JASON HO YI ZENG ASSESSMENT OF DIAGNOSTIC CLINICAL REASONING SKILLS AMONG UNDERGRADUATE PHYSIOTHERAPY STUDENTS 2024

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ASSESSMENT OF DIAGNOSTIC CLINICAL REASONING SKILLS AMONG UNDERGRADUATE PHYSIOTHERAPY STUDENTS

By

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A Research proposal submitted to the Department of Physiotherapy, M. Kandiah Faculty of Medicine and Health Sciences, Universiti Tunku Abdul Rahman, in partial fulfillment of the requirements for the Degree of Bachelor of Physiotherapy (Hons)

ASSESSMENT OF DIAGNOSTIC CLINICAL REASONING SKILLS AMONG UNDERGRADUATE PHYSIOTHERAPY STUDENTS

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ABSTRACT

Background: Clinical reasoning is a vital cognitive process in physiotherapy, directly influencing patient outcomes. However, its assessment among Malaysian physiotherapy students has been under-explored. Understanding the diagnostic clinical reasoning skills of these students can provide insights into the effectiveness of current educational strategies and highlight areas for improvement. This study aims to bridge the gap by evaluating the diagnostic clinical reasoning abilities of undergraduate physiotherapy students in a private university, focusing on the integration of theoretical models with practical applications to enhance patient care.

Objective: To assess and analyze the diagnostic clinical reasoning skills of undergraduate physiotherapy students at Universiti Tunku Abdul Rahman, Malaysia, using the Diagnostic Thinking Inventory (DTI).

Methods: A cross-sectional study design was carried out among the physiotherapy students who had completed a clinical reasoning course or clinical posting experience. Participants were consented and they were required to complete the DTI, comprising sections on flexibility in thinking and structural memory. Data were analyzed using descriptive and inferential statistics, including normality tests (Kolmogorov-Smirnov), correlation tests (Pearson's and Spearman's), and reliability tests (Cronbach's alpha).

Results: Statistical analysis revealed that 41.7% of participants exhibited poor diagnostic clinical reasoning skills. Among the cohort, fourth-year students achieved the highest mean scores in both flexibility in thinking and structural memory, suggesting that clinical exposure positively influences these abilities. Overall, flexibility in thinking scores exceeded those for structure in memory, indicating an imbalance in skill development.

Conclusion: Based on the present study, it is concluded that the students lacks in clinical reasoning capabilities especially the diagnostic reasoning skills as it was assessed using the diagnostic thinking inventory. This study emphasizes the need for targeted educational reforms to address gaps in clinical reasoning

education and refine strategies to produce skilled, patient-centered physiotherapists capable of delivering superior healthcare outcomes.
Keywords: Diagnostic Thinking Inventory, clinical reasoning, physiotherapy students, assessment of diagnostic reasoning skills.

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APPROVAL SHEET

This Research project entitled "**ASSESSMENT OF DIAGNOSTIC CLINICAL REASONING SKILLS AMONG UNDERGRADUATE PHYSIOTHERAPY STUDENTS"** was prepared by JASON HO YI ZENG and submitted as partial fulfillment of the requirements for the degree of Bachelor of Physiotherapy (HONOURS) at Universiti Tunku Abdul Rahman.

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PERMISSION SHEET

It is hereby certified that **JASON HO YI ZENG** (ID No: **21UMB06884**) has completed this Research project entitled "ASSESSMENT OF DIAGNOSTIC CLINICAL REASONING SKILLS AMONG UNDERGRADUATE PHYSIOTHERAPY STUDENTS" under the supervision of **Mr. Avanianban Chakkarapani** (Supervisor) from the Department of Physiotherapy, M. Kandiah Faculty of Medicine and Health sciences.

Yours truly,

(JASON HO YI ZENG)

DECLARATION

I hereby declare that the Research project is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: JASON HO YI ZENG

Date: 19/12/2024

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CHAPTER 1

1.0 INTRODUCTION

1.1 Chapter Overview

This chapter will first discuss the background of the study. The chapter was then continued with the research questions followed by the research objectives, hypothesis as well as the operational definition of terms.

1.2 Background of The Study

1.2.1 Clinical Reasoning

Clinical reasoning represents a complex cognitive process crucial for the comprehensive assessment and effective management of a patient's medical condition (Yazdani & Abardeh, 2019). Clinical reasoning contains tasks such as diagnosing the patient's condition, formulating therapeutic decisions, and estimating the prognosis for the individual. This multifaceted process involves the combination of information to guide medical professionals in delivering effective and tailored care to patients. The key components of clinical reasoning are cognitive processes, educational strategies and interprofessional training. Clinical reasoning required intricate cognitive models that monitor decision-making, emphasizing the need for training that enhances these psychological constructs (Ng et al., 2024). Furthermore, effective teaching strategies methods include identifying knowledge gaps, using worked examples, and promoting reflection on diagnostic justifications to reduce errors (Jay et al., 2024). Other than that, practitioners engaging in

diverse patient encounters, whether real or virtual, is essential for developing clinical reasoning skills across various healthcare professions (Eriksen & Gögenur, 2024). When discussing the importance of clinical reasoning, it has been acknowledged that clinical reasoning is one of the core medical skills that plays a significant role in a physiotherapist's capacity to diagnosis and decision making. For physiotherapy students, developing effective clinical reasoning skills is not only essential for accurate diagnosis but also critical for devising evidence-based and patient-centered treatment plans. In physiotherapy, clinical reasoning is strictly based on the principles of Evidence Based Practice. Undergraduate students are instructed to use the most up-to-date information in decision making with the client in a clear and thoughtful manner. Undergraduate students are taught to make explicit and conscientious use of current best evidence (Wijbenga et al., 2019).

1.2.2 Current Education Approaches

Understanding clinical reasoning is challenging due to the dispersed information across numerous journal articles and books. Some of these are authored by doctors who share their personal views on how doctors should think, often without thorough self-reflection or awareness of modern research. Conversely, educational and cognitive psychologists examining aspects of medical reasoning frequently lack insight into the realities of being a practitioner, including the responsibility of accurately diagnosing and treating patients. Consequently, they tend to explain the entire process through behaviors highlighted by their specific research methods, which often rely on low-validity patient problem simulations conducted in environments that differ

significantly from real clinical settings (Barrows & Feltovich, 1987). Even though clinical reasoning is a challenging, complex, multidimensional process, it is poorly understood due to the lack of theoretical models. While researchers have explored its nature since 1980, the concept remains vague until these days (Adams, 2013). The reason of this study is to give an overall view of clinical reasoning in medical education as well as a critical analyses of the research literature on these topics. Moreover, this research collects the information about the student perspective in clinical reasoning. Medical educators can also plan more effectively plan, teach, and test clinical reasoning when they have deeper understanding of the models and theories underlying the clinical reasoning. To improve the way of teaching and learning process, lecturers and undergraduate physiotherapy students need to employed the concept of clinical reasoning in their studies. This is done with the goal of increasing diagnosis accuracy and, as a result, making more appropriate decisions about physiotherapy interventions. Thus, the use of Diagnosis Thinking Inventory (DTI) has the potential to have a big impact on the educational and clinical thinking processes of physiotherapists, as well as their practice. It may even improve patient outcomes and promote them in their field.

1.2.3 Importance of Diagnostic Skills in Physiotherapy

Diagnostic skills are critical in physiotherapy, forming the foundation for effective patient management and treatment planning. Accurate diagnosis allows physiotherapists to identify health problems, guide interventions, and ensure care is tailored to individual patient needs. This process is not only a

legal mandate in many regions but also a cornerstone of clinical reasoning that significantly impacts treatment outcomes. Making a diagnosis is an essential competency, particularly in contexts where physiotherapists have direct access to patients, necessitating autonomous decision-making (Perron et al., 2023). The proposed universal diagnostic concept, PT-Dx-C, supports the classification of health problems, impairments, and activity limitations, facilitating clear communication among healthcare providers (Perron et al., 2023). Effective diagnostic reasoning integrates patient evaluations and clinical knowledge, allowing physiotherapists to practice autonomously and develop precise treatment plans. However, research indicates that entry-level physiotherapy education often lacks adequate emphasis on fostering these critical reasoning skills (Gilliland, 2017). Furthermore, evidence-based diagnostic processes enhance the accuracy of diagnoses by enabling physiotherapists to select and interpret appropriate diagnostic tests (Fritz & Wainner, 2001). This approach ensures that clinical decisions are informed by research findings, enhancing the quality of care. Nonetheless, some argue that an overemphasis on diagnosis may overshadow a holistic understanding of patient care, potentially narrowing the focus to specific impairments at the expense of broader well-being (Thornquist, 2001).

1.2.4 Relevance of Study

Diagnostic reasoning is fundamental for physiotherapists, enabling them to make informed decisions regarding patient diagnosis and treatment. The ability to analyze clinical information effectively distinguishes expert

practitioners from novices, impacting the quality of care provided. The assessment of diagnostic clinical reasoning skills among undergraduate physiotherapy students in Malaysia is critical for addressing gaps in knowledge, practice, and confidence. Malaysian physiotherapists' diagnostic abilities are influenced by their knowledge, experience, and the integration of contemporary techniques. Studies indicate that while physiotherapists demonstrate a moderate understanding of general conditions, significant gaps exist in specialized areas, such as idiopathic scoliosis and diabetes management. For instance, poor knowledge of idiopathic scoliosis correlates with limited clinical experience (Aisha et al., 2023). Similarly, while physiotherapists exhibit moderate competence in managing Type 2 diabetes, they lack confidence in critical aspects like hypoglycemia management (Krishnan et al., 2022). Additionally, there is a notable preference for traditional methods over newer approaches like Instrument-Assisted Soft Tissue Mobilization (IASTM), despite awareness of its benefits (Jo et al., 2023). Emotional intelligence and stress management further impact diagnostic performance, underscoring the multifaceted nature of these skills (Kutty et al., 2020). This study focuses on undergraduate students, a population often overlooked in existing research, to identify how early educational strategies influence diagnostic reasoning. By addressing these gaps, this research can contribute to improving diagnostic proficiency through localized, evidence-based educational reforms. The findings hold relevance for enhancing the quality of physiotherapy services in Malaysia, aligning with global trends in healthcare education and practice. Research indicates that clinical reasoning skills develop significantly through clinical placements and experiences. Students who engage in reflective practices, such as using learning

contracts and diaries, demonstrate improved self-awareness and clinical reasoning capabilities (Ramli et al., 2013a).

