COMPARING THE EFFECTS OF SELF- AND INSTRUCTOR-REGULATED LEARNING ON SKILL ACQUISITION, RETENTION AND TRAINEES’ LEARNING APPROACHES

Medical Trainees’ Awareness and Transfer of Learning Approaches

By

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Abstract

During instructor-regulated learning (IRL), trainees must reconcile the instructor’s teaching approaches with their own learning approaches. Conversely, trainees engaged in self-regulated learning (SRL) may benefit from developing individualized learning approaches. We compared the effects of SRL to IRL on cardiac auscultation skill acquisition and retention, and on trainees’ transfer of learning approaches to another session. After randomization (SRL or one-on-one IRL groups), novice medical students (n=32) practiced diagnosing simulated murmurs and then completed a post-test. Two-weeks later, participants completed a retention test, practiced diagnosing new simulated murmurs, and completed another post-test. There were no between-group differences on any performance-based assessment. Most IRL participants did not use the learning approach in session two that instructors taught them in session one. Interview data suggest the instructor’s presence had both positive and negative impacts on learning. The
findings highlight factors that prevent IRL training from having the benefits supervisors expect from their teaching.
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Chapter 1
Introduction, Hypotheses, and Objectives

1.1 General Introduction

Trainees used to rely on the apprenticeship model\(^1\) and spontaneous exposure to patient cases to acquire clinical competence. That model may no longer be sufficient, however, due to significant changes in clinical training environments including resident work hour restrictions, financial pressures, and societal patient safety concerns.\(^2\) These changes have resulted in decreased training opportunities in the clinical context.\(^3\)-\(^7\) The loss of supervised teaching within the clinical context means that trainees’ ability to self-regulate their learning has become vital, especially when considering the multitude of options they have available to them (e.g., simulation, e-learning) from which to learn. Concerning then, is the fact that most of these learning materials do not come with guides for how a trainee might use them to manage his/her own learning.

Although such unsupervised, independent learning will allow trainees the convenience to practice according to their own schedules without being restricted by their instructors’ schedules, concerns arise regarding trainees forming bad habits, inaccurately assessing their own judgments of learning progress, or lacking motivation when no longer mentally stimulated.\(^8\) These concerns suggest that clinician-educators need to design curricula with features aimed at preventing bad habits from occurring, increasing motivation, and enabling trainees to make accurate judgments of learning. One concept that could be used to design such curricula is self-regulated learning (SRL). Self-regulated learning refers to controlling affective, behavioral, and cognitive processes throughout a learning activity in order to attain a certain level of achievement.\(^9\) Unfortunately,
the approaches that instructors use to keep a trainee engaged, motivated, appropriately challenged, and regulating their learning remain under-studied. That is, not all training interventions are designed to support trainees’ SRL skill acquisition. Thus, research aimed at clarifying the mechanisms by which SRL works would allow researchers and educators to create interventions that will improve trainees’ learning outcomes during unsupervised training.

### 1.1.1 Evidence for SRL Interventions in the Health Professions

A recent systematic review and meta-analysis by Murad et al. investigated the effectiveness of SRL in improving learning outcomes. Fifty-nine studies enrolling 8011 trainees were included. Interventions in which trainees had the opportunity for SRL were associated with significant moderate effects in knowledge outcomes (pooled effect size = 0.45), and no significant effects were observed for skills outcomes and attitudes. Furthermore, there was a significant interaction (i.e., the value of a dependent variable is contingent on the value of the other interacting variables) when trainees were involved in choosing their own learning approaches, methods, and resources. There were no significant interactions on knowledge outcomes with the instructor being a facilitator of learning and not just a content expert and when the trainee self-assesses the learning process. They also report that more advanced trainees (i.e., non-naïve trainees) may benefit from SRL. However, this systematic review and meta-analysis is limited by the small number of studies included in the subgroup analyses and by the high heterogeneity. What remain to be determined are the correct instructional design features, the correct trainee characteristics, and the proper topics most amenable to SRL.
Another recent systematic review and meta-analysis investigated the comparative effects of instructor-supervised versus unsupervised training using simulation-based medical education (SBME) as the training modality. In addition to comparing supervised and unsupervised interventions, the authors of that review also studied the effects of whether SRL processes were supported or unsupported (i.e., whether the instructor and/or the environmental design enabled an SRL process such as goal-setting). Based on these definitions, the authors analyzed several comparisons between different interventions. Two analyses are particularly relevant to this thesis. First, when comparing supervised to unsupervised interventions that did not include supports for SRL processes (19 studies enrolling 1422 participants), the pooled effect size for immediate post-test assessments of participants’ skills was small and non-significant at 0.34 (p=0.09), favouring supervised training. Eight of those studies included a retention test (i.e., greater than or equal to one week post-intervention) and the pooled effect size across those studies was negligible at 0.11 (p=0.63), and in favour of unsupervised training interventions. Second, when comparing unsupervised, unsupported interventions to unsupervised, supported interventions (n=5 studies enrolling 240 participants), the pooled effect size for immediate post-test assessments of skills outcomes was small and non-significant at 0.23 (p=0.22), favouring supported interventions. Three of those studies included a retention test and the pooled effect size across those studies was small and non-significant at 0.44 (p=0.067), favouring supported interventions.

In summary, instructor-supervised interventions using SBME appear to be associated with small benefits on immediate learning outcomes and negligible effects on retention learning outcomes. Moreover, Brydges et al. note that all of the instructor-supervised interventions were
classified as ‘unsupported’ in their coding framework. One interpretation of these results is that simply placing an instructor within the learning environment may not improve trainees’ long-term learning outcomes. Instead, the results showing a small benefit of unsupervised, supported training on skill retention shows the potential of training that is designed to include explicit supports to promote SRL processes. A recent concept called ‘directed self-regulated learning’ (DSRL) may be a theoretical foundation through which educators provide trainees these supports.

1.1.2 Directed Self-Regulated Learning

Recent research suggests that allowing trainees to practice unsupervised in a setting where the instructor is physically absent, but is integrated through the instructional design, can improve educational outcomes associated with SRL. Brydges et al. refer to this kind of instructional design as *directed self-regulated learning* (DSRL). Using the designed directions or ‘supports’ (e.g., a list of goals for a training session), the trainee is allowed to self-regulate his/her own learning of certain aspects of practice (e.g., monitoring his/her progress toward a specific goal). Conceptually, this ‘shared control’ between the trainee and the instructional design allows the trainee to be motivationally, behaviorally, and metacognitively active within the learning situation while being provided support to guide his/her learning. The DSRL concept is based on the notion that learning is a socially-constructed phenomenon, and draws heavily on the Social Cognitive theory of SRL (discussed in full in Section 1.2.2 below).
1.1.3 Evidence-Base for Directed Self-Regulated Learning Interventions

Brydges et al. studied first year medical trainees’ cardiac auscultation skill acquisition and retention. They compared two interventions: an ‘unsupported’ SRL group and a ‘supported’ DSRL group. Participants in the SRL group learned and practiced seven murmurs on a simulator after watching an instructional video, whereas participants in the DSRL group received the video plus a booklet that taught them to learn murmurs according to a timing-based approach (i.e., whether murmurs occur in systole or diastole). Over two training sessions separated by 3-weeks, they measured learning time, learning outcomes, and the way participants sequenced their learning of the seven murmurs. The latter measure was meant to serve as a proxy for participants’ ‘conceptions of learning’ (i.e., the order in which one learns may reflect how one thinks about learning). In the first session, all participants in the unsupported SRL group used a ‘location-based approach’ (i.e., grouped all aortic murmurs then all mitral murmurs, etc) and all participants in the DSRL group used the booklet’s timing-based approach. During the second session in which all participants learned a novel set of murmurs without any video or booklet, the authors found that 84% of DSRL and 100% of SRL participants used the location-based approach. Learning outcomes (i.e., diagnostic accuracy) did not differ between the groups, yet the SRL group required 50% less practice time in the first session.

Brydges et al. suggested that the DSRL participants experienced ‘destructive friction’ in the first session as the booklet taught them a way of learning that did not reflect their approach to studying cardiac auscultation (i.e., location-based approach) and ultimately appeared to result in
a longer time to achieve the same learning outcomes as the SRL group. A study of computer-based training showed similar benefits of an SRL over an DSRL intervention, with the latter group demonstrating less efficient performance and more trial-and-error solutions. Those authors speculate that DSRL impedes performance because the conceptual framework has been defined for the individuals, rather than having them actively produce their own approaches for problem resolution. Based on these studies and additional reviews of the literature, we concluded that the DSRL cardiac auscultation booklet may have interfered with participants’ ‘conceptions of learning’. Therefore, conceptions of learning became a primary construct of interest for this thesis.

1.1.4 Thesis Overview

The preceding sections introduced the general landscape surrounding this thesis including the need for improved SRL in health professions education (HPE), the concept of DSRL, and the mixed evidence associated with DSRL interventions. Please note that the interventions in this thesis are not DSRL, and instead involve a comparison of ‘unsupported’ SRL and IRL training, with the aim of following up on the tentative conclusions offered by Brydges et al.

To add to that general introduction, the following literature review includes additional details about the Social Cognitive theory of SRL, which is subsequently linked to literatures on conceptions of learning. Finally, literature on preparation for future learning (PFL) and transfer is discussed as a methodological framework for this thesis.
1.2 Self-Regulated Learning Theory

1.2.1 General Overview of SRL Theory

Learning theories that address how trainees learn in static, stable systems are no longer as relevant as they once were. Learning is now viewed as a socially-constructed phenomenon that takes place in dynamic, fluid, and complex systems. Hence, the interplay between the instructor, the trainee, and the learning environment becomes a crucial area of study. No single factor will have a direct impact on learning as a number of moderating and mediating variables affect this complex interaction.

Many theoretical perspectives of SRL exist, with each describing different degrees of cognition, motivation, and behavior.\(^\text{16}\) In particular, the Social Cognitive theory of SRL provides a useful lens through which to study how the complex interactions between an instructor and trainee affect behaviours and overall learning outcomes.

1.2.2 Social Cognitive Theory

Originally starting as social learning theory, Bandura later translated many principles to develop his Social Cognitive theory in which trainees are described as purposeful, goal-oriented, and motivated through their self-efficacy beliefs.\(^\text{17}\) Bandura describes learning as a dynamic social interaction with reciprocal interactions between the trainee (i.e., personal factors including cognitive, affective, and biological events), the environment, and the trainee’s behaviours (e.g., task choice, persistence, effort, performance, acting puzzled so that an instructor reteaches the material\(^\text{18}\)) an interaction known as *triadic reciprocality* or reciprocal determinism.\(^\text{17}\) These three
factors function as interacting determinants that influence each other bidirectionally. The theory also considers trainees’ past experiences, which is a factor determining whether or not behavioural change will occur. Social Cognitive theory helps us understand how trainees regulate their behaviour through control and reinforcement to maintain useful behaviours over time with the hopes of transferring these behaviours into novel situations.

Bandura also identified three main factors that influence the personal factor within the Social Cognitive theory model: self-efficacy, outcome expectations, and SRL. Self-efficacy beliefs refer to one’s confidence that he/she possesses for engaging in a learning activity which will dictate if a trainee will attempt the learning task, persevere throughout the learning task, whether or not the trainee will accomplish his/her pre-set goals, and when the trainee will give up from performing the task. Outcome expectations are the results the trainee foresees as a consequence of his/her behaviours, which will impact a trainee’s choices. SRL is described as the process in which trainees take control over their own learning (i.e., active agency). Therefore, self-efficacy beliefs, outcome expectations, and SRL all influence the personal factor within the Social Cognitive theory.

Bandura’s trainee, Zimmermann, developed the first model of SRL theory. Within this SRL theory, trainees are active participants in organizing their own thoughts and behaviours in attaining their generated goals. From a social cognitive perspective, self-regulation develops whereby a shift from social influences to individual influences occurs. Four levels of development exist: (i) observational learning, (ii) emulation, (iii) self-control, and (iv) self-regulation. Observational learning, also known as vicarious learning, posits that trainees learn by watching others perform a task. As such, social influences are greatest at this level of
learning. Although the major steps of learning a task are acquired through observational learning, trainees require practice with some sort of feedback. Emulating the task occurs via the trainee performing the task in question by mimicking the steps that he/she observed. The trainee must internalize these two levels, and therefore, these two levels are socially dependent. The third level is self-control, that is, the trainee independently uses the acquired skills or approaches. The fourth level is complete once the trainee learns self-regulation and is able to adopt and adapt based on different personal, behavioural, and environmental conditions. Below, the focus shifts to the triadic reciprocality framework and how these personal factors, behaviours, and environmental factors all influence each other, bidirectionally.

1.2.3 Triadic Reciprocality

Human behaviours were previously described as unidirectional entities and behaviours were depicted as being influenced by environmental or personal factors alone, not simultaneously. Social Cognitive theory depicts the triadic reciprocal determinism in which behaviours, personal factors, and environmental factors all influence each other in a bidirectional fashion (Figure 1). Social Cognitive theory does not suggest that all factors are of equal magnitude at once. Reciprocity is influenced over time. Therefore, at any given time in any educational context, social and environmental influences will have different effects on personal factors, which will ultimately change one’s behaviours.
Figure 1. The triadic reciprocality framework. This framework depicts the bidirectional influences of personal and environmental factors on behaviours. Modified from Bandura.17
The bidirectional relationship between personal factors and the behaviours reflects the interaction amongst trainees’ thoughts, affects, and actions. An individual’s internal states (e.g., beliefs, self-efficacy, social attitudes, personality, mood, affect, expectations, and goals) give rise to behaviours. For example, as a trainee progresses through a task, he may mentally note the progress he achieves (i.e., behaviour), which indirectly conveys to him that he is capable of learning (i.e., increased self-efficacy, a personal factor).

The bidirectional relationship between personal factors and the environment illustrates how individuals influence the environment in which their behaviour occurs. One example of this bidirectional relationship occurs when a trainee must keep his/her concentration (i.e., personal factor) in a distracting environment. Another example is that an individual’s social status will affect his/her self-efficacy, which in turn will affect aspects of his/her social environment. These social reactions may affect an individual’s conceptions of himself/herself. As another example, Buss characterized ways in which individuals influence their environment, one way being through evocation (also known as the Hawthorne effect). The presence of an individual within the environment, even in the absence of behaviours and independent of traits, alters that environment. Cognitive transformation, the process in which a trainee develops effective coping mechanisms in an environment, is another means by which individuals change their environment; however it is not the physical environment that is altered, rather, it is the subjective environment that is altered.

Bandura explains the bidirectionality between behaviours and the environment as follows:
“Because of the bidirectionality of influence between behavior and environmental circumstances, people are both products and producers of their environment. They affect the nature of their experienced environment through selection and creation of situations. People tend to select activities and associates from the vast range of possibilities in terms of their acquired preferences and competencies.”

