TRANSLATING FOCUS OF ATTENTION (FOA) KNOWLEDGE TO TELEHEALTH PHYSIOTHERAPY FOR CHILDREN WITH NEURODEVELOPMENTAL DISORDERS (NDDs)

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Translating focus of attention (FOA) knowledge to telehealth physiotherapy for children with neurodevelopmental disorders (NDDs)

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CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

_____ (Signed)

EGUIA, Ma. Kathlynne Fernandez (Name of student)

Dedication

I dedicate this thesis to all children with disabilities, especially the Filipino children, who deserve to live in a world that truly sees them—a society that moves beyond acceptance to actively include everyone, regardless of their abilities.

"Strength lies in differences, not in similarities"

-Stephen R. Covey

Abstract

Motor learning research supports the benefits of an external focus of attention (FOA) for delivering instructions and feedback to individuals learning movement skills. Such evidence may apply to children with neurodevelopmental disorders (NDDs) during physiotherapy to address impaired movement control, coordination, or acquisition of new motor skills. However, two gaps exist: (i) a gap in synthesised knowledge and (ii) a gap between knowledge and practice. Little is known about how FOA is utilised by physiotherapists in developing countries within the Southeast Asian region, particularly in the Philippines. Moreover, despite telehealth's potential to enhance physiotherapy accessibility, strategies to mitigate telehealth-related challenges are needed.

To address these gaps and needs, this research aims to (i) synthesise current evidence on motor learning and FOA among children, (ii) describe physiotherapists' use of FOA in the Philippines, and (iii) examine paediatric physiotherapists' use of FOA in delivering instructions and feedback for children with NDDs via telehealth in the Philippines. The overall purpose of this research is to support knowledge translation so that FOA strategies may be suitably utilised among children with NDDs.

This research comprises five studies. The first two, published scoping reviews, addressed the gap in synthesised knowledge. Emerging research generally supports external FOA advantages for children; however, limited studies focus on children with NDDs, and research on motor learning strategies in this population has focused on those with primary motor impairments such as cerebral palsy. The synthesised evidence suggests that further exploration of FOA use in clinical settings is needed.

The latter three studies addressed the gap between knowledge and practice. In our published survey study, physiotherapists in the Philippines (n=182) were found to prefer internal FOA when delivering instructions and feedback, regardless of educational or

professional background and including those delivering telehealth services. About half of the respondents reported familiarity with the FOA concept. A subsequent structured observational study of telehealth sessions for children with NDDs showed physiotherapists preferred internal FOA when delivering feedback and external FOA when delivering instructions. Although external FOA was preferred for instructions during telehealth, its use remains just above 50% of instructions, indicating the potential to increase its use in practice. The survey indicated no association between physiotherapists' characteristics and FOA preferences, but the observational study showed that higher physical and cognitive development levels in children were linked to a preference for internal FOA. Telehealth instructions and feedback were categorised by audience (child/caregiver) and modality (verbal/visual/both).

Recognising the need to translate motor learning knowledge into physiotherapy practice in the Philippines, the fifth study used a sequential mixed-methods knowledge translation study design. Following a workshop delivered by a motor learning expert for paediatric physiotherapists (n=126), significant improvements in self-reported knowledge, self-efficacy, and intention to implement external FOA in practice were found. Interviewed participants (n=6) found FOA helpful in overcoming telehealth instruction challenges and considered client characteristics and home resource availability when choosing between internal and external FOA.

This thesis followed a stepwise approach to addressing research gaps. Synthesised evidence facilitated knowledge translation, demonstrating a pathway to impact where motor learning research is translated into physiotherapy practice.

List of Publications During the Course of Study

PhD-related publications:

Eguia, K.F., Ng, S, S.M., & Wong, T.W.L. (2023). Attentional focus strategies for promoting children's motor learning: A scoping review with a learner-task-environment framework. *Perceptual and Motor Skills*, 130(6), 2700-2722. https://doi.org/10.1177/00315125231210150

Eguia, K. F., Ng, S. S. M., Capio, C. M., & Wong, T. W. (2025). Applications of motor learning strategies in children with neurodevelopmental disorders: A scoping review. *Review Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s40489-025-00500-6

Eguia, K. F., Ng, S. S. M., & Wong, T. W. (2025). Physiotherapists' use of attentional focus instructions and feedback in the Philippines: A survey study. *Physiotherapy Research International*, *30*(2), e70035. https://doi.org/10.1002/pri.70035

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ADHD	Attention-deficit / Hyperactive disorder
ASD	Autism spectrum disorder
CAH	Constrained Action Hypothesis
CO-OP	Cognitive Orientation to daily Occupational Performance
CP	Cerebral palsy
DCD	Developmental coordination disorder
DS	Down Syndrome
FOA	Focus of Attention
ID	Intellectual disability
JBI	Joanna Briggs Institute
KT	Knowledge Translation
KTA	Knowledge-to-Action
NDDs	Neurodevelopmental disorders
OPTIMAL Theory	Optimising Performance Through Intrinsic Motivation and Attention for Learning Theory
PCC	Population, Concept, and Context
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PRISMA-ScR	PRISMA Extension for Scoping Reviews
RCTs	Randomised controlled trials

Chapter 1: Introduction and Literature Review

Many individuals who require physiotherapy typically need to learn or re-learn skills relevant to the maintenance of balance, independent locomotion, or the performance of complex movements such as the combination of fundamental movement skills when children engage in physical activity and sports (World Physiotherapy, 2019). Thus, physiotherapists are continuously searching for more effective and efficient ways to facilitate movement skills acquisition (Kleynen et al., 2020). One approach that physiotherapists are exploring is the use of motor learning strategies. A systematic mapping review has identified commonly used strategies in older neurological and geriatric populations, highlighting the prominence of dual-task learning, observational learning, movement imagery, errorless learning, and trial-and-error practice (Jie et al., 2024). It is widely acknowledged that motor learning strategies are highly relevant in physiotherapy, but they appear to be underutilised in clinical practice (Kafri & Atun-Einy, 2019).

Previous research identified possible reasons for the underutilisation of motor learning knowledge in physiotherapy practice. Levac and colleagues (2016) suggested that it can be challenging for therapists to identify relevant motor learning strategies to use due their abundance, the lack of consensus among experts regarding the definitions and application of key motor learning terms, and the limited educational resources available to support clinicians. A survey of physiotherapists in Israel revealed that approximately 40% perceive their knowledge of motor learning as insufficient, attributing this to the complexity and ambiguity of terminologies (Atun-Einy & Kafri, 2019). Furthermore, motor learning research are mostly drawn from controlled experimental protocols, while clinical practice consists of highly variable circumstances (Kleynen et al., 2015). Thus, it appears that we need further work to facilitate physiotherapists' use of motor learning knowledge in their practice.

Research that examines the use of motor learning strategies by physiotherapists, especially in paediatric settings, are limited. The application of these strategies in paediatric interventions may be challenging, as their underlying assumptions were primarily developed within controlled experimental set-ups involving healthy adults performing simple tasks (Larin, 1998). Researchers also suggest that there is a notable absence of a practice model that effectively translates motor learning theoretical principles into a practical framework tailored for paediatric settings (Zwicker & Harris, 2009). Also, studies that facilitate an understanding of physiotherapists' practice in relation to motor learning strategies tend to be specific to their locality (e.g., Canada, Hussien & Ste-Marie, 2023; Israel, Atun-Einy & Kafri, 2019; Netherlands, Kal et al., 2018) as practice relates to professional training and national standards. Thus, there appears to be a limitation in knowledge in relation to the use of motor learning strategies in paediatric practice in Southeast Asian countries such as the Philippines.

1.1 Scope and Background

Presenting instructions and feedback about movement skill performance is a key element of motor learning (Kleynen et al., 2020) and a critical component of physiotherapy practice, which may be delivered through demonstrations, verbal instructions, or tactile cues (Palisano et al., 2018). Instructions refer to a description of how to perform an action, while feedback provides specific information about previous performance after the action has been completed (Durham et al., 2009; Kal et al., 2018). These elements are particularly important because they serve as primary tools in physiotherapy, used extensively to guide and facilitate client learning. Observational studies have shown that instructions and feedback constitute a significant proportion of physiotherapists' communication: in the UK, 66% of statements made by physiotherapists are instructions or feedback (Johnson et al., 2013) while a similar study in Canada reported this figure as high as 75% (Zachariah, 2013). Given their frequent

use, it is essential to explore how to optimise the delivery of instructions and feedback to promote the most efficient learning outcomes for patients.

In physiotherapy for children with neurodevelopmental disorders (NDDs), the use of instructions and feedback is especially crucial because of the potential physical constraints, sensory impairments and cognitive challenges that may affect how they process movement-related information (Gordon & Magill, 2016). In this thesis, the term neurodevelopmental disorders (NDDs) is used in a pragmatic, paediatric rehabilitation sense to refer to early-onset, non-progressive disorders of brain development that result in impairments in motor, cognitive, communication, or behavioural functions. While the DSM-5 classification of NDDs primarily covers intellectual disability, communication disorders, autism spectrum disorder, ADHD, specific learning disorder, and motor disorders such as developmental coordination disorder, many neurodisability and public health frameworks explicitly include cerebral palsy within the broader category of neurodevelopmental disabilities because it arises from disturbances in the developing brain and leads to persistent motor and associated impairments. Given the focus of this work on paediatric physiotherapy and motor learning, this broader, rehabilitation-oriented definition is adopted consistently throughout the thesis. In this study, NDDs include conditions such as cerebral palsy (CP), developmental coordination disorder (DCD), autism (ASD), intellectual disability (ID), and attention deficit-hyperactivity disorder (ADHD) (American Psychiatric Association, 2022). Children with NDDs experience impairments in movement control, coordination, and cognition, and physiotherapy contributes to managing such impairments. Building upon the recognition of instructions and feedback as foundational components of physiotherapy practice, especially within paediatric neurodevelopmental contexts, a deeper examination of how these elements can be most effectively utilised is warranted. A key aspect of this involves considering the concept of focus of attention (FOA) within motor learning.

1.2 Literature Review

The key concepts related to the effective delivery of the motor learning elements of instructions and feedback are reviewed in this section, including the related theoretical frameworks and physiotherapy practice contexts.

1.2.1 Motor Learning and Focus of Attention

We can deliver instructions and feedback with reference to the focus of attention (FOA), which can be external or internal. Internal FOA directs the learner's attention to the movements and mechanics of their own body—for example, focusing on finger placement or how the feet land during a jump. In contrast, external FOA directs attention toward the effects of the movement on the environment, such as the path taken or specific targets in the surroundings (Wulf, 2013). For example, an internal focus instruction for a child who is practicing jumping could be, "land on your two feet together". An external focus instruction, on the other hand, could be, "land on the red square on the floor".

Over the past decade and a half, significant research has focused on the role of attentional focus (FOA) in motor learning, with a particular emphasis on comparing internal and external FOA. Wulf's comprehensive review in 2013 analysed 53 studies conducted over 15 years, revealing strong evidence supporting the benefits of external FOA. Specifically, improvements in movement effectiveness, such as accuracy and balance, were observed in 44 studies, while enhancements in movement efficiency, including muscular activity, force production, and cardiovascular responses, were consistently reported in all 23 studies that measured these outcomes. Although the majority of these studies involved healthy adults, three included children, one of which involved children with intellectual disabilities (ID), suggesting early indications of the potential benefits of external FOA in paediatric populations.

It has been proposed that external FOA promotes automatic control of movement, while internal FOA leads to heightened consciousness which can disrupt automatic movement control (McNevin et al., 2003). Supporting this, Law and Wong (2021) provided neurological evidence using electroencephalogram data showing increased conscious movement planning when individuals adopt an internal FOA. Wulf and Lewthwaite (2016) further suggested that external FOA instructions direct attention to an actual goal (i.e., the outcome or result), which influences the learners' sense of satisfaction and competence associated with their ability to achieve those goals.

There are also potential benefits to integrating the use of FOA in clinical settings. For instance, a review by Ziv and Lidor (2015) concluded that external FOA instructions are advantageous for older adults in clinical settings, such as those who had stroke or have Parkinson's disease. Most evidence, however, has been drawn from controlled experiments that have shown the advantages of external FOA on balance, gait, and psychological outcomes of older adults (e.g., Law & Wong, 2021; Mak et al., 2020). In recent years, research involving children has also emerged, showing the advantages of external FOA in motor skill acquisition tasks such as golf putting (Brocken et al., 2016) and ball throwing (van Cappellen – van Maldegem et al., 2018). Recent reviews of studies involving typically developing children have concluded that external FOA instructions are beneficial for learning fundamental movement skills (Simpson et al., 2021) and that the effects vary according to the frequency, timing and form of instructions and feedback (van der Veer et al., 2022).

Despite promising findings in children, evidence supporting FOA use in children with NDDs (e.g, ADHD, Ghorbani et al., 2020; DCD, Jarus et al., 2015) remains limited and has not yet been synthesised. To illustrate, only one study has specifically examined attentional focus in children with ASD, including only those with mild symptoms (Tse, 2019), and no studies have yet investigated attentional focus in children with CP. Compared with their

typically developing peers, children with NDDs often experience significant motor delays. Compared with their typically developing peers, children with NDDs often experience significant motor delays. These delays affect both gross and fine motor skills, impacting coordination, balance, and motor planning (Mohd Nordin et al., 2021; Volkan-Yazici et al., 2018). These motor impairments, combined with sensory and cognitive challenges, influence how children with NDDs process and respond to motor learning strategies like FOA, making it inappropriate to generalise findings from typically developing children. For example, while some studies reported benefits of external FOA in children with intellectual disabilities during throwing tasks, similar benefits were not observed in children with DCD in tracking tasks (Jarus et al., 2015). Moreover, methodological weaknesses in previous studies involving children with NDDs highlight the need for more research to enable the utilisation of evidence in practice (van der Veer et al., 2022).

Taken together, these findings reveal a significant gap in the literature regarding FOA use in children with NDDs. Although external FOA appears generally advantageous for motor learning across populations, there is currently no evidence synthesis that addresses its application in paediatric neurodevelopmental contexts. There is limited understanding of the types of motor tasks and settings in which FOA could benefit children with NDDs. More broadly, even research on the range of motor learning strategies utilised in children with NDDs has yet to be synthesised. The physical and sensory impairments commonly displayed by children with NDDs require the effective use of instructions and feedback when learning movement tasks. The apparent advantages of external FOA instructions and feedback are promising and could potentially be utilised in physiotherapy sessions. To better understand how such strategies can be applied effectively, it is important to consider the underlying processes as explained in the related theoretical frameworks. Motor learning consists of the internal processes associated with practice or experience that lead to relatively permanent

changes in movement skill proficiency (Schmidt & Lee, 2020) and is theorised to occur in stages.

In their classic work, Fitts and Posner (1967) identified three stages of motor learning: cognitive, associative and autonomous. During the initial cognitive stage, learners engage in considerable cognitive activity as they are introduced to movement rules and focus on understanding what to do. This stage is characterised by frequent errors and a reliance on explicit, rule-based knowledge. As learners progress to the associative stage, they refine their movement strategies through practice, resulting in improved consistency. Finally, in the autonomous stage, skills become automatic, requiring less conscious attention to the underlying rules, allowing performance to become efficient and adaptable. This progression highlights the importance of cognitive resources early in learning, which gradually shift toward more automatic control as proficiency increases. Underlying this shift are neural adaptations that enhance cognitive efficiency in planning and executing movements (Immink et al., 2020). Because most information related to learning the movement is processed and stored during the cognitive stage, this phase is considered to demand significant working memory resources (Maxwell et al., 2003), which support the processing, storage, and manipulation of incoming sensory information (Baddeley, 2003). Motor learning has also been conceptualised as a problem-solving process in which movement errors are resolved using cognitive resources (Adams, 1971). Neuroimaging studies have further demonstrated the neural correlates of these stages, showing increased prefrontal cortex activation during early learning (cognitive stage) and greater involvement of motor and premotor areas during later stages (autonomous stage) (Dayan & Cohen, 2011; Doyon & Benali, 2005).