1.2.5 Concluding Remark

This study seeks to evaluate the assessment of clinical reasoning skills among undergraduate physiotherapy students using the Diagnostic Thinking Inventory (DTI) as a key evaluative tool. By exploring how students develop and apply diagnostic reasoning, this research provides insights into their ability to integrate theoretical knowledge with clinical practice effectively. The findings will contribute to understanding how diagnostic reasoning skills evolve in the Malaysian academic and clinical environment, highlighting areas for improvement in educational strategies. Ultimately, this study seeks to support the enhancement of clinical reasoning education, ensuring future physiotherapists are equipped to deliver patient-centered, evidence-based care.

1.3 Problem Statement

Clinical reasoning, a cornerstone of effective healthcare, is underemphasized in educational curricula despite its importance. At the moment, educators of physical therapists recognize clinical reasoning as a critical bridge between metacognition and the application of clinical knowledge within the contextual environment of the patients. Despite the instrumental role that it plays in ensuring diagnosis and treatment planning are effective, there is succinct understanding and awareness of these skills among physiotherapy students, especially in Malaysia. The complexity and multi-dimensionality of

clinical reasoning get further confused because of the lack of comprehensive theoretical models that explain how it is understood and applied in practice. A national survey in the U.S. found that medical students receive an average of only 6.4 hours of dedicated instruction in clinical reasoning during internal medicine clerkships, with 67% of clerkship directors advocating for increased focus on this area (Rencic et al., 2017). Barriers such as limited curricular time (87%) and a lack of qualified faculty (70%) hinder comprehensive instruction. Additionally, diagnostic errors, often attributed to insufficient clinical reasoning skills, affect up to 15% of patient encounters, resulting in significant morbidity and mortality (Duca & Glod, 2019). On the contrary, there are no such studies explicitly conducted among physiotherapy students which is important to understand the level of clinical reasoning capabilities among physiotherapy students. Similar gaps exist in physiotherapy education, where research indicates entry-level training often fails to adequately emphasize diagnostic reasoning, leaving graduates unprepared for the complexities of autonomous practice (Gilliland, 2017) The fragmented nature of existing theoretical models and the inconsistent use of evidence-based teaching strategies exacerbate these challenges (Schmidt & Mamede, 2015). Addressing this gap is imperative to ensure healthcare professionals can deliver accurate diagnoses and patient-centered care effectively.

The main objective of the study is to know about the lacuna in knowledge regarding awareness and development of clinical reasoning skills among physiotherapy students. It shall provide a comprehensive overview of clinical reasoning in medical education and critically analyze the available

research literature on the same subject. In addition, research will obtain insights from the views and experiences of physiotherapy students on this aspect of clinical reasoning. With a better understanding of the clinical reasoning models and theories underlying physiotherapy interventions, this study seeks to improve the teaching and learning of educators and learners, respectively; increase the accuracy of diagnosis; and enhance decision-making in physiotherapy interventions for better patient outcomes and advancement in the field of physiotherapy.

Improved clinical reasoning education can transform physiotherapy practices by enhancing diagnostic accuracy and treatment planning. Physiotherapists equipped with robust reasoning skills are better able to assess complex conditions, select appropriate interventions, and adapt treatments to individual patient needs. Incorporating structured tools like the Diagnostic Thinking Inventory (DTI) into physiotherapy education provides a means to evaluate and develop reasoning skills systematically. This approach aligns educational strategies with real-world demands, fostering evidence-based and patient-centered care. Studies have shown that physiotherapists with advanced clinical reasoning capabilities demonstrate greater confidence in managing conditions like idiopathic scoliosis and diabetes, which require nuanced decision-making and patient management (Aisha et al., 2023; Krishnan et al., 2022). Moreover, embedding these skills in educational frameworks can reduce diagnostic errors, improve patient outcomes, and elevate the standard of physiotherapy practice. By bridging the gap in clinical reasoning education,

physiotherapy programs can produce practitioners who are both effective and adaptable in diverse clinical environments.

1.4 Research Question

1. What is the current level of diagnostic clinical reasoning skills among undergraduate physiotherapy students in UTAR?

1.5 Research Objectives

1. To assess the diagnostic clinical reasoning skills among undergraduate physiotherapy students in UTAR.

1.6 Operational Definitions

1. **Clinical Reasoning**

   To diagnose and treat a patient's medical condition, a complex cognitive process known as clinical reasoning is required (Pelaccia et al., 2011). It comprises making a diagnosis, choosing a treatment plan, and figuring out the patient's prognosis (Daly, 2018).

2. **Physiotherapy Students**

   An individual participating in a board-approved physical therapy education program and performing physical therapy treatments is referred to as a "physiotherapy student." (Law Insider, n.d.).

1.7 Hypothesis

There is no hypothesis in this study because this was a exploratory study.

1.8 Structure of Research Project

This research paper is structured as follows. Chapter 1 introduces the background of the study, encompassing the research questions, objectives, and the importance and relevance of the topic. Chapter 2 provides a review of literature, summarizing key findings from prior studies on related subjects. Chapter 3 outlines the study's methodology, detailing the research design, sample framework, research instruments, data collection procedures, and data analysis methods. Chapter 4 presents the results derived from descriptive and inferential data analyses. Finally, Chapter 5 offers a review of the findings, discusses the study's limitations, and provides recommendations for future research.

CHAPTER 2

2.0 REVIEW OF LITERATURE

2.1 Chapter Overview

This chapter presents a review of past journals and literature from different topics, providing the blueprints for this research project.

2.2 Assessment of Clinical Reasoning Skills in Health Care Providers

Although clinical reasoning is intrinsic to health care practice in all its disciplines, the extent to which it is well developed, or prevalent among individuals, varies greatly depending on training, experience, and context. Clinical reasoning in healthcare providers is very well developed in experienced practitioners. A study done by Schmidt et al., (1990) reported that experienced physicians demonstrate a better level of clinical reasoning skills than students and residents. This is based on the finding that expert clinicians can link their large repository of case-based knowledge in identifying patterns intuitively and, therefore, making decisions.

Clinical reasoning is a critical skill in nursing that integrates knowledge, skills, and experience to make informed clinical decisions. It enhances patient safety and care quality, making it essential in nursing education and practice. The importance of clinical reasoning can be understood through its impact on educational strategies, assessment tools, and the overall effectiveness of nursing practice. Moreover, clinical reasoning in nursing is vital for the safety of patients and the provision of quality care. Clinical reasoning is increasingly incorporated

into nursing curricula, emphasizing active learning and collaborative reflection among students (Leal et al., 2024). However, it has been discovered that most nursing students and novice nurses have been shown to be unable to translate theoretical knowledge to clinical practice. Tilden & Tilden (1985) explained how a novice becomes an expert in nursing, and she further stated that novices usually have underdeveloped clinical reasoning skills. This could result from inadequate clinical experiences and imbalance in educational preparation where the theoretical aspects of nursing outweigh the practical ones. Various evaluation tools, such as self and peer assessments, are utilized to gauge nursing students' clinical reasoning abilities (Zhao & Dator, 2024). The development of specific competency scales, like the Clinical Reasoning Competency Scale (CRCS), provides a structured approach to measure and enhance clinical reasoning skills (Bae et al., 2023). While the emphasis on clinical reasoning is crucial, some argue that the focus on standardized assessments may overshadow the need for holistic patient care approaches, suggesting a balance between technical skills and empathetic practice is necessary.

Clinical reasoning is a fundamental skill for physiotherapy students, essential for providing effective patient care. Despite its importance, studies suggest that many students struggle with clinical reasoning, often relying heavily on rote learning rather than applying theoretical knowledge to clinical problem-solving (Joy Higgs et al., 2008). This gap in clinical reasoning skills has led to the exploration of various innovative approaches to enhance student proficiency. Structured tools like the Anticipate-Plan-Pause Clinical Reasoning (APP CR) Tool have shown promise in improving clinical reasoning, though

further refinement is needed (Kargela et al., 2024). Similarly, technology-driven solutions such as chatbots for training in clinical questioning and reasoning offer automated feedback and progress tracking, though their effectiveness is still under evaluation (C. Lee et al., 2022). Collaborative learning also plays a significant role, with international teaching initiatives fostering analytical decision-making and emphasizing multicultural perspectives (Gonzalez-Caminal & Kangasperko, 2023). Moreover, clinical supervisors are instrumental in tailoring learning experiences to students' dynamic needs, particularly in specialized fields like gerontological physiotherapy (Sharma et al., 2024). These advancements highlight the importance of continuous evaluation and integration of innovative teaching strategies to prepare students for the complexities of clinical practice.

2.3 Perception of Clinical Reasoning Skills in Health Providers

Awareness of the importance and mechanisms of clinical reasoning seems to be a requirement for the development and refinement of healthcare professionals. However, evidence suggests that little awareness prevails about clinical reasoning, especially among the student and novice practitioner population. For physicians, clinical reasoning is often viewed as a complex cognitive process essential for diagnosing and managing patient problems. Studies indicate that doctors emphasize the importance of structured reasoning models, such as the hypothetico-deductive model, which aids in transforming unstructured problems into manageable ones (C. Y. Lee et al., 2021). This model is widely regarded as effective for medical students and has been validated through empirical research. Physicians typically associate clinical reasoning

with decision-making and diagnostic justification, highlighting its critical role in ensuring patient safety and effective treatment outcomes. However, the literature also points out that many theoretical models of clinical reasoning have limited explanatory power, leading to ongoing debates about their applicability in real-world scenarios (Yazdani & Abardeh, 2019).

In contrast, nurses and nursing students tend to adopt a more patient-centered approach to clinical reasoning. Their definitions often encompass a broader understanding of the concept, focusing on the holistic management of patient needs. Research shows that nurses prioritize understanding patient situations and developing care plans that balance treatment objectives with patient motivations (Huesmann et al., 2023). They also emphasize the significance of clinical reasoning in ensuring patient safety, with some stating that it can be decisive for patient survival. This perspective highlights the relational aspect of nursing practice, where effective communication and empathy are integral to clinical reasoning In nursing, Cheng et al. (2013) stated that most of the nursing students are not aware of the process of clinical reasoning, which in effect reflects in a student's capability of producing sound clinical judgments. The observation may have spilled over from traditional educational models that emphasized memorization and procedural knowledge at the expense of fostering critical thinking and reflective practice.

