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EDITORIALS

Examining Clinical Reasoning Through a Threshold Concept Lens

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Abstract

Importance: While there is an extensive body of evidence examining the learning of clinical reasoning in medicine, there is limited discussion of this in the context of musculoskeletal therapies. There is a need to better understand the complexity of clinical reasoning and to consider pedagogical approaches to support students to learn this troublesome skill. This commentary aims to (1) explore the complexity of clinical reasoning for the musculoskeletal therapies; (2) review clinical reasoning for musculoskeletal therapies through the lens of Threshold Concepts; and (3) explore approaches to curriculum and pedagogy to address the troublesome nature of learning to clinically reason.

Observations: Beyond the established cognitive and metacognitive processes occurring as part of clinical reasoning, there are several factors that contribute to the complexity of this skill and make the learning and mastering clinical reasoning a challenge. Clinical reasoning has been identified as a threshold concept, in adjacent disciplines. The learning of clinical reasoning is troublesome, not least because of variability, issues with authenticity and integration of learning. Educators can assist students to navigate uncertainties faced when learning clinical reasoning.

Conclusion and relevance: It is recommended that educators use an integrative pedagogical approach for developing the education of clinical reasoning in musculoskeletal therapies. Case based instruction and high-fidelity simulation may offer opportunities for students to develop adaptive expertise and self-regulatory reflective skills, improving their diagnostic and therapeutic reasoning. Approaching the education of clinical reasoning with the use of a threshold concept lens and integrative pedagogical approach, can assist students in learning the troublesome skill of clinical reasoning.

Keywords: Clinical reasoning, Threshold concepts, Integrative pedagogy, Case based learning

1. Introduction

Clinical reasoning is the ability to ‘sort through a number of features presented by a patient and accurately assign a hypothesis or diagnosis, culminating in the development of an appropriate treatment strategy’ [1]. The development of clinical reasoning is complex and requires practice both inside and outside of a didactic curriculum [2,3]. It is complex because students must respond to an unfamiliar and ill structured problem in a dynamic context, including feedback loops between clinician and patient, knowledge, and a growing body of evidence [4]. The reasoning process involves recognising and formulating a correct a diagnosis

(diagnostic reasoning), testing hypotheses, devising novel solutions to formulate the best possible treatment plan (therapeutic reasoning), noticing cues and identifying patterns [5,6]. Whilst considerable research has been conducted with a focus on diagnostic reasoning, there is seemingly less for the therapeutic arm of the clinical reasoning dichotomy.

Several models of diagnostic reasoning have been proposed and helpfully summarised into three main conceptualisations: (1) “reasoning as cognitive activity” including processes such as pattern recognition, metacognition and hypothetico-deductive reasoning; (2) “contextually situated activity” including the use of adaptive expertise; and (3) “Socially mediated activity” where learning to

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reason cannot be separated from learning to be a professional [6]. Whilst the latter appears to be more dominant in the social sciences, the connections made between this conceptualisation and professional socialisation, culture and language are present in the musculoskeletal therapies.

Students of musculoskeletal therapies learn the skills of clinical reasoning during their preparatory training, alongside developing knowledge, understanding, practical skills, reflective skills and communication. While there is an extensive body of evidence examining the learning of clinical reasoning in medicine there is more limited discussion of this in the context of the musculoskeletal therapies. As a critical skill for effective practice, there is a need to better understand this complexity and consider pedagogical approaches to support students to learn this troublesome skill. Threshold Concepts (TCs) [7] may provide a useful lens to view and develop clinical reasoning education in the musculoskeletal therapies and is worthy of further exploration.

2. The troublesome nature of learning clinical reasoning

In the musculoskeletal therapies context, we identify three interrelated problems faced by students that do not exist in isolation, that make learning and mastering clinical reasoning a challenge. These are: variability, authenticity and integration of learning.