Based upon this understanding, motor learning has been described to occur explicitly or implicitly. Explicit motor learning is typically accompanied by the accumulation of declarative knowledge (i.e., rules, mechanics of movement) that is used to support motor

performance (Maxwell et al., 2003). Implicit motor learning, on the other hand, does not necessarily require increased knowledge of rules and mechanisms to support performance despite learners being aware that they are learning the movement(s). Age and intelligence (e.g., IQ), which are related to cognitive capacities, have also been identified as individual factors that affect explicit, but not implicit, motor learning (Steenbergen et al., 2010).

Researchers argue that implicit motor learning occurs largely in the absence of the cognitive phase and is therefore less dependent on working memory resources (Steenbergen et al., 2010), whereas explicit learning relies heavily on working memory, as demonstrated in both children and adults (Jongbloed-Pereboom et al., 2019). Considering that many children with NDDs experience cognitive impairments, implicit motor learning may offer distinct advantages by reducing the cognitive demands associated with the acquisition of new motor skills. For example, children with intellectual disabilities or DCD often show deficits in working memory and executive functioning (Alloway & Archibald, 2008; Wilson et al., 2013), which can hinder their ability to benefit from explicit learning approaches. By minimising reliance on these cognitive resources, implicit learning strategies may offer distinct advantages, facilitating better skill acquisition and retention in these populations (Maxwell et al., 2003; Wulf & Lewthwaite, 2016).

1.2.2 Theoretical Frameworks

1.2.2.1 Motor Learning Framework for Rehabilitation

Kleynen and colleagues (2020) proposed a comprehensive taxonomy designed to support clinical decision-making in the application of motor learning principles within neurorehabilitation settings. Unlike traditional views that categorise motor learning as either explicit or implicit (Taylor & Ivry, 2013), this framework conceptualises motor learning along a continuum ranging from more implicit to more explicit processes, rather than having a dichotomy of either implicit or explicit (see Figure 1.1). Moreover, they emphasised that

explicit and implicit motor learning strategies do not need to occur exclusively of each other. This framework identifies seven motor learning strategies and three elements based on a Delphi study of experts (Kleynen et al., 2015). Each motor learning strategy is based on a theory and has distinct characteristics as described in Table 1.1. Elements which consist of (i) instructions, (ii) feedback, and (iii) organisation of the learning environment are combined to deliver a chosen motor learning strategy.

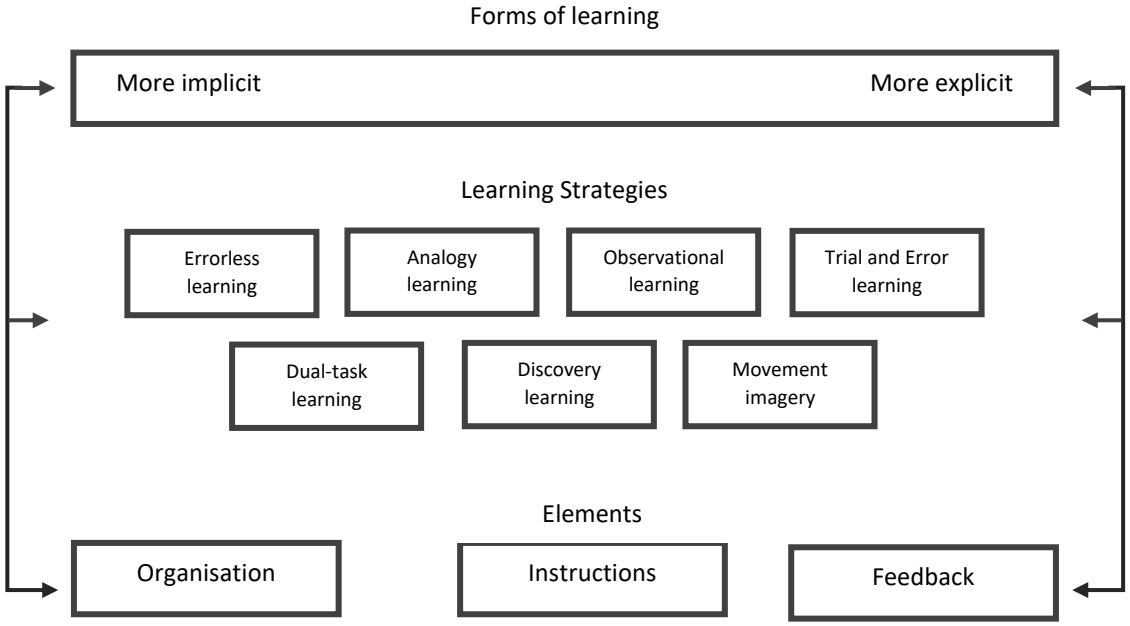


Figure 1.1. Motor learning framework for rehabilitation (Kleynen et al., 2020)

Physiotherapists could use a motor learning strategy and deliver the elements in a varied fashion. For example, a physiotherapist might provide verbal instructions and feedback that are explicitly detailed, focusing on the mechanics of movement without necessarily adopting a formal motor learning strategy. On the other hand, a physiotherapist might also deliver verbal instructions using analogies (i.e., analogy learning) and promote more implicit learning by reducing the learner's reliance on explicit rule-based knowledge (Kleynen et al., 2020). The delivery of instructions and feedback can also be guided by the concept of FOA. Research suggests that an internal FOA, where attention is directed toward

the body's movements, aligns more closely with explicit learning processes. Conversely, an external FOA, which directs attention toward the effects of movement on the environment, is associated with more implicit learning (van Abswoude et al., 2021). This motor learning framework, having been designed to support clinical reasoning in rehabilitation, is a potentially useful guide for synthesising evidence and tailoring physiotherapy interventions to individual needs.

Table 1.1

Motor learning strategies and motor learning elements (Kleynen et al., 2020)

	Name	Definition
Motor learning Strategy	Analogy learning	Use of a biomechanical metaphor to deliver instructions and cancel the complex rules for performing a movement task
	Dual-task learning	Simultaneous performance of a motor or cognitive secondary task that requires attention
	Discovery learning	Practice of skills without guidance or feedback from any information source
	Errorless learning	Constraining the environment to minimise practice errors which is believed to limit the involvement of working memory during motor performance
	Mental practice (movement imagery)	Imagining oneself performing the movement task without actual actions
	Observational learning	A learner determines the spatial and temporal features of movement task through observation
	Trial and error	Repeated attempts by the learner to perform a movement task while errors are detected and corrected
Motor learning Element	Organisation	Organisation of the practice environment (i.e., protective or open, simple or complex, quiet or busy, and constrained or open).
		Organisation of the task (i.e., subdividing or practicing the whole task, blocked or random, and massed or distributed practice).
	Instructions	Information on what the task is, and how it is to be performed (verbal or non-verbal).
		May also adopt internal or external focus of attention.
	Feedback	Information about the preceding movement performance (verbal or non-verbal).
		May also adopt internal or external focus of attention.

1.2.2.2 Constrained Action Hypothesis and OPTIMAL Theory

McNevin and colleagues (2003) provided a foundational explanation for the differential effects of internal and external FOA on motor performance through the development of the Constrained Action Hypothesis (CAH). According to this hypothesis, adopting an external FOA promotes more automatic and efficient control of movement, whereas an internal FOA encourages more deliberate and conscious control of movement processes. As such, greater conscious control facilitated by instructions and feedback that are

delivered using an internal FOA could potentially disrupt the execution of a well-learned motor skills by constraining the motor system's neural automaticity (Wulf et al., 2000, 2002). The mechanism explained by the CAH has been demonstrated across a variety of motor tasks and populations. For example, in sports-related tasks such as basketball shooting, Zachry et al. (2005) found that participants who adopted an external FOA showed greater accuracy and consistency in shooting performance compared to those who used an internal FOA (Zachry et al., 2005). Similarly, Wulf et al. (2010) reported enhanced jumping performance when participants focused externally on the target or landing area rather than on their leg movements. In rehabilitation contexts, the CAH's principles have been applied in studies on balance training (Chiviacowsky et al., 2009; Jackson & Holmes, 2011), which demonstrated that external FOA instructions improved postural control and stability in both healthy individuals and clinical populations. These findings collectively highlight the disruptive potential of an internal FOA on movement efficiency and the facilitative role of an external FOA in promoting more effective motor performance.

As a progression of the CAH, Wulf and Lewthwaite (2016) introduced the Optimising Performance Through Intrinsic Motivation and Attention for Learning (OPTIMAL) theory. This theory proposes an explanation for the evident advantages of an external FOA relative to an internal FOA. The OPTIMAL theory proposes that motor learning and performance are optimised by directing attention externally and by enhancing intrinsic motivation. Central to this theory is the concept of goal-action coupling, where the learner's attention is focused on the intended outcome or effect of the movement rather than on the body's movements themselves. This external focus reduces self-directed conscious interference, allowing motor processes to operate more automatically and efficiently, resulting in faster, smoother, and more adaptable performance (Kal et al., 2013; Wulf et al., 2001).

OPTIMAL theory identifies three key factors that synergistically enhance motor learning (Wulf & Lewthwaite, 2021):

1. **Enhancing expectancies for success:** Positive beliefs about one's ability to perform well increase motivation and engagement, which facilitate learning. This aligns with self-efficacy theory, which posits that confidence in one's capabilities directly affects performance outcomes (Bandura, 1997).
2. **Creating autonomy through choice:** Allowing learners control over aspects of their practice fosters intrinsic motivation by satisfying psychological needs for autonomy, a core component of self-determination theory (Deci & Ryan, 2000). Autonomy-supportive environments have been shown to improve persistence and effort in motor learning tasks (Wulf & Lewthwaite, 2016).
3. **Promoting an external focus of attention**: Directing attention to the movement's effects on the environment strengthens goal-action coupling and automaticity, thereby enhancing motor performance and learning (Wulf, 2013).

Moreover, greater experiences of successful movement performance positively influence the learners' sense of satisfaction and competence in relation to their ability to achieve those goals. As such, enhanced expectancies for positive outcomes are created, which further reinforces motivation and learning (Pascua et al., 2015; Wulf et al., 2014). In sum, the OPTIMAL theory explains that instructions and feedback that utilise an external FOA are more advantageous than those that rely on an internal FOA because they direct one's concentration to an appropriate external goal while simultaneously enhancing the psychological aspect of self-competence. This dual focus on cognitive efficiency and affective factors provides a holistic understanding of how motor learning could be optimised.

The mechanisms posited by the CAH and OPTIMAL theories highlight the cognitive (i.e., conscious control, goal-action coupling) and affective aspects (enhanced expectancies)

within the motor learning process, and how they relate to FOA when delivering instructions and feedback. OPTIMAL theory, in particular, provides a holistic framework for understanding and optimising motor learning by integrating intrinsic motivation and attentional focus as essential elements. The theorised mechanisms support the potential utility of FOA-based strategies in physiotherapy, especially for children with NDDs who often experience difficulties sustaining attention and maintaining motivation, which can hinder their progress (American Psychiatric Association, 2022; Ghanizadeh, 2011; Koegel et al., 2010; Novak et al., 2013). Interventions that combine an external FOA with autonomy-supportive elements (e.g., allowing choice and fostering intrinsic motivation) have been shown to produce additive benefits for motor performance in children (Abdollahipour et al., 2017). These combined strategies enhance both cognitive efficiency and motivational engagement, leading to improved therapy adherence and outcomes (Abdollahipour et al., 2017; Wulf & Lewthwaite, 2016). These studies further emphasise the value of integrating FOA strategies in paediatric physiotherapy.

1.2.3 Focus of Attention (FOA) in Physiotherapy Practice

Research on physiotherapists' use of FOA strategies reveals contextual and geographical limitations that need further exploration. Studies indicate that Canadian physiotherapists working with adult patients predominantly favour internal FOA when delivering instructions and feedback. This preference may reflect specific training paradigms, clinical traditions, or cultural preferences within the Canadian healthcare system (Hussien & Ste-Marie, 2023). Researchers have also identified that FOA preference is influenced by a variety of factors, including the characteristics of both the therapist and the client, the nature and complexity of the motor task being performed, as well as the therapist's educational background and clinical experience (Hussien, Gignac, et al., 2023). Previous investigations that directly observed FOA application in practice have been confined to stroke rehabilitation

contexts within Western countries such as the United Kingdom and the Netherlands (e.g., Durham et al., 2009; Johnson et al., 2013; Kal et al., 2018). Other local research based on physiotherapists' self-reports have explored general motor learning strategies in Israel (Atun-Einy & Kafri, 2019) and FOA implementation in Canadian general practice (Hussien & Ste-Marie, 2023). While these studies provide valuable insights, they are limited in scope regarding patient populations and settings and may not be generalizable across diverse healthcare environments.

The available research provides no knowledge thus far of how physiotherapists who manage children with NDDs utilise motor learning principles in general, and FOA instructions and feedback in particular, in their clinical practice. Paediatric physiotherapy practice for children with NDDs presents unique challenges due to the complex interplay of motor, cognitive, and sensory impairments, necessitating tailored intervention strategies. There is also no current knowledge drawn from within the Southeast Asian region, and the processes through which physiotherapists utilise FOA in such contexts have not been explored. Experts emphasise that understanding context-specific practice is essential before designing clinical trials for FOA in paediatric physiotherapy (Johnson et al., 2013). Without this foundational knowledge, interventions risk being culturally incongruent or clinically irrelevant, thereby making effective knowledge translation challenging.

Existing evidence has shown that discrepancies exist between local practices and international guidelines for condition-specific physiotherapy management (Nowobilski et al., 2013; Ranganathan & Singh, 2024). For instance, a recent study on physiotherapy research in South Korea revealed that local practices for the management of osteoarthritis do not include some strategies recommended in the international clinical practice guidelines, possibly due to cultural and healthcare system differences (Park et al., 2024). These findings highlight the need to explore the use of FOA strategies in diverse geographical and practice contexts to

support knowledge translation in physiotherapy. Research addressing these gaps would enable the translation of motor learning knowledge to clinical practice and potentially improve therapeutic outcomes for children with NDDs. To date, the very limited documented efforts on the knowledge translation of motor learning evidence to physiotherapy practice (e.g, Hussien, Khodko, et al., 2023; Kafri et al., 2023) have been informed by local understanding of practice (e.g., Atun-Einy & Kafri, 2019; Hussien & Ste-Marie, 2023).

Building on the need to adapt physiotherapy practices across diverse contexts, recent global events such as the COVID-19 pandemic have further highlighted challenges and opportunities in how physiotherapy interventions are delivered, particularly in relation to communication and instruction methods. Although in-person services have resumed, telehealth continues to be an option for families of children with NDDs, as it enhances accessibility and supports the delivery of family-centred care (Shin et al., 2025).

1.2.4 Telehealth

The recent COVID-19 pandemic has affected the provision of physiotherapy services globally. At the height of the pandemic, when territories have moved through various levels of quarantine and lockdowns, telehealth platforms have rapidly emerged as a critical means of delivering care (e.g., Bennell et al., 2021; Flannery et al., 2020). Among the challenges associated with the suspension of face-to-face service delivery were the physiotherapists' diminished ability to provide non-verbal cues and tactile feedback, which are integral components of traditional therapeutic interactions. These non-verbal elements often facilitate motor learning and patient understanding by providing essential sensory information and reinforcing verbal instructions (Grigos et al., 2024; Nelson et al., 2025). Their absence necessitated a heightened reliance on verbal instructions (Eguia & Capio, 2022). Furthermore, the dynamics of therapy sessions had also changed, such that family participation became crucial. This change has important implications for how therapists

deliver their instructions and feedback, as the involvement of caregivers influences communication styles and strategies, requiring therapists to engage not only with the child but also with family members who often act as facilitators or co-therapists during sessions. Under such conditions, the use of external FOA instructions and feedback can be beneficial because they tend to enhance learners' motivation and strengthen the coupling of goals and actions (Wulf & Lewthwaite, 2016). External FOA can direct the child's attention to the desired outcomes of the movement (i.e., goal-directed) which can build on the motivations of both the child and the family member. In contrast, internal FOA instructions may be particularly challenging for the child in the absence of tactile prompts by the therapist to cue the body parts that need to move. Finally, external FOA instructions also minimise the use of technical terms, which can become intimidating for non-specialist family members.