The bidirectional influence between behaviours and environment is a dynamic process, especially because the environment is not a static entity, changing from instant to instant. Most aspects of the environment do not act on the trainee until catalyzed by the appropriate behaviour (i.e., lecturers do not influence trainees unless trainees attend class). Behaviours are what turn the potential environment into the actual environment. Thus, this suggests that simply having an instructor present within an environment does not facilitate learning if the trainee does not engage within this learning environment. Another example depicting the bidirectional influence between behaviours and environment occurs when an instructor introduces a new concept (i.e., environment) and the trainees need to divert their attention (i.e., behaviour) to this new concept.

A change in environment does not always dictate a change in behaviour, and a limitation of Social Cognitive theory is the assumption that a change in environment automatically leads to a change in the trainee. Furthermore, Social Cognitive theory does not explain the dependence of any one factor having a potentially greater mediating effect on the other factors within the triadic reciprocality framework.

This dissertation draws from the Social-cognitivist four-level model of SRL and triadic reciprocality framework to help describe and understand how novice medical trainees’
behaviours can be modified in a social learning environment. As noted in the DSRL research, a key influence on novice trainees’ behaviours (i.e., how they sequenced their learning) appears to be the personal factor of ‘conceptions of learning’, which we explore in the next section.
1.3 Conceptions of Learning and Teaching

Brydges et al.\textsuperscript{14} suggested that educators’ conceptions for organizing murmurs differed significantly from trainees’ conceptions. They based that tentative conclusion on the murmur sequencing data, where most trainees deviated from the DSRL booklet, which used a timing-based approach, and chose instead to use a location-based approach in their second training session. Specifically, they proposed that trainees’ conceptions of learning (COL) influence their approaches to designing and structuring their learning. To explore this relationship further, a review of the COL literature is needed to examine the evidence related to this tentative conclusion.

1.3.1 Defining COL

How do trainees conceptualize what is required of them throughout their educational training? Trainees’ thoughts about or conceptions of the learning task will define how they approach the task. In an educational context, conceptions of learning (COL) refer to a trainee’s “coherent system of knowledge and beliefs about learning” (i.e., how we think we should learn).\textsuperscript{26} According to Saljo,\textsuperscript{27} who studied adults with different levels of education, a hierarchical system of five different COL exists: (i) increasing knowledge, (ii) memorization and reproduction, (iii) applying (i.e., facts and procedure acquisition that can be retained and utilized in practice), (iv) understanding (i.e., meaning abstraction), and (v) seeing things in a different way (i.e., interpretative process).\textsuperscript{27,28} According to Marton,\textsuperscript{29} a more elaborate sixth COL signifies (vi) changing one’s attitudes and values. Educational researchers have produced much work suggesting that individuals’ COL can differ widely, both within an individual across differing subject areas and between individuals. Similar to the triadic reciprocality framework,
much of the COL literature considers the influences of the environment, the instructor, and the trainee.

1.3.2 COL and the Environment

Trainees’ conceptions of a task will depend on the task itself, the perceived ways they can complete that task, and perceived contextual differences. Hence, trainees can possess different COL, contingent on their prior experiences, perceptions of the environment, and ultimately, learning outcomes. These conceptions, coined situated COL, are those that trainees adopt in specific situations. If trainees experience two similar learning situations over time, they are more likely to demonstrate the same situated COL during both experiences.

When a trainee is introduced to a new learning environment or a changing learning environment, there is often a period of “cognitive disequilibrium.” If it occurs, then trainees need to become acclimatized to the new learning environment, for example, by discovering that their ideas of knowledge and how to learn may no longer be adequate. Although this period of cognitive disequilibrium is spontaneously induced, trainees are thought to evaluate their situation to trigger positive change. Instructors, therefore, should be cognizant of this period of disequilibrium and pay particular attention to learning processes that will support the trainee to reflect on his/her COL.

Trainees’ COL are situated in and, therefore, can be a product of the environment. When immersed into a new environment for the first time, trainees may experience cognitive
disequilibrium, which elicits a transition period, where they not only need to adjust to the environment but also to the instructional method presented.

1.3.3 COL and the Instructor

Trainees and instructors influence each other whenever learning occurs. Many instructors have pre-conceived notions that teaching is about conveying information in the most efficient manner possible rather than trying to promote conceptual change in their trainees. That is, instructors have their own conceptions of teaching (COT), which influences their teaching approaches.

Research has demonstrated that instructors adopt different teaching approaches in the same context and that too much instructor involvement can lead to dependence. Trigwell and Prosser, for example, interviewed instructors on their teaching approaches and divided their intentions and teaching approaches into two main categories: teacher-centered approaches and trainee-centered approaches. Trainees in a trainee-centered curriculum developed higher level COL whereas trainees in a teacher-centered curriculum developed lower level COL. Entwistle warns against interfering with too many trainees’ learning activities as this may cause dependence. That is, trainees believe that in order to be completely valued in the instructor’s eyes, they must reproduce the instructor’s information and that this reproduction is all that is expected of them. Hence, instructors’ teaching approaches and COT can have both positive and negative impacts on trainees’ perceptions, COL, and learning outcomes.

Vermunt and Verloop suggest a friction that can occur between trainees’ learning
approaches and instructors’ teaching approaches.\textsuperscript{42} Brydges \textit{et al} have also suggested friction was a potential negative factor associated with their DSRL booklet.\textsuperscript{14} That is, participants who were forced to use a timing-based approach with the DSRL booklet were not being able to actively create their own conceptual framework for cardiac auscultation skill acquisition. Friction can be both positive and negative and trainees likely experience both in any given learning situation. Further research is needed at encouraging periods of positive friction and diminishing periods of negative friction. To accomplish this, researchers must attend to the interplay between COL and the environment, the instructor, and the trainee.

1.3.4 COL and the Trainee

Trainees’ COL are also shaped by their perceptions about themselves as trainees and by their perceptions about learning. Sadlo and Richardson demonstrated that when trainees’ perceptions for the same course were controlled for, trainees’ COL varied and that each trainee adopted different approaches depending on his/her COL and conception of himself/herself as an individual trainee.\textsuperscript{43} In 1976, Marton demonstrated that trainees who take on a higher level COL (e.g., understanding, seeing things in a different way, and changing one’s values) view themselves as active trainees in their learning whereas those who take on a lower level COL (e.g., increasing knowledge, memorizing and reproducing, and applying) view themselves as passive trainees to whom learning just happens.\textsuperscript{44} Thus, trainees’ levels of COL are influenced by their perceptions of themselves as trainees.

For example, one study that depicts the relationship between trainees’ characteristics and their COL showed that trainees with high SRL practices and higher level COL did not need
detailed manuals for learning (i.e., they apply their own methods and find their own answers), whereas undirected trainees who adopted lower level COL would like external sources available to them more often.\textsuperscript{45} Learning is therefore impacted not only by the environment but also by the instructor’s conceptions and a trainee’s perception of himself/herself as a trainee.

1.3.5 Evidence in the HPE Literature

Research on COL and COT in HPE is limited. However, some empirical work does exist for medical education. One seminal study compared the COL and study practices described by psychology and medical trainees.\textsuperscript{46} Medical trainees used “externally-regulated, reproduction-directed learning” whereas psychology trainees used “self-regulated, meaning-directed learning.”\textsuperscript{46} In simplistic terms, medical trainees applied lower level COL whereas psychology trainees applied higher level COL. In a second study, 67 medical trainees were tracked over time and researchers found that those trainees with higher level COL had higher pre-clerkship and clinical grades than those trainees with lower level COL.\textsuperscript{47} A third study showed a discrepancy between medical trainees’ stated COL (i.e., often higher level COL) and the study approaches that they used (i.e., often lower level COL).\textsuperscript{48} Further analysis suggested that the learning environment in medical school appeared to cause this ‘dissonance’ for the trainees and that the medical trainees chose approaches to satisfy curricular and staff physician demands rather than their own learning goals.

As medical trainees progress into clerkship, their focus widens from knowledge acquisition to overall competence, but one study suggests that this shift has no effect on COL.\textsuperscript{49} Yet reviews in the general educational literature suggest that interventions can alter trainees’
COL and that those changes, consequently, can alter learning approaches. A substantial body of evidence demonstrating COL influences on learning outcomes exists for undergraduate trainees.\textsuperscript{50-55} However, studies that link learning conceptions with learning outcomes in HPE remain scarce.\textsuperscript{26}

Lycke \textit{et al} compared COL and learning outcomes between trainees enrolled in a problem-based learning (PBL) curriculum and those in a traditional curriculum over six years.\textsuperscript{56} They demonstrated that although there were no between-group differences on factual knowledge, the PBL group used significantly more SRL approaches to process learning results and content.\textsuperscript{56} Furthermore, the PBL trainees regarded learning as knowledge construction, held higher standards for their instructor, thought about learning as relying on their own initiatives and processes to arriving to their own outcomes (i.e., congruent with their learning approaches), and regarded themselves as active trainees in collaborating with their peers. Therefore, the type of curriculum in which trainees learn can have an impact on COL in HPE.

In summary, evidence from a number of education-related literatures show that COL are content and context specific, and are influenced by trainees’ perceptions of the environment, by their perceptions of their instructor and by their perceptions about themselves and the way they view learning. Much evidence for COL exists in the general educational and psychology literature, but research in HPE remains scarce. Hence, there appears to be a need to focus attention on which factors affect trainees’ COL in HPE. In particular, this thesis is focused on whether the situated COL that trainees develop in a specific practice session are sustained and/or transferred across time.
1.4 Transfer and Preparation for Future Learning

1.4.1 Transfer of Learning

Theorists describe preparation for future learning (PFL) as the ability to acquire new knowledge from available resources, past experiences, and be innovative with problem solving the task at hand.\textsuperscript{57-59} Ensuring trainees engage in PFL is particularly important because the best problem-solving instruction is unable to prepare a trainee for every possible future scenario that she/he may encounter.\textsuperscript{41} Although the medical community created a prototypical lifelong learner, what has been poorly studied is the ability for trainees to apply their knowledge, skills, and approaches to future situations, a phenomenon known as \textit{transfer}.

Transfer is the act of deploying strategic knowledge and content stored in long-term memory in order to solve novel encountered situations that are structurally and conceptually similar to prior learning situations.\textsuperscript{58, 59} An on-going debate around transfer has some researchers suggesting that transfer rarely occurs,\textsuperscript{60} whereas others believe that it is ubiquitous.\textsuperscript{61} The factors that promote positive transfer (i.e., learning in one context improves learning in a new context)\textsuperscript{62} and those that inhibit negative transfer (i.e., previous learning experience inhibits learning in a new context)\textsuperscript{62} would maximize trainees’ abilities to transfer knowledge to future problems in independent practice.

Traditional models of transfer, defined as applying what was learned in one situation to a new situation, did not show positive transfer consistently.\textsuperscript{63, 64} The lack of evidence supporting positive transfer has led to a shift in the way researchers view transfer, for example, by looking at trainees’ epistemologies,\textsuperscript{65, 66} looking at how they activate segments of knowledge,\textsuperscript{67} and
looking at how knowledge is constructed based on previous knowledge.\textsuperscript{68} Hence, the questions researchers ask have shifted from researchers’ pre-conceived definition of transfer to a trainee-centric definition of transfer. Despite much research over the past century, transfer researchers have yet to come to a consensus as to the best way to study transfer, how best to define transfer, and how transfer occurs in medical education.

1.4.2 Types of Knowing

Broudy studied ways of knowing and educational experiences with the goal of understanding how to prepare trainees for life rather than for test taking. Broudy derived three types of knowing: \emph{replicative, applicative, and interpretive}.\textsuperscript{59}

A trainee demonstrates replicative knowing by directly recalling what was learned in a teaching session and subsequently using this knowledge as needed in a similar situation. Although replicative knowing is the ‘lowest’ form in Broudy’s categorization, without activating this prior knowledge, trainees’ more complex mental processes would be disorganized. One might suggest that Broudy’s replicative form of knowing aligns with Saljo’s lower level COLs including ‘increasing knowledge’ and ‘memorizing and reproducing knowledge’.

A slightly higher order type of knowing is what Broudy called applicative knowing. Through applicative knowing, a trainee can deduce a solution to a new problem using prior knowledge. Therefore, knowledge learned in one context can be applied to a subsequent situation, and this type of knowing parallels Saljo’s COL termed ‘application’.
Interpretive knowing occurs when trainees categorize knowledge and make inferences based on this knowledge. Although interpretive knowledge involves using prior knowledge and experiences, it is not simply replicating or applying that previous knowledge. That is, interpretive knowledge elicits a situational response. And even though a trainee may not recall the specifics of a particular knowledge base, he/she is able to use what was previously learned to solve a novel problem in the present given context. Broudy’s interpretive way of knowing mirrors Saljo’s higher level COL categories, where learning and knowledge are seen as more meaning-making processes, and where individuals understand and see things a different way. In turn, they are able to apply their knowledge to novel situations, based on the present context, bringing certain knowledge items back in their focus even though they may have been previously placed in the periphery.

1.4.3 Evidence in the HPE Literature

A recent study of first year medical trainees learning cardiac auscultation skills demonstrated that those who studied mitral regurgitation exclusively using a cardiopulmonary patient simulator were better able to identify and diagnose mitral regurgitation on real patients than participants who studied aortic stenosis exclusively using the cardiopulmonary patient simulator and participants who did not train with any cardiopulmonary patient simulator (p=0.0005 and p=0.01, respectively for identification and diagnosis). Using Broudy’s classification, this is an example of a study of replicative knowing – it is not surprising that participants who study MR are better able to identify and diagnose MR in real patients than other participants who studied other cardiac valvular pathologies or compared to no intervention.
In another study, de Giovanni *et al.* studied third year medical trainees’ ability to transfer knowledge from simulation-based training to real patients for diagnosing cardiac murmurs. All participants received one hour of didactic teaching and were then randomized to one of two research arms: 3h of teaching on Harvey© compared to 3h of instruction using a CD of heart sounds. After a six-week delay period, all participants were invited to return and were tested on real patients with stable cardiac murmurs. Results indicate that the Harvey©-trained group performed slightly better on identifying heart sounds, but this was not statistically significant (p=0.06). There were no significant group differences on diagnostic accuracy, communication skills, and physical exam skills. Using Broudy’s classification, this is an example of an applicative study – participants trained on Harvey© were no better able to transfer (i.e., apply) cardiac auscultation skills learned using their simulator to real patients than those learning with a CD.

While each of these studies demonstrate variable success of inducing replicative and applicative knowing in medical trainees using simulation-based training for cardiac auscultation skills, what is absent are studies of interpretative knowing. In particular, the literature review yields no studies (for any clinical training) that included an assessment of how trainees’ use the knowledge and approaches acquired in previous situations to solve novel problems. A study that aims to compare the influence of different interventions on all three ways of knowing would be an important ‘knowledge translation’ study of Broudy’s framework into HPE literature. This dissertation is focused on trainees’ replicative and applicative knowing of cardiac auscultation skills.
1.5 Research Aims and Hypotheses

1.5.1 Research Aims

Using similar techniques as Brydges et al., this dissertation compares the effects of IRL and SRL interventions on novice medical trainees’ learning approaches (i.e., sequences used to practice cardiac murmurs), and on their cardiac auscultation skill acquisition and skill retention in a simulation-based educational context. Our main research questions include:

(i) How does IRL compare to SRL for acquisition and retention of cardiac auscultation skills?