In physiotherapy, likewise, very few students have an awareness of clinical reasoning models and frameworks. Edwards et al. (2004) were

interested in including clinical reasoning education in physiotherapy curricula because lack of awareness may prevent students from making appropriate clinical decisions. Not having this awareness is a concern as it will result in suboptimal patient outcomes and poor professional development of physiotherapists. Physiotherapy education has also recognized the importance of clinical reasoning as a core competency. The literature indicates that physiotherapists view clinical reasoning not only as a cognitive process but also as an integral part of their practice that influences treatment planning and intervention strategies. Research suggests that physiotherapy curricula increasingly incorporate simulation-based learning to enhance students' clinical reasoning skills, allowing them to apply theoretical knowledge in practical settings (Brentnall et al., 2022). However, similar to other health professions, there is a need for standardized assessment methods to evaluate clinical reasoning effectively within physiotherapy education.

2.4 Developing Clinical Reasoning Skills

The development of clinical reasoning skills is essential for healthcare professionals as it directly influences patient care and diagnostic accuracy. Effective strategies to enhance these skills include innovative teaching methods, curriculum integration, and educator training. Strategic questioning, particularly using Bloom’s taxonomy, has proven effective in improving critical thinking and clinical decision-making, as evidenced by nursing students in experimental groups outperforming those taught using traditional methods (Yasir & Nasir, 2024). Integrating clinical reasoning modules early in medical education, such as cranial nerve anatomy, has shown a 26% improvement in student

performance and reduced learning disparities by emphasizing analytical reasoning (Loomis et al., 2024). Furthermore, training clinical educators is critical, as they are responsible for teaching and assessing students. Equipping educators with modern tools, such as simulation-based learning and virtual reality, can significantly enhance student engagement and understanding (Piryani et al., 2023). Despite these advancements, challenges persist in addressing cognitive biases and ensuring consistent implementation across diverse clinical settings. Ongoing adaptation of educational strategies is imperative to meet the evolving needs of medical trainees and foster the effective development of clinical reasoning skills (Jay et al., 2024).

On the other hand, illness scripts are also vital cognitive tools that enhance the clinical reasoning skills of physiotherapists, facilitating the efficient diagnosis and management of patient conditions. An illness script is essentially a mental framework that organizes knowledge about specific health conditions, encompassing various components such as pathophysiology, typical signs and symptoms, epidemiology, and expected clinical courses. When physiotherapists encounter a patient, they subconsciously activate relevant illness scripts based on initial cues from the patient's presentation. This process, known as script activation, allows clinicians to frame their expectations regarding the patient's condition and guide their data collection and clinical decision-making (Charlin et al., 2000). The utility of illness scripts extends beyond mere recall of information; they facilitate pattern recognition and differential diagnosis by enabling physiotherapists to compare the patient's clinical presentation with their pre-existing knowledge structures. This comparison aids in identifying

matches or discrepancies between expected and actual findings, thus informing further assessment strategies (Matsui & Kawaguchi, 2014). Moreover, as physiotherapists accumulate clinical experiences, their illness scripts become more refined and detailed, allowing for quicker recognition of common conditions and enhancing diagnostic accuracy (Matsui & Kawaguchi, 2014). Incorporating illness scripts into physiotherapy education can significantly improve students' clinical reasoning capabilities. By teaching students to develop and utilize these scripts, educators can foster deeper understanding and retention of complex clinical concepts while preparing future practitioners for real-world challenges (Woods et al., 2015). Overall, illness scripts serve as a foundational element in the development of effective clinical reasoning skills among physiotherapists, ultimately leading to improved patient outcomes through better-informed diagnostic processes.

2.5 Evaluation of Methodologies in Assessing Clinical Reasoning Skills Among Undergraduate Physiotherapy Students

Various methodologies have been employed to assess and enhance clinical reasoning skills among undergraduate physiotherapy students. Qualitative research designs, such as those involving focus groups and semi-structured interviews, provide rich insights into students' experiences during clinical placements. For instance, a study at the European School of Physiotherapy highlighted the influence of the learning environment, clinical supervision, and individual factors on the development of clinical reasoning (Wijbenga et al., 2019). However, qualitative approaches face challenges

related to generalizability due to small sample sizes and the potential for subjective bias. Longitudinal studies track the progression of clinical reasoning over time, revealing shifts from basic anatomical reasoning to complex diagnostic thinking as students advance in their education (Wojkowski et al., 2021). These studies effectively capture developmental trajectories but are resource-intensive and prone to attrition bias. Simulation-based learning (SBL) has emerged as a practical method for improving clinical reasoning, particularly in contexts like chronic pain management, where it enhances critical thinking and psychosocial interpretation skills (Barranco-i-Reixachs et al., 2024). While SBL provides controlled environments for experiential learning, its effectiveness varies with simulation design and post-simulation debriefing, and cultural biases may influence outcomes. Finally, framework development studies aim to standardize teaching practices by creating structured approaches to integrate clinical reasoning into physiotherapy curricula (Sole et al., 2019). Although these frameworks enhance training consistency, their rigid nature may not accommodate diverse learning styles or evolving healthcare demands. Together, these methodologies highlight the multifaceted approach needed to assess and develop clinical reasoning skills in physiotherapy students, each with its strengths and limitations.

2.6 Barriers to Clinical Reasoning in Health Care Providers

Many barriers threaten the healthy development and use of clinical reasoning among healthcare providers. Educational, institutional, or individual factors may be split into broad categorizations. Traditional methods of teaching seldom encourage the ability to reason clinically. According to Facione &

Facione (1996), nursing education does not give prime importance to critical thinking and clinical reasoning. It is more about acquiring the knowledge in facts. This method leaves the student somewhat unprepared for an actual clinical setting, where knowledge will have to be combined with experience to become useful in arriving at the correct decision. Another gap is existing in the pedagogies for the teaching of clinical reasoning within physiotherapy curricula. According to Joy Higgs et al. (2008), most programs of physiotherapy education do not deal effectively with the complexities of clinical reasoning. Therefore, students are forced to adopt superficial approaches to learning that do not transfer easily into clinical practice. When without case-based learning and real-life clinics, the opportunities for deep learning to take place toward the development of effective clinical reasoning are simply missed out.

Health care institutions often face various challenges in the development of clinical reasoning skills, among the staff. One very common barrier is lack of support and resources to maintain professionals' ongoing development. According to Banning (2008), pressure with workload and shortage of time in clinical settings allow for limited space for reflection and learning, an important process in the development of clinical reasoning skills. Therefore, without the institution's support, health practitioners will have a rough time engaging in reflective practice that leads to the development of clinical reasoning abilities. In addition, the large health setup seems to create a hierarchy making the junior staff feel reluctant to question decisions or even actively participate in critical discussions. This deflates the edifying of clinical reasoning skills since it often

builds out of the challenging of assumptions and alternative ways of attending to a patient's needs.

Other big hurdles are differences in learning styles, and even going to the extremes of cognitive biases by individuals. According to Croskerry (2003), cognitive biasness may result in diagnostic errors and poor clinical judgments. Limitation of most of these biases is quite devastating in a high-pressure working context, where timely decision-making is critical. Apart from these general factors, it has been proposed that individual learning styles may further contribute to differences in clinical reasoning development. There are going to be some students who just do not feel comfortable with high-level abstractions of clinical reasoning and who therefore have a hard time getting beyond rote memorization and applying knowledge in flexible context-dependent ways. Whatever the cause of these failures either developmental or curricular, or both, healthcare educators must become aware of the existence of these differences and adjust teaching strategies appropriate to the breadth of the continuum to ensure that all students develop robust clinical reasoning skills.

2.7 Clinical Reflection

Clinical reflection is an effective strategy for advancing one's career and refining clinical reasoning abilities (Atkinson & Nixon-Cave, 2011). The ability to reflect is essential to learning and metacognition, which is defined as the awareness or examination of one's own learning or thought processes (Merriam-Webster, n.d.). Clinical reasoning techniques are fostered by this "thinking about thinking." According to Schön (2017), clinical reflection can occur "in action" during the event and "on action" after the event. The "think-aloud" method is a novel way to support reflection in action for both the mentor and the learner in specific circumstances. During a clinical encounter, the mentor can identify areas where reasoning techniques need improvement by encouraging the novice physiotherapist to articulate their thoughts aloud. Furthermore, expressing clinical reasoning has the potential to support the metacognitive process; during a therapeutic encounter, a mentor may also think aloud to provide insights into their reasoning methods. Improving learning and reasoning skills can occur either orally or in writing after clinical encounters. Journal entries or portfolios serve as examples of structured reflective writing that encourages reflection on action. The application of structure is a crucial component of these educational strategies intended to promote introspection and enhance clinical reasoning. Although students' clinical education in physical therapy includes structured reflective learning experiences, little is known about how these experiences are utilized in the real-world workplaces of practicing physiotherapists. Research indicates that reflective practice is vital for effective clinical decision-making and professional development (CSP, 2019). Reflection is recognized as a key component of health professionals' practice, enabling clinicians to develop and

maintain best practices. Additionally, studies have shown that experienced physiotherapists view reflection as essential for making wise judgments and navigating complex clinical scenarios (Ramli et al., 2012). This aligns with findings that structured reflective practices, such as keeping a reflective journal, help students bridge academic learning with clinical practice, fostering critical thinking and improved patient care outcomes To conclude, while structured reflective practices are incorporated into physiotherapy education, further exploration is needed to understand their implementation in clinical settings. Encouraging a culture of reflection within healthcare teams can enhance learning and improve service delivery, ultimately benefiting both practitioners and patients alike.

CHAPTER 3

3.0 METHODS

3.1 Chapter Overview

This chapter will cover the research methodology used, including the research design, ethical approval, sampling design, research instrument and study procedures and data analysis strategies.