With the continuing evolution of technology, it is likely that telehealth will continue to be a viable and valuable platform for physiotherapy, particularly in geographically dispersed or resource-constrained regions where access to in-person services is limited. In such settings, telehealth can help address equity and accessibility issues by connecting patients in remote or underserved areas to physiotherapy services without requiring travel, and by reducing practical barriers such as transport costs and travel time. These considerations are especially pertinent for paediatric physiotherapy, where consistent access to services can be critical for children with NDDs. The specific ways in which these issues manifest in the Philippine context are outlined in Section 1.2.6. Even in densely populated urban centres such as Metro Manila, where most clinics are located, telehealth offers practical advantages by circumventing severe traffic congestion, which ranks among the worst globally (2023 traffic index). Moreover, research conducted during the pandemic highlighted that parents of children with NDDs reported increased empowerment through telehealth, as their active involvement enhanced their confidence and ability to support their child's therapy

(Eguia & Capio, 2022). In addition to fostering family engagement, telehealth has been shown to increase treatment availability, reduce diagnosis waiting times, and facilitate the ongoing monitoring of children with NDDs (Valentine et al., 2020). A recent systematic review of telehealth services across the Asia-Pacific region identified promising practices for managing children with various NDDs, including autism spectrum disorder and cerebral palsy, demonstrating the potential of telehealth to improve access to and the quality of care in diverse settings (Devagiri et al., 2024).

Despite these advantages, telehealth presents ongoing challenges for physiotherapy delivery. Beyond the increased reliance on verbal instructions, physiotherapists must now explicitly articulate cues that they would typically convey through physical contact – many of which have become automatic and are possibly difficult to verbalise. Moreover, the increased involvement of family members in telehealth sessions necessitates adjustments in how instructions and feedback are communicated to ensure that they are clear and effective for both the child and their caregivers. Therapists themselves have identified the need for support to effectively implement telehealth, with one key area being training in communication skills to optimise interactions via phone and internet, as well as to replace hands-on interventions (Camden & Silva, 2021). Addressing these challenges requires further research to explore how physiotherapists can optimally utilise FOA strategies within telehealth settings, thereby enhancing the quality and efficacy of instruction and feedback.

1.2.5 Knowledge Translation

The rapid evolution of telehealth has introduced new opportunities and significant challenges for physiotherapists, particularly in paediatric care. Meeting these challenges requires more than just technological advancements; it also demands the thoughtful integration of current research in motor learning into daily clinical practice. As such, the ability to effectively translate knowledge to accommodate modalities like telehealth is vital

for delivering optimal physiotherapy services. This is especially important in contexts with workforce shortages and access barriers, such as those described for paediatric physiotherapy in the Philippines (see Section 1.2.6).

Knowledge translation (KT) plays a critical role in narrowing the gap between research and practice in healthcare (Graham & Tetroe, 2010; Kawchuk et al., 2014). It emphasises the synthesis, exchange, dissemination, and application of research with the aim of improving health outcomes and the effectiveness of health systems (Straus et al., 2011). This process ensures that evidence is not only accessible but also clearly understood by key target audiences, including clinicians who apply the knowledge, patients who receive care, and policymakers who guide healthcare priorities (Khalil, 2016; Straus et al., 2011). KT strategies can range from developing conceptual frameworks to practical interventions such as workshops, structured training sessions, and clinical audits (Jamtvedt et al., 2006; Menon et al., 2009; Scott et al., 2012). These strategies are designed to address the numerous barriers that prevent the consistent application of research evidence in real-world clinical practice, such as gaps in knowledge, resource limitations, and varying organisational cultures.

There continues to be limited work on the systematic translation of FOA knowledge to physiotherapy practice, particularly in Southeast Asia, including the Philippines, where research and implementation infrastructures may differ from those in Western settings. This gap highlights the need for structured approaches to bridge the gap between evidence and practice in diverse healthcare environments. One widely recognised framework that can guide this process is the Knowledge-to-Action (KTA) framework, developed by Graham and colleagues (2006), which provides a comprehensive and iterative model for implementing evidence-based healthcare practices (Field et al., 2014). It consists of two iterative components of knowledge translation: (i) knowledge creation and (ii) the action cycle. Knowledge creation involves the generation and synthesis of high-quality research evidence

that forms the foundation for practice recommendations. The action cycle then operationalises this knowledge by adapting it to specific local contexts, which includes evaluating and addressing factors that either facilitate or hinder the effective application of evidence in practice settings (Manns, 2021). By explicitly recognising these contextual factors, the KTA framework supports tailored strategies to maximise the uptake and sustainability of evidence-based interventions, such as FOA strategies in physiotherapy.

The framework has been applied in various healthcare settings, including stroke rehabilitation (Janzen et al., 2016) and physiotherapy (Sibley & Salbach, 2015). Janzen and colleagues (2016) conducted a study aimed at situating an evidence-based review of stroke rehabilitation and the rehabilitation knowledge and actions within the KTA framework. They demonstrated how the KTA framework contributed to improving evidence-based stroke rehabilitation practices. This process enabled one centre to implement changes in clinical practice and foster a culture supportive of evidence-based approaches to stroke rehabilitation. In a study by Sibley and Salbach (2015), the KTA framework was used to examine balance and gait assessments in physical therapy practice. Their research identified gaps in the use of standardised tools as well as individual and organisational barriers that hinder the implementation of best practices. They further demonstrated the necessity of synthesising evidence before developing targeted interventions. Adopting the KTA framework helped clarify challenges and informed strategies to enhance the adoption of evidence-based assessment methods in physiotherapy. The distinct processes of the KTA framework could also be used to translate motor learning knowledge into physiotherapy practice.

Specific to motor learning research, KT efforts have focused on the development of conceptual frameworks (e.g., Kleynen et al., 2020; Winstein et al., 2014) and instruments that aim to understand physiotherapists' knowledge and understanding of motor learning principles (Levac et al., 2011; Ryan et al., 2020). One study implemented and evaluated a

knowledge translation intervention that included a didactic course to build Israeli physiotherapists' capacity to integrate general motor learning knowledge into their practice (Kafri et al., 2023). They found that the intervention enhanced physiotherapists' self-efficacy and self-reported use of motor learning principles in their general practice.

Another study applied a systematic approach to translating FOA knowledge to Canadian physiotherapy practice (Hussien, Khodko, et al., 2023). Based on the input of practitioners, the intervention combined a virtual workshop with asynchronously accessible online modules. They reported that the intervention enhanced the physiotherapists' self-reported knowledge, skills, attitudes, and self-efficacy with applying FOA knowledge to practice. The participants also self-reported greater use of external FOA and perceived improved client outcomes.

1.2.6 Paediatric Physiotherapy in the Philippines

The Philippines is a lower-middle-income country in Southeast Asia, comprising an archipelago of over 7,600 islands with a population of approximately 112 million (Baticulon et al., 2024; Official Gazette of the Republic of the Philippines, 2025). The physiotherapy workforce in the Philippines is significantly constrained. According to the World Physiotherapy country profile, there are approximately 16,605 registered physiotherapists, yielding a ratio of roughly 1 physiotherapist per 6,900 people—substantially lower than ratios in high-income countries (World Physiotherapy, 2023). The country faces a critical shortage of approximately 190,000 healthcare workers, including physiotherapists (Mangaluz, 2024). This workforce shortage has particular implications for paediatric rehabilitation services.

Access to physiotherapy in the Philippines is further constrained by structural and financial barriers. Physiotherapy services are primarily funded through out-of-pocket expenses or compulsory/voluntary insurance arrangements, and patients must obtain physician referrals to access services directly (World Confederation for Physical Therapy,

2019). Research on Filipino families of children with special needs has identified socioeconomic factors, including affordability and accessibility challenges, as significant barriers to accessing rehabilitation services (Chiu et al., 2023). In urban areas, most physiotherapy clinics are concentrated in densely populated centres such as Metro Manila (Abrigo, 2019), while the geographical dispersion across thousands of islands adds to these access challenges for families in rural or remote areas. Additionally, severe traffic congestion in metropolitan areas creates practical barriers to clinic-based care (Straits Times, 2019). These structural and financial constraints mean that many children with neurodevelopmental disorders in the Philippines experience delayed diagnosis and limited access to timely, evidence-based physiotherapy services.

Within this context, telehealth emerges as a potentially transformative platform for enhancing equity and accessibility. For geographically dispersed populations across the Philippine archipelago, telehealth can connect children in remote and underserved areas to physiotherapy services without requiring travel. Barriers to equitable access can be mitigated through participatory approaches and by integrating telehealth into rehabilitation programs (Chiu et al., 2023). As noted earlier, research conducted during the COVID-19 pandemic demonstrated that parents of children with NDDs reported increased empowerment through telehealth participation, with enhanced confidence and capacity to support their child's rehabilitation (Eguia & Capio, 2022). However, to maximise the effectiveness of telehealth delivery in this resource-constrained environment, physiotherapists require evidence-based strategies tailored to the unique demands of remote service delivery. The integration of motor learning principles, particularly FOA strategies, into telehealth practice is a potential avenue through which physiotherapists in the Philippines can optimise instruction and feedback delivery for children with NDDs, which, in turn, may enhance the quality and reach of services despite workforce and access limitations.

This thesis is situated within this Philippine context and addresses the critical need for context-specific, evidence-informed approaches to translating motor learning knowledge into paediatric physiotherapy practice, particularly for telehealth delivery.

1.3 Research Objectives

The theories of motor learning and the framework for neurorehabilitation justify the use of FOA strategies for delivering instructions and feedback to children with NDDs especially within telehealth platforms. However, two kinds of gaps currently exist.

First, there is a gap in synthesised knowledge. There is a large base of evidence related to motor learning in general, and FOA for instructions and feedback in particular for adult populations (see Lohse, 2012; Ziv & Lidor, 2015). Similar evidence for children has only begun to emerge, such that syntheses of evidence have been limited thus far to reviews examining effectiveness (see Simpson et al., 2021; van der Veer et al., 2022). The contexts in which motor learning strategies have been used for children have yet to be summarised, and little is known about their use among children with NDDs. We are particularly interested in physiotherapy for children with NDDs because of their impairments in movement control and coordination.

Second, there is a gap between knowledge and professional practice. The currently available information on the use of FOA by physiotherapists has been drawn mostly from practices in stroke rehabilitation within European contexts (e.g., Durham et al., 2009; Johnson et al., 2013; Kal et al., 2018) and self-reports of general practice within a Canadian context (e.g., Hussien & Ste-Marie, 2023). Currently, there is no published information describing how paediatric physiotherapists deliver instructions and feedback in actual practice. We also do not have knowledge of practice patterns in developing countries within the Southeast Asian region, such as the Philippines. An understanding of these patterns of

practice can facilitate the delivery of activities that would translate evidence-based knowledge into physiotherapy practice. However, evaluations of knowledge translation regarding motor learning to physiotherapy practice have, to date, been conducted only in Israeli and Canadian contexts (i.e., Hussien, Khodko, et al., 2023; Kafri et al., 2023) limiting the generalisability of findings to other regions and populations.

Alongside the need to address these two gaps, evidence-informed strategies need to be explored to help mitigate the challenges associated with telehealth practice. There appears to be potential to enhance the accessibility of paediatric physiotherapy through telehealth, but we need to understand how instructions and feedback can be optimally delivered on this platform to maximise therapeutic outcomes. Applying and evaluating knowledge translation strategies in the telehealth context in the Philippines is especially timely and relevant. The complex communication needs, along with the involvement of caregivers in remote paediatric physiotherapy, highlight the importance of tailored knowledge translation interventions. By systematically adapting and delivering motor learning and FOA principles to meet the realities of telehealth, physiotherapists can be better supported in providing effective, high-quality care for children with NDDs across diverse settings.

To address these gaps and needs, this dissertation sought to:

(1) synthesise the current evidence related to motor learning and FOA among children,
(2) describe physiotherapists' use of FOA in the Philippine practice context,
(3) examine paediatric physiotherapists' use of FOA in delivering instructions and feedback to children with NDDs using a telehealth platform in the Philippine practice context, and
(4) evaluate the effects of a knowledge translation activity on paediatric physiotherapists' use of FOA in clinical practice, including the telehealth platform.

The ultimate aim of the research is to support knowledge translation through which FOA may be suitably deployed when delivering instructions and feedback to children with NDDs in settings that match their needs and enhance service accessibility. Through the four objectives outlined above, this research contributes to closing the gaps in evidence synthesis and bridging the divide between research and paediatric physiotherapy practice.

1.4 Outline of the Chapters

This dissertation represents a stepwise and systematic approach to addressing the research objectives stated in the preceding section. With the exception of Chapter 1, which serves as the introduction, and Chapter 7, which provides the discussion and synthesis of the overall findings, each chapter functions as a standalone manuscript (i.e., published paper, manuscript under review). As such, each chapter contains its own sections for background, methods, results and discussion, and there may be repetition of information given such format of this thesis. Nevertheless, the studies presented across the chapters are linked to each other and collectively contribute to a coherent body of research. The relationships between each chapter, including how each study builds upon or complements the others, will be explicitly outlined here to provide a comprehensive understanding of the overall research narrative. For clarity and completeness, the references from each standalone manuscript are combined and listed collectively at the end of this dissertation.

Chapter 1 (this chapter) serves as the introductory foundation for this dissertation, providing the scope, background, and theoretical context essential for understanding the subsequent studies. This chapter offers a comprehensive literature review that explains key concepts such as motor learning, the focus of attention (FOA), neurodevelopmental disorders (NDDs) and telehealth, alongside relevant theoretical frameworks, including the motor learning framework for neurorehabilitation. It elaborates on the importance of these concepts

in paediatric physiotherapy and justifies the need to explore FOA strategies, particularly within the telehealth setting. Chapter 1 also articulates the research objectives that guide this dissertation. It concludes by providing an overview of the dissertation structure, outlining each chapter's focus and how they collectively address the identified research gaps.

Chapters 2 and 3 address the gap in synthesised knowledge and fulfil the first objective of this research. Chapters 4, 5, and 6 address the gap between knowledge and professional practice. Specifically, Chapter 4 meets the second objective, Chapter 5 meets the third objective, and Chapter 6 meets the final objective of this research.

Chapter 2 reports one of two systematic scoping reviews that were conducted in parallel, guided by the motor learning framework for neurorehabilitation (Kleynen et al., 2020). In this scoping review, we aimed to identify the specific *motor learning strategies* that have been applied to distinct diagnostic groups of children with NDDs along with the outcomes reported in these studies. We followed established procedures and protocols for conducting scoping reviews (Arksey & O'Malley, 2005; Peters et al., 2021) to ensure methodological rigor and transparency. It was determined that there is growing evidence for the use of two motor learning strategies for children with CP and children with DCD: the dual-task strategy and observational learning. Research that specifically examines motor learning strategies tends to address NDDs that have primary motor impairments, which also reflects the paediatric cases typically referred to physiotherapy.

Chapter 3 presents the second systematic scoping review that focused specifically on FOA in relation to the *motor learning elements* of instructions and feedback (Kleynen et al., 2020). In this scoping review, we aimed to map the conditions under which FOA had been utilised for delivering instructions and feedback in children. We initially intended to focus on children with NDDs but given the extremely limited evidence for such clinical populations, we expanded the review to include children with typical development. To organise and

interpret the studies systematically, we used a learner-task-environment framework (Gordon & Magill, 2016), which allowed us to map the evidence based on children's developmental characteristics, the nature of the movement tasks that were learned, and the settings in which the movement skills were learned. We determined the extent of research conducted to date on the use of FOA to facilitate children's learning of movement tasks. Most of the reviewed studies support the advantages of an external FOA in promoting motor learning, but some studies also showed no significant differences between external and internal FOA, highlighting the need to consider individual differences among children or among conditions. Regarding the types of tasks, FOA was evidently useful for tasks that range from isolated fundamental movement skills to complex functional and sport-related tasks in various settings, including school environments or laboratory conditions. The limited number of studies that focused on children with NDDs suggests that the use of FOA in clinical settings needs further exploration.

Chapter 4, therefore, presents a study that initiated an exploration into the use of FOA strategies by physiotherapists in their clinical practice within the Philippines. Using a survey design and instruments adapted from previous related research (Hussien & Ste-Marie, 2023; Kal et al., 2018), we found that physiotherapists self-reported a predominant preference for internal FOA for delivering both instructions and feedback, regardless of their educational qualifications or professional background. Only approximately half of the respondents reported familiarity with the concept of FOA in relation to the delivery of instructions and feedback. The findings suggest that further work is needed for research evidence to be translated to professional practice. Those who currently deliver physiotherapy in telehealth platforms also preferred to deliver instructions and feedback using internal rather than external FOA. Given the inherent limitations of the survey design, such as the reliance on

self-reported data, further research is needed to examine telehealth practice in depth using an alternative design.

