residents will be sent an e-mail confirming the schedule and giving them information on its process and goals. The moderator will be provided with a guide that includes core questions and additional ones.

Script used for the focus group:

Exploring Observational Learning of Junior Residents during Surgery
Focus Group Protocol – FG1

- INTRODUCTION
  - My name is … and I'm here to discuss your experience of observing surgeries. The ultimate aim is to improve the learning experiences of surgical residents
  - I'd like to start by thanking you for your participation.
  - I'm here to facilitate discussion, not participate. So talk to each other, not to me. Please share your thoughts with each other and respond to one another. Ideally, everyone will have the opportunity to contribute.
  - There are no correct answers. We're exploring ideas, thoughts and factors together, so all ideas are welcome. This is new ground for everyone.
  - Try not to talk over each other at the same. Every comment matters.
- FOCUSING STATEMENT:

  Today we are interested in exploring the thoughts, expectations, reactions and learning experiences you have had when observing surgeries. We want to discover what has contributed to your positive learning experiences and what could be done to enhance learning during surgical observations. Think back to an experience you had while observing a surgery. You might also want to think back to some of the first surgeries you saw, as well as more recent ones.

- FOCUS GROUP:

1. First, let's talk about what comes to mind when I say "you are about to observe a surgery"? I'd like to get everyone's perspective if possible. *(Pick up on themes and follow through with the whole group.)*

2. Why do you think you watch so many surgeries?

3. I want to explore what you might do. Do you prepare for observing surgeries in any way? Do you do anything after the surgery?
    a. What steps do you take? Prompt: read up; take notes; debrief, etc.
    b. What do you find helpful and why?

4. When you are observing, do you feel engaged in the surgery? *(Probe –how many observers; where are you in relation to the group; what role do you take? etc.)*
    a. If your answer is yes, what helps you to be engaged?
    b. If no, what is inhibiting your engagement – e.g. can you see adequately?
    c. What do you tend to focus on?
    d. Are there distractions? How do you deal with distractions?

5. Do you feel part of the team? Does your role make a difference?

6. What do you think you learn while observing surgeries?

7. What do you think you should be learning (i.e. what are the expectations of your 'teachers')?
    a. If this differs from what you do learn, why might that be?

8. What would you like to be learning? *(Probe to try to get at more subtle hopes and wishes.)*

9. What do you think might improve the quality of your learning?
    a. What could you do to improve the quality of your learning experience?
    b. What could others do to help improve the quality of your learning experience?

10. Before we finish, please feel free to comment on anything else that you feel is relevant to the discussion?

- Conclusion: Thank you for your participation.

Appendix E

Focus group protocol – FG2

**** RECORDER ****

- INTRODUCTION
    - My name is …. and I'm here to discuss your experience of observing surgeries. The ultimate aim is to improve the learning experiences of surgical residents.
    - I'd like to start by thanking you for your participation. I also want to assure you that everything you say is anonymous – any mention of names will be removed from the study data
    - I'm here to facilitate discussion, not participate. So talk to each other, not to me. Please share your thoughts with one another and respond to others. It is ideal if everyone has an opportunity to contribute.
    - There are no correct answers. We're exploring ideas, thoughts and factors together, so every idea is welcome. This is new ground for everyone.
- FOCUSING STATEMENT:

    You have all observed at least one surgery using the Lap Chole questions. We want to explore any changes you may have found when observing surgeries as a result of the questions on the website.
- **FOCUS GROUP:**

11. First, I'd like to explore what it was like using the questions:
    a. What did you like about Lap Chole questions? Why? (prompt: ease of use, use of website and having to login, having different questions each time)
    b. What didn't you like about the questions? Why? *Prompt: what are the barriers to using it?*
    c. Which types of questions did you like most, and why?
    d. Do you have any comments on the level of the questions – for example, were they appropriate to your level of development, was the vocabulary appropriate?
    e. What did you think about the two-staged process i.e. reading the questions prior to observing the surgery and then answering the questions after surgery? *Prompt: Was it a nuisance or helpful to come back and answer the post-surgery questions? Prompt: Did it help to consolidate your learning? If so, how?*

f. Can you talk about your level of confidence in answering the questions? Might your level of confidence alter with more experience? In what ways will it do so?
g. Were you able to use the question prompts to help ask the surgeon questions? If so, explain how they helped. If not, why not?
h. In the first focus group, there was a lot of mention of how the milieu or OR environment can have an impact on your learning – often in a negative way. Could you describe any change in the impact the OR environment had on your learning in any way as a result of the questions?
i. Do you have any suggestions on how to improve the usability of the questions?

12. Compared to before…

a. In the first focus group, people said that they focused on various aspects of the surgery while observing (for example: some watch hands, some concentrate on anatomy, others follow steps, some pay attention to instruments, etc). How do you know what to focus on? Have the questions helped you to choose what to focus on? If yes, in what way?
b. Did the questions change anything in your observation experience? Explore any differences and why. *Prompt: e.g. Has use of the questions impacted your approach to other surgeries you observe in any way?*
c. Have you noticed a difference in the way you observe surgeries after having used the questions? If yes, how many times did you use it before you noticed a difference? What was different?
d. As a result of using the questions, do you think there has been any change in your understanding of what it is possible to learn when observing surgeries? Explore any changes.
e. As a result of using the questions, is there any difference in your understanding of the gaps that might exist in your knowledge? Do you envisage the surgery differently? Explore differences. *(Looking for signs of "reading the surgery".)*

13. Overall

a. Can you identify what made a question or type of question useful to you? *Prompt: for example, did it help to define objectives, to know what to focus on?*
b. Why do you think these particular questions were selected?