(ii) How does the instructors’ teaching approach affect trainees’ transfer of that approach to a future learning session? Relatedly, how do the learning approaches of SRL trainees transfer to a future learning session?

(iii) How do trainees’ perceptions of their learning align with their observed behaviours?

To better understand whether or not participants are aware of transferring their instructors’ teaching approaches and whether this transfer/lack of transfer has an impact on performance-based assessments, we mixed both qualitative and quantitative research methods and utilized a concurrent study design in order to attribute equal weighting to both methods.

1.5.2 Hypotheses

(i) In relation to research aim #1, we have two main hypotheses that are based on a previous systematic review and meta-analysis that compared SRL and IRL interventions. First, we expected participants in the IRL group to perform better than
the participants in the SRL group for immediate cardiac auscultation skill learning, and for the IRL group to learn more efficiently (i.e., take less time). Second, we expected that participants in the SRL group would perform better than participants in the IRL group on skill retention tests.

(ii) In relation to research aim #2, we have two main hypotheses based on the literature describing the relationship between trainees’ self-perceived COL and their behaviours. First, we expected that participants from the IRL group would transfer the approach taught to them by the instructor to a future learning session with a new set of murmurs. Second, based on the previous work of Brydges et al.,\textsuperscript{14} we expected that participants in the SRL group would use a consistent learning approach across two learning sessions.

(iii) In relation to research aim #3, this is an exploratory component of the mixed methods design, and typically an \textit{a priori} hypothesis is inappropriate. However, previous research suggests that medical trainees are not aware of their learning approaches and state they employ higher level COL when in reality they use lower level COL.\textsuperscript{48} Therefore, we expected that participants in the IRL group would not be aware of their learning approaches and would possess lower level COL.
Chapter 2
Methods and Materials

2 Methods and Materials

2.1 Experimental Design

We conducted a convergent, mixed methods design, specifically a concurrent triangulation design (see Figure 2). This design allows different, yet complementary data to be collected concurrently and analyzed separately, in an effort to corroborate the results from the different data sources.

**Figure 2.** Schema depicting a convergent, mixed methods, concurrent triangulation design. Modified from Creswell.\(^7\)
QUANTITATIVE COMPONENT

We conducted a prospective, randomized controlled trial evaluating the effects of SRL (representing our ‘control group’ to determine trainees’ learning approaches when learning cardiac auscultation skills independently) and IRL (i.e., one-on-one instructor-trainee interaction) on cardiac auscultation skill acquisition and retention. Our full design included two practice sessions: the first ended with an immediate post-test, while the second began with a retention test which was followed by a second ‘transfer’ practice session in which participants self-regulated their learning of a second set of murmurs and were tested once more. Hence, our design allowed us to test learning retention and the transfer of learning approaches between the two sessions.

QUALITATIVE COMPONENT

We conducted one semi-structured interview per participant at the end of the second training session to better understand how participants acquire cardiac auscultation skills. The initial interview guide was developed using questions aimed at understanding the learning approaches trainees use within this specific study, and more generally, in all their learning. We refined the initial interview guide continually based on the initial emerging concepts that trainees articulated.

2.2 Ethics Approval

We received ethics approval from the University of Toronto, Office of Research Ethics (Protocol Reference Number 28412).
2.3 Participants

Our sample size was determined using an *a priori* power analysis calculation where we set an increase in mean difference of 20% as per prior research,\(^2\) one standard deviation of 0.2 based on a previous study,\(^2\) power of 0.8, and a one-tailed alpha set at 0.05. Our primary outcome measure used for this calculation is diagnostic accuracy. Non-parametric analysis sample size calculation adjustment was performed using Pitman asymptotic relative efficiency, which compares the relative efficiency of two competing tests (i.e., Fisher’s Exact test compared to the independent student t-test) thereby resulting in the ratio of sample sizes required for equal power using the two tests. The upper limit of the ARE for this power analysis calculation is approximately 1,\(^3\) which results in a total sample size of 32 (i.e., 32/1 = 32), with 16 participants per research arm.

To sample participants for the semi-structured interviews, we performed stratified random sampling meaning that first and second year medical trainees were randomized to either the SRL or the IRL condition (balancing total number of first and second year medical trainees within each research condition). Furthermore, we performed stratified purposeful sampling to equally sample participants who trained with each of the four instructors in the IRL group (details on instructors provided below). This sampling strategy was employed to capture a rich understanding of participants’ experiences with the different attending physicians who acted as instructors within the study.
2.4 Materials

2.4.1 Simulator

We used a commercially available cardiopulmonary patient simulator (Harvey©).

2.4.2 Murmurs

Two sets of six murmurs were created for this project. Firstly, set one included mitral regurgitation (MR), aortic stenosis (AS), mitral stenosis (MS), aortic regurgitation (AR), AS+AR, and MR+MS, which are all left-sided murmurs. The first set of murmurs was used in a previous study on DSRL interventions described above. Our collaborators at the University of Miami developed a second variation of each murmur (i.e., MR from a different patient) that we used for the immediate post-test. Secondly, set two included pulmonic regurgitation (PR), tricuspid stenosis (TS), pulmonic stenosis (PS), tricuspid regurgitation (TR), MR+TS, and MR+PR, which are predominantly right-sided murmurs. Our collaborators at the University of Miami (BI and RS) created the murmurs based on our theoretical framework (i.e., balancing the predominantly left-sided murmurs for practice session one with right-sided murmurs for practice session two). To increase content validity, the author (GRL) and one of the cardiologist instructors listened to all of the murmurs and noted the characteristics present and absent for each murmur, which led to some refinement by the programmers at University of Miami.

2.4.3 Video

Brydges et al. previously created an instructional video to orient trainees to basic cardiac auscultation skills. The video was divided into two sections: (i) a 15-minute introductory session, and (ii) a 15-minute murmur module. The 15-minute introductory session included an
introduction to Harvey®, stethoscope use, basics of cardiac auscultation skills (i.e., location, timing, shape, and radiation), and animations depicting the physiology, the pathophysiology, and the phonocardiograms along with their respective audio files for each murmur. The 15-minute murmur module allowed trainees to choose how they wished to sequence murmur practice (i.e., AS, MR, AR, MS, AS/AR, MR/MS, and TR). The video did not provide any conceptual framework. For specifics, please refer to Brydges et al. A copy of this instructional video was supplied to each instructor well in advance to study start date. Each instructor was told that he/she could teach outside of the constraints supplied in the video and that teaching session should be a dynamic experience influenced by both the instructor and the participant.

2.5 Study Setting

All participants received an orientation to the simulation lab at the Helliwell Centre, Toronto General Hospital at University Health Network, and to the simulator’s use and features. Specifically, all participants were oriented to the stethoscope, the carotid pulse along with the jugular venous pulse, the specific locations for cardiac auscultation along with the specific location for murmur radiations on the cardiopulmonary patient simulator. Participants within the SRL group were oriented to the laptop along with navigating the instructional video.

2.6 Educational Interventions

Self-Regulated Learning (SRL): Following the instructional video, participants chose how to organize their practice of the murmurs. As practice progressed, each participant was able to ask the research assistant (RA) to select a specific murmur to be presented on the simulator. The participant then practiced until she/he wished to switch to a different murmur, and this process
was repeated. Therefore, participants in the SRL group had full control over the structuring and sequencing of the practice session.

Instructor-Regulated Learning (IRL): Each instructor taught the same set of six murmurs that the SRL group learned. Each instructor received a copy of the same instructional video that was supplied to the participants randomized to the SRL group. The participants in the IRL group were involved in a dynamic learning setting in which they and the instructor mutually controlled the time spent on each murmur.

2.7 Data Collection Procedures

All data were collected from the end of September 2013 up until the beginning of March 2014 at a mutually-convenient time for the participants and the instructors.

2.7.1 Pilot Work

We conducted pilot work where four graduate trainees were approached to participate in trialing our research protocol for the SRL group. We trialed our protocol with four murmurs that were already present within the Harvey® murmur library (e.g., normal, aortic stenosis, mild aortic regurgitation, and mild mitral regurgitation). Based on this experience, murmurs, session times, and logistics (i.e., RA field notes) were refined and we were ready for full protocol implementation.
2.7.2 Initial Practice Session and Immediate Post-Test

The overall flow of the entire study protocol is provided in Figure 3. After signing the consent form, participants reported their age, gender, level of experience performing the cardiac physical exam (e.g., 5-pt Likert scale from 1=”no experience” to 5=”very experienced”), their previous experience with cardiac physical examination skills on both live patients and on simulators (e.g., time spent, in hours), if they have any hearing impairments, and if they have any musical training. We used these data as a baseline measure of experience rather than using a pre-test. We chose not to use a pre-test for logistical reasons and because our previous work suggested that medical trainees at this level of training have equivalent background experience at baseline.14
Figure 3. Trial flow diagram depicting study design as well as participant randomization to either the IRL or SRL condition.
During the initial practice session, participants had up to 60 minutes to practice identifying the six murmurs. Participants in the SRL group were able to take notes and re-watch the video. The RA documented the sequence of murmurs in which each participant wanted to practice learning the murmurs. Participants in the IRL group experienced the session as the natural progression that occurred during their interaction with the instructor. The RA documented field notes based on the interactions between participant and instructor and documented the sequence in which the participant and instructor mutually chose to learn the murmurs.

The RA documented the sequence in which participants from both groups practiced the murmurs. From the sequence, the RA aimed to deduce the participants’ learning approaches. That is, if participants (and/or instructors with the participant) practiced the murmurs according to location over the precordium (e.g., AS, AR, MS, MR), a location-based approach was deduced. If participants practiced the murmurs according to when they occur within the cardiac cycle, a timing-based approach was deduced (e.g., AS, MR, AR, MS). The other commonly used learning approaches were murmur-based (e.g., AR, MR, AS, MS) and random.

Immediately following the practice session, participants completed a post-test. Twelve murmurs (i.e., two variations of each practiced murmur) were presented in a random sequence, and this sequence was the same for all participants (e.g., MR/MS, MR, AS/AR, AS, AR, MS, MR, MR/MS, AS, AS/AR, MS, and AR). The murmur code on Harvey’s head, was hidden from the participant with a blank page at all stages of testing. For each murmur, participants had up to 60 seconds to examine the simulator and record a diagnosis along with their confidence in their diagnostic accuracy on a 5-point Likert scale. Participants were not able to see the duration it took them to arrive to their diagnosis but were
told to stop if instructed to do so at the 60-second mark. The first attempt at cardiac auscultation on this test was video-taped in order to evaluate each participant’s approach to physical examination. The RA then asked participants to provide a diagnostic justification of their diagnosis for the first 6 murmurs, specifically asking participants to fully characterize the murmur to the best of their ability. This conversation was audio recorded (i.e., murmurs include MR/MS, MR, AS/AR, AS, AR, and MS). Following the post-test, participants provided their self-reported confidence performing auscultation (e.g., 11-pt Likert scale), satisfaction with their learning, and an overall evaluation of the session (e.g., 11-pt Likert scale) as per Appendix II.

2.7.3 Delayed Retention Test and ‘Transfer’ Practice Session

Approximately two weeks after the initial session, participants returned to complete a retention test of the same 12 murmurs from the immediate post-test yet in a different random order (i.e., MR, MR/MS, AS, AS/AR, MS, AR, MR/MS, MR, AS/AR, AS, AR, and MS), which allowed us to assess their skill retention. For each murmur, participants were given 60 seconds to examine the simulator. Participants were asked to record their final diagnosis and circle their confidence with their diagnostic accuracy on a 5-point Likert scale as per Appendix III. Participants also provided diagnostic justification for six murmurs (i.e., one variation of each murmur in the first practice session; MR, MR/MS, AS, AS/AR, MS, and AR), and this conversation was audio recorded.

Next, participants completed a ‘transfer’ practice session with a set of murmurs with similar characteristics to those learned during the first session, yet distinct as defined above. Deliberately, participants received no explicit instructions and the instructional video was not available. Hence,
for both groups, the 60-minute session proceeded in an entirely self-regulated manner (i.e., as experienced by the SRL group in the first session). During this second session, participants from both groups generated their own sequence for practicing the murmurs, and the RA noted this sequence. Following practice, another immediate post-test required participants to provide their diagnosis for the 12 murmurs (i.e., MR/PR, PR, MR/TS, TS, TR, PS, PR, MR/PR, TS, MR/TS, PS, and TR) and circle their confidence in their diagnostic accuracy. Participants also provided their diagnostic justification for 6 murmurs (i.e., one variation of each murmur in the first practice session; MR/PR, PR, MR/TS, TS, TR, and PS), and this conversation was audio recorded.

2.7.4 Post-Session Semi-Structured Interviews

The initial guide to baseline questions for the semi-structured interviews was refined from 5 major themes to 4 major themes. This was an iterative process where the initial questions were cultivated by the two main co-PIs. These were subsequently sent to 2 qualitative research experts for further refinement. Constant comparison ensued, and respecting the iterative process of qualitative research, the interview guide was refined a total of four times as themes emerged (Appendices VI and VII). These emergent themes were then refined, where duplicate themes were categorized together, and the five main themes presented herein resulted. A collaborative meeting was subsequently held where three members of the team met to agree on a theoretical framework of emergent themes. Saturation dictated the number of interviews performed.

The interview guide was designed to explore participants’ COL, awareness of their own learning approaches along with their instructor’s teaching approaches, and general learning.
Immediately after the transfer practice session, the RA conducted an audio-recorded interview with the participants for approximately 30 minutes. In the interview, the RA asked participants to describe their approaches for learning in this second session (i.e., how did they set expectations? and why did they sequence the murmurs in the order they chose?). For the SRL group, the RA probed further to understand the rationale behind why the participant chose a particular sequence. For the IRL group, a key factor was whether the sequence that participants chose was the same ‘approach’ the instructor taught them in the first session. First, the RA asked participants if they understood the sequence that they used (i.e., was it a conscious decision to use that sequence?). Second, participants were asked to recall the principles taught to them by the instructor in the previous session and to comment on whether they thought their approach matched or did not match. Finally, in either case (i.e., a match or mismatch with the instructor’s approach), the participants were asked if they were aware of the match/mismatch and to comment on this information.

The PI maintained confidentiality and privacy by performing the semi-structured interviews in the same room that the study took place with nobody else present in the room. Participants were also reassured that all information remained confidential and that they were provided with a participant number that could not be tracked by anyone other than the RA. Participants were also reassured that any identifying information would be removed and that all audio-recordings would be transcribed so that their voices would not be identified. Each semi-structured interview ranged from 20-45 minutes in duration.

2.7.4.1 Reflexivity
I am currently an MSc trainee at the University of Toronto, Institute of Medical Sciences conducting research in medical education at The Wilson Centre. I am concurrently a PGY-4 in Anesthesiology – Clinician Investigator Program here at the University of Toronto. My experience in medical education research is shaped by two main factors: trainee/educator-based and methods-based.