Chapter 5 is a structured observational study (Kal et al., 2018; van der Veer et al., 2023) that addresses the limitations noted in Chapter 4. In this study, we aimed to determine the preference for internal and external FOA by paediatric physiotherapists during telehealth sessions for children with NDDs in the Philippines. Our findings revealed an overall relative preference for internal FOA, which is consistent with the findings of the survey study in Chapter 4. However, a relative preference for external FOA was found for instructions and internal FOA for feedback. Although paediatric physiotherapists prefer external FOA for instructions during telehealth, its use remains just a little over 50%, indicating that there is room to increase external FOA to optimise practice if applicable. While we found in the survey study that physiotherapists' characteristics were not associated with their preference for internal or external FOA in their general practice, the observational study revealed that internal FOA tended to be used for children who displayed higher physical and cognitive development levels. It is important to note, however, that the physiotherapists utilised FOA in only 19.5% of their statements during a telehealth session, suggesting a substantial opportunity to enhance the use of FOA in practice. In relation to our observational methods, we determined that in telehealth paediatric practice, instructions and feedback may be categorised according to the audience (i.e., child or caregiver) and modality (i.e., verbal, visual, both). Such parameters had not been considered in previous observational studies of in-person physiotherapy of adult patients (e.g., Johnson et al., 2013; Kal et al., 2018), which when considered, provides a clearer context for understanding telehealth paediatric physiotherapy practice.

Chapter 6 presents a sequential mixed-methods knowledge translation study. A KT activity consisting of a synchronous webinar delivered by a motor learning expert and

materials that participants can access asynchronously aimed to facilitate physiotherapists' use of FOA when working with children with NDDs. The KT activity was designed based on the evidence that was synthesised in Chapters 2 and 3, and the knowledge of local physiotherapists' practice reported in Chapters 4 and 5. Quantitative data from questionnaires adapted from previous studies (i.e., Hussien, Khodko, et al., 2023; Kafri et al., 2023) revealed that the paediatric physiotherapists' (n = 126) self-reported knowledge, self-efficacy, and intended implementation of FOA in practice improved after the webinar. The participants' self-reported preferences were also found to shift from internal to external FOA following the webinar. A subsample of physiotherapists (n = 6) participated in individual interviews post-webinar, which revealed that physiotherapists found the use of FOA helpful in addressing the constraints associated with delivering instructions and feedback during telehealth. The participants considered client characteristics and the resources in the home environment when choosing to adopt internal or external FOA.

Chapter 7 is the final chapter that offers a comprehensive discussion based on the combined findings of the five studies in this dissertation. We determined from our evidence synthesis that knowledge about FOA may be useful for paediatric physiotherapists who work with children with NDDs. We found through the survey and observational studies that there is a need for targeted activities that would facilitate the translation of motor learning knowledge into physiotherapy practice, including telehealth, within the local Philippine context. Drawing from these four studies along with related research but in Canadian and Israeli contexts (Hussien, Khodko, et al., 2023; Kafri et al., 2023), we delivered a KT activity that evidently supported paediatric physiotherapists in the Philippines in using FOA to deliver instructions and feedback for children with NDDs, particularly on a telehealth platform. While previous knowledge translation efforts of motor learning for physiotherapists have only assessed the impact on physiotherapists' knowledge, skills and attitudes in relation to

FOA use (e.g., Hussien, Khodko, et al., 2023; Kafri et al., 2023), we now offer insights into actual practice following knowledge translation. The contributions of these combined findings to our understanding of motor learning frameworks and their relationship to paediatric physiotherapy practice are discussed in this final chapter. From an applied perspective, we also discuss the contributions to the translation of motor learning research into physiotherapy practice, with an emphasis on the context of a developing country, as represented by the Philippines.

Chapter 2: Motor Learning Scoping Review[1]

Applications of motor learning strategies in children with neurodevelopmental disorders: A scoping review

2.1 Commentary

This chapter presents a systematic review that consolidates and maps existing research on motor learning strategies applied to children with neurodevelopmental disorders (NDDs). The purpose of this review is to identify which specific motor learning strategies have been used across different diagnostic groups within NDDs and to examine the reported outcomes associated with these interventions. A systematic mapping review identified key strategies frequently used in older adults with neurological and geriatric conditions, including dual-task learning, observational learning, movement imagery, errorless learning, and trial-and-error practice (Jie et al., 2024), but no equivalent review exists for children with NDDs before our work. By synthesising current evidence, this study aimed to facilitate the translation of research findings into clinical practice. Furthermore, the review highlights gaps in the literature where targeted research is needed to optimise therapeutic approaches for this population. This is the first of two studies that address the gap in synthesised knowledge and fulfil the first objective of this research.

[1] This chapter is based on a manuscript that has been published: Eguia, K. F., Ng, S. S. M., Capio, C. M., & Wong, T. W. L. (2025). Applications of motor learning strategies in children with neurodevelopmental disorders: A scoping review. *Review Journal of Autism and Developmental Disorders.* https://doi.org/10.1007/s40489-025-00500-6

2.2 Introduction

Motor skills include a wide range of abilities, from simple movements like reaching or grasping toys to complex tasks such as playing a musical instrument or performing sports-related movements like dodging (Matheis & Estabillo, 2018). The acquisition of these motor skills plays a crucial role in child development, as these abilities are not only important for accomplishing activities of daily living but also influence other aspects of development, such as cognitive, social, and emotional growth (Leonard & Hill, 2014; Veldman et al., 2019). However, acquisition of motor skills often presents unique challenges for children with neurodevelopmental disorders (NDDs), including attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), cerebral palsy (CP), developmental coordination disorder (DCD), dyslexia, and intellectual disability (ID) (American Psychiatric Association, 2022).

While each NDD is unique in its clinical presentation, they share a common thread of impairments in movement control, coordination, or cognition, which could affect both gross and fine motor skills. For instance, children with ASD have been shown to exhibit difficulties in motor coordination and imitation, which can impact social interaction and play (Zampella et al., 2021). Children with DCD, on the other hand, struggle with fundamental motor tasks such as handwriting or catching a ball, particularly in activities that require motor planning or sequencing of movements (Biotteau et al., 2015). Understanding how to effectively facilitate motor skill acquisition in children with NDDs is important, as it holds the potential to enhance their overall quality of life by contributing positively to their overall physical competence and independence (Cameron et al., 2016).

Motor skill acquisition in children with NDDs is facilitated through motor learning strategies in the early years of their lives. Although there is a large body of research on motor learning strategies, their application in paediatric populations, particularly among those with

NDDs, remains underexplored (Eguia et al., 2023). This knowledge gap is partly due to a lack of motor learning research on younger individuals, as most studies on motor learning involve older individuals in laboratory settings (Kleynen et al., 2015). Researchers argue that exploring the controlled application of motor learning strategies in paediatric settings could be challenging due to the necessity of adapting strategies according to individual child characteristics and reactive factors during intervention (Ryan et al., 2020). This need for adaptation is particularly heightened among children with NDDs. Furthermore, the inconsistent use of motor learning terminology among practitioners and researchers adds complexity to the literature search (Zwicker & Harris, 2009), hindering the interpretation of study results (Ryan et al., 2020). Consequently, translating evidence-based strategies into practice for children with NDDs continues to be a challenge (Levac et al., 2009).

Motor learning strategies include analogy learning, dual task learning, discovery learning, errorless learning, mental practice, observational learning, and trial and error (Kleynen et al., 2020). Analogy learning strategies deliver instructions by using a biomechanical metaphor, effectively concealing the complex rules for performing a movement task (Masters, 2000). An example of analogy learning instruction would be "Shoot the ball as if you are trying to put cookies into a cookie jar on a high shelf" to teach learners to shoot the ball into the basketball hoop (Tse & Masters, 2019). Dual-task learning involves the simultaneous performance of a motor or cognitive secondary task that requires attention, whereas discovery learning is described as one where skills are practiced without guidance or feedback from any information source (Kleynen et al., 2020). Errorless learning consists of constraining the environment to minimise practice errors, which is believed to limit the involvement of working memory during motor performance (Maxwell et al., 2001). One way to apply errorless learning when teaching movement tasks is by setting up the environment to minimise errors. For example, in a dart-throwing exercise for someone with sensorimotor

issues, a larger dartboard and brightly coloured bullseye could reduce the chance of missed throws. Mental practice or movement imagery involves a learner imagining oneself performing a movement task without actual actions (Kleynen et al., 2020). Observational learning has been described as one where a learner determines the spatial and temporal features of movement tasks through observation, whereas trial and error involves repeated attempts by the learner to perform a movement task while errors are detected and corrected (Kleynen et al., 2015).

Previous reviews have synthesised evidence of specific motor learning strategies but for typically developing children (e.g., implicit motor learning strategies, van Abswoude et al., 2021; focus of attention, van der Veer et al., 2022; motor imagery, Behrendt et al., 2021). While van Abswoude et al. (2021) assessed both typically developing children and those with developmental disabilities, they identified only seven studies with significant variability in methodological rigor. Similarly, van der Veer and colleagues (2022) found 13 studies of low methodological quality, with only six involving children with atypical development, and focused narrowly on implicit and explicit motor learning strategies. For children with NDDs, an earlier review of motor learning strategies in the context of physical therapy interventions suggested that the strategies need to be better understood to be integrated into interventions (Levac et al., 2009). More recently, motor learning elements and principles have been reviewed but limited to the diagnosis of CP (e.g., feedback provision, Schoenmaker et al., 2023; motor learning theories for upper limb function, Taghizadeh et al., 2023; virtual reality, Demers et al., 2021). A review that maps motor learning strategies specifically across a range of NDDs could facilitate knowledge translation and integration into the practices of occupational therapists, physiotherapists, and trainers. We therefore aim to identify the specific motor learning strategies that have been applied to specific NDD diagnoses and the reported outcomes. We seek to aid the translation of research to practice by consolidating and

mapping the research that has examined motor learning strategies in children with NDDs. Considering our research objective, a scoping review is deemed appropriate. Scoping reviews provide a comprehensive platform for exploring the breadth and diversity of available evidence (Tricco et al., 2018). Furthermore, they are well-suited for the systematic examination of research characteristics pertaining to a given topic, the identification of knowledge gaps, and the shaping of future research endeavours (Peters et al., 2021), and contribute to reducing research waste (Khalil et al., 2022).

2.3 Methods

We registered this review (https://doi.org/10.17605/OSF.IO/DSQYR) on OSF Registries. The procedures were guided by the framework for scoping reviews proposed by Arksey and O'Malley (2005) and the enhanced protocol endorsed by the Joanna Briggs Institute (JBI) (Peters et al., 2021). The first five steps of the framework consisted of (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, and (5) collating, summarising, and reporting the results. We deemed the sixth step, which involved expert consultation, unnecessary for this review. Following the JBI protocol for scoping reviews, we did not conduct a critical appraisal to assess the risk of bias.

2.3.1 Identifying the research question

Using the Population, Concept, and Context (PCC) format for scoping reviews (Kao et al., 2017), the following review question is posed: *What motor learning strategies (concept) have been examined among children with NDDs (population) as a means to acquire movement skills (context)?*

The specific objectives of this review are further defined below:

1. To identify the specific motor learning strategies that have been used in studies of children with NDDs.

2. To identify the specific diagnostic groups within NDDs for which motor learning strategies have been applied.
3. To map the research, including study designs and outcomes, should be mapped to inform future research directions and practice recommendations.

2.3.2 Identifying relevant studies

We located published studies that included quantitative, qualitative, and mixed-methods designs. We conducted the search in November 2023 and did not apply any restrictions for the date of paper publication. We updated the search in January 2024. We searched the following electronic databases: PubMed, Scopus, EBSCO, ProQuest, JSTOR, and Web of Science. We used the Boolean operators "AND", "OR", and "*" to conduct the search with multiple combinations of keywords. Based on the PCC elements outlined in the review question, we constructed the following search phrases: ("child*" OR "early child*" OR "young child*" OR "adolescen*" OR youth) AND (("motor" OR "movement") AND ("skill" OR "task" OR "development")) OR "skill acquisition" OR "locomotor" OR "manipulative" OR "stability") AND ("errorless learning" OR "analogy learning" OR "trial and error" OR "observational learning" OR "dual-task" OR "discovery learning" OR "mental practice" OR "movement imagery") AND ("neurodevelopmental disorder*" OR "cerebral palsy" OR "down syndrome" OR autism OR "developmental coordination disorder" OR dyspraxia OR ADHD OR "intellectual disability" OR "special education needs"). The search results were uploaded into Zotero 6.0.15 (Digital Scholar, VA, USA).

2.3.3 Selecting studies

The study selection process followed the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Page et al., 2021) and the PRISMA Extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018), as shown in Fig. 2.1.

Two reviewers performed the selection of studies independently. After removal of duplicates, the titles were screened, and those that were irrelevant to the review question were excluded. The reviewers read the abstracts of the selected titles to assess each record's eligibility. Studies were selected if they met the following criteria: (1) the participants were aged 3 to 17 years and represented a diagnostic group within NDDs, (2) involved learning a movement task - i.e., the study should have a learning phase, (3) tested a motor learning strategy,; (4) reported on original research – i.e., not a review, and (5) the paper was written in English. Moreover, studies were excluded if they (1) involved a movement task that was not sufficiently complex – e.g., pressing buttons (van Abswoude et al., 2021), (2) focused on instrument validation, or (3) were published study protocols, conference abstracts, or dissertations. The reviewers' selection results were compared, and any inconsistency was resolved through discussion and consensus.

2.3.4 Charting the data

Following the JBI protocol for scoping reviews (Peters et al., 2021), the following data were charted: author(s), title, year of publication, study design, aim(s) of the study, participants, motor learning strategy used, settings, measures and outcomes, and main findings. Data extraction was performed by one reviewer and verified by a second reviewer for accuracy.

2.3.5 Collating, summarising, and reporting the results

Two reviewers collaboratively collated the data following a framework based on the specific NDD and the types of motor learning strategies that were identified by Kleynen and colleagues (2020). We summarised the results descriptively and report them in the next section.

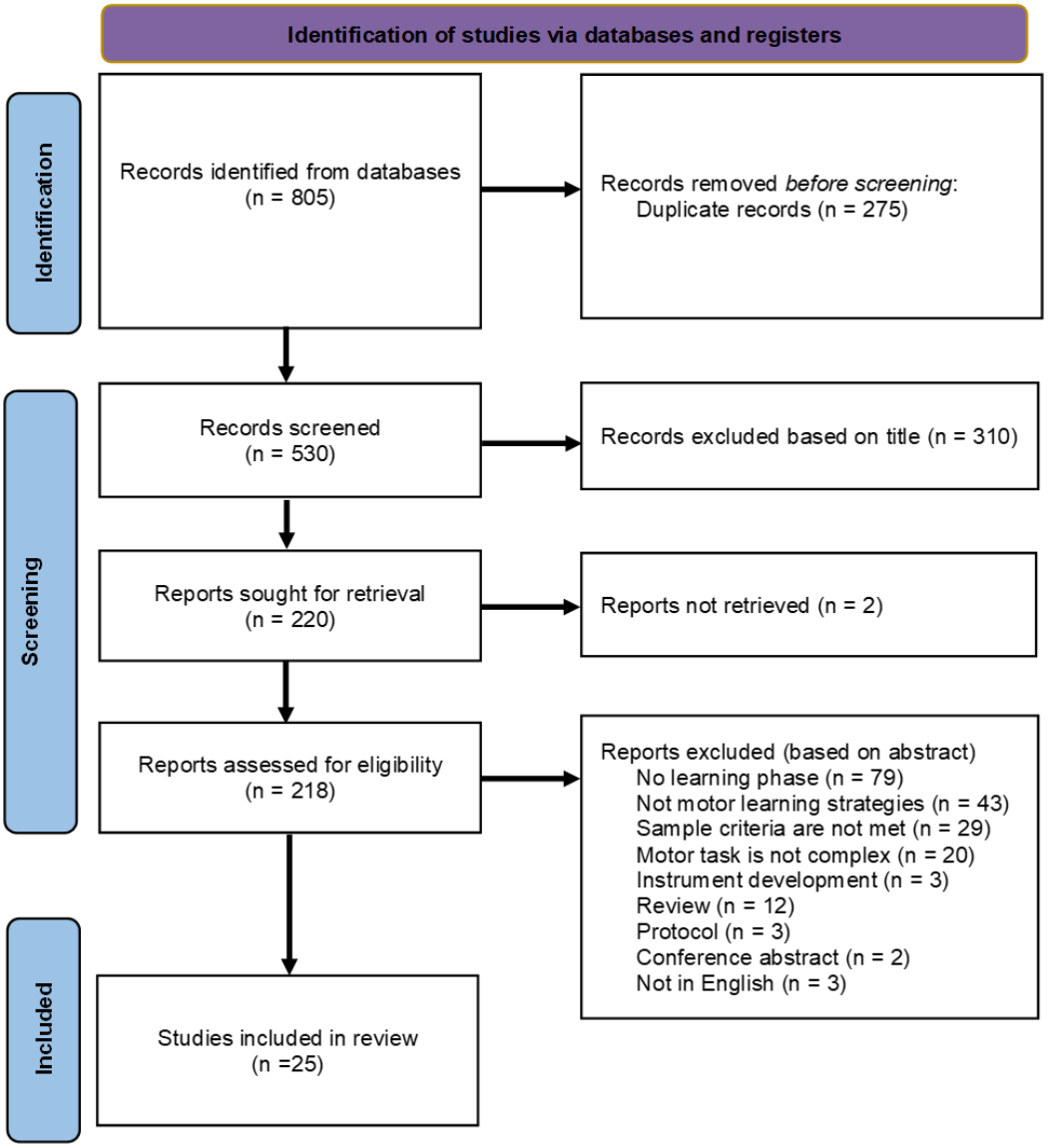


Figure 2.1. PRISMA flow diagram (Page et al., 2021) for article selection.