3.2 Research Design

This study adopts a cross-sectional descriptive research design to assess clinical reasoning skills among undergraduate physiotherapy students. The data will be collected through a self-administered online survey using Google Forms. The survey includes the Diagnostic Thinking Inventory (DTI) and additional items to evaluate factors influencing diagnostic reasoning. Participants will be invited through universal sampling within the target university. Responses will be collected anonymously, ensuring confidentiality and data integrity. This design allows for a comprehensive snapshot of the students' clinical reasoning abilities at a specific point in their academic journey.

3.3 Ethical Approval

This study was conducted following the approval of the Scientific and Ethical Review Committee (SERC) of Universiti Tunku Abdul Rahman (UTAR). All participants were thoroughly briefed on the study's purpose, procedures, and potential risks or benefits before being invited to participate. Written informed consent was obtained from each participant, ensuring

voluntary participation and understanding of their rights, including the confidentiality of their data. Demographic information and survey responses were collected through Google Forms and securely recorded using Microsoft Excel. The ethical clearance reference number can be found in Appendix A.

3.4 Sampling Design

The targeted participants were students from the Physiotherapy Department, M. Kandiah Faculty of Medicine and Health Sciences, Universiti Tunku Abdul Rahman (UTAR), Malaysia. The total cohort size was 202 students, of which 103 met the inclusion criteria and were eligible for participation. The sample size was calculated using OpenEpi's Sample Size for Frequency in a Population tool. Parameters for the calculation which include population size of 103 students, confidence level of 95%, and a margin of error of 5% The required sample size was determined to be 82 students. OpenEpi was selected as it provides a reliable suite of statistical and epidemiologic tools specifically designed for public health studies (Sullivan et al., 2009).

These participants were selected using a universal sampling method, wherein all eligible students from the cohort were included in the study. While universal sampling ensures the inclusion of all eligible participants, it has several drawbacks as the sample is specific to a single university and department, findings may not be generalizable to other physiotherapy students in different institutions or regions. First of all, there may be selection bias as

the reliance on a pre-determined cohort and inclusion/exclusion criteria may exclude students with marginal qualifications, potentially skewing the results. There may also be participation bias as willingness to participate may introduce self-selection bias, as students who opt-in may have higher motivation or interest in clinical reasoning compared to non-participants. Other than that, data homogeneity may reduce variability in the dataset, leading to limited insights into diverse perspectives.

The inclusion criteria of this study is a) Male and female students enrolled in the physiotherapy program at UTAR Sungai Long Campus, b) Students who had completed a clinical reasoning course or gained clinical posting experience, c) Students able to understand and read English, d) Willingness to participate in the study. On the other hand, the exclusion criteria is students who had not completed specific courses related to diagnostic reasoning or lacked clinical posting experience.

3.5 Research Instrument

Originally designed for physicians and medical students, the Diagnostic Thinking Inventory (DTI) serves as a self-evaluation tool developed by Bordage et al. (1990) to gauge the progression of clinical reasoning abilities. Two dimension of clinical reasoning is being evaluate by DTI which is the creative thinking and the structured retention of information irrespective of the context. Its applicability extends to distinguishing between medical specialists with varying levels of training. Adapting the DTI for use in physical therapy shows promise, offering physiotherapists a means to assess their

clinical reasoning, enabling educators to evaluate students, and allowing educational researchers to assess the effectiveness and validity of specific teaching methods Salles et al. (2022). The DTI has been shown to have strong content validity, with items developed based on extensive literature review and expert input. Construct validity has been supported through factor analysis, which confirms the instrument's ability to measure the intended dimensions of diagnostic thinking (Bordage, 1994). The reliability of the DTI is supported by high internal consistency, with Cronbach's alpha coefficients reported in various studies ranging from 0.70 to 0.85, indicating good reliability (Bordage et al., 1990). Two subscales are being compromised in DTI which is the flexibility in thinking and structure in memory. The former measures the extent to which diverse means or processes can be employed during the diagnostic process, with 21 items and a score range of 21 - 126. The latter assesses the availability of knowledge stored in memory during diagnosis, with 20 items and a score range of 20 -120. This subscale operates under the assumption that knowledge availability is a direct outcome of effective knowledge organization. The DTI questions all have a stem and a six- point semantic differential scale where the participants need to mark a “x” in the place they think it is suitable. The inventory yields two scores, evaluating distinct aspects of diagnostic thinking. Flexibility in Thinking assesses the use of diverse thinking means or processes during diagnosis, while structure in memory evaluates the availability of knowledge stored in memory. A higher score on either subscale indicates more advanced diagnostic thinking.

3.6 Procedure

3.6.1 Recruitment process

Participants for this study were recruited from the Physiotherapy Department, M. Kandiah Faculty of Medicine and Health Sciences, UTAR Sungai Long Campus, using universal sampling method. Participants will be recruited through universal sampling method using social media platforms including Facebook, Instagram, and WhatsApp, ensuring a representative sample. Additionally, in-person recruitment will be conducted at UTAR. Each participant will receive a detailed explanation of the study's objectives and will be asked to complete an informed consent form indicating their willingness and agreement to participate.

3.6.2 Data Collection

Data collection involved administering the Diagnostic Thinking Inventory (DTI) through a questionnaire in google form. These tools were used to evaluate participants' clinical reasoning skills and ensure they met the eligibility criteria. They will be provided with an online questionnaire (Google Form). The questionnaire consists of 2 parts: I Informed consent form (refer to Appendix I), II Demographic data (refer to Appendix II). After obtaining the participant’s consent, this demographic data form will be used to obtain the participant’s name, age, gender, UTAR student ID and contact number. To screen the participants based on the exclusion criteria, questions regarding the course taken will be asked. Included participants from the previous

procedures will then proceed to fill in the online form of DT inventory (refer to Appendix III) in Google Form. Data will then be processed and analysed.

3.7 Data Analysis

All response collected will be screened before proceeding to the statistical analysis. This is to filter out any data of missing values or outliers. To analyse the study outcomes, the final data was analysed by using IBM Statistical Package for Social Science (SPPS) software version 26.0. The data collected in this study through the Diagnostic Thinking Inventory (DTI) and demographic questionnaires will be analyzed using a combination of descriptive and inferential statistical methods. Descriptive statistics, including means, standard deviations, and frequency distributions, will summarize the overall DTI scores and subscales for flexibility in thinking and evidence of knowledge structure. Cronbach's alpha will be used to test the reliability of the DTI, ensuring its consistency in measuring clinical reasoning within the study population, as demonstrated in prior research (Bordage et al., 1990). Salles et al., (2022) has suggested the use of the Kolmogorov–Smirnov test to examine the distribution of the sample. A p-value which is greater than 0.05 indicate that the data follows a normal distribution. The Pearson's and Spearman's correlation test was performed to examine the relationship between the year of study and the level of diagnostic clinical reasoning skills. The results will indicate that the level of diagnostic clinical reasoning skills among undergraduate physiotherapy students is significantly associated with their year of study. Correlation analysis will explore relationships between DTI scores and demographic variables to identify factors influencing diagnostic

reasoning. Participants will also be categorized into levels of diagnostic reasoning attainment based on DTI scoring descriptors, offering insights into skill development and potential gaps.

CHAPTER 4

4.0 RESULTS

4.1 Chapter overview

This chapter presents the results derived from the data collected for this research. It begins with a summary of the demographic characteristics of the participants to provide context for the study population. Following this, descriptive statistics are presented to highlight key trends and patterns in the dataset. The chapter then moves on to the outcomes of inferential statistical analyses, providing insights into the relationships and differences identified within the data. Each section includes a brief description of the statistical tests applied, a summary of the results, and supporting visualizations such as pie charts and tables to enhance clarity and understanding. The chapter concludes with the findings of hypothesis testing, linking the results back to the research questions and objectives. This structured presentation ensures a logical and comprehensive interpretation of the data.

4.2 Demographic of Participants

4.2.1 Gender

This study involved 84 participants in total with 24 males and 60 females. Figure 4.1 shows the gender distribution of participants in this study. The participants consist of 28.6% males and 71.4% females.

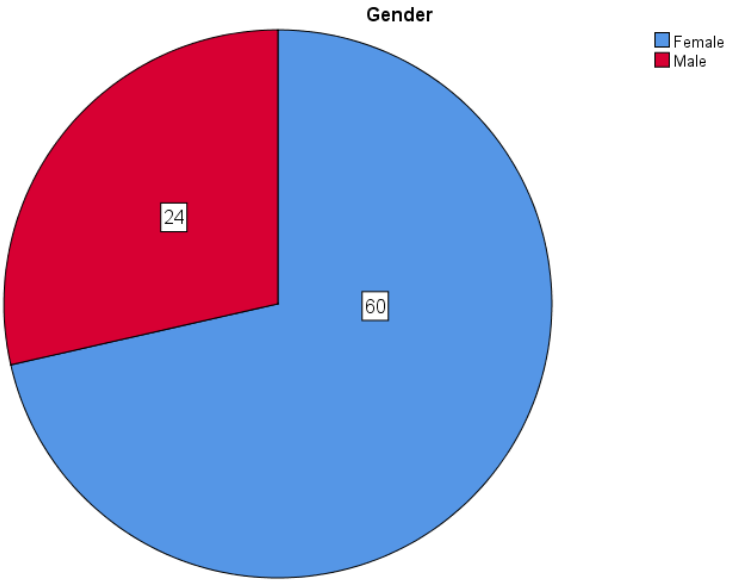

Figure 4.1 Gender distribution among participants

4.2.2 Year of Study

Figure 4.2 show the year of study among the participants for this study. There are 15 second year student, 34 third year student and 35 fourth year student.

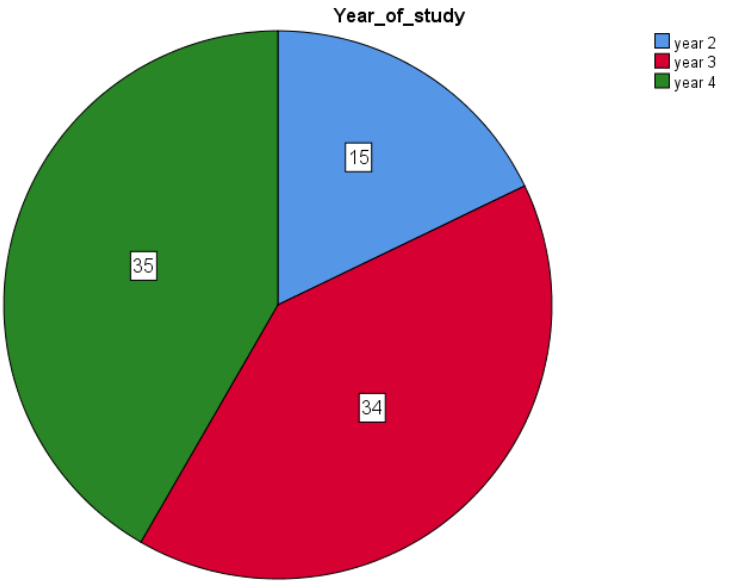

Figure 4.2 Year of study among participants

4.3 Statistical Analysis

4.3.1 Mean Scores of DTI and Its Two Subscales

Table 4.1 shows means for the overall DTI score and its two subscales for each subject groups.