I have been an instructor for the University of Toronto, Faculty of Medicine’s Art and Science of Clinical Medicine (i.e., longitudinal weekly class where trainees learn all components of history-taking and physical exam skills) for the last four years. This sparked a desire during the research process to supply trainees with the most robust and efficient educational experience that provided a better understanding of the importance of these skills for long-term patient care. My interest in medical education research was also evoked by my teaching evaluations, where I continue to want to improve taking into consideration trainees’ constructive feedback. At times, we tend to forget the overwhelming nature of medical school, where trainees feel as though a plethora of information is being imparted to them, and we forget the ‘information overload’ that we once experienced. I thought to myself, how can we as instructors best teach a subject so that trainees can learn, but as we try to teach with best evidence in education, we notice that the evidence in medical education is scarce.

My first experience with research in medical education started July 2012. My appreciation for medical education research stems from having taught numerous courses and lectures at the undergraduate level and having a different daily clinical experience throughout my residency training. With an interest in creating better education and to continue being a clinician-
investigator-educator in the future, medical education research intrigued me. I developed an appreciation for the difficult nature of medical education research throughout this process.

My background in research stemmed from years of basic science and clinical research, ranging from organic chemistry, to cell biology, to immunology in HIV, to other clinical directions. My experience in research gave me a great foundation for basic science research and experience in quantitative research methodologies. However, I wanted to challenge myself and learn newer methodologies and methods for questions that could not necessarily be answered by a randomized controlled trial. This led me to mixed method designs, which allow researchers to supplement randomized controlled trial data with qualitative research.

Learning to perform qualitative research has been challenging at times, learning to switch from a positivistic, quantitative paradigm to a post-positivistic approach. Learning to adjust my way of thinking from one “truth” to multiple truths was an easier shift once immersed in the emergent conceptual framework from the qualitative data. These shifts have given me a greater appreciation for a constructivist way of knowing.

Recognizing that qualitative research is a co-construction between instructors, trainees, and myself, the lens that I bring forward is based on my research background, my clinical experience, and my future directions. Qualitative research deals with assigning meaning to individuals’ experiences. As I do come from a clinical background, and having been exposed to a number of clinical specialties, I became self-aware that my prior experiences may potentially shape the research process. I needed to be mindful of any preconceptions and purposefully challenge myself so as to assign the proper meaning to individuals’ experiences and not take any
preconceived notions and knowledge that I may have had into consideration. By immersing myself in the educational environment, I allowed my understanding of a first and/or second year medical trainee learning cardiac auscultation skills emerge from observing their interactions with the instructor, with the cardiopulmonary patient simulator, with the educational video and from the interviews. To maintain reflexivity, my non-clinical committee members were able to challenge and balance my clinical opinions.

2.8 Outcome Measures

Our primary outcome measures were participants’ diagnostic accuracy on the immediate post-test, the two-week delayed retention test and immediate post-test #2. We marked all tests on a dichotomous scale (i.e., 0 for incorrect and 1 for correct), with a maximum allowable score of 12, and converted these scores into percentages for each session. For diagnostic justification, two blinded raters independently scored each diagnostic justification according to a 5-point Likert scale (please see Appendix VII). Participants only had to provide their diagnostic justification for the six new variations of the murmurs (i.e., those they did not practice). Therefore, the maximum allowable score was 30, and these scores were converted into percentages for each session. For physical exam scores, two blinded raters independently scored each video according to a 5-point Likert scale (please see Appendix VIII). Only the first physical exam per session was video-recorded. Therefore, the maximum allowable score was 5.

2.9 Validity Evidence for Diagnostic Justification Metric Tool

After receiving informed written consent at The University of Miami, Gordon Centre for Research in Medical Education, to create the marking rubric for the diagnostic justification, six American cardiologists were independently asked to assess the murmurs used in this study. Each
cardiologist followed the same protocol as each participant in this study. In this fashion, we accumulated content validity evidence for our tool. After having discussed the results of the Miami Cardiologists data with two of our instructors who had completed being active instructors in our study, we derived a marking rubric for all diagnostic justifications appropriate for a first and second year medical trainee.

Next, the principal investigator (PI) taught two raters how to use the marking rubric. The raters were both end of year post-graduate year three in Internal Medicine, one starting a fellowship in Cardiology and the other in Critical Care Medicine. Two independent raters subsequently rated each diagnostic justification. Of note, each set of videos was randomized for each rater so as to respect the rater cognition literature and not have our results subjected to both contrast effects and assimilation effects. An overall grade was assigned for each testing scenario, and an intra-class correlation coefficient (ICC) was calculated.

For the physical exam videos, raters were taught on using the marking rubric. The raters were both MD/PhDs, one a post-graduate year three in Anesthesiology and the other a fellow in Anesthesiology. The fellow in Anesthesiology is currently pursuing a master’s of education. Two raters rated five videos independently according to our global rating scale (GRS; please see Appendix VIII). After reviewing those five videos collectively, we discussed reasons for having chosen the rating they chose. After approximately 1.5h of teaching, the two raters reached consensus on accurate representations for nine videos rated in the presence of the RA. Two blinded raters independently evaluated the videos based on our global rating scale (GRS; please see Appendix VIII), and subsequently, an ICC was calculated.
2.10 Data Analysis

**Quantitative Data:** We analyzed participants’ demographic data of post-graduate training level, gender, and number of previous simulation experiences, along with their baseline data (e.g., experience of the cardiac physical exam) and post-practice self-reported data (e.g., satisfaction) using different tests that depended on the data. Specifically, we used the Fisher’s Exact test if the expected frequency for each cell was <5 and a Chi-squared test of independence if the expected frequency for each cell was >5 (i.e., for all nominal data), the Mann–Whitney-U test (i.e., for all ordinal data), and the independent samples student t-tests (i.e., for all continuous data).

We used Fisher’s Exact test to investigate differences in participants’ learning sequences across the two learning sessions. Specifically, participants’ learning sequences within the SRL group in session one were compared to their learning sequences in session two. Similarly, participants’ learning sequences within the IRL group in session one were compared to their learning sequences in session two.

For the immediate post-test and the retention test, our primary outcome was participants’ diagnostic accuracy. To examine between-group and within-group differences on these two tests (same 12 murmurs on each test), we used a mixed-design analysis of variance (ANOVA) for diagnostic accuracy (i.e., sum of all correct diagnoses converted to a percentage). For all 2x2 mixed-design ANOVAs, we did not need to check Mauchly’s assumption of sphericity, as only two levels exist (i.e., sphericity is therefore assumed). To surpass any assumption of sphericity, a multivariate analysis was asked for along with the univariate analysis mentioned above, and the two results were corroborated. We report Wilk’s lambda for each analysis as it explains the percentage of unexplained variance. Levene’s test for homogeneity of variances was taken into
account.

We used independent samples t-tests to examine between-group differences on transfer diagnostic accuracy for post-test two and total practice time for all sessions. The aforementioned analyses were also performed for participants’ confidence, where the sum of all the confidence scores per session (5-point Likert scale) were added and converted into a percentage. We set alpha (one-tailed) at p<.05 for all analyses.

Hedges’ g ES was classified according to the standard classification, where <0.2 is negligible, 0.2-0.5 is small, 0.5-0.8 is moderate, and >0.8 is large.\textsuperscript{75}

Inter-rater reliability was calculated according to a two-way mixed, consistency, single measures and average measures intra-class correlation (ICC), as this is equivalent to the weighted kappa.\textsuperscript{76, 77} Importantly, calculation of the ICC supplies us with internal structure (i.e., related to reliability) validity evidence.

\textbf{Qualitative Data:} The semi-structured interview data was both inductively and deductively coded. For the inductive coding, we used the Framework Method for the management and the analysis of the semi-structured interview data.\textsuperscript{78} Preliminary analysis of the interview data occurred concurrently with data collection, meaning the development of understanding of the data was refined through iterative constant comparative analysis with ‘fresh’ examples from ongoing data collection. Independently, the PI open coded six initial transcripts (four from the SRL group and two from the IRL group) on a line-by-line basis. Independently, and simultaneously to the PI, the supervisor (RB) open coded four transcripts. Subsequently, the two met to discuss new
emerging themes, and to make changes to the initial interview guide. Preliminary categories were identified during data collection through constant comparative analysis. We went through this iteration three times. Subsequently, the two conducted a thematic, inductive analysis of the transcribed interviews to uncover broad, emergent themes. An analytical framework was agreed upon, and these emergent themes within the analytical framework were subsequently indexed to all transcripts (PI) using NVivo 9 (QSR International). As these themes were explored, we used the theoretical frameworks that inform this research, such as the social cognitive theory of SRL, triadic reciprocality, and COL. At all stages of data collection, the PI created an audit trail of memos. Inconsistent performance-based assessment data were further explored, representing the mixing of methods. Throughout data collection, we purposefully investigated emerging themes and identified negative examples to ensure the resulting categories were representative. This team approach to data analysis enhanced dependability of the results. As we developed and redeveloped codes at each stage of our analysis, we documented our decisions to enhance confirmability.

From the semi-structured interviews in which all participants were asked, *how do you define learning*, all transcripts were deductively coded using Saljo’s five categories of COL (and added the 6th category from Marton et al.). For this deductive coding, we used a similar process to that described for the inductive coding.

The diversity of all team members within the project added to the reflexivity process at all phases of data collection.
Chapter 3

Results

3 Results

3.1 Study Flow

As shown in Figure 3, we allocated 32 first and second year medical trainees to either the SRL group or the IRL group.

As one participant within the SRL group was a clear outlier (i.e., >2 standard deviations), this participant was excluded from our data analysis. A teaching session was provided for this particular participant, during which the PI uncovered that the participant felt extreme pressure during the time-restricted examination of Harvey®.

3.2 Demographic Data

Participants’ demographic data are reported in Table 1.
Table 1. Summary of demographic data. All nominal data were analyzed according to Fisher’s exact, all ordinal data were analyzed with a Mann-Whitney U test, and all continuous variables were analyzed with independent samples t-tests (assumptions met for each test). $M =$ median, $SD =$ standard deviation, $IQR =$ interquartile range, and CPS = cardiopulmonary patient simulator.

<table>
<thead>
<tr>
<th></th>
<th>SRL (n=16)</th>
<th>IRL (n=16)</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Trainee Year, median (IQR)</td>
<td>2 (1-2)</td>
<td>2 (1-2)</td>
<td>0.64</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>23.13±1.20</td>
<td>23.81±2.69</td>
<td>0.36</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>62.5</td>
<td>43.8</td>
<td>0.29</td>
</tr>
<tr>
<td>Experience with physical exam, median (IQR)</td>
<td>2 (2-3)</td>
<td>2.5 (2-3)</td>
<td>0.38</td>
</tr>
<tr>
<td>Hours on Harvey®, mean (SD)</td>
<td>0.41±0.64</td>
<td>0.08±0.26</td>
<td>0.08</td>
</tr>
<tr>
<td>Hours on other CPS, mean (SD)</td>
<td>0.08±0.25</td>
<td>0.06±0.25</td>
<td>0.86</td>
</tr>
<tr>
<td>Hearing pathologies (% yes)</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Musical training (% yes)</td>
<td>56.3</td>
<td>62.5</td>
<td>1</td>
</tr>
</tbody>
</table>
3.3 Results Related to Research Aim #1: Performance Differences Between SRL and IRL Groups

3.3.1 Diagnostic Accuracy

The results of the ANOVA indicate that there was no significant test by group interaction, Wilk’s $\Lambda=0.95$, $F(1,31)=1.60$, $p=0.22$. There were no significant main effects for test $[F(31)=1.60, p=0.22]$ or group $[F(1)=0.90, p=0.35]$. Our t-test also suggests no significant between-group difference on immediate post-test #2 ($p=0.56$, 95% CI [-13.94, 7.69]). All results for diagnostic accuracy are shown in Figure 4.
Figure 4. Diagnostic accuracy (percentage ± STD) for all three tests for both the SRL and IRL groups. No difference was statistically significant. A negligible effect (Hedges’ g=0.03) favouring the SRL group was found for session one’s post-test, whereas a moderate effect (Hedges’ g=0.55) favouring the SRL group was determined on the retention test. A small effect (Hedges’ g=0.20) favouring the IRL group was determined for immediate post-test #2.
As for participants’ self-reported confidence for all three sessions, there were no significant between-group differences (Figure 5). The results of the ANOVA indicated that there was no significant test by group interaction, Wilk’s $\Lambda=0.93; F(1,31)=2.31; p=0.14$. There was a significant main effect for test \(F(31)=8.53, p=0.007\), suggesting the confidence was lower on retention test. However, we did not observe a significant group main effect \(F(1)=0.25, p=0.62\). We observed no significant difference on immediate post-test #2 (\(p=0.35, 95\% \text{ CI } [-0.48,0.18]\)).
Figure 5. Confidence (mean ± STD) for all three tests for both the SRL and IRL groups. No between group differences or interactions were statistically significant. A small effect (Hedges’ g=0.39) favouring the SRL group was found for session one’s post-test, whereas a negligible effect (Hedges’ g=0.04) favouring the IRL group was determined on the retention test. A negligible effect (Hedges’ g=0.15) favouring the IRL group was determined for the immediate post-test #2.
3.3.2 Diagnostic Justification

Two independent raters rated 31.25% of all diagnostic justifications with a two-way mixed average measures ICC = 0.86 and a single measures ICC = 0.76. In order to decrease rater mental fatigue, the remaining diagnostic justifications were split, and each rater independently rated his/her respective set.

According to the ANOVA, there was no significant test by group interaction, Wilk’s \( \Lambda = 0.994, F(1.31)=0.18, p=0.67 \). There was a significant main effect for test \( F(1)=7.554, p=0.01 \), suggesting the justification score was lower on retention test. However, we did not observe a significant group main effect \( F(31)=0.53, p=0.47 \). We observed no group difference on immediate post-test #2 (\( p=0.35, 95\% \text{ CI} [-0.48,0.18] \)). All results for diagnostic justification are shown in Figure 6.
Figure 6. Diagnostic justifications (mean ± STD) for all three tests for both the SRL and IRL groups. No between group differences or interactions were statistically significant. A negligible effect (Hedges’ g=0.10) favouring the IRL group was found for session one’s post-test, whereas a small effect (Hedges’ g=0.33) favouring the IRL group was determined on the retention test. A small effect (Hedges’ g=0.32) favouring the IRL group was determined for the immediate post-test #2.
3.3.3 Physical Exam Performance

Two independent raters rated all of the physical exam performances that were videotaped and edited, and inter-rater reliability was poor. The two-way mixed average measures ICC = 0.54 and a single measures ICC = 0.37 based on 92 ratings (four missing data points deleted employing exclude cases analysis by analysis and not list-wise deletion). These poor results might be explained given there was a lag period of three weeks for one rater from time of rater training to time of video ratings. Or it may be that it is difficult for raters to achieve consistency using this particular measure.