2.1. Variability

Clinical reasoning is multifaceted with considerable variability [8]. It is contextually situated [6] and characterized by collaboration to understand the patient's perspective [9] with each clinical encounter being different and presenting a continually shifting context [10]. This inconsistency can be a difficult notion for students to grasp and may lead to feelings of uncertainty. Variability arises from individual differences presented from one patient to another, not only in their physical presentation of symptoms but also in the interpretation and communication of the condition. In the context of musculoskeletal therapies this includes anatomical variance, psychological and physiological response to injury, other contextual factors such as physical activity and sports performance level (e.g., recreational or professional), occupational demands, social influence, social determinants of health and clinician resources. The influence of these factors over clinical decision making, mean that students can and will encounter something that departs from a model or 'textbook' injury presentation and are faced with 'a

grey area' [11]. Though variability itself can be perceived as problematic for students, it is the student's ability to cope with that variability and departure from the textbook presentation, that appears to be critical. The ability to let go of previously held assumptions and approaches and respond flexibly to new situations is a hallmark of what Hatano and Inagaki [12] labelled 'adaptive expertise'.

While rote learning is not entirely redundant as it may ensure a solid grounding for foundational skills and act as a clinical safety net for students, it is acknowledged that a mechanistic approach to clinical practice is not appropriate [13]. Furthermore, simply delivering a checklist of skills to students, to meet the competencies prescribed by a professional body, risks creating *performers* able to pass competency based assessments, rather than competent clinicians able to address complex challenges, through creative problem solving and excellent clinical reasoning [14].

2.2. Authenticity

It is common in the musculoskeletal therapies for clinical skills to be taught in silo without contextual factors and in inauthentic environments. An example of this is teaching students a practical examination test on a non-injured peer. Whilst students can practice their handling skills and refine these in a safe environment, they rarely see, feel, or experience the responses of an injured patient until they are nearing the end of their training. Clinical content is traditionally taught in a laboratory setting. However, laboratory settings limit the transferability of skills because they are not authentic [15]. This is supported by DeBourg [16] who states that learning in the context of a patient case or encounter provides the foundation needed for mastering clinical skills, early in the curriculum. Additionally, it is suggested that only when students become truly responsible for patient care in a natural setting, are they able to fully appreciate what is needed for adaptive expertise [17] and by extension, what is needed for clinical reasoning.

In medicine, Norman [18] states that much clinical learning is directed at learning signs and symptoms. Emphasis on this kind of knowledge and skill underestimates the importance of actual clinical experiences in the acquisition of expertise [18]. An early focus on developing strategies to manage the dynamic multi-dimensional clinical scenarios rather than focus on memorization of protocols has been advocated [19]. Furthermore, a pedagogical focus on more traditional frameworks of clinical reasoning, such as the hypothetico-deductive model, may manifest in a lack of authentic learning experiences and encourage students to focus on acquiring

factual content rather than developing a variety of clinical approaches or developing a flexible approach to problem solving [17].

2.3. Integration of learning

Inherent to teaching clinical skills is the challenge for the learner to perform the skill, interpret the outcome and discern implications with consideration for the whole person [20]. Consequently, it is important that the content is not left in disciplinary silos (e.g. anatomy, physiology, biomechanics, and neuromusculoskeletal assessment) but is integrated quickly and coherently, so that students are able to recognise the connections and begin to emulate the behaviours and patterns of thinking essential for success in practice. Integration is essential to avoid the information overload that is associated with traditional curriculum where information is delivered as a series of disciplinary blocks that focus on detail with little emphasis on the links between concepts and its clinical relevance [21]. This issue is often exacerbated in the earliest parts of musculoskeletal therapy programmes, where curriculum focus is mainly concerned with getting students competent with the many basic practical skills, or in the vast underpinning knowledge, that is required. This problem is compounded by curriculum structures that are typically modular and may involve shared curricula with other disciplinary programmes, such as sport and exercise sciences or other health professional programmes.