2.4 Results

As shown in Fig. 2.1, the electronic search yielded a total of 805 articles. Based on the titles, 220 articles were identified. Following the review of abstracts, we found 25 papers that met our selection criteria. The papers were published between the years of 2010 to 2023. The study designs utilised control groups (n = 18) including six randomised controlled trials (RCTs), cohort samples that compared NDD groups with typically developing groups (n = 4), and single NDD groups without control (n = 3). The main findings are summarised according to specific NDDs and motor learning strategies in Table 2.1.

Table 2.1

Settings and main findings of motor learning studies involving samples of children with neurodevelopmental disorders

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
CP	Nekar Daekook et al., 2022	Dual-task	Pretest-Posttest control group design	Clinic-based training in a rehabilitation center; intervention facilitated by physiotherapists.	Basic hand function training (conventional) vs. Basic hand function + visual perception task (dual-task) 3 sessions/wk; 4 weeks	Dual-task training and conventional training both improved hand function but only dual-task training improved visual perception ability.
	Okur et al., 2022	Dual-task	Self-controlled clinical design	Clinic-based training in a rehabilitation center; intervention facilitated by physiotherapists.	Balance and walking training (conventional), followed by Balance and walking + cognitive task (dual-task) 2 sessions/wk; 8 weeks for each condition	Dual-task in addition to conventional training further improved gait parameters, gross motor function, functional movement skills, and health-related quality of life in children with spastic diplegic CP.
	Tadvalkar & Metgud, 2023	Dual-task	Pretest-Posttest one group design	Telerehabilitation training facilitated by physiotherapists.	Balance and walking exercise + secondary motor task 3 sessions/wk; 6 weeks	Dual-task training via telerehabilitation improved balance, coordination, and functional mobility of children with CP at GMFCS levels I and II.
	Uysal et al., 2023	Dual-task	Randomised controlled trial	Clinic-based training in a rehabilitation center with the intervention facilitated by physiotherapists.	Lower limb strengthening (conventional) vs. Balance and walking exercises + cognitive task (dual-task) 3 sessions/wk; 12 weeks	Dual-task training was advantageous for balance, fitness, and quality of life of children with CP at GMFCS levels I and II.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
	Nuara et al., 2019	Observation	Time series one group design	Home-based training delivered through online videos, facilitated by therapists.	Upper limb movements following a video demonstration + interaction with another child 5 consecutive days/wk; 4 weeks	Action observation combined with child-to-child interaction improved hand motor function in unilateral CP.
	Sgandurra et al., 2013	Observation	Randomised controlled trial	Clinic-based training in two child rehabilitation centers with the intervention facilitated by therapists.	Upper limb movements + verbal instructions (control) vs. Upper limb movements + video demonstration (observation) Daily; 15 consecutive days	Action observation training improved upper limb function in daily activities of children with unilateral CP.
	Simon-Martinez et al., 2020	Observation	Randomised controlled trial	Day camp model with the intervention facilitated by physiotherapists.	Unimanual upper limb actions + video games + verbal instructions (control) vs. Unimanual upper limb actions + video demonstration (observation) 15 sessions over 9 days	Action observation did not differ from control in improving bimanual hand performance, body functions, and manual activity among children with unilateral CP.
	Simon-Martinez, Mailleux, Jaspers, et al., 2020	Observation	Randomised controlled trial	Day camp model with the intervention facilitated by physiotherapists.	Unimanual upper limb actions + video games + verbal instructions (control) vs. Unimanual upper limb actions + video demonstration (observation) 15 sessions over 9 days	Action observation shortened the movement time for reaching tasks and led to limited benefit in movement patterns.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
	Burtner et al., 2014	Trial and error	Time series cohort design (hemiplegic CP and typical development)	Laboratory-based study with the experiment conducted by researchers.	Coordinated tracking task involving elbow flexion and extension with 100% feedback vs. 62% feedback Daily; 2 consecutive days	More frequent feedback from trial and error led to retention of an upper limb motor skill; lower accuracy and consistency among children with spastic hemiplegic CP compared to those with typical development. Children with CP use feedback from trial error in a manner similar to children with typical development.
	van Abswoude et al., 2015	Errorless learning	Pretest-Posttest control group design	School-based training of an aiming task, facilitated by researchers.	Boccia aiming task with gradually increasing size of target (error-strewn) vs. gradually decreasing size of target (errorless) 1 practice session	Both errorless and error-strewn learning conditions improved aiming accuracy and stable motor performance of the aiming task in children with CP. Children with low motor proficiency benefited from fewer errors during practice.
	Cabral-Sequeira et al., 2016	Movement imagery	Pretest-Posttest control group design	Laboratory-based study with the experiment conducted by researchers.	Tabletop task of aiming a hand-held pointer towards a target following mental rehearsal (motor imagery) vs. Playing the "tetris" game by manipulating a keyboard (control) Daily; 2 consecutive days	Motor imagery led to improved and stable speed and quality of upper limb movements among adolescents with hemiparetic CP. The addition of physical practice to motor imagery enhanced the learning effects.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
ID	Capio et al., 2013	Errorless learning	Pretest-Posttest control group design	School-based training facilitated by researchers.	Overhand throwing task with a gradually increasing target size (error-strewn) vs. gradually decreasing target size (errorless) 1 session/wk; 4 weeks	Errorless learning improved movement form, and increased throwing activity during free play to a greater extent than error-strewn learning among children with ID.
	Capio & Eguia, 2021	Errorless learning	Pretest-Posttest control group design	School-based training facilitated by researchers.	Object control skills (throw, roll, catch, kick, dribble, strike) with gradually increasing task difficulty (errorless) vs. Waitlist (control) 1 session/wk; 8 weeks	Errorless learning led to significant improvements in object control skills proficiency of children with ID.
	Hemayattalab & Movahedi, 2010	Movement imagery	Pretest-Posttest control group design	School-based training facilitated by researchers.	Basketball free throw with Movement imagery vs. Physical practice vs. Physical practice followed by Movement imagery vs. Movement imagery followed by Physical practice vs. No practice (control) Daily; 24 consecutive days	All practice conditions led to improved skill performance; movement imagery followed by physical practice led to the greatest improvement among adolescents with ID.
	Mikolajczyk & Jankowicz-Szymanska, 2015	Dual task	Pretest-Posttest control group design	School-based training facilitated by researchers.	Postural stability exercise + upper limb motor task (dual-task) No information about control 3 sessions/wk; 12 weeks	Dual-task training led to improved postural stability in adolescents with moderate ID.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
	Mikolajczyk & Jankowicz-Szymanska, 2015b	Dual task	Pretest-Posttest control group design	School-based training facilitated by physiotherapists.	Postural stability exercise + upper limb functional activity (dual-task) vs. No intervention (control) 3 sessions/wk; 12 weeks (continuation of earlier study)	The extended dual-task training improved the static balance of adolescents with moderate ID.
ASD	Tse & Masters, 2019	Analogy	Pretest-Posttest control group design	Laboratory-based study with the experiment conducted by researchers.	Basketball shooting with visual analogy vs. verbal analogy vs. explicit instructions vs. no instruction (control) 1 practice session	Verbal and visual analogy learning were comparable with explicit learning in improving basketball shooting performance in children with ASD; visual analogy learning led to sustained performance during transfer tasks.
	Heidari et al., 2021	Observation	Pretest-Posttest control group design	Laboratory-based study with the experiment conducted by researchers.	Overarm throw with video demonstration + physical practice (observation) vs. no intervention (control) Daily; 3 consecutive days	Observational learning led to improvements in throwing accuracy, visual search behaviour, and duration of quiet eye among children with and without ASD.
	Saber Sotoodeh & Taheri-Torbati, 2021	Observation	Pretest-Posttest two-arm cohort design (ASD and typical development)	Laboratory-based study with the experiment conducted by researchers.	Underarm throw with Video demonstration + physical practice vs. Point light display model + physical practice Daily; 2 consecutive days	Observational learning using point-light display led to better skill performance compared to observational learning using video demonstration among both children with ASD and with typical development.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
	Taheri-Torbati & Sotoodeh, 2019	Observation	Pretest-Posttest two-arm cohort design (ASD and typical development)	Laboratory-based study with the experiment conducted by researchers.	Underarm throw with Video demonstration + physical practice vs. Live demonstration + physical practice Daily; 2 consecutive days	Observational learning using video or live demonstration both led to improved skill performance among male children with ASD and with typical development.
DCD	Inacio et al., 2023	Dual task	Time series cohort design (DCD and typical development)	School-based training facilitated by researchers.	Rhythmic stepping task + cognitive task 2 sessions/wk; 7 weeks	Rhythmic stepping with dual-task demands led to improvements in step timing in children with probable DCD that is comparable to typically developing children.
	Jahanbakhsh et al., 2020	Dual task	Pretest-Posttest control group design	Laboratory-based study with the experiment conducted by researchers.	Balance and walking exercise (single-task) vs. Balance and walking exercise + cognitive task (dual-task) vs. No exercise (control) 3 sessions/wk; 8 weeks	Dual-task training improved the balance performance of children with DCD, more than the single-task training.
	Scott et al., 2023	Movement imagery + Observation	Pretest-Posttest control group design	Home-based training facilitated by parents who received training on the intervention.	Practice of activities of daily living following Mental practice of the hand movements (motor imagery) while watching a Video demonstration (observation) vs. Playing a computer game (control) 1 session/wk; 4 weeks	Combined observation and motor imagery learning led to greater improvements in shoelace tying and cup stacking, relative to the control condition, among children with DCD.

NDD	Author/Year	Strategy	Study Design	Setting	Interventions/Tasks	Main findings
DCD + ADHD	Izadi-Najafabadi et al., 2022	Discovery	Randomised controlled trial	Clinic-based training in a hospital rehabilitation department with the intervention facilitated by occupational therapists.	Cognitive Orientation to Occupational Performance (CO-OP) consisting of Goal-Plan-Do-Check strategy to discover strategies to perform motor tasks (discovery) vs. Waitlist (control) 1 session/wk; 10 weeks	CO-OP which included discovery learning led to improvements in self-perceived motor performance and movement quality among children with DCD and those with DCD + ADHD.
DS	Büyükçelik et al., 2023	Dual task	Randomised controlled trial	Clinic-based training in a hospital rehabilitation department with the intervention facilitated by physiotherapists.	Balance exercise + cognitive task (dual-task) vs. No intervention (control) 2 sessions/wk; 8 weeks	Dual-task training led to improved balance and functional independence in self-care among children with DS.

2.4.1 Cerebral palsy (CP)

Among children with CP, the papers reported on the following motor learning strategies: dual-task learning (n= 4), observational learning (n=4), errorless learning (n=1), trial and error (n = 1), and movement imagery (n = 1). Three of the studies used dual-task targeted balance and walking performance of the participants (Okur et al., 2022; Tadvalkar & Metgud, 2023; Uysal et al., 2023); one study aimed to improve hand function (Nekar Daekook et al., 2022). All four studies involved interventions in clinical settings that were facilitated by physiotherapists, with one study using a tele-rehabilitation platform (Tadvalkar & Metgud, 2023). All four studies reported improved outcomes following dual-task training, but only one study reported that dual-task training is more advantageous compared to a control group (Uysal et al., 2023). One study reported comparable outcomes between dual-task and control groups (Nekar Daekook et al., 2022), whereas two studies did not utilise control groups in their study designs (Okur et al., 2022; Tadvalkar & Metgud, 2023).

Three studies used observational learning, but the findings of one study were reported in two papers (i.e., Simon-Martinez, Mailleux, Hoskens, et al., 2020; Simon-Martinez, Mailleux, Jaspers, et al., 2020). All three studies focused on upper limb functions (Nuara et al., 2019; Sgandurra et al., 2013; Simon-Martinez, Mailleux, Hoskens, et al., 2020; Simon-Martinez, Mailleux, Jaspers, et al., 2020) where therapists facilitated the interventions in clinical contexts, with one study adding the practice of tasks at home (Nuara, et al., 2019). Verbal cues or feedback were provided to the children in two studies (Nuara et al., 2019; Sgandurra et al., 2013). All the studies suggested benefits associated with observational learning in children with unilateral CP. One study did not have a control group in their study design (Nuara et al., 2019), while one study that compared video observation with watching computer games found clear advantages associated with observational learning (Sgandurra et al., 2013). One other study added observational learning with constraint-induced movement

therapy (CIMT) and found the outcomes were comparable with using CIMT alone (Simon-Martinez, Mailleux, Hoskens, et al., 2020). They further reported that adding observational learning to CIMT led to faster task performance, i.e., shortened movement time (Simon-Martinez, Mailleux, Jaspers, et al., 2020).

One study used trial and error in a laboratory and involved practicing discrete arm movements using a computer-based task, where children had to move a lever to replicate a movement trajectory displayed on a screen and receive feedback on their errors (Burtner et al., 2014). They found that trial and error led to improved motor performance in children with CP but with lower accuracy and consistency compared to children who are typically developing. In contrast, a school-based experiment compared errorless learning with an error-strewn approach when practicing an aiming task (van Abswoude et al., 2015). They reported that committing fewer errors during practice was associated with greater performance improvements and greater automaticity of movement. Thus, they suggested that minimising errors could be a suitable strategy for children with CP. Finally, a laboratory study evaluated the effects of movement imagery training followed by physical practice among adolescents with CP who were learning an aiming task (Cabral-Sequeira et al., 2016). Compared with the control group who played a computer game, those who engaged in movement imagery displayed greater improvements in movement performance, which were stable at retention.

2.4.2 Intellectual disability (ID)

Among children with ID, dual-task learning (n = 2), errorless learning (n = 2), and movement imagery (n = 1) were examined. Two studies by a group of researchers utilised a dual-task strategy to improve postural balance in school-based settings. In both studies, both tasks were motor in nature, such as combining a balancing task (i.e., sitting on an exercise ball) and a reaching task (Mikolajczyk & Jankowicz-Szymanska, 2015a) and combining balance exercises with activities of daily living (Mikolajczyk & Jankowicz-Szymanska,

2015b). Both studies reported benefits to postural stability following dual-task interventions. Two studies by another group of researchers utilised errorless learning in school-based programs that targeted the object control skills of children with ID. The first study focused on the overhand throwing task, and they found that children with ID improved their movement skills while displaying the ability to multitask (Capio et al., 2013). A second study applied errorless learning across a range of object control skills, such as catching and kicking, and reported significant and large improvements among the participants (Capio & Eguia, 2021). Finally, a school-based study tested movement imagery among adolescents with ID who were learning basketball free throws (Hemayattalab & Movahedi, 2010). They found that all practice conditions, whether physical practice, movement imagery, or combinations of physical practice and movement imagery in sequence led to significant improvements among the adolescents with ID. However, the greatest gains were found when movement imagery was followed by physical practice.