The results of the ANOVA indicated that there was no significant test by group interaction, Wilk’s Λ=0.92, F(1,29)=2.37, p=0.14. There were no significant main effects for test (F(29)=0.18, p=0.68) or group (F(1)=0.046, p=0.83). We observed no difference on immediate post-test #2 (p=0.66, 95% CI [-0.91,0.58]). All results for physical exam scores are shown in Figure 7.
Figure 7. Physical exam scores (mean ± STD) for all three tests for both the SRL and IRL groups. No difference was statistically significant. A negligible effect (Hedges’ g=0.14) favouring the SRL group was found for session one’s post-test, and a negligible effect (Hedges’ g=0.05) favouring the SRL group was determined on the retention test. A negligible effect (Hedges’ g=0.16) favouring the IRL group was determined for the immediate post-test #2.
3.3.4 Timing Data

There was no significant difference between the total practice time for the SRL group (1.45±0.23h) and the IRL group (1.28±0.26h) for session one (p=0.056, 95% CI [-0.004,0.35]; Hedges’ g=0.68). Similarly, the two groups did not differ in their time for session two (SRL = 0.62±0.15h; IRL = 0.74±0.29h; p=0.18, 95% CI [-0.28,0.06]; Hedges’ g=0.51). The groups also did not differ in their retention period between the two sessions: the SRL group (14.75±1.39 days) and the IRL group (14.75±1.57 days).

3.3.5 Overall Evaluation

There were no differences between groups’ satisfaction with the sessions, comfort with diagnosing murmurs, and overall evaluation of the study (Table 3).

**Table 3.** Comfort level, satisfaction, and overall evaluation for both groups. All data were analyzed using Mann-Whitney U test, and medians (interquartile ranges) are presented.

<table>
<thead>
<tr>
<th></th>
<th>SRL (n=16)</th>
<th>IRL (n=16)</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>7 (7-8)</td>
<td>8 (7-8)</td>
<td>0.90</td>
</tr>
<tr>
<td>Comfort</td>
<td>9 (8-10)</td>
<td>10 (9-10.75)</td>
<td>0.20</td>
</tr>
<tr>
<td>Overall Evaluation</td>
<td>10 (8-11)</td>
<td>10 (9-11)</td>
<td>0.40</td>
</tr>
</tbody>
</table>
3.4 Results Related to Research Aim #2: Transfer of COL and Learning Approaches for SRL and IRL Groups

There were no between-group differences on immediate and retention performance-based assessments. We also observed a shift of learning approaches, where only four participants maintained their instructors’ teaching approaches from practice session one to practice session two (i.e., behavioural traces). The iterative mixing of methods, whereby the semi-structured interview data complements the quantitative data, sheds light on the lack of differences on performance-based assessments and on the shift of participants’ behavioural trace data.

3.4.1 COL and Learning Approaches

We recorded the sequence in which each participant independently studied the murmurs and how each instructor-participant dyad studied the murmurs. We assumed that the sequence of practice served as a proxy of participants’ learning approaches to cardiac auscultation.

For the SRL group, the participants’ learning sequences from practice session one were compared to their sequences from practice session two using a Fisher’s Exact test demonstrating no significant differences (p=0.84). In session one, four participants used a timing-based approach, eleven used a location-based approach, and one used a murmur-based approach. By contrast, in session two, three used a timing-based approach, ten used a location-based approach, one used a murmur-based approach, and two used a ‘random’ approach (dictated by the order in which the RA listed the to-be-learned murmurs).
On the other hand, for the IRL group, the instructor-participant dyad learning sequences from session one were compared to self-generated learning sequences from practice session two using a Fisher’s Exact test, which showed statistically significant differences in the learning approaches utilized (p<0.0001). In session one, fifteen instructors used a timing-based approach and one instructor used a location-based approach, whereas in session two, only four participants maintained the timing-based approach and the rest diverged (i.e., four participants each used a location-based approach, a murmur-based approach, and a random approach).
**Figure 8.** Learning approaches for both the SRL and the IRL groups for practice sessions one and two.
3.5 Results Related to Research Aim #3: Semi-Structured Interview Data

Our deductive results related to participants’ COL/learning approaches are mapped according to Saljo/Marton’s hierarchical COL framework. In addition to the deductive themes, our inductive themes include: COL, learning strategies, situated confidence, normative pressures, and instructor presence.

3.5.1 Deductively Coded Conceptions of Learning

Table 4. Participants COL deductively coded according to Saljo/Marton’s hierarchical framework.

<table>
<thead>
<tr>
<th>Level</th>
<th>COL</th>
<th>Representative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Increasing</td>
<td>“I think learning is a process whereby you go from having a certain degree of knowledge, it can be... minimal or a lot... and you go about adding to that knowledge so it might be a lot if you have a very small base or less if you are already somewhat of an expert, so it starts somewhere, and learning is a process that happens between the start point and end point of a relatively greater knowledge and skill level.”</td>
</tr>
<tr>
<td></td>
<td>knowledge</td>
<td>-P508</td>
</tr>
<tr>
<td>II</td>
<td>Memorization and Reproduction</td>
<td>“I believe that memorization is a component of understanding, but memorization on its own is just the ability to regurgitate certain facts whereas understanding is knowing what they mean and how to apply it but for understanding to happen, you have to do some memorization …”</td>
</tr>
<tr>
<td>III</td>
<td>Application</td>
<td>“Well, I mean in this context, obviously, [the] clinical skill applied in the future [is] the overall goal of treating patients, retain it, and be able to use it, use the skill, apply knowledge to other situations.”</td>
</tr>
<tr>
<td>IV</td>
<td>Understanding</td>
<td>“I think understanding, well anyone can memorize a set of facts[,] … understanding … especially in this profession, is more an appreciation of what you are learning, so appreciation towards how it affects a prognosis, a diagnosis, a form of treatment, somebody’s well-being, someone’s attitude, those</td>
</tr>
</tbody>
</table>
kinds of things, and you can feel like you understand something again…[I]f you feel how it fits into everything else, you are learning. Learning medicine you feel like you understand part of it and…you can be confident that you understand how it fits into the big picture. That to me is an important goal of all because anyone can memorize slides but being able to understand it, its value and importance unless you have an appreciation for all those other factors.”

-P645

Notably, the last two COL according to Saljo/Marton’s conceptual framework [i.e., seeing things in a different way (i.e., fifth level COL) and changing as a person (i.e., sixth level COL)], although mentioned, did not reach saturation as stand-alone themes in our data.

3.5.2 Inductively Coded Conceptions of Learning

As part of the theme regarding conceptions of learning, inductively, a number of child nodes emerged. A multifaceted nature of learning was a common theme whereby participants believed that learning could occur through many different activities.

“The learning itself is very multi-faceted and it can be learning through teaching others, through having discussions about something, through research on the matter, applying your skill on a simulator, through sitting there and going through your slides and memorizing it but then also making associations in other ways whether it’s like you applying it or reading a research paper on it…I think many, many things that happen consciously but also subconsciously.”
Participants realize that learning can occur through different situations and that a cumulative approach does occur, whereby they can self-regulate their own learning or learn in a guided environment, whether it with an instructor or with instructor-supplied presentations.

Participants recognize the learning process, where one learns an approach to learning and then uses it to learn the content. Participants also recognized that they had no knowledge and left it up to their instructors to provide them with a framework. They adapted their own findings that made more sense to them and dismissed others.

“I felt like I just did not really know what was happening, so I just trusted my instructor to sort of know the way to sequence everything that would make most sense. I did it a little different this time because he did the aortic stenosis and then the mitral regurgitation…and then I found that a little bit confusing to go between the different valves, so I changed that this time on my own. Last time I would not have known the difference, but after I experienced and saw that it was confusing, then I changed it on my own.”

Although participants do want guidance when starting off with no background knowledge in a content area, they appear to adjust the conceptual framework taught to them to make it their own, what resonates most with them, and what offers the least amount of confusion to understand the underlying concepts.
Strategic mindfulness, defined as a trainee’s awareness of how they are using strategies to learn content, became apparent in multiple ways. Participants believed that simulation, although beneficial, would never be fully representative of a clinical task.

“I think everyone needs to practice with real patients a little bit because there is a lot more to it than just learning to distinguish sounds; it’s how to make the patient feel comfortable, it’s how if you have a female and you have a breast there how do you examine the apex that is comfortable for the both of you and learn how to distinguish the sounds on an individual and learn how to tune everything out.”

-P909

Although participants do appreciate learning on simulators, they recognize that the art and science of clinical medicine requires a patient-centered approach to health care.

Participants also acknowledged that two different individuals may have two separate approaches to a clinical presentation.

“People have different experiences, different knowledge, different backgrounds and so they will have two different approaches to the same problem and so when you have two people working together towards the same goal, often they can build off of each other’s strengths and knowledge and different tips and tricks they each have for learning and come up with something that is better and more memorable.”

-P909

Participants see the advantage of collaborating with their peers, whereby an educational experience can be mutually beneficial. Participants also acknowledged that being externally guided early on provided them with the proper techniques needed.
“I know for a fact that I was doing things incorrectly, and I didn’t realize that until several murmurs later that I was doing something incorrectly whereas if I think someone was there during the practice, [he/she] would have corrected me right away or right after that one murmur so when it comes down to the whole motor memory you don’t incur that bad habit…”

-P967

Participants are also mindful that when being taught, confusion may occur, but one who can self-regulate his/her learning will adjust any source of confusion.

“I think now that I realize sometimes instructors do not teach in the best way I learn, I would probably be more wary in my confusion and go back and try to see if there is a better way to go through and do it instead of what the instructor might be teaching in class.”

-P276

Within the IRL group only, participants felt that they replicated their instructors’ conceptions. That is, participants found it helpful to be given a conceptual framework off of which to base any subsequent knowledge.

“I guess there’s learning how to learn and then there is actually learning the content. Last time I was able to get an idea of what kind of an approach you should use to learn about murmurs even though today’s murmurs are kind of different, I sort of tried to use the same approach.”

-P973
In summary, within the confines of this study, participants tend to employ lower level COL, although some appeared to recognize the need to prepare for future learning. These COL may influence the learning experience, including the learning strategies a participant employs.

3.5.3 Learning Strategies

Learning strategies emerged as an overarching theme. Within learning strategies, participants expressed that they found comparing and contrasting beneficial for learning new material.

“[T]here are some things I…compare and contrast to help solidify my concepts.”

-P100

Participants believed that comparing and contrasting elements helped them understand concepts that they had been taught or that they learned independently. Participants also found it beneficial to compare murmurs against normal heart sounds. Specifically, participants created their own conceptual framework by comparing and contrasting murmurs.

“As I would go through I lumped them into groups and then I would make sure that within a group I could compare the two so first I distinguished it by site and then within a site I would distinguish it based on the sound such as when it was occurring or the loudness and then I would listen to the two back and forth and try to make sure the criteria I had come up with matched the sounds I was hearing. I made a pattern to try to remember it, but it didn’t work so well.”

-P909

Participants compared and contrasted on multiple levels, starting with what was familiar knowledge (e.g., location), and within each location, subsequently comparing and contrasting other characteristics (e.g., timing) in order to try to create patterns to remember the murmurs.
As part of participants’ learning strategies, *generating and seeking feedback* emerged as another child node. Participants seek feedback in order to know if they are right, and by default, if their method at arriving to the diagnosis is correct.

> “I think exceptionally important whether it’s positive or negative feedback because otherwise you would have no way of ascertaining whether what you did is correct or incorrect. Those can be very subjective constructs in terms of you may learn something and if you don’t have that feedback depending on the type of person you are or your personality you might think you’re doing a great job or conversely you might think you are doing a really awful job when you are getting a little bit right so I think having a more objective person telling you what you are and aren’t doing wrong can help you develop those skills better.”

-P508

Moreover, participants acknowledge the need to be mindful of the individual that one may be, and that positive and negative feedback is necessary so as to not believe that one is excelling when one actually is not.

Participants also tended to *identify and integrate features*. Participants saw the need to create an overall learning framework.

> “I guess I’m kind of like I like to think of a big picture in my head so whether it’s some disease I’m learning on my own through researching or interviewing a patient and I’m getting new information and I’m trying to learn about their condition I always try to take the pieces that I read or learn or hear put them together into a big picture. If that big picture makes sense in my head then I know
okay I have this nice understanding of whatever it is I’m learning but if the fragments don’t fit together or form a very logical picture in my head I think that’s when I know okay I haven’t learned maybe enough and I can’t go any further and I think that applies here as well. Whenever I was trying to learn the heart sounds I would always go back to the big picture, does it make sense where the heart valves are and the way it was flowing and things like that.”

-P100

Participants integrated all features within their conceptual framework for diagnosing murmurs, and they reverted back to all information with which they were familiar. Participants returned to the ‘big picture’ in order to determine for themselves whether or not whatever new piece of information made sense based on knowledge they already possessed. With that being said, participants see the need for repetitive practice and believe that learning is achieved through repetition.

“Through repetition, through being open to learning and realizing there as much as you feel you can’t learn there is more to learn. I think having an open mind about it and trying to encourage yourself like you should never really stop, it’s important, so a lot of it is attitude based and a lot of it is the hard work you put into it. Yea I would say that’s how learning is achieved you have to keep repeating and keep trying and pursuing additional bits of information.”

-P645

Self-testing emerged in the semi-structured interview data as another learning strategy. Participants used self-testing as a proxy for learning and saw the role confidence plays in learning.
“[C]onfidence is very internal and there are external factors supporting it, but you are using what you are sensing for confidence whereas until you are actually testing yourself and knowing whether you are accomplishing what you want to accomplish, you don’t know if you’ve learned.”

-P248

Participants used internal and external sources to learn. Participants believe that until one self-tests, one is not aware of what one is learning. One participant realized the need to be disciplined in order to use self-testing effectively.

“My opinion on self-testing is that it takes someone more disciplined and more interested…”

-P752

This participant linked a highly-interested and highly-motivated individual to one who may use self-testing. This participant did not use self-testing.

“Because I would say I’m less disciplined than some of my colleagues.”

-P752

Participants’ learning strategies tended to focus around feedback, repetition, self-testing, and integrating features. As participants deploy these learning strategies, the resulting success may influence another factor that we termed ‘situated confidence’ (i.e., confidence in the moment).

3.5.4 Situated Confidence

Participants believed that situated confidence was a sense of knowing, a “gut feeling” as -P752 explained it.
“I think about confidence as knowing for yourself that you are more sure than not that you have done something correctly or that you don’t need to seek validation necessarily from other people in terms of whether or not you are on the right path.”

-P402

Participants described confidence as a feeling that determined if they were or were not learning appropriately. Furthermore, participants described the need to remain confident, but not so confident that it does not allow for growth.

“I think confidence is a double edged sword because I think there is a confidence that may be a little bit more like arrogance where that can actually be negative for your learning because you might have the attitude that you know enough or you know everything or you are a bit closed off to ways that you might improve or your knowledge might not be adequate.”

-P402

Participants recognized that being over-confident could be problematic, for example, leading to one being closed off to learning new material or learning new techniques in order to improve oneself.

“I think I see people a lot in medicine who are over confident which actually impedes their learning. I think they appear over confident because they are worried like I said of looking foolish or that they don’t know something to begin with. You don’t want to be so non confident in your learning that you’re not progressing, you have to be able to venture out and move on to the next step to keep building up your learning but some people move too quickly and are too headstrong and they didn’t learn the fundamentals to begin with and that kind of
spirals like out of control. I feel people are really hesitant at getting critical feedback in medicine I think they kind of actively avoid it and take it as a knock to them as opposed to an opportunity for constructive learning. It just bugs me when people are over confident and throwing out diagnoses and stuff and it’s like you’ve never been in this setting before you have no skills in this area. It seems like they are putting a stop at their own learning before it even really begins sometimes.”