To successfully clinically reason, a student must be able to draw elements of their learning together. The interrelated problems of variability, authenticity and integration of learning are *troublesome* for learners (Fig. 1). ‘Troublesomeness’ is a characteristic of the pedagogical framework of Threshold Concepts (TC's). In their qualitative synthesis of TC's in health sciences education, Barradell and Peseta [22] suggest that the use of a threshold concept lens should be considered when inducting students into complex practices, as it can provide academics with a way to acknowledge critical elements of their disciplines and types of curriculum strategies that might be needed to help students to cope with future clinical roles. To the best of our knowledge, viewing clinical reasoning through the lens of TC's has not been considered specifically for the musculoskeletal therapies.

2.4. Clinical reasoning through a threshold concept lens

Meyer and Land [7] describe a TC as “a portal, opening a new and previously inaccessible way of thinking about something. It represents a

transformed way of understanding, interpreting, or viewing something, without which the learner cannot progress” (p.1). These conceptual gateways are key to the individual being able to understand other aspects of the discipline, often described as troublesome knowledge [7].

TC's are distinct from core concepts within a subject; whilst a core concept must be understood, it does not necessarily lead to a different view of subject matter [7]. TC's are provocative; they challenge the learner and may lead to feelings of uncertainty, discomfort, anxiety, confusion, or the feeling of being ‘stuck’, thus inhibiting progression [23]. Therefore, it is essential that students pass through the conceptual gateway to progress. Meyer and Land [7] suggest that difficulty in understanding TCs may leave the learner in a state of *liminality*, a suspended state in which understanding approximates to a kind of mimicry or lack of authenticity.

There are five key characteristics of TC's: they are transformative, irreversible, troublesome, integrative, and bounded. Transformation is a process that can be sudden or may be protracted over a considerable period [13] but results in changing the way in which a student views the subject matter, subject landscape, or even worldview. In the health sciences, Barradell and Peseta [22] state that TC's are transformative in how students' encounter and (re) construct the knowledge of a discipline or profession. Meyer and Land [7] state that such transformed understanding leads to a privileged or dominant view and therefore a contestable way of understanding something. TC's are irreversible, given their transformative nature, they are difficult to unlearn. A TC is troublesome meaning students may encounter conceptual difficulty and/or emotional uncertainty as what they know is redefined [22]. Additionally, the drawing together of fundamental knowledge to develop a more sophisticated and essential understanding makes a TC integrative but may also contribute to difficulty and uncertainty faced by students. Finally, a TC is bounded in that any conceptual space will have terminal frontiers and demarcation between disciplinary areas, to define academic territories [7].

In viewing clinical reasoning through the lens of TC and drawing back to the previous analysis of clinical reasoning as being troublesome due to variability, issues with authenticity and integration of learning, the characteristics of TC's are apparent.

The most recognisable characteristic of TC's seen within clinical reasoning, might be the pulling together of fundamental knowledge to develop a more sophisticated and essential understanding (*Integrative*). The integrative nature of clinical