2.4.3 Autism spectrum disorder (ASD)

In children with ASD, the motor learning strategies that have been examined include observational learning (n = 3) and analogy learning (n = 1). Two of the studies that used observational learning were laboratory-based, involved throwing tasks, and facilitated observation through videos (Heidari et al., 2021; Saber Sotoodeh & Taheri-Torbati, 2021). A third study compared the effects of video and live observations, also in a throwing task (Taheri-Torbati & Sotoodeh, 2019). All the studies reported that video observation was beneficial for children with ASD, but only one study utilised a control group (Heidari et al., 2021). No difference was found in the beneficial effects of video and live observation (Taheri-Torbati & Sotoodeh, 2019), but a point-light display (i.e., irrelevant information was removed) was more advantageous than video observation (Saber Sotoodeh & Taheri-Torbati, 2021) among both children with ASD and children with typical development.

One school-based study facilitated the practice of a basketball shooting task using verbal (i.e., “Shoot the ball as if you are trying to put cookies into a cookie jar on a high shelf”) and visual (i.e., picture of a child putting cookies into a cookie jar) analogies, which were compared with explicit biomechanical instructions and no-instruction control (Tse & Masters, 2019). Movement performance improved for all children except those in the no-instruction control group. Only those who were given visual analogy displayed stable performance one day after learning (i.e., retention) and when the hoop distance was increased (i.e., transfer).

2.4.4 Developmental coordination disorder (DCD)

The motor learning strategies that have been examined in children with DCD include dual-task learning (n = 2), discovery learning (n = 1), observational learning (n = 1), and movement imagery (n = 1). Two studies examined the use of dual-task learning. One study was school-based and utilised a combination of motor and cognitive auditory tasks (Inacio et al., 2023). Children with DCD and a comparison group of typically developing children practiced stepping with a concurrent auditory Stroop task and displayed improvements in step timing following the training period, which were retained five weeks later. The other study was laboratory-based and utilised a combination of motor and cognitive tasks (Jahanbakhsh et al., 2020). The dual-task training group practiced balance activities while engaging in cognitive tasks such as counting and memory games. Compared to groups that performed only the balance activities (i.e., single task) and that did not receive any training (i.e., control), the dual-task group displayed greater improvements in both static and dynamic balance.

The study that used discovery learning was conducted in a clinical setting facilitated by occupational therapists, where discovery learning was used in the context of the Cognitive Orientation to Occupational Performance (COOP) (Izadi-Najafabadi, Gunton, et al., 2022).

The participants included children with DCD and those with cooccurring ADHD. Compared with participants in the waitlist control group, those who participated in CO-OP displayed greater improvements in self-perceived and therapist-rated motor performance. Improvements in neural connectivity, however, were not observed among those who were concurrently diagnosed with ADHD. Finally, one study investigated the efficacy of a home-based and parent-led intervention that combined observational learning and movement imagery for learning daily movement tasks (Scott et al., 2023). Compared with those in the control group, those in the training group displayed greater improvements in the shoelace tying and cup stacking tasks, but not in the shirt buttoning and cutlery tasks. In particular, the study recommended that combined observational learning and movement imagery is useful for movement tasks that are completely novel for children.

2.4.5 Down Syndrome

One study investigated the effects of a dual-task balance training delivered by physiotherapists for children with DS (Büyükçelik et al., 2023). Postural and balance motor tasks (e.g., sit to stand, standing on one leg) were combined with cognitive tasks (e.g., naming animals, identifying colours). When compared to a control group, the dual-task group displayed significantly better balance and functional performance following the training period.

The summary in Table 2.2 shows that the use of motor learning strategies has been most examined in children with CP (n=11). The other NDDs for which motor learning strategies had been applied included ID (n = 5), DCD (n = 4), ASD (n = 4), ADHD (n = 1) and Down syndrome (DS, n = 1). The most commonly used motor learning strategies were dual-task (n = 9) and observational learning (n = 7). Fewer studies have examined errorless learning (n = 3) and movement imagery (n = 3). Only one study each used analogy learning, discovery learning, and trial and error.

Table 2.2

Number of studies found for each motor learning strategy and diagnostic group

Strategy	Diagnostic Group					
	CP	**ASD**	**ADHD**	**DCD**	**ID**	**DS**
Analogy		1				
Discovery			1*	1*		
Dual-task	4			2	2	1
Errorless	1				2	
Observational	4	3		1**		
Trial and error	1					
Movement Imagery	1			1**	1	
Total	11	4	1	4	5	1

Note: * One study in the corresponding motor learning strategy involved two diagnostic groups, and ** one study involved two motor learning strategies; hence, the overall total score per diagnostic group was greater than the actual total score of the reviewed studies. Diagnostic groups: cerebral palsy (CP), autism spectrum disorder (ASD), attention deficit–hyperactivity disorder (ADHD), developmental coordination disorder (DCD), intellectual disability (ID), and Down syndrome (DS).

2.5 Discussion

In this scoping review, we aimed to contribute to translating research to practice by mapping the research that examined motor learning strategies as a means to acquire motor skills among specific diagnostic groups of NDDs. Guided by a framework for neurorehabilitation (Kleynen et al., 2020) and focused on functional motor skills rather than simple tasks such as pressing of buttons or following sequences, we identified three main findings. First, most evidence of motor learning strategies has been generated for children with CP. Among the diagnoses under the umbrella of NDDs (American Psychiatric Association, 2022), CP might be considered to have primarily motor impairments. The updated definition of CP specifies that it is characterised by impaired development of movement and posture (Sadowska et al., 2020). While impairments in other domains (e.g.,

socioemotional, cognitive) may also be apparent in children with CP, the primacy of motor impairments probably generates strong interest among motor learning researchers. Research involving other NDDs is also emerging, including for those where the primary issues are not motor impairments – i.e., ID, ASD. Second, most studies delivered interventions in real-life settings over several weeks (as opposed to one to two days in the laboratory), which could lead to programs that could be implemented in practice. However, many interventions were still delivered by researchers, which suggests that the transfer of knowledge to practitioners (e.g., occupational therapists, physiotherapists, and trainers) could still be limited. Finally, while majority of the studies used control groups, fewer than a quarter of them were randomised controlled trials. This suggests that more robust evidence is needed to support the use of motor learning strategies in facilitating motor skill acquisition among children with NDDs.

In translating motor learning research to practice, we focused on children with NDDs to address their need for effective management of impairments in motor control and coordination. Research involving children with NDDs has focused on those with CP who are typically referred to physiotherapy for early intervention, where motor learning strategies are considered of great importance (Gordon & Magill, 2016). Our findings suggest that research on motor learning strategies for children with CP tends to veer toward practice contexts with clinical interventions delivered by therapists to address daily activities such as balance and hand function. While the reviewed studies generally show that dual-task strategy is suitable for children with CP, the learner's characteristics and the complexity of the tasks at hand should be considered. The concept of dual-task strategy entails the concurrent execution of two distinct tasks – either cognitive or motor – each characterised by varying degrees of difficulty (Kleynen et al., 2020). In children with CP, the level of challenge associated with motor tasks that are deemed automatic, such as walking, could vary according to their tone

(i.e., spasticity) or affectation (e.g., diplegia, hemiplegia). Introducing an additional cognitive or motor load may pose an excessive challenge, potentially resulting in a decline in their overall task performance (Roostaei et al., 2021).

Therapists and trainers of children with CP likely integrate observational learning into practice by demonstrating the tasks themselves. Our reviewed studies suggest observational learning could be integrated into therapist-led training programs in a clinic, via telehealth, or in a day camp model in the form of video demonstrations. Together with emerging technologies, we might consider that observational learning by children could be facilitated by video games or virtual reality. For instance, virtual reality has been seen as a promising platform for improving the balance and motor skills of children and adolescents with CP (Ravi et al., 2017), but motor learning principles need to be integrated better when such systems are used (Demers et al., 2021). Future studies could explore digital technology-enabled observational learning, especially given the recent exponential growth in generative artificial intelligence.

While the definition of ID does not specify motor impairments and describes it to be characterised by impairments in functioning and adaptive behaviours (Schalock et al., 2021), it has been shown that the severity of ID is positively associated with problems in manual dexterity and balancing skills (Vuijk et al., 2010). It is promising that researchers have explored the use of motor learning strategies for children with ID. Errorless motor learning was proposed as a suitable strategy for children with ID because the relative lack of reliance on cognitive resources associated with this approach accommodates the cognitive impairments of children with ID (Capio et al., 2013). In contrast, a dual-task strategy that typically imposes concurrent cognitive and motor tasks (Kleynen et al., 2020) could exacerbate the difficulties that children with ID experience associated with their cognitive deficits. However, the studies that tested a dual-task strategy for children with ID used two

concurrent motor tasks (Mikolajczyk & Jankowicz-Szymanska, 2015a, 2015b). As this is not consistent with how dual-task strategy is typically delivered (i.e., concurrent motor and cognitive tasks), there does not seem to be support for the use of dual-task strategy for children with ID. Considering the impairments of children with ID, a relatively lower reliance on cognitive resources such as that in errorless motor learning could be considered by practitioners.

Children with DCD typically display impaired execution of coordinated motor actions that lead to slow, clumsy, or inaccurate movements (Biotteau et al., 2020), and so would benefit from effective motor learning strategies. A DCD diagnosis tends to be established when children reach school age (Vens et al., 2022), as the impairments affect school functions such as handwriting and performance in physical education. Hence, opportunities for early intervention tend to be rare, and interventions when they are provided tend to be focused on functional motor skills associated with school activities. As DCD impairments are not associated with cognitive deficits, motor learning strategies that require cognitive resources could be suitable in this condition. For instance, dual-task strategy appears promising, especially when the secondary task is designed to reinforce the primary motor task (Inacio et al., 2023; Jahanbakhsh et al., 2020). They can also engage in discovery learning in the context of CO-OP (Izadi-Najafabadi, Gunton, et al., 2022), and in motor imagery combined with observational learning (Scott et al., 2023). These motor learning strategies appear to be important for learning complex motor tasks that involve multiple discrete movements performed in a sequence, which are particularly difficult for children with DCD (Cantin et al., 2014). While further studies are needed to establish robust evidence, the identified strategies appear to match the characteristics and needs of children with DCD.

ASD is characterised by social communication impairments, restricted interests, and a tendency for repetitive behaviours (Hodges et al., 2020). Despite motor impairments not

being a defining factor in ASD, there has been growing evidence that motor deficits are, in fact, pervasive in children with ASD (Bhat, 2021; Odeh et al., 2022). As such, research on motor learning strategies for children with ASD is warranted. Thus far, only observational learning (Heidari et al., 2021; Saber Sotoodeh & Taheri-Torbati, 2021; Taheri-Torbati & Sotoodeh, 2019; Tse & Masters, 2019) and visual analogy (Tse & Masters, 2019) have been explored. However, these motor learning strategies are both heavily reliant on processing of visual input and could be challenging for children with ASD who often have impaired visuospatial abilities (Nejati et al., 2021). Given that all the reviewed studies were laboratory-based, there is currently limited evidence to identify practicable motor learning strategies for children with ASD.

2.5.1 Recommendations for future research

Our review shows that the majority (72%) of the studies evaluated motor learning strategies in the context of clinic or school interventions that were delivered over several weeks. This suggests that most of the study designs enable the translation of research to practice, where motor learning strategies may be integrated into functional training programs. Only the studies involving children with ASD were limited to laboratory contexts, indicating a relatively bigger gap between research findings and practice. In contrast, previous reviews of motor learning research have shown that studies have been mostly in laboratory settings that involve short practice (e.g., one day) of simple tasks (e.g., Eguia et al., 2023; van Abswoude et al., 2021). However, our current review also shows that despite the contexts being mostly in practice settings, less than half (48%) of the interventions were delivered by therapists. Except for the case of children with CP, the interventions in our reviewed studies were mostly researcher-led. This may suggest an insufficient alignment between research designs and practitioners' needs which often leads to passive dissemination of evidence that is known to be ineffective (Shato et al., 2024). We therefore recommend that future studies

should aim to engage practitioners in designing, delivering, and evaluating motor learning strategies in children with NDDs.

While RCTs are considered the highest level of evidence of intervention effectiveness (Wallace et al., 2022), our review found only six RCTs most of which were conducted in children with CP. With growing evidence of sensorimotor issues in ID and ASD (Bhat, 2021; Odeh et al., 2022; Vuijk et al., 2010) and the deficits in complex movement planning in DCD (Cantin et al., 2014), RCTs are critically needed to identify suitable and effective motor learning strategies that will address the needs of children with these NDDs. Moreover, to facilitate uptake in practice, implementation science studies are also recommended to understand how practitioners can embed effective motor learning strategies into their real-world clinical contexts (Moir, 2018).

2.5.2 Limitations

In searching for studies that specifically applied motor learning strategies in groups of children with NDD, we were guided by the neurorehabilitation framework for motor learning proposed by Kleynen and colleagues (2020). However, we note that there may be other motor learning strategies that were left out of our review by following the terminology of our adopted framework. For example, studies have used FOA strategies for children with NDDs, but FOA is considered a means of delivering the elements of instruction and feedback rather than a specific motor learning strategy, as will be reviewed in the next chapter. Considering the recently proposed Optimising Performance through Intrinsic Motivation and Attention for Learning (OPTIMAL) theory (Wulf & Lewthwaite, 2016, 2021), which suggests that an external FOA contributes to the effectiveness, efficiency, and automaticity of movement, a further synthesis of evidence related to motor learning strategies should include research on the use of FOA. Given our purpose, we adopted a scoping review protocol that does not include a quality assessment of the reviewed studies. Nevertheless, we noted whether the

mapped studies in this review adopted elements of robust study designs such as the use of control groups, the nature of the interventions (i.e., clinical, school, laboratory), and testing procedures. Moving forward, a systematic review and meta-analysis may be considered to evaluate publication bias and assess the quality of the evidence.

2.6 Conclusion

In this scoping review, we identified that research on motor learning strategies for children with NDDs have so far focused on CP, with studies that include RCTs and delivered clinical interventions that addressed upper limb functions, balance, and locomotion. Practitioners may consider the use of dual-task strategies and observational learning for children with CP. There is emerging interest in applying motor learning strategies for children with ID, ASD and DCD but further research is needed to generate more robust evidence. Combined with careful consideration of individual learner characteristics, practitioners can explore motor learning strategies to address sensorimotor issues of children with NDDs. Future studies could also strengthen the involvement of practitioners and generate knowledge to support successful integration of motor learning strategies in real-life programs.

2.7 Relevance to Thesis

Based on the motor learning framework for neurorehabilitation as proposed by Kleynen and colleagues (2020), the synthesised evidence in this chapter focused on motor learning strategies. This chapter addresses the gap arising from the lack of consolidated and comprehensive evidence regarding motor learning strategies used for children to acquire functional motor skills. The mapped evidence in this chapter offers paediatric physiotherapists a complete, yet concise and clinically relevant overview of motor learning

strategies to inform their practice. The information synthesised here also informed the development and content of the knowledge translation activity that was implemented in this thesis and presented in Chapter 6. A parallel scoping review is presented in Chapter 3, which focuses on FOA as a means to deliver the motor learning elements of instructions and feedback in children, with reference to the motor learning framework for rehabilitation (Kleynen et al., 2020). This progression from a broad synthesis to a focused exploration of the framework components reflects the overarching aim of this thesis: to support evidence-based applications of motor learning principles in paediatric rehabilitation, with particular attention to FOA as a promising motor learning strategy.