-P521

Participants saw the need to be open to feedback, and not to be blinded by being over confident. Participants also recognized the need for experience and how experience plays into confidence.

Self-assessment was an emergent child node where participants applaud being able to dictate their time allocated to certain tasks, dependent on how much they knew and how confident they felt.

“The pros of learning on your own are that you are able to identify the parts that are harder for you or easier for you so you don’t have to spend as much time on the things that you pick up real quickly.”

-P402

Participants self-assess their knowledge and their confidence, and they regulate the time spent on their learning based on these factors. Importantly, we do not suggest that participants were accurate in their judgments of confidence or self-assessment, yet these ‘feelings’ clearly impacted their learning experience.
3.5.5 Instructor Presence

As we conducted our thematic analysis, we determined that participants in the IRL group articulated instructor presence as an emergent theme whereas participants in the SRL group would speak about instructor presence on a theoretical basis (i.e., they can perceive these similar pressures in classrooms, outside of the study context).

Instructors have an influence on trainees’ strategies and thinking, whether or not participants are consciously aware. Participants believe that they use their instructors’ conceptual frameworks and that this is carried through in future scenarios.

“What I did was I used Dr. X’s…framework differentiating whether it was systolic or diastolic with palpation [of the carotid pulse] and then at the location…”

-P752

Most participants are unaware that they do not utilize their instructors’ conceptual frameworks, but they do believe that they use what their instructors have taught them. Whether they are aware or unaware of using their instructors’ frameworks, participants tend to modify approaches to what makes most sense to them.

“Parts of it I dropped, when exactly I heard it during systole or within diastole, the volume, or the pitch. I kept going a little bit but it didn’t help me distinguish it, something I recognized...Just making the distinction of where I’m hearing it, over which valve and in systole or diastole, those things I kept from what he told me and it was all I needed I think…”

-P827

Participants are aware that they do not have much background in cardiac auscultation, and they state that they adopt their instructors’ approaches to diagnosing murmurs, but they adjust their
instructors’ conceptual framework into what makes sense to them. Interestingly, with the lack of knowledge, participants still determine what they deem important to diagnosing murmurs and dismiss all other information that they deem extraneous.

Within the instructor presence emergent theme, another child node emerged, instructor as an enabler to SRL. Participants find it important to have an individual present to teach the basic background information.

“Last time I was taught all the physiology background in the beginning and that really helped to understand...the first time around learning it. I used what he taught me to sort of reason out this time these new murmurs and what they should sound like.”

-P276

Participants find it important for instructors to teach them the background information and guide them prior to being immersed into another educational opportunity when they need to direct their own learning. Participants seek logic explanation.

Concurrently, participants also express instructors as impediments to SRL. This mostly is derived from their perception of ‘intimidation.’

“I wish I had been a bit more active like maybe go over my approach with her and get the kind of validation that I was referring to earlier that I think would help with having some level of confidence.”

-P645

Participants see the need to be more active, but the instructor’s presence impedes them from asking questions to seek the validation that they need. This may be influenced mostly from
the trainees’ perceived lack of control when being taught. Participants perceive that instructors control teaching to a high degree.

“He sort of determined where to go and then told me to listen and I listened, told me to draw things and I drew things.”

-P276

Participants recognize that instructors control the educational experience to a high degree, and they portray themselves as obeying commands. As they do not “really know anything and she [is] the expert.” –P752. Participants seemed to be content with not having control except for asking questions for clarification.

3.5.6 Normative Pressures

The participants outlined a set of normative pressures that they believed were either self-constructed or externally regulated. Impression management and time pressures were prominent issues within our first and second year medical trainees at the University of Toronto. Medical trainees realize that they are trainees, but the perpetual cycle of not knowing information when being an over-achiever can become unnerving.

“When you are used to always being the person who is capable in doing things and suddenly you are thrown somewhere where you don’t know anything and you are back at medicine, it feels like you are perpetually in the state of knowing nothing. I think that can be unnerving for some people, but I also think part of it is accepting you are a student and a learner and being comfortable with that.”

-P909
Participants need to acknowledge that they remain trainees, and at each level in training, they fall back to not knowing the details that those more senior to them know. It is the factual nature of training, where the hierarchy is omnipresent.

Within the normative pressures emergent theme, impression management emerged as a prominent discourse where participants did not want to appear ‘incompetent’ or ‘dumb’ in front of their instructors as these instructors have influence over them.

“I think it’s a conflict of interest between education, so the same people who are teaching you are also going to be involved in your hiring and firing down the road and that’s not really like other areas I feel. It’s not like if you are in the world of business… it’s not like your teacher in university is also going to hire you on to his company right, so most teachers in business are just teachers and bosses of companies are bosses, but in medicine, the teachers also work and hire and fire at the hospital so you know you are always on the tips of your toes to not look like a fool during the learning process because when you meet that instructor in third or fourth year in the rotation, they’ll remember you as the kid who didn’t know anything and asked stupid questions, and then when you apply to that residency program, they will remember that as well. It’s definitely something I haven’t really thought about it too much but it’s definitely always there in the back of your mind if you ask too many foolish questions or kind of act like a fool and you meet them in a professional work setting it’s going to influence their impression of you.”

-P521
Participants believe that clinician-educators will remember trainees’ foolish behaviour or if they asked questions that they thought were not at the level where a medical trainee should be. The interesting aspect is that the clinician-educators in this study spent one hour with each participant, and yet these opinions are still prominent in our medical trainees’ minds. One participant best described the reciprocal nature of impression management:

“The way you perceive others and the way you think others perceive you.”

-P709

Although participants usually perceived impression management to be unidirectional, this participant explained it being bidirectional, how he/she is being perceived.

*Time pressures* were also prominent within participants. They felt as though they did not want to waste time.

“I try to be cognizant of the fact I don’t want to take up too much of their time and burden them with too many questions, and I feel like I almost put these restrictions on myself.”

-P508

Participants feel as though they do not want to waste their instructors’ time, and they are aware that for the most part, these restrictions are self-imposed. Other time pressures in bigger spaces include wasting other trainees’ time.

“If there are too many people in the room, then I would feel like I might be taking away time from other people if I asked questions.”

-P276

Participants feel as though they waste other trainees’ time if they do not understand. They will not ask questions so as to spare others.
3.5.7 Summary

Deductively, trainees’ appeared to develop COL that revolved around increasing their knowledge, memorizing and reproducing this knowledge, applying this knowledge, and being able to understand this knowledge. Inductively, trainees’ COL such as the multifaceted nature of learning, replicating their instructors’ conceptions, PFL, and strategic mindfulness may underpin how they choose amongst learning strategies. Collectively, it appears that novice medical trainees have relatively low level COL; however, they tended to consider higher level COL, yet not be fully guided by such high level considerations at this stage of their training.

Participants’ tended to employ learning strategies such as generating and seeking feedback, identifying and integrating features, repetitive practice, and self-testing. As these learning strategies unfolded, participants described how they developed what we term ‘situated confidence’, and although participants could not fully and clearly define confidence, they regarded it as a subjective sense and a feeling of knowing.

Our analysis of these data suggests that these three factors ‘set the stage’ for learning. That is, it may be that trainees have different COL that influence their choice of learning strategies. As these learning strategies are deployed, they likely influence how trainees develop situated confidence, which appears to be a subjective sense that can have additive effects or detrimental effects to learning.

Two additional emergent themes that likely influence the participants’ learning experience include instructor presence and normative pressures. The presence of an instructor appears to either enable or impede SRL by influencing participants’ strategies and thinking. A
particularly negative impact of the instructor appears to be that participants perceived a lack of control when being taught. This may have led to not asking for clarification and not being able to actively problem solve in the manner the participant wanted. Moreover, the normative pressures they described, including time pressures and the need for impression management, appeared to affect their perceptions (i.e., try not to appear incompetent) as well as how much time they spent on a task. The relationship between all of these factors identified in the interviews is presented in Figure 9.
Participants articulated COL, learning strategies, and situated confidence as factors that we suggest set the stage for learning. This stage appears to be influenced by instructor presence, which is related to normative pressures. We suggest that these factors are all interacting with each other in a bidirectional fashion.
Chapter 4
Discussion and Future Directions

4 Discussion and Future Directions

Our research questions focused on determining how IRL compares to SRL for the acquisition and retention of cardiac auscultation skill learning. We also focused on how the instructors’ teaching approach affects trainees’ transfer of that approach to a future learning session. Surprisingly, we did not detect any significant between-group differences for all performance-based assessments (i.e., diagnostic accuracy, diagnostic justification, and physical exam). For participants’ learning approaches, we observed that participants within the IRL group did not transfer their instructors’ teaching approach to a future learning session, whereas those in the SRL group were consistent across sessions.

For our first hypothesis, that participants in the IRL group would perform better on the immediate post-test and be more efficient than the participants in the SRL group, we did not detect the expected benefit of IRL training for any performance metric, though the SRL group did take approximately 17 minutes longer than the IRL group. We also expected that participants in the SRL group would perform better than participants in the IRL group on retention and transfer tests. However, once again we found no differences on performance-based assessments. For our second hypothesis, that participants from the IRL group would transfer the approach taught to them by the instructor to a new set of murmurs and that participants within an SRL group will proceed with their previous learning approach, we found that only 25% of participants within the IRL intervention maintained their instructors’ teaching approach. We also found that most of the participants in the SRL group were consistent across sessions. Taken together, the
performance-based and behavioural trace data produced unexpected results that will be discussed in light of our interview data below.

With regards to our third research aim, participants within the IRL intervention did not appear to be aware of their learning approaches. This aligns with our expectations and, interpreted with the findings noted above, suggests that participants’ lack of awareness can potentially be problematic in that this may impede them from transferring a learning approach to a second learning session.

4.1 Comparison to Previous SRL Literature

Post hoc, Brydges et al. hypothesized that clinician-educators believe that trainees would replicate the instructor’s approach should an instructor be present within the environment and that a booklet could not reproduce the dynamic teaching interaction between a trainee and an instructor. Furthermore, all of the clinician-educators surveyed prior to starting our research project believed that trainees would use the approach that they are taught in future learning sessions (data not shown). In comparison to this previous work and anecdotal evidence, we observed no between-group performance differences (similar to Brydges’ DSRL compared to SRL), which is surprising given the stature of the clinician-educators enrolled within this study. We also observed that trainees in the SRL group were consistent with their learning approaches, whereas those in the IRL group shifted their approaches from one session to the next. From session one to session two, the consistent learning approaches for participants within the SRL group and the divergence in learning approaches for participants within the IRL group are similar to Brydges et al.’s previous study. The two sets of findings conflict with Brydges et al.’s hypothesized effect of clinician-educators’ presence. Therefore, replacing a booklet with
highly-rated and enthusiastic instructors did not change the observed effects. What this present study offers as a potential explanatory mechanism for these findings is the addition of semi-structured interview data and the triangulation between those data and the performance/behavioural traces noted above. Indeed, the mixed methods design addresses the limitation to Brydges’ previous DSRL study, which was the lack of rich description of trainees and their COL, learning strategies, and other facets of their learning.

4.2 Relating Findings to the Triadic Reciprocal Framework

While the following model is not meant to depict causal relationships, we do find it useful to map the results from the semi-structured interview data onto the triadic reciprocity framework.

We propose that participants’ COL can be labeled as a ‘personal factor’ that participants generate within and use to frame a learning experience. According to the general COL literature, evidence suggests that COL and learning approaches underpin learning strategies. Thus, we propose that learning strategies can be labeled as ‘behaviours’ that are influenced by and decided upon in a bidirectional relationship with participants’ situated COL. As participants use learning strategies and generate feedback about their effectiveness, they may self-assess their performance and use that assessment to define their level of situated confidence. Therefore, we can map COL and situated confidence as personal factors within the triadic reciprocity framework, and we propose that these personal factors have a bidirectional relationship with trainees’ behaviours, such as their learning strategies (Figure 10). By mapping our data to the framework in this way, we suggest that participants’ COL, learning strategies, and situated confidence interacted to set the stage for trainee’s learning as situated in the study context.
**Figure 10.** Mapping of COL and situated confidence as personal factors and learning strategies as behaviours within the triadic reciprocality framework.
Mapping our remaining qualitative results on to the triadic reciprocality framework, the additional themes of normative pressures and instructor presence are considered environmental factors influencing the aforementioned relationship between COL, situated confidence, and learning strategies in a bidirectional fashion. We suggest that the overall model may explain why we (i) observed no between-group differences on performance-based assessments, and (ii) observed a shift in IRL participants’ behavioural traces between the two practice sessions.
Figure 11. Mapping of normative pressures and instructor presence as environmental factors within the triadic reciprocity framework.
4.3 Integrating the Triadic Reciprocity Mapping with Performance-Based and Behavioural Trace Data

What was surprising about our results was the non-superiority of the IRL group over the SRL group on performance-based assessments on both post-test #1 and on the retention test. Furthermore, participants within the IRL group did not transfer their instructors’ teaching approaches from practice session one to practice session two. We propose that mapping the emergent themes from the semi-structured interview data onto the triadic reciprocity framework may help to explain these results.

4.3.1 Performance-Based Data on Post-Test

We speculate that one of the reasons for the surprising non-superiority on post-test for the IRL group over the SRL group is the influence of normative pressures. The normative pressures participants articulated include impression management and time pressures. Participants experienced impression management (i.e., not wanting to appear incompetent in the instructor’s presence), but no feedback loop existed to inform instructors that participants perceived these normative pressures. As such, the bi-directional nature within the triadic reciprocity framework was heavily skewed towards influencing the trainee. In this way, normative pressures may have potentiated friction within the learning environment. When applied to the triadic reciprocity framework as shown in Figure 11, instructor presence and normative pressures are environmental factors that appear to influence the stage for learning. Participants articulated normative pressures (e.g., impression management, time pressures) when learning with an instructor, thereby deterring them from asking questions for clarification. Normative pressures
arise from environmental influences and create personal emotions. These affective processing activities were articulated in our study even though trainees expressed that the instructors were approachable and created a friendly environment. It may be that the interaction between the instructor and trainee proceeded too quickly where the trainee was actively engaging in trying to understand the instructor’s teaching approach at the expense of the learning material. Indeed, this friction between instructors’ teaching approaches and trainees’ learning approaches may be a potential reason we did not observe the expected benefits of the IRL group on the immediate post-test performance-based assessments.

We speculate that these normative pressures were absent for the retention test and for the second practice session as this second practice session proceeded in an entirely self-regulated manner. As such, the environmental factors (e.g., normative pressures: impression management and time pressures) were eliminated within this second practice session as depicted in Figure 10.