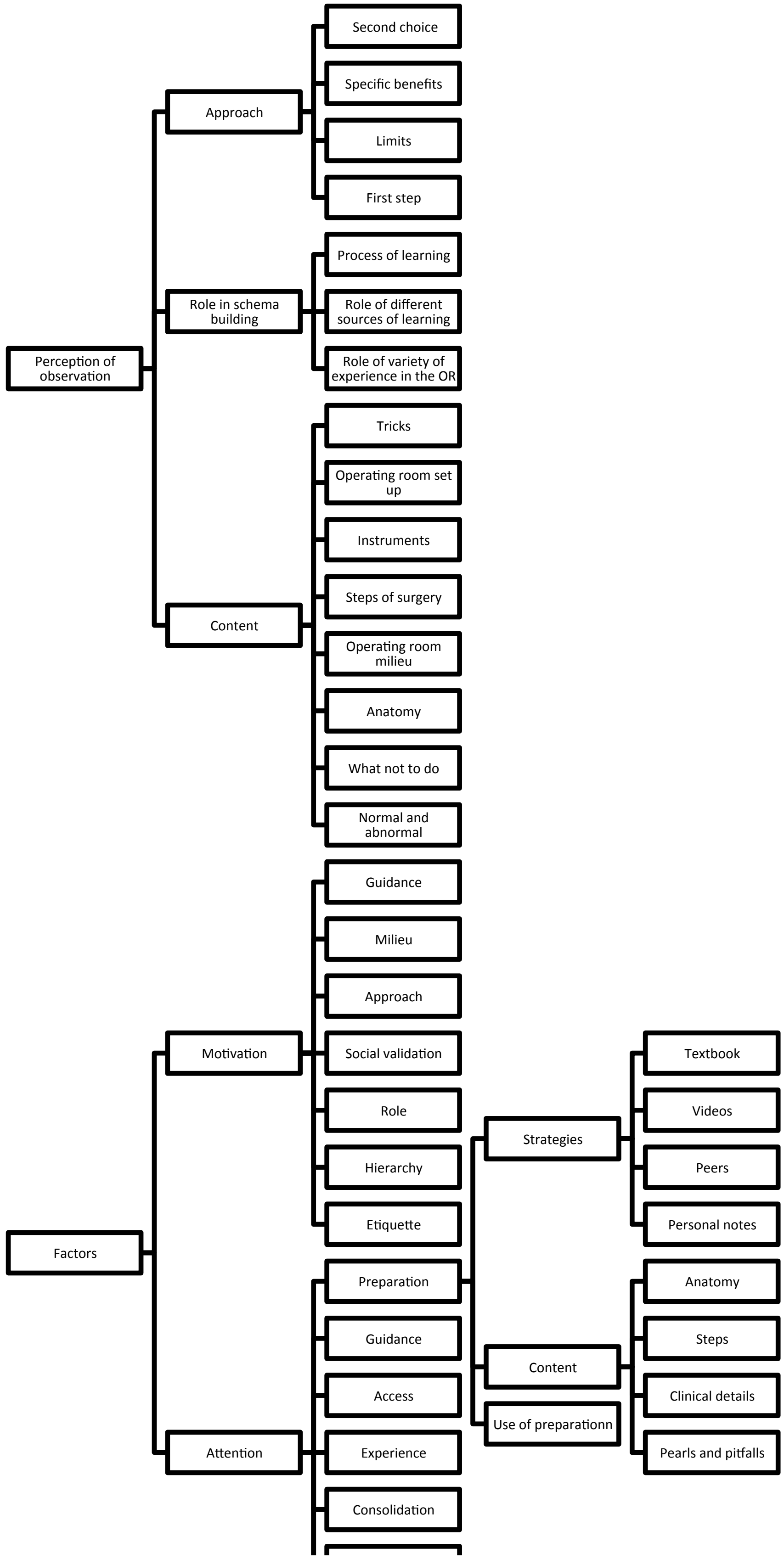
c. Can you talk about any questions that you thought about afterwards?
d. Do you think these types of interventions (ie the questions and the website) could help to streamline your learning and understanding of surgeries? If yes, how? If no, why not? *i.e. could it shorten the 'see one' phase?*
e. Would you use this tool outside of this research project? For this surgery and others (if developed for other surgeries).
f. Do you think there is a better time to introduce this type of intervention in one's learning path? Why would your suggestion be a good time?
g. Do you have any sense of the impact that using the questions might have on your technical skills in the future when you start doing the procedure yourself?
h. Do you have any suggestions for improving the questions in any way?

14. Before we end, would anyone like to add anything further?

- Conclusion: Thank you for your participation.

Appendix F

Coding tree for first focus groups



Appendix G

Coding tree for second focus groups