Chapter 3: Attentional Focus Scoping Review[2]

Attentional Focus Strategies for Promoting Children's Motor Learning: A Scoping Review with a Learner-Task-Environment Framework

3.1 Commentary

This chapter presents a scoping review that maps and synthesises current evidence on FOA strategies used to facilitate motor learning in children. The previous review highlighted a lack of research on motor learning strategies in children with NDDs and attempted to systematically summarise the available research on motor learning strategies within this population. However, the existing motor learning framework does not identify elements such as instructions and feedback as specific motor learning strategies. Since FOA strategies are inherently connected to these instructional components, they could not be fully captured in the initial review, thus this additional review. Using a learner-task-environment framework, this review provides a detailed and comprehensive synthesis of the existing research, highlighting the range of learner characteristics, types of motor tasks, and settings in which FOA strategies have been studied and applied, thereby supporting the translation of these findings into clinical paediatric physiotherapy practice. This review highlights the limited research involving children with NDDs and clinical settings, pointing to areas requiring further focused investigation. As the second study in this thesis, this scoping review builds on the synthesis presented in Chapter 2 and contributes to fulfilling the overarching research

[2] This chapter is based on a manuscript that has been published: Eguia, K.F., Ng, S,S.M., & Wong, T.W.L. (2023). Attentional focus strategies for promoting children's motor learning: A scoping review with a learner-task-environment framework. *Perceptual and Motor Skills, 130*(6), 2700-2722.

objectives by bridging gaps in synthesised knowledge about FOA strategies relevant to paediatric motor learning.

3.2 Introduction

Instructions form a critical component of movement skill acquisition and may be presented through demonstrations, verbal instructions, or tactile cues (Palisano et al., 2018). Access to feedback also contributes to the motor learning process by providing learners with information that can improve future performance (Schmidt & Lee, 2020). Motor learning strategies related to providing instructions and feedback include directing the learner's focus of attention (FOA) externally or internally during practice (Wulf, Chiviacowsky, et al., 2010). An external FOA directs the learner's attention to some end-product of the action or to the external effects of one's movement on an object or to the environment. An internal FOA directs attention to the learner's own body movements or to how these movements are being produced while performing the task (Schmidt & Lee, 2020). For example, an external FOA instruction for throwing would be, "*Hit the center of the target*," while an internal FOA instruction for the same task would be, "*Start the throw with a wind-up where your hand is behind your head*."

Strategies that direct FOA are founded on McNevin et al.'s (2003) Constrained Action Hypothesis (CAH), which proposes that an external focus promotes automatic control of movement, while an internal focus leads to a heightened consciousness that can disrupt automatic control of movement. Wulf and Lewthwaite (2016) further proposed that an external focus directs attention to an actual goal (i.e., the outcome or result), explaining that emphasis on the end result enhances the learner's satisfaction and confidence in their ability to achieve the desired goals. An extension of the CAH is referred to as optimising performance through intrinsic motivation and attention for learning (OPTIMAL) theory.

Lewthwaite and Wulf (2017) further elaborated that an external FOA enables skill learning through mechanisms that involve learning and memory associated with enhanced expectancies.

In other research, strategies such as implicit motor learning, quiet eye, mindfulness training, and self-talk have also been related to FOA (Wulf & Lewthwaite, 2016). For instance, a quiet eye, defined as visual fixation lasting at least 100 ms on a specific target just before movement (Vickers, 2009), is believed to promote an external FOA through a visual focus on a relevant aspect of the task (Vine et al., 2013). Evidence of enhanced performance associated with the quiet eye has grown over recent years (e.g., Miles et al., 2015).

Experimental studies with young adults have shown that adopting an external FOA is more advantageous than adopting an internal FOA in functions that include balance, movement accuracy and form and to enhance muscular activity and force production (Lohse, 2012). Supportive studies for external FOA have included both novice and skilled performers of tasks such as long jumping and dynamic ski simulation. A recent meta-analysis showed that external focus tends to be more effective than internal FOA for the performance, retention, and transfer of movement skills across children, adults, and older adults (Chua et al., 2021). Such findings were based on both behavioural and electromyogram outcomes, which were consistent regardless of age, health status, or skill level. Specific to older adults, a review by Ziv and Lidor (2015) concluded that external focus instructions were more advantageous than internal focus instructions. Studies in controlled experimental settings have also shown similar advantages of external focus instructions on older adults' balance, gait, and fall-related psychological outcomes (e.g., Law & Wong, 2021; Mak et al., 2020). The promotion of automatic control through external focus appears sensible for older adults because typical cognitive decline in late adulthood leads to limitations in cognitive capacity. We might expect similar cognitive limitations among young children who have yet to reach

full cognitive development. Indeed, experimental studies with young children have also shown advantages of external focus instructions in motor skill acquisition (e.g., Brocken et al., 2016; van Cappellen – van Maldegem et al., 2018).

Of note, however, a recent review of children's overall motor learning strategies found inconclusive evidence with regard to FOA instructions, with a number of studies showing no differences in the effects of internal and external FOA on learning and performance (van Abswoude et al., 2021). On the other hand, another review by van der Veer et al. (2022) examined the effectiveness of FOA in relation to the frequency, timing, and form (i.e., visual or auditory) of instructions and feedback and found moderate evidence that self-controlled external FOA feedback during practice was most effective for children's retention of gross motor tasks. In another review, Simpson and colleagues (2021), guided by the OPTIMAL theory, examined the impact of FOA together with motivational mechanisms on children's fundamental movement skills and found emerging evidence that external FOA is particularly beneficial for object control skills, with the effects moderated by the children's stage of development. Collectively, these past reviews suggest that there is still evolving evidence related to FOA instructions and feedback for children's motor learning, with information to date still to be synthesised.

3.2.1 Current Review

Gordon and Magill (2016) described an important framework for understanding how children learn movement skills. This framework particularly attends to the characteristics of (a) the learner, (b) the task, and (c) the environmental context in which the task is to be performed. This framework is consistent with a developmental perspective in which individual characteristics of a child (e.g., age, disability) transact with the demands of learning a specific movement task in the environmental context (e.g., instructional cue, practice opportunities) (Goodway et al., 2021). Instructions can be catered to a specific

learner's needs for information about the task and the prevailing environment, while feedback facilitates improved performance and motivation. From a developmental perspective, we believe there is value in examining FOA instructions and feedback in children by using the learner-task-environment framework. While synthesised evidence to date (i.e., Simpson et al., 2021; van der Veer et al., 2022) suggests that external FOA instructions and feedback may be beneficial to children (i.e., learners) who are learning gross motor and fundamental movement skills, recent reviews have been concerned with quantifying the effectiveness of FOA strategies; however, because they have not mapped data regarding FOA in relation to learner characteristics, movement tasks, and learning environments, there is not yet a full understanding of the conditions in which instructions and feedback can be enhanced by directing FOA (externally or internally). Such understanding is crucial if instructional strategies are to be deployed in a developmentally appropriate manner in varied applied contexts.

Evidence of how learner characteristics (e.g., developmental stage, disability), a range of suitable tasks (e.g., complexity, novelty), and environmental settings (e.g., school, clinic) affect the application of FOA instructions and feedback has yet to be synthesised. For instance, childhood is further divided into developmental phases during which learning processes vary with children's cognitive development (Donnelly et al., 2017). In early childhood (i.e., 5-10 years of age), sensory and motor development are accelerated, while logic becomes prominent at approximately 10 years of age (Piaget, 1963). Thus, the use and effects of FOA instructions and feedback are apt to be different at the varied developmental stages of learners. Learners' environments may also vary as in, for example, whether learning settings are clinical or non-clinical. Clarifying the learner-task-environment aspects of using FOA strategies is crucial in designing future learning paradigms that can integrate

developmentally appropriate instructions and feedback for specific groups of children, tasks, and environments.

We sought to perform a scoping review that would be appropriate for exploring the nature and diversity of current evidence (Tricco et al., 2018). Scoping reviews have been considered suitable for mapping the characteristics of prior research, as scoping reviews strive to identify and analyse knowledge gaps and inform future work (Peters et al., 2021). To check whether a scoping review that met our purpose was currently being conducted, we conducted a preliminary search of the Cochrane Database of Systematic Reviews (sources including PubMed, Embase, CINAHL, ICTRP), Prospective Register of Systematic Reviews (PROSPERO), and the Joanna Briggs Institute (JBI) Evidence Synthesis. Since we found no current systematic reviews or scoping reviews that matched our research aims to be ongoing, we undertook the present review.

3.3 Methods

We followed the framework for scoping reviews originally proposed by Arksey and O'Malley (2005) and used the enhanced protocol endorsed by JBI for guidance (Peters et al., 2021). The first five steps of the framework consisted of (a) identifying the research question, (b) identifying relevant studies, (c) selecting the study, (d) charting the data, and (e) collating, summarising and reporting the results. We did not deem the sixth step (i.e., consultation of experts) to be necessary. As scoping reviews are not designed to assess the quality of evidence (Munn et al., 2018; Pollock et al., 2021), we did not engage in a critical appraisal or assessment of the risk of bias in the studies we examined.

3.3.1 Identifying the Research Question

Using the Population, Concept, and Context (PCC) format for scoping reviews (Kao et al., 2017), we posed the following review question: *What are the developmental*

characteristics of children (population; aged 3-17 years), movement tasks, and settings (context) where attentional focus strategies have been examined (concept)? The specific objectives of this review are further defined below:

1. To describe the developmental characteristics of children for whom FOA instructions and/or feedback had been applied and examined.
2. To identify the breadth of movement tasks that were learned by children with FOA instructions and feedback.
3. To map the settings in which children learned movement tasks with FOA strategies.

3.3.2 Identifying and Selecting Studies

We aimed to locate published studies that included mixed-methods (quantitative and qualitative data) designs. We conducted the search in March 2023 and applied no date of publication restrictions on the papers selected. We searched the following electronic databases: PubMed, Scopus, EBSCO, ProQuest, JSTOR, and Web of Science. We used the Boolean operators "AND", "OR", and "*" with multiple combinations of keywords. Based on the PCC elements outlined in the review question, we constructed the following search phrase: ("child*" OR "early child*" OR "young child*" OR "adolescen*" OR youth) AND (((("motor" OR "movement") AND ("skill" OR "task" OR "development")) OR "skill acquisition" OR "locomotor" OR "manipulative" OR "stability") AND (("focus" AND ("attention*" OR "external" OR "internal" OR "mixed")) AND ("instruction" OR "feedback"). We reviewed the reference lists of the selected papers to find any further published studies that might meet selection criteria but found no additional studies in this way.

Two reviewers selected studies independently; their selection results were compared, and any inconsistency was resolved through discussion and consensus. Studies were selected

if they met the following criteria: (a) utilised attentional focus instruction and/or feedback, (b) participants were aged 3 to 17 years, (c) involved learning or re-learning movement tasks, (d) reported on original research (i.e., not a review), and (e) written in English. Studies were excluded when they did not include a learning phase and/or involved only movement performance following instructions.

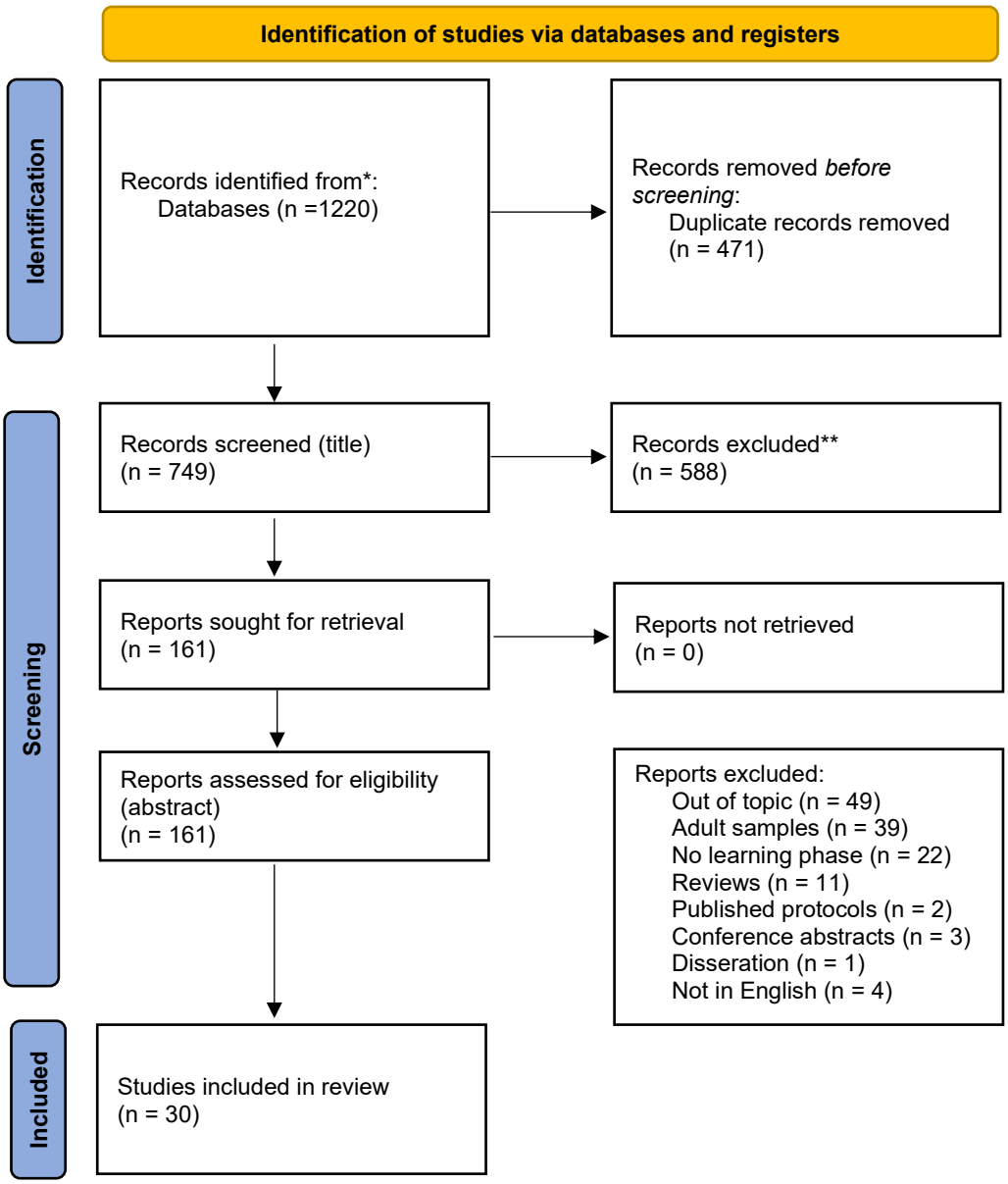


Figure 3.1. PRISMA flow diagram (Page et al, 2021) for article selection.

Our electronic search initially yielded 1,220 articles that were uploaded into Zotero 6.0.15 (Digital Scholar, VA, USA). The study selection process followed the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021) and the PRISMA extension for scoping reviews (PRISMA-ScR; Tricco et al., 2018), as shown in Figure 3.1. After removal of duplicates, the titles were screened, and those that were irrelevant to the review question were excluded, reducing the number of studies to 161 articles for the next stage (review of abstracts). We excluded articles in which participants did not include children, tasks did not focus on learning movement skills (e.g., language acquisition, reading skills), and observation of movement performance was limited to following instructions at a single point in time (i.e., no learning phase). We also removed published reviews and study protocols, conference abstracts, and dissertations. Our final selections totalled 30 articles for this current review.

3.3.3 Charting the Data

Following the JBI protocol for scoping reviews (Peters et al., 2021), we charted the following data: author(s), title, year of publication, study design, aim(s) of the study, participants, attentional focus strategies used (including detailed descriptions of instructions and/or feedback), settings, measures and outcomes, and main findings. Data extraction was performed by one reviewer and verified by a second reviewer for accuracy. The results are summarised and reported in the next section.

3.4 Results

All the studies we reviewed used either an experimental or a quasi-experimental research design. The detailed information from each of the studies is summarised in Table 3.1, while a descriptive summary of the studies, according to the learner-task-environment framework, is presented in Table 3.2.