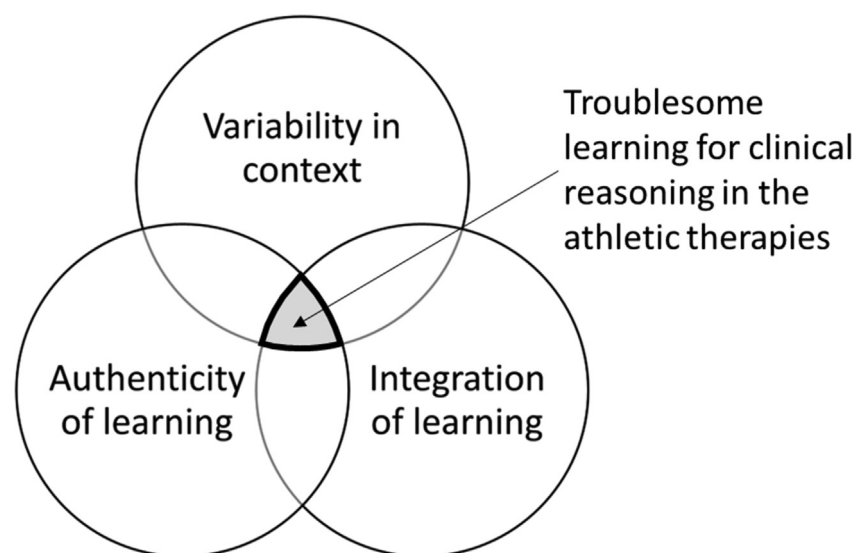


Fig. 1. The nexus of the three interrelated problem is where ‘troublesomeness’ of learning clinical reasoning in the musculoskeletal therapies is located.

reasoning appears to contribute to feelings of uncertainty and challenge experienced as part of the learning process, mirroring the troublesome characteristic of TC. Much of the prerequisite knowledge required to clinically reason is itself, something that students find difficult to learn and understand: human anatomy, physiology, and biomechanics for example. Learning through lists, patterns and scripts, rather than developing the ability to deal with variability, risks creating performers rather than competent clinicians able to clinically reason. The notion of a *performance* aligns with the mimicry described by Meyer and Land [7] when a learner is in a liminal state, oscillating between old and new understandings on the journey towards crossing the threshold. The application of TC characteristics to clinical reasoning is further explored in Table 1.

2.5. Addressing the troublesomeness of clinical reasoning

To address the three interrelated problems that make clinical reasoning a troublesome threshold concept, educators will need to address both curriculum and classroom pedagogy. *Integration* of learning is paramount for students approaching challenging clinical scenarios. An integrative pedagogical model might be appropriate, whereby theoretical knowledge, practical skills and reflective/metacognitive skills are merged [25]. In integrative pedagogy, the teacher acts as a guide and plans and arranges learning environments where students can find their personal philosophy parallel to practical abilities and skills by discussing, studying, and reflecting issues together with supervisors and peers [25]. Four

knowledge types: sociocultural, theoretical, practical, and self-regulatory are developed through integrative pedagogy, which together lead to a process of *transformation* [26]. Connections made between different forms of knowledge are achieved through activities that enable students to utilize theoretical concepts in practice or conceptualize and reflect on practical experiences, such as case-based instruction. Case-based instruction is known to be integral part of the educational and clinical component of preparing musculoskeletal therapists and can address a number of the clinical skills required [27] but perhaps most importantly critical thinking and clinical decision making can be enhanced by offering students an opportunity to examine complex clinical scenarios, from a variety of perspectives [28].

Integrative pedagogy through the use of case based instruction connects to and addresses the nexus of problems identified in this paper through being reflective of an authentic working environment, having variability built into cases and through promoting the integration of knowledge. To give students opportunity to succeed in the face of *non-textbook* clinical presentations, early exposure to clinical scenarios and the opportunity to develop an adaptive mindset, are required. This may be achieved in the classroom with a variety of case scenarios and clinical interactions, but these should be realistic and expose students to authenticity. Progressive, guided practice with multiple opportunities to apply skills is needed to increase the authenticity and real-world applicability of clinical skills [15]. Such opportunities will also allow students to build professional culture, language and identity addressing the socially focussed

Table 1. Analysis of TC characteristics as applied to clinical reasoning.