4.3.2 Performance-Based Data on Retention Test

There were no between-group differences on the performance-based assessments on retention test, which does not align with our expectation of superior performance by the SRL group. This lack of difference begs the question if the SRL group was optimized to promote the best self-regulation possible. Butler and Brydges suggest that learning depends on supports embedded within the learning environment and the learning approaches that trainees take up within the learning environment. From Brydges et al.’s recent systematic review and meta-analysis, we observe that SRL groups can be offered content and/or process supports. While the data are rather preliminary, they suggest that trainees who self-regulate their learning benefit
from these supports on both post-tests and retention tests compared to SRL groups without such supports.

When mapping content supports versus process supports to our study, the SRL group received a content support in the form of an instructional video, but this intervention may not have been the most ideal support for the SRL group. Instead, process supports where participants would have been supported, for example, to set appropriate goals, to learn how to use resources effectively, and to learn how to monitor their progress effectively, may have proven to be a more ideal method of supporting the SRL group. Not only did the SRL group receive no process supports, but the SRL group also received no environmental supports (e.g., instructor presence). This lack of an optimally supported SRL group may be a reason for observing no between-group differences on performance-based assessments for the retention test. Therefore, the SRL group within this study likely was not an ideal example of effective self-regulation.

4.3.3 IRL Group’s Lack of Transfer of Learning Approaches

Many plausible interpretations for the lack of consistency of learning approaches may be explained by personal factors (e.g., situated confidence) that are influenced by environmental factors (e.g., normative pressures, instructor presence) within the triadic reciprocity framework. These influences are likely under bi-directional control, with some factors having a possible greater influence on the trainee.

Firstly, our findings on situated confidence may help explain the lack of transfer of learning approaches by the IRL group when interpreted according to Entwistle’s concept of dependency.\textsuperscript{40} Dependency may have developed as trainees worked with the instructor and may
have provided them with a false sense of confidence, leading them to believe that they had learned cardiac auscultation sufficiently. That is, when the instructor is present and trainees are receiving feedback, trainees may have a false heightened sense of situated confidence. However, when the second practice session subsequently proceeds in an entirely self-regulated manner, trainees from the IRL group may then lack a basis for their situated confidence. As a result, it may be that trainees’ confusion around how situated confidence is defined in each session may impact their learning approaches as observed in this thesis.

Secondly, the literature shows that participants’ COL may be inconsistent and simply change from situation to situation, with evidence supporting the concept of situated COL, where COL vary within a given trainee, within different trainees, and according to subject area. As noted in the literature review, learning approaches are behaviours related to COL that we propose are also under triadic reciprocity influences. This notion of ‘situated COL’ may explain why only 25% of our IRL participants maintained their teaching approaches in the second learning session and why most were not aware the instructor had taught them a particular approach. Notably, the latter finding aligns with Kornell and Bjork’s study where 80% of trainees responded never having been taught a study approach by an instructor.

Thirdly, participants’ experiences with normative pressures may also potentially explain the lack of consistent learning approaches. These normative pressures may have suppressed participants from asking questions for further clarification and prevented them from actively creating their own conceptual framework for cardiac auscultation skill acquisition. As such, participants may not fully comprehend their instructors’ teaching approaches, preventing them
from transferring them to the subsequent session. These normative pressures, therefore, may act as a blocking mechanism for trainees.

Notably, four participants within the IRL group practiced the second set of murmurs in the order in which the RA supplied them with the list of murmurs that they could practice. In session one, instructors controlled the interaction to a high degree, as suggested in our semi-structured interview data (i.e., subtheme being perceived lack of control), and this high level of instructor control demonstrates Entwistle’s concern that interrupting in too many trainees’ learning activities may create dependency. Participants’ approach for cardiac auscultation skills had already been created for them, and they seemed not to have integrated that approach into their own conceptual framework for cardiac auscultation skills. In their second practice session, some participants depended upon the RA as their external source of knowledge without having to create a conceptual framework conducive to them for learning the murmurs. That is, participants practiced the murmurs in the order in which the RA supplied them the murmur list. A sense of agency appeared to have been lost, as articulated in the emergent theme of perception of lack of control. Hence, the RA may have acted as a temporary external regulatory source in place of the instructor for some participants. Ultimately, it seems that the learning environment appeared to cause ‘dissonance’ for the trainees who chose approaches to satisfy instructor/external demands.

In summary, participants’ lack of consistent learning approaches may have been influenced by personal and environmental factors. That is, the fluid nature of participants’ situated COL, the potentially false situated confidence instilled by instructor presence, and the normative pressures participants experienced, all are potential interpretations to interpret the lack of consistent learning approaches within the IRL group.
4.3.4 Total Practice Time

With regards to practice time and efficiency, participants were inclined to agree with instructors, to indicate that they were comfortable with an aspect of cardiac auscultation, and to proceed without understanding concepts to not occupy more of the instructor’s time and not to look incompetent. These behaviours may have led participants in the IRL group to take slightly less time as their instructors delineated their conceptual framework for them. Alternatively, these normative pressures are non-existent within the SRL group (although participants still expressed these normative pressures in a more theoretical and hypothetical situation), and the participants in the SRL group may become their own active trainee not influenced by instructor presence. This trainee may develop his/her own conceptual framework for classifying cardiac murmurs, subsequently transferring this already-created conceptual framework to a novel learning situation. This active engagement may explain the overall average of 17 minutes longer practice time for the SRL group in practice session one. Consequently, participants in the SRL group were faster in practice session two as they may have been able to transfer their already created conceptual framework to cardiac auscultation from practice session two.

4.4 Thesis Strengths and Limitations

This research project contains several strengths as well as limitations. Many limitations inherent in the cardiopulmonary patient simulator and the murmurs with their respective physical exam findings are present. The murmurs did not contain the peripheral exam findings: no jugular venous pulse (JVP), no change in carotid pulse time and amplitude, and no point of maximal impulse (PMI) displacement. These findings provide extra features for diagnosis and in helping
differentiate different murmurs. However, upon speaking with our collaborators and our instructors, they believe that these advanced findings are not appropriate when teaching first and second year medical trainees. Our expert Cardiologists in Miami described their discontent with the absence of these peripheral signs, as they could not confidently diagnose certain murmurs without these findings. Another limitation would be that some of the right-sided murmurs varied with respiration, but they were not exactly timed perfectly such that the murmur would be accentuated with inspiration. This could have led to some confusion in our participants causing for lower diagnostic accuracies. However, participants did not mention this in their diagnostic justification. Moreover, in clinical practice, high-pitched sounds are detected using the diaphragm of the stethoscope while low-pitched sounds are detected using the bell of the stethoscope; in Harvey©, the bell is non-functional, and all sounds are detected using the diaphragm of the stethoscope. Having said that, our collaborators reassured us that the murmur accentuation is also present in the American Board high-stakes examination.

Incorrect murmur programming for one of the transfer test murmurs (MR/TS) remains another limitation of this study. The murmur that was programmed was (MR/TS with the phonocardiogram of MS radiating to the axilla rather than the phonocardiogram of MR). Incorrect stethoscope placement from the usual location of mitral valvular pathologies at the fourth intercostal space, mid-clavicular line to the location of radiation (i.e., forth intercostal space, anterior axillary line) may have lead to incorrect diagnoses. However, these diagnoses were marked incorrectly for all participants.

Another limitation includes ceiling effects (i.e., level above which the variance of an independent variable can no longer be measured). Ceiling effects may also have been an
explanation for the lack of differences seen between participants in the SRL and the IRL group. We were unable to discriminate amongst the top performers, and this may be due to the murmurs. Furthermore, all diagnoses for the twelve murmurs were written on the same sheet of paper, and participants would have been able to return to their previous answers and, if on the correct diagnoses track, would be able to deduce by default that there were two variations of each murmur. Hence, the test structure likely facilitated the potential ceiling effect. This ceiling effect may very well lead us to a mistaken conclusion that there are no between-group differences on the performance-based assessments.

An additional limitation would be having four instructors, two from the Department of General Internal Medicine, and two from the Department of Cardiology. This was purposefully done in order to increase study feasibility, as one instructor to teach 16 participants would be unfeasible within the time constraints of this MSc project. However, we wanted to take into account the richness of everyday teaching and capture trainees’ clinical teaching variability; that is, in clinical practice, trainees are taught by a number of different attending physicians from a number of different specialties, and we wanted to capture this added layer of complexity in our study to augment clinical fidelity. In as much as this is a study strength, it can also be perceived as a limitation. Also, we did not enroll instructors from the same specialty as research shows that there is no difference in how generalists and specialists teach cardiac auscultation skills to pre-clerkship medical trainees.\textsuperscript{85}

Our results should be interpreted with caution given that our sample size was taken from a single institution. Future research should focus on increasing the sample size from different institutions in order to establish whether trainees’ COL vary in different environments. A greater
number of participants should be studied in order to determine whether participants who maintain, or those who diverge from, their instructors’ teaching approaches affect learning outcomes (i.e., diagnostic accuracy, diagnostic justification, and physical exam skills). As a greater number of participants diverge than use their instructor’s teaching approaches in a subsequent learning session, a greater sample size is required in order to perform an *a priori* analysis looking at whether the natural maintenance of behavioural traces has an impact on learning outcomes.

Another limitation is that we did not perform negative case sampling to ensure that the PI did not select for cases that would confirm the conceptual framework. We also did not perform member checking (i.e., the final conceptual framework is supplied to participants of our sample to ensure authenticity and accuracy – a respondent validation technique). However, we wanted to create a conceptual framework, rather than describing a lived experience, in order to help us further understand trainees’ awareness of learning approaches and what factors novice medical trainees articulate as being beneficial for their learning.

### 4.5 Implications for Researchers

Mixing of methods is important in health professions research. Mixing of methods has informed us that researchers cannot infer trainees’ learning approaches based on observation alone. In fact, the semi-structured interview data has given us a greater appreciation that participants’ conceptual frameworks may be different than their behaviours. Furthermore, what clinician-educators deem important may not be the same that trainees deem important. Semi-structured interviews may supply us with a greater appreciation of personal and environmental factors that trainees perceive to be important in an educational context. Trainees may perceive
environmental factors that will influence their behaviours, and instructors may be completely blind to these perceived situated environmental factors. The semi-structured interviews may supply us with greater insight into these environmental factors. On the whole, mixing of methods is important to further understand trainees’ cognitive processing and the influences that trainees’ experience, possibly interfering with their stage for learning.

4.5.1 Performance-Based Assessments on Immediate Post-Test and Retention Test

The period of cognitive disequilibrium, along with the potential friction between instructors’ teaching approaches and trainees’ learning approaches, may be possible explanations for the lack of between-group differences on the performance-based assessments. As such, researchers should focus on how instructors might overcome or work to reduce this apparent friction. One approach may be to provide supports for SRL processes, helping trainees to ‘learn how to learn’ and recognize how best to manage such friction. A program of research could investigate the effects of such supports on trainees’ learning experiences and the overall impact on learning outcomes.

If we continue to use the triadic reciprocality framework, normative pressures (i.e., impression management) seem to be much more unidirectional than bi-directional, where the trainee experiences the normative pressures more than the instructors perceive their trainees’ experience with these normative pressures. Therefore, researchers should focus on plausible feedback loops to inform instructors when their trainees are experiencing these normative pressures.
4.5.2 IRL Group’s Lack of Transfer of Learning Approaches

We observed that directing participants with a one-on-one teaching approach did not result in the transfer of approaches across learning conditions. We uncovered a number of different potential mechanisms for the lack of transfer in the IRL group. First, researchers could study the different impacts of the subject material and the environment on how trainees develop ‘situated COL’ across different learning situations. Second, our findings related to trainees’ ‘situated confidence’ suggests that researchers may wish to study how trainees develop this confidence and how to make trainees’ confidence reflective of their actual competence. Third, the effects and management of normative pressures, specifically impression management, need to be assessed and evaluated, and we need to determine their effects on clinical competence.

Based on Brydges et al.’s findings in the previous DSRL study, COL emerged as a key concept to guide the present study, and at first we believed that COL played a large role in participants’ experience while learning cardiac auscultation. However, we find that rather than focus on trainees’ COL, it may be more informative to focus on how their learning approaches unfold within and across learning sessions. Moving forward, researchers should be aware that COL exist but not place utmost importance on this concept and that learning approaches may be better studied to understand how manipulations of approaches impact learning outcomes.

In general, in order to support preparation for future learning, more applicative and interpretive research needs to be performed looking at the transfer of skill and the transfer of learning approaches to future learning sessions. Once evidence has been accumulated, translation to the clinical setting should proceed in order to assess effects of SBME on patient outcomes.
These higher order research designs may have the potential to prepare trainees for future learning.

We need to better understand which personal factors trainees deem important for learning and which environmental factors may influence these personal factors. Furthermore, we need to better understand which factors create an educational environment conducive to learning versus those factors that negatively impact learning outcomes. If we could augment those factors that positively impact learning outcomes and diminish those factors that negatively impact learning outcomes, we can maximize trainees’ learning experiences.

4.6 Implications for Educators

Instructional design that considers participants’ stage for learning, in addition to the impacts of normative pressures would have direct practical implications. Clinician-educators need to be cognizant that trainees perceive normative pressures (i.e., time pressures and impression management) and likely should try to alleviate such perceptions. Faculty development programs may incorporate our findings to help instructors become aware of trainees’ perceived normative pressures associated with instructor presence. Also, ways of decreasing these perceived normative pressures need to be determined to create an environment conducive to learning. Instructors can create an amicable environment conducive to learning by discussing with trainees their approaches and to discuss with the trainee to feel free to interrupt to ask for clarification as need be. Also, continuity of education with one instructor over a longer period of time may diminish trainees’ perceived normative pressures as the trainee becomes more acquainted with the instructor and his/her approaches. Moreover, if we shift from a more outcome-oriented learning environment to one that allows trainees to not feel the normative
pressures of appearing competent at all times, trainees may become more encouraged and more empowered to ask questions.

The instructor plays an influential role in learning. The way medical school instructors think about trainee learning appears not to correlate well with how they approach teaching. In an everyday context, where trainees are exposed to pressures (e.g., ego-oriented, that is, a threat to the trainee’s ego) even trainees who utilize higher levels of COL will convert to lower levels of COL. Fransson varied the test conditions where trainees were either in an ego-oriented and threat to self-esteem environment or to a non-demanding, supportive environment. A lack of motivation and high test anxiety increased the tendency to adopt lower level COL. A threat to one’s ego leads to lower level COL and to lower outcome scores. As such, instructors should be cognizant of the impact they may have on trainees.

Clinician-educators should also try to further understand trainees’ learning approaches that are most effective for them. After having a better understanding of the trainee’s background information, the clinician-educator can subsequently tailor his/her teaching approaches and be explicit with the reasons for choosing one learning approach over another.

Pragmatically, we observed a disconnect between behaviours and perceptions, where some participants articulated that although they may be practicing murmurs in a location-based approach, that is not always the way they think about them. Participants articulated that their conceptual framework consisted of classifying murmurs in a timing-based approach, even though they practiced them in a location-based fashion. Hence, these results suggest a need to further understand trainee intuition first prior to designing curricula. This disconnect enforces the
importance of triangulation methods where clinician-educators and researchers cannot infer learning approaches based on behaviours. This finding could be used to stimulate faculty development changes.