Table 4.1 Mean scores of DTI and its two subscales

Year of study	Mean (sd)		
	DTI score	Flexibility in thinking	Structure in memory
Year 2	150.33 (8.77)	76.67 (4.51)	73.67 (5.23)
Year 3	154.74 (15.62)	78.71 (8.43)	76.03 (8.74)
Year 4	157.60 (18.00)	79.49 (10.71)	78.11 (8.79)
Total	155.14 (15.79)	78.67 (8.92)	76.48 (8.32)

4.3.2 Level of Attainment

In relation to the DTI score, Bordage et al. (1990) identified descriptors for five different levels of attainment:

Level 0 = Very poor flexibility and little evidence of structure.

Level 1 = Poor flexibility and little evidence of structure.

Level 2 = Some evidence of developing structure and flexibility.

Level 3 = Evidence of overall developing flexibility and structure.

Level 4 = Good flexibility of thinking and evidence of structure.

Level 5 = Excellent flexibility and evidence of structure

Based on the level of attainment by (Bordage et al., 1990), the results obtained show that most of the students which was 41.7% fall in the group of very poor flexibility and little evidence of structure. Only 19% of the total participants were categorized as the highest level which was having excellent flexibility and evidence of structure.

Table 4.2 The Level of Attainment

		Year of study			
Scale	Level	Year 2	Year 3	Year 4	Total (%)
<150	0	7	13	15	35 (41.7)
150-155	1	4	8	2	14 (16.7)
156-160	2	2	3	1	6 (7.1)
161-165	3	2	2	4	8 (9.5)
166-170	4	0	1	4	5 (6.0)
171-246	5	0	7	9	16 (19.0)

4.4 Normality Test

Table 4.1 presents the results of normality tests using both the Kolmogorov-Smirnov and Shapiro-Wilk tests for three variables: total DTI score, structure of memory, and flexibility in thinking. For the Kolmogorov-Smirnov test, the total DTI score ($p = 0.008$) and flexibility in thinking ($p =$

0.001) are statistically significant, indicating a deviation from normality. However, the structure of memory variable (p = 0.086) does not show significant deviation, suggesting it approximates normal distribution. Similarly, in the Shapiro-Wilk test, the total DTI score (p = 0.006) and flexibility in thinking (p = 0.007) are significant, while structure of memory (p = 0.641) passes the normality test. Based on these results, total DTI score and flexibility in thinking show evidence of non-normality, while structure of memory appears to follow a normal distribution. The Shapiro-Wilk test is more suitable for small sample sizes (fewer than 50), but it can also be applied to larger samples. On the other hand, the Kolmogorov-Smirnov test is typically used when the sample size is 50 or greater (Mishra et al., 2019). Since the sample size of this research is 84, the Kolmogorov-Smirnov test is appropriate.

Table 4.3 Test of Normality

	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
Total DTI Score	0.115	0.008	0.956	0.006
Structure of Memory	0.090	0.086	0.988	0.641
Flexibility in Thinking	0.129	0.001	0.957	0.007

$p \leq 0.05$ suggesting the data deviates from normality.

4.5 Exploratory Analyses

This section will discuss the exploratory data analysis, which were used for research project, including the Normality Test, Pearson's & Spearman correlation test and Cronbach's Alpha reliability test.

4.5.1 Pearson's & Spearman's Correlation Analysis

Table 4.2 presents the Pearson's correlation between the structure of memory and the year of study, with a coefficient value of 0.195. A r = 0.195 indicates a poor positive correlation, suggesting that as the year of study progresses, there is only a slight and inconsistent improvement in the structure of memory among students. The use of Pearson correlation here is appropriate, as the structure of memory subscale follows a normal distribution, and the analysis assumes a linear relationship.

Table 4.3 illustrates the Spearman's correlation between the total Diagnostic Thinking Inventory (DTI) score and the year of study, showing a coefficient value of 0.109. This r = 0.109 also indicates a poor positive correlation, implying that students' overall diagnostic reasoning skills, as measured by the DTI, show minimal improvement as they advance in their studies. Additionally, Table 4.3 includes the Spearman's correlation between the flexibility of thinking (a subcomponent of DTI) and the year of study, with a coefficient value of 0.065. Here, r = 0.065 reveals another poor positive correlation, suggesting that the students' ability to think flexibly in clinical reasoning scenarios does not significantly improve as they gain more academic and clinical experience. Since the total DTI score and flexibility of thinking

subscale do not follow a normal distribution, Spearman's correlation was the appropriate choice for these analyses. To conclude, there was no significant correlations for all the three variables which were total Diagnostic Thinking score, structure in memory and flexibility in thinking when compared to the year of study.

The distinction between Pearson and Spearman correlation is based on the characteristics of the data. Pearson correlation is used for parametric data, assuming a linear relationship between two continuous variables and a normal distribution. In this study, it was applied specifically to the structure of memory subscale because it met these assumptions. Spearman correlation, on the other hand, is a non-parametric test suitable for ordinal, non-linear, or non-normally distributed data. It was applied to the total DTI score and flexibility of thinking, as these variables did not follow a normal distribution and their relationships might not be strictly linear.

These findings suggest that while progression through the academic years might bring increased exposure to clinical scenarios and theoretical knowledge, these experiences alone may not substantially enhance the diagnostic reasoning skills measured by the DTI. This highlights the potential need for targeted educational interventions that directly focus on developing diagnostic reasoning abilities in physiotherapy students. By identifying and addressing specific gaps in reasoning development, educators can better support students in improving their clinical reasoning skills.

Table 4.4 Pearson's correlation for structure of memory

		Year of study	Structure of memory
Year of Study	Pearson Correlation	1	0.195
	Sig. (2-tailed)		0.075
	N	84	84

r value closer to 1 or -1 indicate stronger relationships, while r value near 0 suggest little to no correlation.

Table 4.5 Spearman's correlation for total DTI score and flexibility in thinking

			Year of Study	DTI score	Flexibility in Thinking
Spearman's rho	Year of Study	Correlation Coefficient	1.000	0.109	0.065
		Sig. (2-tailed)		0.322	0.559
		N	84	84	84

4.5.2 Cronbach Alpha reliability test

Reliability test shows that DTI has a 0.74 reliability whereas reliability of flexibility of thinking and structure in memory is 0.57.

Table 4.6 Reliability of Diagnostic Thinking Inventory, flexibility of thinking and structure in memory

	Cronbach's Alpha	N of items
Diagnostic thinking inventory	0.746	41
Flexibility of thinking	0.571	21
Structure in memory	0.572	20

Coefficient value ≥ 0.70 are generally considered acceptable, indicating reliable measurement.

Table 4.7 Comparison of reliability across studies

	(Bordage et al., 1990) (270 subjects)	(Jones, 1997) (48 subjects)	(Rahayu & McAleer, 2008) (919 subjects)	Present study (84 subjects)
Reliability (α-coefficient)	0.83	0.846	0.74	0.74

CHAPTER 5

5.1 Chapter Overview

This chapter provides a summary of key findings in the beginning. Then for each section, an overview and interpretation of the findings to match the research objectives was presented, followed by comparison with previous research and justification. The chapter then continues with discussion of present study's limitations, recommendations for future studies and ends with conclusion of this study.

5.2 Discussion

5.2.1 Summary of Findings

This study aimed to assess the diagnostic clinical reasoning skills of undergraduate physiotherapy students using the Diagnostic Thinking Inventory (DTI). The findings indicated that DTI scores increased progressively from second-year to fourth-year students, reflecting a positive relationship between clinical exposure and diagnostic reasoning development. Fourth-year students achieved the highest mean scores in both flexibility in thinking and structure in memory subscales. However, the differences in mean scores across years of study were modest, suggesting potential limitations in the curriculum's emphasis on applied diagnostic reasoning. Flexibility in thinking consistently scored higher than structure in memory, highlighting an imbalance in the development of these two essential components.

5.2.2 Interpretation of Results

The study revealed significant differences in DTI scores across years of study, with fourth-year students achieving the highest mean scores in both subscales which are flexibility in thinking and structure in memory. This finding aligns with prior research, such as Schmidt et al. (1990), which demonstrated that advanced training and clinical exposure enhance clinical reasoning skills. The progressive improvement from second-year to fourth-year students reflects the role of cumulative clinical experience and education in fostering diagnostic reasoning abilities.

Interestingly, while the mean scores for DTI and its subscales increased with the year of study, the differences were relatively small. For instance, the total DTI score increased from 150.33 (±8.77) in second-year students to 157.60 (±18.00) in fourth-year students. This modest improvement suggests that while students gain more experience and theoretical knowledge over time, the curriculum may not sufficiently emphasize the integration of these elements to foster substantial growth in diagnostic reasoning. The similarity in scores may also reflect shared limitations in the educational approach across all years, such as a lack of focus on applied critical thinking or case-based learning.

The potential reason behind the poor reasoning skills among the majority of the participants can be due to inadequate preclinical training for the earlier years students. Many students feel that their preclinical education does not

sufficiently prepare them for the complexities of real-world clinical practice. This lack of preparation hinders their ability to integrate theoretical knowledge with practical application, which is essential for effective clinical reasoning (Wijbenga, Bovend'eerdt, et al., 2019). Students often report insufficient patient exposure during their clinical placements. This limitation restricts their opportunities to practice and refine their clinical reasoning skills in diverse scenarios, leading to a reliance on textbook knowledge rather than experiential learning (Ramli et al., 2013). Reflective practice is a vital component of developing clinical reasoning skills. However, reflective tools such as diaries and learning contracts are not widely utilized among Malaysian physiotherapy students. The absence of structured reflection limits their ability to critically analyze their experiences and learn from them (Cruz et al., 2012). Another reason of lack of clinical reasoning could be due to insufficient feedback mechanisms. Both students and clinical teachers emphasize the importance of feedback in the learning process. However, inadequate feedback during clinical placements can prevent students from understanding their strengths and weaknesses, thereby stunting their development of clinical reasoning skills (Ramli et al., 2013).