TC characteristic	Application to clinical reasoning
Transformative	Pinnock et al. [24] describes the transformative nature of clinical reasoning as involving a qualitative shift in ways of understanding and undertaking this skill. In the context of musculoskeletal therapies, clinical reasoning transforms the way practitioners are able to think about injury scenarios and come to reasoned conclusions, to form a diagnosis/hypothesis and plan for treatment. This encompasses the recognition, acceptance and embodiment of variability as a core aspect of the clinical reasoning process. Once the threshold is crossed, students no longer expect textbook presentations of injury but anticipate and are prepared for complexity.
Irreversible	While there is limited evidence for the irreversibility of this skill [24] we would suggest that once able to clinically reason, there is no return. The practitioner builds on their knowledge base with each clinical encounter, building on their experiences and pattern recognition bank. Through experience, the reasoning becomes stronger due to growth of non-analytical and analytical reasoning processes.
Troublesome	Clinical reasoning is difficult because it requires a student to integrate all aspects of other learning, it is subject to variability from one patient to the next and varies in complexity. In addition, Pinnock et al. [24] align patient and context specific complexities and the subsequent challenge to clinically reason with “issues with transferability”. Clinical reasoning cannot be achieved through rote learning.
Integrative	To clinically reason, students must draw together knowledge, skill and scientific underpinning which may have been learnt in isolation. While clinically reasoning the integration of learning will occur to varying degrees, dependent on contextual factors and influenced by challenges posed by variability. Once the threshold is crossed, the student will autonomously make connections and integrate, as part of the clinical reasoning process. Pinnock et al. [24] suggests clinical reasoning enables students to see the interconnectedness of ideas.
Bounded	Clinical reasoning is bounded in the discipline of health and allied health professions. For the musculoskeletal therapies in particular, it is bounded by the distinct context of the musculoskeletal environment and the clinical encounter with the ‘athlete as patient’.

conceptualisation of clinical reasoning presented by Koufidis et al. [6].

Understandably, there may be some caution around early clinical exposure with an incomplete skill set. However, clinical exposure does not have to mean hands on. Earliest opportunities may include simple patient interactions, practising subjective assessment skills and the handling of clinical notes. Observational activity and simulation may also provide early-stage authentic environments. Whilst simulation is not entirely authentic, there is evidence to suggest that high fidelity simulation based clinical placement can be used to replace standard ‘real life’ placements, with no loss of competency [29]. Therefore, high fidelity simulation might offer the space for students to develop their clinical reasoning and be useful for presenting the aforementioned variability, in a controlled and ‘safe to fail’ environment [30].

Coupled with this, opportunities to develop and use self-regulatory skills of reflection and meta-cognition will facilitate the learning of new scientific information and improve diagnostic reasoning [31]. The importance of creating opportunities for authentic reflection and discussion to facilitate students linking theory to real-world practice and help to make sense of their experiences in the context of threshold concepts has been identified [32]. Effective reflective practice can be achieved through opportunities of deliberate reflection [29], simulation and standardized patient cases [33]. To augment the reflective practice for musculoskeletal

therapy students learning clinical reasoning, educators should be explicit to students in framing clinical reasoning as a TC to support students to utilise the lens to help develop understanding and navigation of the *liminal space* that they may find themselves in.

2.6. Conclusion

Threshold concepts have provided a useful lens through which the *troublesomeness* of clinical reasoning in musculoskeletal therapies could be viewed. The use of the TC lens is not without controversy, but it has offered a useful perspective for looking at clinical reasoning and unearthing the three interrelated problems. For the educator the lens frames clinical reasoning in such a way that may aid both the understanding of this skill and assist them in designing learning tasks to support students in the learning of this skill. For the student the lens provides insight into the complexity and normalises the challenge of learning this troublesome skill. Whilst individuals might navigate these problems at contrasting times, to varying degrees and potentially for differing durations the nexus of problems remains troublesome and should be addressed by educators in the teaching of clinical reasoning. In summary, it is recommended that an integrative pedagogical approach for developing the education of clinical reasoning in musculoskeletal therapies be utilised, including:

- The early introduction of clinical reasoning using a TC lens to discuss troublesome knowledge.
- Case based instruction methods that incorporate variability and promote the four knowledge types of integrative pedagogy.
- Scaffolded, authentic, clinical experiences or high-fidelity simulation that offer opportunities for students to develop the skills necessary to clinically reason and promote an adaptive mindset.
- Caution not to overburden students with volume or use typical ‘signs and symptoms’ approaches, in order to avoid the production of performers or mimicry.

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Conflicts of interest

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