Furthermore, the murmurs incorporated within this study included one systolic and one diastolic murmur at each location for both practice sessions. Consequently, the structure may have prompted trainees to use a location-based approach for sequencing the murmurs during practice, as they may have wanted to discern the two different murmurs over the same anatomical location. To prevent this potential bias, we could have included other murmur variants at the same anatomical location (e.g., mild MR, moderate MR, severe MR, mitral valve prolapse, MR with systolic anterior motion) to increase the murmur library and allow participants to have to further conceptualize organizing murmurs. Clinician-educators should be aware of this and increase the number of murmurs in order to help trainees recognize that different learning approaches are possible.¹⁴

4.7 Future Directions

Future research should focus on further developing the mechanisms by which SRL works. This program of research can lend itself to a number of different future directions, from understanding the stage from which trainees learn, to the external influences impacting the triadic reciprocality between behavioural, personal, and environmental factors.
4.7.1 Performance-Based Assessments on Immediate Post-Test and Retention Test

Future research should look at whether researchers can make situated confidence better and whether or not situated confidence is even really an important consideration. Development of situated confidence and how this may relate to clinical competence needs to be evaluated, both in an SRL and an IRL condition. Confidence is a feeling of knowing, yet trainees cannot judge their own confidence well. If we can create mechanisms for trainees to better judge their own confidence well, this may direct trainees to regulating their time towards subject areas in which they are weak. Therefore, the mechanisms that create and that diminish situated confidence need to be better delineated. Future research that defines situated confidence and that looks at further understanding the process how trainees define it may potentially improve situated confidence.

Research should focus at determining and defining normative pressures and how to best establish feedback loop mechanisms so that instructors become cognizant of when trainees are experiencing normative pressures. The effect of normative pressures on performance-based assessments needs to be further clarified. Semi-structured interviews may further delineate why trainees experience such normative pressures, under which circumstances, and with whom they experience such normative pressures. Research may determine the optimal point at which impression management serves as a motivator versus impedance to learning.

4.7.2 IRL Group’s Lack of Transfer of Learning Approaches

The natural maintenance of learning approach from one educational session to a future education session is an interesting future direction. More research, with an increased sample size,
is required to determine the impact of dissonance, or ‘friction,’ between an instructor’s teaching approach and a trainee’s learning approach on learning outcomes (i.e., subgroup analysis looking at the impact of consonant instructor-trainee approaches on learning outcomes). This future research could inform whether or not shifting of approaches, or maintenance of approaches, has any impact on the way we teach our trainees. Semi-structured interviews would be beneficial to understand trainees’ perceptions of the difficulties and ease of employing certain approaches over others has on learning outcomes.

Other interventions that we recommend include teaching our trainees all possible COL and learning approaches and why one COL and learning approach is more beneficial than another. That is, \textit{a priori} research where the instructor explicitly articulates the different COL and learning approaches compared to another intervention where instructors do not explicitly teach COL and learning approaches and assess the effects on cardiac auscultation skill acquisition and retention should be performed. This research will elaborate on whether or not trainees transfer higher level COL to subsequent learning sessions and whether or not these higher level COL may lead to higher level learning outcomes.
4.8 Conclusions

The most surprising results of this dissertation are that the IRL group did not demonstrate superior cardiac auscultation skills at any point in our design and, further, that most participants did not use their instructors teaching approach in a subsequent training session. Our mixed methods results suggest that trainees set their stage for learning by developing a relationship between their own emerging sense of confidence and learning approaches and the specific learning strategies they choose to work with. Yet this stage is influenced by external factors that appear to have detrimental effects, including normative pressures and instructor presence. Methods that augment those factors that affect learning outcomes in a positive manner, and diminishing those factors that affect learning outcomes in a negative manner, need to be determined through further research and implemented within curricula.

The absence of between-group differences on all performance-based assessments indicates that future research looking at how best to support trainees’ learning experiences is required. Furthermore, we need to better understand the mechanisms of how both SRL and IRL work and which factors improve educational outcomes for both immediate and long-term learning. If these factors are better delineated, they may subsequently be implemented within the instructional design, creating further opportunities for innovation within the DSRL domain.
References


20 Brydges R. A CRITICAL REAPPRAISAL OF SELF-LEARNING IN HEALTH PROFESSIONS EDUCATION: DIRECTED SELF-GUIDED LEARNING USING SIMULATION MODALITIES. *Institute of Medical Sciences*. Toronto: University of Toronto, 2009; 197


23 Zimmerman BJ. Self-efficacy: An essential motive to learn. *Contemporary educational psychology* 2000; 25: 82-91


34 Entwistle D. Approaches to learning and perceptions of the learning environment - Introduction to the special issue. *Higher Education* 1991; 22: 201-4


40 Entwistle N. *The impact of teaching on learning outcomes in higher education — a literature review*. Edinburgh: University of Edinburgh, Centre for Research on Learning and Instruction, 1992

41 Vermunt JDaV, N. Congruence and friction between learning and teaching. *Learning and Instruction* 1999; 9: 257-80

42 Vermunt JDaV, N. Congruence and friction between learning and teaching. *Learning and Instruction* 1999; 9: 257-80


44 Marton F. *What does it take to learn? Some implications of an alternative view of learning*. Amsterdam: Swets and Zeitlinger., 1976


46 Lonka KaL-Y, S. Epistemologies, conceptions of learning, and study practices in medicine and psychology. *Higher Education* 1996; 31: 5-24


59 Broudy HS. Types of knowledge and purposes of education. Hillsdale, NJ.: Erlbaum, 1977

60 Detterman DK. The case for the prosecution: Transfer as epiphenomenon. Norwood, NJ: Ablex, 1993

61 Dyson AH. Transforming transfer: Unruly children, contrary texts, and


70 de Giovanni D, Roberts, T., and Norman, G. Relative effectiveness of high- versus low-fidelity simulation in learning heart sounds. Medical education 2009; 43: 661-8


75 Cohen J. Statistical power analysis for the behavioral sciences. Lawrence Erlbaum, 1988

76 Cohen J. Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit. Psychological bulletin 1968; 70: 213-20

77 Fleiss JL. The equivalence of the weighted kappa and the intraclass correlation coefficient as measures of reliability. Educational and Psychological Measurement 1973; 33: 613-9


82 Denzin NK LYHoqrneTO, Calif.: Sage Publications; 2000.


87 Fransson A. On qualitative differences in learning: effects of intrinsic motivation and extrinsic test anxiety on process and outcome. *Journal of Educational Psychology* 1977; **47**: 244-57
Appendices

Appendix I - Baseline Knowledge of Cardiovascular Physical Examination

Participant Number: __________________  Date: ____________________

Please provide a score for your baseline knowledge/experience of the following (please circle one):

<table>
<thead>
<tr>
<th>Cardiac Physical Exam</th>
<th>1</th>
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<tbody>
<tr>
<td>No experience</td>
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<td></td>
<td>Very experienced</td>
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<tr>
<td>Some experience</td>
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</table>

Age: _______________  Gender: _______________

Language fluency (list all): _______________

Previous degrees and in what area:
________________________________________________________________________

Number of hours spent with Harvey© previously? __________

Have you interacted with any other heart sound simulations? (y / n)
Time spent in hours: _____

Do you have any diagnosed hearing pathologies / hearing loss? If so, please describe:
________________________________________________________________________

Do you have any musical training? If so, please describe nature and length of training:
________________________________________________________________________
Appendix II - Posttest of Cardiovascular Physical Examination

Participant Number: __________________  Date: ____________________

For each cardiac condition you are presented with, please write the most likely diagnosis. In addition, please provide a score for how confident you are that you have made the correct diagnosis (please circle one per diagnosis).

<table>
<thead>
<tr>
<th>#</th>
<th>Diagnosis</th>
<th>1 Very unconfident</th>
<th>2 Unconfident</th>
<th>3 Neutral</th>
<th>4 Confident</th>
<th>5 Very confident</th>
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</thead>
<tbody>
<tr>
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</tbody>
</table>
Please provide us with your confidence level in performing cardiac auscultation (please circle one):

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<tbody>
<tr>
<td>Very unconfident</td>
<td></td>
<td></td>
<td></td>
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<td>Neutral</td>
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<td>Very confident</td>
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Please inform us how satisfied you were with your learning (please circle one):

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<td>Neutral</td>
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<td></td>
<td>Very satisfied</td>
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Please provide us with an overall evaluation of the session (please circle one):

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<td>Very unsatisfied</td>
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<td>Neutral</td>
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<td></td>
<td></td>
<td>Very satisfied</td>
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Appendix III - Retention Test of Cardiovascular Physical Examination.

Participant Number: __________________  Date: ____________________

For each cardiac condition you are presented with, please write the most likely diagnosis. In addition, please provide a score for how confident you are that you have made the correct diagnosis (please circle one per diagnosis).

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<tr>
<th>#</th>
<th>Differential Diagnosis</th>
<th>1 Very unconfident</th>
<th>2 Unconfident</th>
<th>3 Neutral</th>
<th>4 Confident</th>
<th>5 Very confident</th>
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Appendix IV - Transfer Knowledge of Cardiovascular Physical Examination.

Practice Session 2/Transfer Session

Participant Number: __________________  Date: ____________________

For each cardiac condition you are presented with, please write the most likely diagnosis. In addition, please provide a score for how confident you are that you have made the correct diagnosis (please circle one per diagnosis).

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<thead>
<tr>
<th>#</th>
<th>Diagnosis</th>
<th>1 Very unconfident</th>
<th>2 Unconfident</th>
<th>3 Neutral</th>
<th>4 Confident</th>
<th>5 Very confident</th>
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**Appendix V - Themes and Questions for Participant Semi-structured Interviews – IRL Group**

| Theme 1: Study Purpose | Did you learn today? If yes, what did you learn today?  
What criteria did you use to assess your learning?  
What were your learning objectives today?  
What do you think this study was focused on? (don’t use *content or strategy*). Can you explain further? |
|------------------------|--------------------------------------------------------------------------------------------------|
| Theme 2: Participant’s Conceptual Framework | How did you sequence the murmurs today?  
Why did you sequence the murmurs in the order you chose? |
| Theme 3: Awareness of Strategies for Regulating Learning | IRL Group  
How do you think the instructor facilitated your learning during the last session?  
To what degree did you control your learning? To what degree did the instructor?  
How did your instructor teach the murmurs during that session?  
Did he/she use a strategy? What exactly?  
Describe your strategies for learning in this second session.  
During today’s session, did you use the strategy that your instructor taught you?  
Why or why not? |
| Theme 4: General Concepts of Learning | How do you define *learning*? Please explain the basis upon which you give your answer.  
How is learning achieved?  
Some of your colleagues discuss *understanding* concepts. What does *understanding* mean to you?  
What criteria do you use to judge if things are going well vs. poorly during a learning situation? How do you figure out which criteria are the ‘right ones’ to make that decision?  
Your colleagues have brought up self-testing. Can you please inform me of your opinion regarding self-testing?  
How important is confidence in learning?  
Can you provide me with how you think... |
about confidence?
How will you take this into your next learning situation?
### Appendix VI - Themes and Questions for Participant Semi-structured Interviews – SRL Group

| Theme 1: Study Purpose | Did you learn today? If yes, what did you learn today? What criteria did you use to assess your learning? What do you think this study was focused on? (don’t use *content or strategy*). Can you explain further? |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------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| Theme 2: Participant’s Conceptual Framework | How did you sequence the murmurs today? Why did you sequence the murmurs in the order you chose? |
| Theme 3: Awareness of Strategies for Regulating Learning | **SRL group** How did you sequence the murmurs during the last session? What strategy did you use to decide that sequence? What could have facilitated your learning? Describe your strategies for learning in this second session. During today’s session, did you use the strategy from last session? Why or why not? |
| Theme 4: General Concepts of Learning | How do you define *learning*? Please explain the basis upon which you give your answer. Some of your colleagues discuss *understanding* concepts. What does *understanding* mean to you? How is learning achieved? What criteria do you use to judge if things are going well vs. poorly? How do you figure out which criteria are the ‘right ones’ to make that decision? Your colleagues have brought up self-testing. Can you please inform me of your opinion regarding self-testing? How important is confidence in learning? Can you provide me with how you think about confidence? How will you take this into your next learning situation? |
Appendix VII – Global Rating Scale for Diagnostic Justifications

You will be presented with 1st and 2nd year medical students’ diagnostic justifications they produced after performing a focused physical exam for cardiac auscultation skills. In each case, the participants recorded their diagnosis and subsequently supplied us with their diagnostic justifications. We are rating diagnostic accuracy separately, so please concentrate solely on the quality of information provided in the diagnostic justification, even if the diagnosis is itself incorrect. In cases where the diagnosis is incorrect, we ask you to not assign a ‘well above expectations’ and instead choose from the remaining options.

- We define “expectations” for MS1 and MS2 as expressing details about murmur timing and location.
- Additional information (e.g., about radiation and other features) would be needed to ‘exceed expectations’, and further information still (e.g., descriptions of murmur shape) would satisfy criteria for “well above expectations.”
- To achieve “below expectations”, the student would report either location or timing, but not both, whereas “well below expectations” would involve the student demonstrating no systematic approach.

Please use the following global rating scale with the provided anchors to rate the student’s overall diagnostic justification.

<table>
<thead>
<tr>
<th>WELL BELOW EXPECTATIONS</th>
<th>BELOW EXPECTATIONS</th>
<th>MEETS EXPECTATIONS</th>
<th>EXCEEDS EXPECTATIONS</th>
<th>WELL ABOVE EXPECTATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appears unreliable and inconsistent in their approach to the exam</td>
<td>Uses an approach that is incomplete and misses important (i.e., timing and location) components of the exam</td>
<td>Demonstrates minimum competence in the exam, showing a relatively systematic approach (i.e., timing and location)</td>
<td>Uses an approach that is thorough, accurate, and efficient</td>
<td>Appears thorough, accurate, efficient, and also uses an approach that shows a clear understanding of underlying cardiac pathologies</td>
</tr>
</tbody>
</table>
You will be presented with videos of 1st and 2nd year medical students performing a focused physical exam for cardiac auscultation skills. In these videos, the participants are diagnosing three cardiac murmurs: mitral regurgitation, mitral regurgitation combined with mitral stenosis, and mitral regurgitation combined with pulmonary regurgitation. You will not know which condition they are diagnosing in each video, so please keep these three possibilities in mind as you rate their physical examination skills.

Please use the following global rating scale with the provided anchors to rate the student’s overall physical examination performance:

<table>
<thead>
<tr>
<th>WELL BELOW EXPECTATIONS</th>
<th>BELOW EXPECTATIONS</th>
<th>MEETS EXPECTATIONS</th>
<th>EXCEEDS EXPECTATIONS</th>
<th>WELL ABOVE EXPECTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appears unreliable and inconsistent in their approach to the exam</td>
<td>Uses an approach that is incomplete and misses important components of the exam</td>
<td>Demonstrates minimum competence in the exam, showing a relatively systematic approach</td>
<td>Uses an approach that is thorough, accurate, and efficient</td>
<td>Appears thorough, accurate, efficient, and also uses an approach that shows a clear understanding of underlying cardiac pathologies</td>
</tr>
</tbody>
</table>