The findings highlight the importance of integrating advanced diagnostic reasoning frameworks into the curriculum. For example, adopting tools like the DTI and emphasizing evidence-based practices can enhance students' ability to navigate complex clinical scenarios. Furthermore, structured reflective practices, such as journaling or think-aloud methods, could be

implemented to promote metacognitive awareness and critical thinking among students. Another key implication is the need to address identified barriers, such as limited clinical exposure and the overemphasis on theoretical knowledge. Aligning educational strategies with real-world clinical demands can better prepare students for autonomous decision-making, a critical skill for physiotherapists working in direct-access settings (Perron et al., 2023).

5.2.3 Differences in Structure and Flexibility Scores

The subscales of the Diagnostic Thinking Inventory (DTI) revealed distinct trends, with the flexibility in thinking subscale consistently scoring higher than the structure in memory subscale across all years. This discrepancy may indicate that while students are trained to approach problems with diverse strategies, their ability to organize and retain structured clinical knowledge lags behind. Flexibility in thinking, which measures the ability to adapt reasoning processes, likely benefits from varied clinical scenarios and problem-solving tasks encountered during education. Conversely, structure in memory requires deliberate efforts to consolidate and organize knowledge, which might not be as explicitly emphasized in the curriculum.

The greater difference in flexibility and structure scores for second-year students (76.67 & 73.67) compared to fourth-year students (79.49 & 78.11) suggests that early-stage learners rely more on developing diverse reasoning approaches rather than structured knowledge. As students progress, these scores converge, reflecting the gradual integration of flexible and structured thinking

skills. However, the persistent gap underscores the need for targeted teaching strategies that equally emphasize both dimensions.

Research indicates that clinical reasoning development is crucial for effective practice in physiotherapy, as it directly correlates with improved patient outcomes (Madi et al., 2021). The findings from this study align with previous literature suggesting that while flexibility in thinking is nurtured through exposure to diverse clinical situations, structured memory may require more focused pedagogical interventions (Jones, 1997). For instance, studies have shown that educational approaches such as problem-based learning (PBL) can enhance both flexibility and structure by encouraging students to engage deeply with clinical cases and reflect on their reasoning processes (Barrows et al., 1980). To address the observed discrepancies between flexibility and structure scores, educators need to implement strategies that foster a balanced development of both competencies. This could involve integrating explicit instruction on knowledge organization alongside opportunities for flexible problem-solving within the curriculum. By doing so, educators can better prepare physiotherapy students to navigate the complexities of clinical practice effectively. To summarize, while flexibility in thinking appears to be a strength among physiotherapy students, there remains a critical need to enhance their structured memory capabilities. Targeted educational interventions that emphasize both aspects of diagnostic reasoning will be vital in equipping future practitioners with the comprehensive skill set required for successful clinical decision-making.

5.2.4 Comparison with Existing Literature

The results are consistent with studies emphasizing the critical role of structured educational approaches and clinical exposure in shaping diagnostic reasoning (Bordage, 1994; Edwards et al., 2004). However, the relatively modest improvement observed in DTI scores across years aligns with findings from Joy Higgs et al. (2008), who reported that many physiotherapy programs inadequately address the complexities of clinical reasoning. This gap underscores the need for more interactive and reflective teaching methodologies, such as case-based learning and structured clinical reflections (Atkinson & Nixon-Cave, 2011). The comparison of mean scores for flexibility in thinking and structure in memory across the years of study reveals notable trends and gaps when measured against the cutoff points based on Bordage et al., (2014). In Year 2, the mean scores for flexibility in thinking (76.67) and structure in memory (73.67) fall below the cutoff points of 81.6 and 76.7, respectively, indicating a developmental lag in both areas. By Year 3, slight improvements are observed, with flexibility in thinking rising to 78.71 and structure in memory increasing to 76.03. However, these still remain below the cutoff points of 87.4 and 82.7. In Year 4, the mean scores reach their peak at 79.49 for flexibility in thinking and 78.11 for structure in memory, but they continue to lag behind the cutoff thresholds of 85.6 and 82.8. This consistent underperformance highlights potential areas for curricular or training interventions to help students achieve the desired standards in diagnostic reasoning capabilities.

In comparing the correlation results of the study on dental students' clinical reasoning and diagnostic thinking with this research on undergraduate physiotherapy students, several similarities and differences emerge that warrant discussion. In the dental study, the Pearson correlation test indicated no significant correlation between students' diagnostic thinking scores and their clinical reasoning scores on the key feature test ($r = 0.16$, $p = 0.19$) (Owlia et al., 2022) . This lack of significant association suggests that, despite varying levels of diagnostic thinking, students did not demonstrate corresponding improvements in clinical reasoning skills. The authors speculated that this might be due to insufficient integration of clinical reasoning training within the dental curriculum, which has been a common theme in educational assessments across health professions (Owlia et al., 2022).

Similarly, this study also found no significant correlations between DTI scores and various demographic factors, including year of study and clinical exposure. This parallels the dental study's findings, indicating a potential disconnect between theoretical knowledge and practical application in both curricula. In both cases, the absence of significant correlations could be attributed to several factors. Both studies highlighted the role of limited clinical exposure among early-year students. In this research, second-year physiotherapy students may have struggled to reflect their diagnostic processes accurately due to a lack of real-world clinical experiences. This aligns with the dental study's suggestion that students may not have had adequate opportunities to apply their diagnostic thinking in practical scenarios, leading to inflated self-

assessments (Owlia et al., 2022). The educational strategies employed in both studies may not sufficiently emphasize the integration of theoretical knowledge with practical application. The dental study noted that many educational systems still focus heavily on rote memorization rather than fostering critical reasoning skills (Owlia et al., 2022). The research findings suggest that similar limitations exist in physiotherapy education, where the curriculum may not adequately promote applied critical thinking or case-based learning. Furthermore, both studies acknowledged potential response biases among students when completing self-assessment tools like the DTI. In this research, second-year students might have provided answers they believed were "correct" rather than reflecting their actual reasoning processes. This phenomenon can obscure true skill levels and contribute to a lack of significant correlation between measured variables (Owlia et al., 2022). Moreover, both studies emphasize the need for reform in educational practices to enhance clinical reasoning and diagnostic thinking skills. The dental study advocates for a shift towards more integrated training approaches that emphasize problem-solving and decision-making skills (Owlia et al., 2022). Similarly, this research suggests incorporating advanced diagnostic reasoning frameworks and structured reflective practices into physiotherapy curricula to foster deeper learning experiences.

To conclude, while both studies reveal a lack of significant correlations between diagnostic thinking and clinical reasoning skills among healthcare students, they underscore common challenges faced in health professions

education. Addressing these issues through curriculum reform and enhanced clinical exposure could lead to improved outcomes in both fields.

5.3 Reliability of the Diagnostic Thinking Inventory

The overall reliability of the Diagnostic Thinking Inventory (DTI) was found to be 0.74, which is consistent with the original findings by Bordage et al. (1990), who reported a reliability coefficient of 0.83. Previous studies have also indicated reliability coefficients ranging from 0.66 to 0.87 (Groves et al., 2002; Jones, 1997). Notably, the reliability of the knowledge structure subscale was measured at 0.57, aligning with earlier findings by Bordage (1990). However, the flexibility in thinking subscale exhibited a similar moderate reliability of 0.57, suggesting that while the DTI is generally reliable, certain subscales may require further refinement or additional context for optimal performance. Bordage (1990) outlined that the DTI can be utilized in two distinct modes: one that assesses diagnostic thinking related to specific clinical cases and another that evaluates general diagnostic thinking. In this study, the DTI was administered to evaluate participants' general diagnostic thinking abilities. The instructions provided emphasized the importance of spontaneous responses, prompting participants to reflect on their actual diagnostic approaches rather than idealized methods, even if they had limited clinical experience.

Further validation studies have reinforced the DTI's effectiveness in different clinical settings. For instance, a study involving musculoskeletal

physiotherapists found an intraclass correlation coefficient (ICC) for test-retest reliability of 0.91, indicating strong consistency over time (Madi et al., 2021). Additionally, the flexibility in thinking and structure in memory subscales exhibited ICCs of 0.92 and 0.90, respectively, further supporting the tool's reliability across its dimensions. Construct validity has also been evaluated by comparing scores between different groups of physiotherapists. Significant differences were observed between expert and novice practitioners, demonstrating that the DTI can effectively distinguish between varying levels of diagnostic reasoning ability (Jones, 1997). This aspect of validity is crucial as it confirms that the DTI is not only reliable but also accurately reflects the diagnostic capabilities of individuals based on their experience. Moreover, recent adaptations of the DTI, such as the Korean shorter version (DTI-SK), have shown strong internal consistency with a Cronbach's alpha of 0.906 and satisfactory construct validity through exploratory and confirmatory factor analyses (Kim et al., 2024). These adaptations highlight the DTI's versatility and its applicability across different cultural contexts while maintaining its psychometric integrity.

Despite clear written and verbal instructions to guide participants in understanding the task, first- and second-year students with limited exposure to patient cases may have struggled to accurately reflect their diagnostic processes. As a result, these students might have focused on providing what they perceived as the “correct” answers rather than their genuine reasoning processes. This tendency could account for the relatively high scores observed among these

groups. Implementing formative educational strategies that require students to elaborate on their choices could mitigate this challenge, fostering deeper insight into their reasoning processes and enhancing their overall diagnostic thinking skills. In conclusion, the Diagnostic Thinking Inventory is a valid and reliable instrument for assessing diagnostic reasoning skills in physiotherapy and other medical fields. Its consistent performance across various studies underscores its importance as a tool for both educational assessment and clinical practice improvement.

5.4 Limitations of Study

The study on the assessment of diagnostic reasoning skills among undergraduate physiotherapy students has several potential limitations. One key limitation is the restricted generalizability of the findings. Using a snapshot of the student population limits the applicability of the results to other contexts. The specific characteristics of the sample, such as age, year of study, clinical experience, and the unique attributes of the university, may not represent all undergraduate physiotherapy students. As highlighted by Williams et al. (2011), this limits the broader applicability of findings derived from single-institution studies. Additionally, the study's cross-sectional design, which involves data collection at a single point in time, constrains the ability to draw conclusions about the progression or development of diagnostic reasoning skills over time. A longitudinal approach, such as the one described by Gilliland (2017), would provide deeper insights into how these skills evolve throughout the educational journey.

While the Diagnostic Thinking Inventory (DTI) is a validated and reliable tool for assessing diagnostic reasoning, its reliance on self-reported data may introduce biases, such as social desirability bias or recall bias. These factors could influence the accuracy of the responses and, consequently, the findings. Additionally, a small sample size could restrict the statistical power of the study, making it challenging to detect significant relationships or differences. Potential confounding variables, such as student motivation, prior knowledge, learning styles, and the quality of instruction, may also affect diagnostic reasoning skills and should be acknowledged as factors that could influence the results.

Conducting the research at a single institution presents another limitation, as the unique curriculum, teaching methods, and clinical placement experiences could skew the findings and reduce their relevance to other physiotherapy programs. Lastly, the lack of qualitative data in the study could be a limitation. While the quantitative assessment using the DTI provides valuable insights, incorporating qualitative methods, such as interviews or focus groups, could offer a more comprehensive understanding of students' thought processes and reasoning strategies, as suggested by Wijbenga et al. (2019) and Karvonen et al. (2017).

5.5 Recommendations for Future Research

Future research should consider a multi-institutional approach to enhance the generalizability of findings. By including students from diverse

educational contexts and institutions, researchers can better capture variations in diagnostic reasoning skills and ensure broader applicability of the results. Additionally, exploring the impact of different teaching methodologies, such as problem-based learning, simulation-based training, or interprofessional education, could provide valuable insights into effective strategies for enhancing diagnostic reasoning skills. Studies incorporating longitudinal designs to track students' progression from novice to expert practitioners would offer a more comprehensive understanding of how diagnostic reasoning evolves over time. Future studies can also consider finding out what are the real reason behind the lack of diagnostic reasoning skills among undergraduate students.

Incorporating assessments of contextual factors such as emotional intelligence, stress management, and cognitive biases could help elucidate their role in influencing diagnostic reasoning. For instance, understanding the impact of non-analytical thinking patterns and cognitive biases, as highlighted by Norman & Eva (2010), could inform strategies to mitigate these challenges. Similarly, future studies should investigate the barriers students face in developing diagnostic reasoning skills, including the lack of explicit teaching in health professions curricula Parodis et al. (2021) and the overwhelming complexity of clinical reasoning processes (Lateef, 2018). Targeted interventions addressing these barriers could include structured briefing sessions to clarify and improve understanding of diagnostic reasoning processes and the implementation of explicit teaching strategies within the curriculum (Parodis et al., 2021).

Effective strategies to enhance clinical reasoning skills could involve personalized educational approaches that cater to diverse learning preferences, thereby optimizing students' development. Encouraging and rewarding progress to motivate students, as suggested by Audétat et al. (2013), and fostering interprofessional collaboration to enhance teamwork and learning outcomes are also promising avenues for further exploration. Additionally, adaptation of tools like the Diagnostic Thinking Inventory (DTI) to better align with the specific needs and contexts of physiotherapy students could enhance the accuracy and relevance of diagnostic reasoning evaluations.

Finally, the integration of advanced technologies, such as virtual reality and artificial intelligence, into teaching and assessment frameworks offers an exciting opportunity to simulate real-world clinical scenarios. These innovations could provide dynamic, immersive environments that help students apply and refine their diagnostic reasoning skills in realistic yet controlled settings. By addressing these areas in future research, educators and researchers can better understand and support the development of diagnostic reasoning skills in physiotherapy students, ultimately enhancing their readiness for clinical practice.

5.6 Conclusion

This study underscores the critical need for targeted interventions in physiotherapy education to enhance diagnostic clinical reasoning skills among students. The findings reveal a concerning trend which was a lack of diagnostic clinical reasoning was a common issue faced by physiotherapy students, which

can adversely affect their ability to provide effective patient care. By addressing existing gaps in the curriculum and fostering a more integrative learning environment, educators can better equip students to navigate the complexities of clinical practice. This approach helps to improve diagnostic reasoning but also contributes to a more comprehensive educational experience that prepares students for real-world challenges.

The results highlight the necessity for localized, evidence-based reforms in physiotherapy education, emphasizing the importance of integrating clinical reasoning training into the curriculum. Current educational practices may overly focus on theoretical knowledge without adequately linking it to practical applications, resulting in students who may struggle with real-life clinical scenarios. Further studies need to be explored to find out the factors or the reasons for the low level of diagnostic reasoning abilities among the physiotherapy students.

By identifying specific areas where students may lack proficiency, educators can implement targeted interventions that address these deficiencies. For instance, incorporating case-based learning and problem-solving activities into the curriculum could foster critical thinking and allow students to apply their knowledge in practical settings. Moreover, this study aspires to demonstrate that improving diagnostic clinical reasoning among physiotherapy students will have a positive impact on their future clinical practice. Enhanced

reasoning skills will enable them to make more informed decisions, leading to better patient outcomes and overall healthcare quality. As such, it is imperative that educational institutions prioritize the development of these skills within their curricula, ensuring that graduates are not only knowledgeable but also adept at applying their knowledge effectively in clinical situations.

In conclusion, the enhancement of diagnostic clinical reasoning in physiotherapy education is essential for preparing competent practitioners who can meet the demands of modern healthcare environments. By fostering an educational framework that emphasizes critical thinking and practical application, we can significantly improve the readiness of physiotherapy students for their professional roles, ultimately benefiting patient care outcomes in the field.

CHAPTER 6

6.0 References

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APPENDIX

Appendix A - Ethical Approval Form

UNIVERSITI TUNKU ABDUL RAHMAN
Wholly Owned by UTAR Education Foundation (Company No. 578227-M)

Re: U/SERC/78-363/2024

23 September 2024

Mr Muhammad Noh Zulfikri bin Mohd Jamali
Head, Department of Physiotherapy
M. Kandiah Faculty of Medicine and Health Sciences
Universiti Tunku Abdul Rahman
Jalan Sungai Long
Bandar Sungai Long
43000 Kajang, Selangor

Dear Mr Muhammad Noh,

Ethical Approval For Research Project/Protocol

We refer to your application for ethical approval for your students' research project from Bachelor of Physiotherapy (Honours) programme enrolled in course UMFD3026. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

No	Research Title	Student's Name	Supervisor's Name	Approval Validity
9.	Assessment Of Diagnostic Clinical Reasoning Skills Among Undergraduate Physiotherapy Students	Jason Ho Yi Zeng	Mr Avanianban Chakkarapani	23 September 2024 – 22 September 2025
10.	Awareness, Knowledge, Attitude and Perception of Active Isolated Stretching Among Physiotherapy Academics and Students in a Private University: A Cross Sectional Study	Law Jing Tien		
11.	Knowledge Of Quadriceps Angle (Q-Angle) Among Physiotherapy Students	Tay Yu Xin		
12.	Cortical Excitability and Body Awareness in Individuals with Adolescent Idiopathic Scoliosis: An Exploratory Study	Mark Isaac Fernandez	Dr Deepak Thazhakkattu Vasu	
13.	Exercise Interventions in Primiparous Women for the Prevention and Management of Pelvic Floor Dysfunction: A Systematic Review	Jenny Peng Mei Shi		
14.	Exploring the Novel Sensor System for Detecting Postural Reactions Among Healthy Younger Adults: A Pilot Study	Ooi Xin Rou		
15.	Prevalence of Chronic Fatigue Syndrome (CFS) and Its Association on Quality of Life and Sleep Quality Among Young Adults: A Cross-sectional Study	Delphine Yeo Sze Qi	Mr Sathish Kumar Sadagobane Co-Supervisor: Mr Tarun Amalnerkar	
16.	Association Between Level of Ergonomic Knowledge and Prevalence of Neck Pain Among Part-time Postgraduate Students in Klang Valley	Ng Jia Xuan	Mr Sathish Kumar Sadagobane Co-Supervisor: Mr Edwin Gaspar	
17.	Effectiveness of Kinesiotaping with Static Stretching and Proprioceptive Neuromuscular Facilitation Stretching for Gastrocnemius Tightness Management Among Adults	Tan Jia Yin	Ms Heaw Yu Chi	
	Awareness, Knowledge and Perceptions of Chronic Fatigue Syndrome/ Myalgic Encephalomyelitis			

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Kampar Campus : Jalan Universiti, Bandar Barat, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 **Fax**: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 **Fax**: (603) 9019 8868
Website: www.utar.edu.my

Should the students collect personal data of participants in their studies, please have the participants sign the attached Personal Data Protection Statement for records.

Thank you.

Yours sincerely,

Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, M. Kandiah Faculty of Medicine and Health Sciences
Director, Institute of Postgraduate Studies and Research

Appendix B - Informed Consent Form

Research Participant Information Sheet

Universiti Tunku Abdul Rahman Faculty of Medicine and Health Sciences Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Information Sheet to Participate in the Study
Assessment Of Diagnostic Clinical Reasoning Skills Among Undergraduate Physiotherapy Students

Student Investigator: Jason Ho Yi Zeng
Department: Department of Physiotherapy
Course Name and Course Code: UMFD3026 Research Project
Year and Semester: Year 3 Semester 1
Course Coordinator: Ms Aqliliriana Zainuddin

You are being asked to volunteer for this research study that is being conducted as part of the requirement to complete the above mentioned Course.

Please read this information sheet and contact me to ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study
The purpose of this study is to evaluate the diagnostic reasoning skills of physiotherapy students.

Approximately 108 UTAR students will participate in this study.

Procedures
If you agree to be in this study, you will be asked to fill out a questionnaire.

Length of Participation
An estimation of 10 minutes.
Risks and Benefits
There are no risks in participating in this study.

There are some direct benefits in participating in this study, which improve knowledge on clinical reasoning skills.

Confidentiality

No information that will make it possible to identify you, will be included in any reports to the University or in any publications. Research records will be stored securely, and only approved researchers will have access to the record

Voluntary Nature of the Study

Participation in this study is voluntary. If you withdraw or decline participation, you
will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Contacts and Questions

If you have any questions, clarifications, concerns, or complaints, about the research, the researcher conducting this study can be contacted at 011-1051 0775, or by email to jasonho@1utar.my.

The Course Coordinator Ms Aqliliriana Zainuddin, can be contacted at 019 706 5140 , or by email with aqliliriana@utar.edu.my if there are any inquiries, concerns or complaints about the research and there is a wish to talk to someone other than individuals on the research team

Please keep this information sheet for your records.

Research Participant Consent Form

Universiti Tunku Abdul Rahman Faculty of Medicine and Health Sciences Department of Physiotherapy

Bachelor of Physiotherapy (Honours)

Consent Form to Participate in the Study

Assessment Of Diagnostic Clinical Reasoning Skills Among Undergraduate Physiotherapy Students

Student Investigator: Jason Ho Yi Zeng
Department: Department of Physiotherapy
Course Name and Course Code: UMFD3023 Research Project
Year and Semester: Year 3 Semester 1
Course Coordinator: Ms Aqliliriana Zainuddin

I have read the provided information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have, has been answered to my satisfaction. I understand that I will be given a copy of this form, and the researcher will keep another copy on file. I consent voluntarily to be a participant in this study.

Name of Participant: _____

IC No: Date:

Appendix C - Demographic Data

1. What is your name?

---

2. Gender

( ) Male ( ) Female

3. UTAR Student ID:

---

4. Contact number:

5.What is your degree course?

---

6. What is your year of study?

_____

Appendix D - Personal Data Protection Notice

PERSONAL DATA PROTECTION NOTICE

Please be informed that in accordance with Personal Data Protection Act 2010 ("PDPA") which came into force on 15 November 2013, Universiti Tunku Abdul Rahman ("UTAR") is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

1. Personal data refers to any information which may directly or indirectly identify a person which could include sensitive personal data and expression of opinion. Among others it includes:

   a) Name
   b) Identity card
   c) Place of Birth
   d) Address
   e) Education History
   f) Employment History
   g) Medical History
   h) Blood type
   i) Race
   j) Religion
   k) Photo
   l) Personal Information and Associated Research Data

2. The purposes for which your personal data may be used are inclusive but not limited to:

   a) For assessment of any application to UTAR
   b) For processing any benefits and services
   c) For communication purposes
   d) For advertorial and news
   e) For general administration and record purposes
   f) For enhancing the value of education
   g) For educational and related purposes consequential to UTAR
   h) For replying any responds to complaints and enquiries
   i) For the purpose of our corporate governance
   j) For the purposes of conducting research/ collaboration

3. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

4. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

5. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

Consent:

6. By submitting or providing your personal data to UTAR, you had consented and agreed for your personal data to be used in accordance to the terms and conditions in the Notice and our relevant policy.

7. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfill our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

8. You may access and update your personal data by writing to us at_____.

Acknowledgment of Notice

[ ] I have been notified and that I hereby understood, consented and agreed per UTAR above notice.

[ ] I disagree, my personal data will not be processed.

.....
Name:
Date:

Appendix E - Diagnostic Thinking Inventory(DTI)

1.	**When the patient presents symptoms,**		
	I think of the symptoms in the precise words used by the patient	☐☐☐☐☐☐	*I think of the symptoms in more abstract terms than the expressions actually used (e.g. '4-day duration' becomes 'acute'; 'two-hands' becomes bilateral)*
2.	**In considering each diagnosis,**		
	I try to evaluate their relative importance	☐☐☐☐☐☐	*I try to give them equal importance or weighting*
3.	**In thinking of diagnostic possibilities,**		
	I think of diagnostic possibilities early on in the case	☐☐☐☐☐☐	*First I collect the clinical information and then I think about it*
4.	**When I am interviewing a patient,**		
	I often seem to get one idea stuck in my mind about what might be wrong	☐☐☐☐☐☐	*I usually find it easy to explore various possible diagnosis*
5.	**Throughout the interview,**		
	If I follow the patient's line of thought, I tend to lose my own thread	☐☐☐☐☐☐	*I can still keep my own ideas clear even if I follow the patient's line of thought*
6.	**When it comes to making up my mind about a diagnosis,**		
	I do not mind postponing my diagnostic decisions about a case	☐☐☐☐☐☐	*I feel obliged to go for one diagnosis or another even if I am not very certain*
7.	**Once the patient has clearly presented his symptoms and signs,**		
	I think about them in my mind in the patient's own words	☐☐☐☐☐☐	*I translate them in my mind into medical terms (e.g. 'numbness' becomes 'paraesthesia' or 'paralysis')*
8.	**In relation to the routine history,**		
	I often feel that I did not sufficiently cover the routine history	☐☐☐☐☐☐	*I usually cover the routine history to my satisfaction*
9.	**As the patient tells his story and the case unfolds,**		
	I often find it difficult to remember what has been said	☐☐☐☐☐☐	*I can usually keep track in my mind of what has been said*
10.	**During the course of the interview, I find that,**		
	Some key pieces of information seem to leap out at me	☐☐☐☐☐☐	*It is often difficult to know which items of information to latch on to*
11.	**When I cannot make sense of the patient's symptoms,**		
	I move on and gather new information to trigger new ideas	☐☐☐☐☐☐	*I ask the patient to define those symptoms more clearly*
12.	**In considering diagnostic possibilities,**		
	I often come up with unlikely diagnoses	☐☐☐☐☐☐	*I am usually in the right area*
13.	**While I am collecting information about a patient,**		
	The various items of information usually seem to group themselves together in my mind	☐☐☐☐☐☐	*I often have difficulty seeing how the pieces of information relate to each other*
14.	**When the diagnosis becomes known and I realise that I have missed it initially,**		
	It is often because I knew the disease but failed to think about it	☐☐☐☐☐☐	*It is often because I did not know enough about the disease*
15.	**During the clinical interview,**		
	I cannot bring myself to dismiss some information as irrelevant	☐☐☐☐☐☐	*I am quite happy to dismiss some information as irrelevant*

16. **When I cannot make sense of the patient's symptoms and signs,**

I move on to get new information and a new perspective | *I look at them from a different perspective before moving on*

17. **When I consider a number of possible diagnoses,**

The diagnoses tend to be related to one another | *The diagnoses tend to be scattered*

18. **When a possible diagnosis comes to my mind,**

I usually find myself anticipating possible abnormal signs and symptoms that go with that diagnosis | *Quite often, it does not help me to decide what to ask the patient next*

19. **When I know very little about a particular type of disease,**

I can still usually come up with a diagnosis | *I have great difficulty in reaching a diagnosis*

20. **In considering the patient's signs and symptoms,**

I think about each in absolute terms as stated by the patient | *I think of them in terms of possible opposites (e.g. progressive vs. sudden; unilateral vs. bilateral; spastic vs. flaccid)*

21. **When I know a lot about a particular type of disease and have to make a diagnosis,**

I find it relatively easy to pin down a diagnosis | *I often seem to be all over the place and have difficulty pinning down a diagnosis*

22. **As the history progresses and I already have some ideas about the possible diagnosis(es),**

New information often makes me have more ideas | *New information does not often make me have more ideas*

23. **When I am taking a history, I find that,**

I can get new ideas just by going over the existing information in my mind | *I need to have new information to make me have a new idea about the case*

24. **When patients use imprecise or ambiguous expressions,**

I let them go on to maintain the flow of the interview | *I make them clarify precisely what they mean before going on*

25. **After an interview with a patient,**

I rarely think of other things that I should have asked in relation to the patient's disorder | *I often think of other things that I should have asked in relation to the patient's disorder*

26. **When a piece of information comes along and makes me think of a possible diagnosis,**

It often makes me go back to previous information to see if things fit together or not | *It rarely makes me review the information that I have gathered previously*

27. **In relation to the diagnosis I eventually make,**

I usually have very few doubts | *I often feel too uncertain for my own comfort*

28. **In making a diagnostic decision,**

I decide by considering each possible diagnosis separately on its own merits | *I decide by comparing and contrasting the various possible diagnoses*

29. **When I know a lot about a particular type of disease and have to make a diagnosis,**

I check up on most possibilities before reaching a decision | *I often have lots of ideas that I don't explore further*

30. **As the case unfolds,**

I do not find it useful to summarise as I go along | *I periodically take stock of the data and my ideas*

31. **When I reach my diagnostic decisions,**

There is often left-over information I have just forgotten about | | | | | | | *I usually will have considered all the information*

32. **When I have got an idea about what might be wrong be the patient,**

I feel most comfortable if I can follow it up without being diverted | | | | | | | *I feel happy to go off on another tack and come back to my original ideas later*

33. **When I come up with a broad idea as to what might be wrong with the patient,**

I can usually proceed to a specific diagnosis | | | | | | | *I find it difficult to put it into specific terms*

34. **Throughout the interview,**

I manage to test my ideas even if I let the patient control the interview | | | | | | | *I am only successful if I can control the direction of the interview*

35. **In relation to choosing from among the diagnostic ideas that I have,**

I am usually not capable of wholly ruling out any of the ideas I have had | | | | | | | *I am capable of ruling out most of my ideas completely*

36. **Once I have made up my mind about a patient,**

I am prepared to change my mind | | | | | | | *I really do not like to change my mind*

37. **When I consider my diagnostic ideas, I do so on the basis of,**

The case as a whole so far | | | | | | | *A few outstanding symptoms or signs*

38. **If I do not know what to make of a clinical interview,**

I can readily see the information in new ways | | | | | | | *I find it difficult to see the information in new ways*

39. **When I order laboratory tests,**

I do it as part of the routine clinical investigation | | | | | | | *I do it expecting specific information or supporting evidence*

40. **In considering diagnostic possibilities,**

I compare and contrast the possible diagnoses | | | | | | | *I consider each diagnosis separately on its own merits*

41. **In terms of the way I conduct an interview,**

I usually cover the ground that I need to during the interview | | | | | | | *Quite often I do not ask all the questions that I should at the time*

Appendix F - Turnitin Report

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Turnitin Originality Report

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