Table 3.1

Descriptive summary of the studies according to the learner-task-environment framework

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2016	Agar et al.	To examine if skill learning was differentially affected by external or internal instructions and feedback; to determine whether there is a difference between younger and older children.	5 - 8 years old; 9-12 years old Typically developing N = 48 (no information on sex and age distribution)	Shuffleboard task using a stick to shoot pucks along a 5-ft-wide lane toward a target placed 10 ft from the starting line	Laboratory	General instructions: The goal is to make the puck stop in the center of the target to score as many points as possible. The closer to the center of the target, the more points you get. Remember to keep your body behind the line. In order to score, the puck must stop on the target. External focus instructions were directed at the target, puck, shuffleboard stick, and the puck's course. Internal focus instructions were focused on body position, movements of the shoulder, stepping of the foot, pushing of the arm, and position of fingers or grip (no verbatim report). External focus feedback: ● The stick needs to push the puck faster. ● The stick needs to push the puck slower. Internal focus feedback: ● Step harder ● Swing your arm faster ● Step and push your arm toward the center	All groups improved their task performance regardless of attentional focus. Older children performed significantly better than the younger children.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2021	Asadi et al.	To investigate performance following instructions that directed an individual to focus internally or externally during the viewing of a model.	7 - 10 years old Typically developing N = 24 (all male)	Overhand throwing of a tennis ball towards a circular target on the wall from a distance of 3 m.	Laboratory	External focus instruction: focus on the ball and the path of the ball to the target. Internal focus instruction: focus on the body movements of the observed model.	External focus on a model leads to greater amounts of improvement in the overarm throw in children. Both external and internal focus groups showed a significant increase in quiet eye duration from pretest to posttest.
2021	Bahmani et al.	To investigate whether children's motor imagery dominance modulated the relationship between attentional focus and motor learning of a tossing task.	9 - 11 years old Typically developing N = 138 (all male)	Overarm toss of a ball towards a target on the wall using the non-dominant hand	Laboratory	External focus instruction: focus on the ball. Internal focus instruction: to focus on the throwing arm.	External focus instructions led to superior learning of the tossing task compared to internal focus instructions.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2016	Brocken et al.	To investigate the relative effectiveness of different attentional focus instructions on motor learning in primary school children; to explore whether the effect of attentional focus was influenced by age and verbal working memory capacity.	8 - 12 years old Typically developing N = 60 (26 male, 24 female)	Golf putting task	Laboratory	General instructions: demonstration of the workings of a pendulum (i.e., by showing a cord with a small object attached to it), and for the children to move like a pendulum. External focus instructions: ● Move the golf club like a pendulum Internal focus instructions: ● Move your arms like a pendulum	External focus instructions led to greater improvements in golf putting accuracy compared to internal focus instructions. Age and verbal working memory capacity did not influence improvements in the motor task.
2013	Chiviacowsky et al.	To examine whether the learning benefits of an external focus of attention relative to an internal focus would be found in children with intellectual disabilities (ID).	10 - 14 years old Children with mild ID N = 24 (14 male, 10 female)	Throwing bean bags to a vertical target with the dominant hand.	School	External focus instruction: direct their attention to the movement of the beanbag. Internal focus instruction: direct their attention to the movement of their hand (no verbatim report).	The external focus group demonstrated more effective learning than the internal focus group, as evidenced by more accurate tosses on the transfer test.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2014	Chow et al.	To determine the impact of attentional focus on standing board jump performance in children.	9 - 10 years old Typically developing N = 36 (all male)	Long jump task on a standing board	School	External focus instructions: ● Look at the target line on the mat as you jump ● Try and reach out and point to the wall when you jump ● Launch yourself into the air as you jump ● Pay attention to the spot on the mat where you are landing Internal focus instructions: ● Pay attention to how your legs and feet push off the ground when you jump ● Pay attention to how your arms swing forward in the air when you jump ● Lift your upper body and shoulders into the air as you jump ● Pay attention to the position of your feet on the mat when you are landing Control group instructions: ● Try your best when you jump ● Do not forget to try your hardest ● Remember that this is a test of your strength ● You should try to be the best in your class	External focus instructions were more effective in assisting learners to improve jump distances.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2008	Emanuel et al.	To investigate whether the effect of attention focus varies between children and adults.	8 - 9 years old Typically developing N = 34 (14 male, 20 female) 22 - 36 years old Typically developed N = 32 (16 male, 16 female)	Darts throwing towards a static target	Laboratory	External focus instructions: ● Hold the dart with your right hand. ● Roll the dart and concentrate on its weight and position. ● Pay attention that the dart is parallel to the ground. ● Bring the dart to eye level and feel the dart directly in front of you on your right. ● Look at the target center carefully for few seconds. ● Bring the dart toward your right ear and throw the dart. ● While throwing the dart, concentrate on its flight directly toward the target. ● After every 10 trials: Focus on the dart (how it feels, its weight and position) and look at the target. Internal focus instructions: ● On your right hand, place your thumb next to your middle finger and index finger ● Flex your elbow until your hand reaches your eye height ● Before throwing, concentrate on your finger motion and the correct position. ● Pay attention to your grasp and to the flexing and extending of your elbow ● Bring your hand backward, approximately to your ear, and while	No difference in darts throwing improvements between external and internal focus instruction for children. Benefits associated with external focus instructions were found only in adults.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
						throwing extend all of your fingers together so that, at the end of the throw, your hand is directed forward and your elbow is fully straightened ● After every 10 trials: Focus on how your arm and hand (elbow, wrist, and fingers) feel before and during the throw	
2016	Flôres et al.	To investigate the influence of focus of attention in learning a balance task among children.	6 - 10 years old Typically developing N = 74 (36 male, 38 female)	Riding a Pedalo without support along a distance of 7 m. When learners stand on the Pedalo, they can pedal up or down to rotate the wheels and move forward or backward.	School	Proximal external focus instruction: focus on pushing the platforms forward. Distal external focus instruction: focus on an orange marker located beyond the finish line. Internal focus instruction: focus on pushing their feet forward (no verbatim report).	Directing the focus of attention externally, at a greater distance from the body, can enhance learning of a balance task among boys.
2015	Flôres et al.	To investigate the influence of focus of attention in learning of boys and girls, in a balance task.	6 - 10 years old Typically developing N = 74 (36 male, 38 female)	Riding a Pedalo, without support.	School	Proximal external focus instruction: focus on pushing the platforms forward. Distal external focus instruction: focus on an orange marker located beyond the finish line. Control: no specific instruction related to focus (no verbatim report).	External focus at a greater distance from the body can enhance learning of a balancing task among boys.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2020	Ghorbani et al.	To examine the effects of adopting an external focus of attention on motor learning among girls with attention deficit and hyperactive disorder (ADHD)	7 years old; 11 years old Children with ADHD N = 48 (all female)	Performing a yoga pose (Warrior III pose) which consists of static balance on the right leg while lifting the left leg off the ground and keeping the arms over the head.	School	External focus instruction: Focus on the yellow marker (placed two meters ahead on the ground). Internal focus instruction: Focus on the right leg.	An external focus of attention led to longer balancing time among girls with ADHD compared to an internal focus of attention. Older children performed better than younger children in balance time.
2016	Gredin & Williams	To examine the relative effectiveness of explicit internal-oriented instructions, explicit external-oriented instructions, and unguided discovery learning on the performance, acquisition, and	9 - 10 year old Typically developing N = 37 novice soccer players (no information on sex distribution)	Kicking a stationary soccer ball over a pole barrier towards the center of a target area which was located on the floor.	School	Explicit external focus instructions: When kicking the ball, next to the side of the ball, place your non-kicking shoe. Imagine holding a shovel in your kicking shoe and sharply hit the bottom of the ball with it and, as if passing the ball to another player, try to make the ball-fly spinning backwards. Explicit internal focus instructions: When kicking the ball, place your left/right foot next to the side of the ball. Lift back the heel of your right/left foot and then quickly bring your foot forward	Internal-oriented and external-oriented explicit instructions tend to impair performances of lofted soccer kicks relative to when no explicit instructions are provided in unguided discovery.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
		learning of a motor skill among youth soccer players.				and, with the lower part of the foot, sharply kick the bottom of the ball.	Explicit internal-oriented instructions may, however, produce the largest instant acquisition effects while both explicit external-oriented instructions and unguided discovery learning seem to be more beneficial after some amount of practice.
2014	Hadler et al.	To examine the effects of instructions promoting external versus internal focus of attention on the learning of a tennis forehand stroke in children.	10 - 12 years old Typically developing N = 45 (24 male, 21 female)	Forehand tennis strokes with dominant arm	Laboratory	External focus instructions: focus on the movement of the racquet. Internal focus instructions: focus on the movement of their arm. Control: no focus instructions. External or internal focus reminders were provided after every 10th trial during the practice phase (no verbatim report).	The external focus group demonstrated greater accuracy in hitting a target relative to the two other groups in retention, and relative to the internal focus

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
							group in transfer.
2015	Jarus et al.	To determine how focus of attention influences motor learning in children with developmental coordination disorder (DCD) in comparison with typically developing children.	8 - 12 years old N = 12 Children with DCD N = 13 Typically developing No information on sex distribution	Continuous computer tracking task where a participant controlled the movement of a red ball on-screen via a joystick.	Laboratory	External focus instruction: focus on the computer screen and movements of the joystick while tracking the target. Internal focus instruction: focus on the movements of their hand, wrist and arm while performing the tracking task (no verbatim report).	External focus instructions provide advantage to typically developing children, but not to children with DCD. No differences in the effects of attentional focus during retention and transfer in children with DCD.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2021	Kok et al.	To examine the effects of explicit versus implicit instructions and feedback methods on motor learning and perceived competence of 9- to 13-year old students with special educational needs.	9 - 13 years old Children with special educational needs N = 115 (85 male, 30 female)	Balancing task that involved walking a slackline using as little support as possible.	School	External focus instructions/feedback: Focus on the red circle Pretend as if you are a big tree, which branches are waving in the wind Direct the tip of your shoe towards the red circle Pretend as if you are sitting on a high chair Internal focus instructions/feedback: Direct your eyes towards the end of the line Keep your upper body in erect position and move your hands above your shoulders Place your feet straight on the line Bend your knees slightly	Balancing skills similarly improved following practice in explicit and implicit instruction and feedback. Greater verbal working memory capacity was associated with greater improvements in balancing and perceived competence following internal focus. Verbal working memory capacity was negatively associated with improvements in balancing outcome only following external focus.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2018	Krajenbrink et al.	To examine the effects of an focus of attention on practice and learning of a motor task in typically developing children.	8 - 12 years old Typically developing N = 162 (86 male, 76 female)	Throwing task including a preliminary swing (i.e., slinger ball) towards a horizontal target	School	External focus instruction: ● Swing: Ensure the ball has a backspin while swinging ● Throwing: Ensure you let the ball go when it is directed towards the target ● Reminder: Pay attention to the ball Internal focus instruction: ● Swing: Ensure your arm turns backwards while swinging ● Throwing: Ensure you let loose when your arm is right in front of you ● Reminder: Pay attention to your arm	Attentional focus only affected practice, but not learning. An external focus of attention led to a higher throwing accuracy immediately following practice compared to an internal focus of attention. No differences in performance during retention and dual-task performance.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2022	Lola et al.	To examine the effectiveness of internal and external focus of attention in the acquisition and transfer of open perceptual motor skills.	9 - 10 years old Typically developing N = 57 (all female)	Volleyball passing towards the front	School	External focus instructions included five rules on the target and trajectory of the ball (no verbatim report). Internal focus instructions included five rules about body part in relation to movement form and outcome (no verbatim report). Control group did not participate in any practice.	Both internal and external focus groups displayed improvements in movement form and outcome of volleyball passing. External focus was more effective than internal focus in facilitating improvements. The advantages of external focus were evident in the acquisition, post-test, and transfer phases.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2021	Lola et al., 2021	To compare the effectiveness of attentional focus on learning and transfer of a throwing skill in kindergarten children.	5 - 6 years old Typically developing N = 51 (no information on sex distribution)	Throwing a beanbag towards a target on the floor (2.8m distance)	School	External focus instructions: ● Focus on the target ● Swing your body like a hammock towards the trajectory of the bean bag ● Tilt your body towards the trajectory of the bean bag ● Look carefully at the target before dropping your bean bag ● Think about the trajectory of the bean bag to reach the target ● Try to measure the distance to the target Internal focus instructions: ● When throwing the bean bag tilt your body from the back foot to the front ● Put one foot forward and the other next to it and a little further back ● Bring your hand behind your body, bend your elbow slightly ● Stretch your elbow when you throw the beanbag ● Move forward with your shoulder and open the palm as soon as your hand comes in front of you ● Follow through the movement made by the bean bag with your hand by stretching it forward	Participants improved in both movement form and outcome regardless of instruction. External focus instructions led to advantages in movement form during the transfer test.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2012	Miçooğulları et al.	To investigate the effects of different types of feedback on learning the soccer "head kick" by female adolescents.	12 - 15 years old Typically developing N = 64 total (all female)	Head kick in soccer	School	The feedback were not reported.	External focus feedback was more effective than internal focus feedback in promoting acquisition and retention of the soccer head kick skill among female adolescents.
2016	Perreault & French	To determine the effect of attentional focus instruction on motor learning in children.	9 - 11 years old Typically developing N = 42 (28 male, 28 female)	Modified basketball free throwing, with reduced distance and goal height	School	First round external focus instruction: focus on balancing the ball on their hand like a waiter balances a tray. Internal focus instruction: focus on making an L-shape with their arm and resting the ball on their finger pads. Second round external focus instruction: focus on creating backspin on the ball during release. Internal focus instruction: focus on snapping their wrist forward when releasing the ball (no verbatim report).	No differences in learning observed between external and internal focus groups on free throw performance.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2015	Perreault & French	To determine the effect of attentional focus feedback on motor learning in children.	9 - 11 years old Typically developing N = 28 (14 male, 14 female)	Modified basketball free throwing, with reduced distance and goal height	School	External focus feedback: ● Balance the ball on your hand like a waiter balances a tray. ● Focus on a spot just above the rim. ● Shoot the ball as if it is going over a volleyball net. ● Try to make the ball spin backward when you release it. Internal focus feedback: ● Make an L-shape with your arm and rest the ball on your finger pads. ● Line up your hand and eye with the basket. ● Extend your knees and arms together as you shoot the ball. ● Snap your wrist forward when releasing the ball.	External focus feedback led to better performance during practice and retention compared to internal focus feedback.
2019	Petranek et al.	To examine the type and frequency of instructions and feedback suitable for younger children performing an overhand throw.	6 - 7 years old Typically developing N = 65 (34 male, 31 female)	Overhand throwing of a plastic covered foam ball to a circular target.	School	External focus instructions: ● Make a "T," ball away from the target (ball to back wall) ● Bring the ball past your ear ● Step with your sneaker closest to the wall ● Follow through and send the ball to the target Internal Focus ● Arms out wide, side to target ● Bring your throwing hand past your ear	Internal focused groups performed significantly better than external focused groups during retention-transfer, and children who received feedback that is

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
						● Step with your opposite foot, closest to the wall ● Follow through and point your finger to the target	more frequent performed better. External-Low performed better than External-High at the end of acquisition and retention--transfer, whereas Internal-High performed better than Internal-Low throughout acquisition.
2013	Saemi et al.	To investigate if children with attention deficit hyperactivity disorder (ADHD) would show enhanced motor skill learning with external focus rather than an internal focus of attention.	8 - 11 years old Children with ADHD N = 20 (12 male, 8 female)	Throwing tennis balls with the dominant arm towards a circular target on the floor at a distance of three meters.	School	External focus instructions: Take the tennis ball with your dominant hand, and as accurately as possible throw it toward the target while concentrating on the ball, particularly the landing location of the ball. Internal focus instructions: Take the tennis ball with your dominant hand, and as accurately as possible throw it towards the target while concentrating on the motion of your hand and wrist that is throwing the ball.	External focus instructions led to more effective performance than internal focus instructions during practice and retention.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2019	Schwab et al.	To investigate the effect of internal and external focus instructions on the knuckle ball technique in soccer among adolescents.	Adolescents (age not specified) Typically developing N = 20 (all male) Adults (age not specified) Typically developed N = 36 (all male) soccer	Knuckle ball free kicking task	Laboratory	External focus instructions: ● Make sure to hit the ball just below its midline to lift the ball ● Make sure to hit the ball only very briefly ● Try to increase the speed to... km/h ● Try to reduce the ball spin to ... turns ● Focus on your primary goal, to score a goal Internal focus instructions: ● Concentrate on hitting the ball exactly with the inner side of your foot ● Stabilise your ankle and extend your toes when you hit the ball ● Try to stop your kick leg after contact with the ball ● During the shot your body should be positioned vertically above the ball ● Jump off with your support leg as soon as you hit the ball and land sideways on your shot foot	There was better performance of knuckle ball free kicking from external focus instructions compared to internal focus instructions among adults and adolescent soccer players.
2019	Stambaugh	To compare the effects of practice following internal and external focus of attention by band students.	12 year old Typically developing N = 57 (no information on sex distribution) Band students	Playing band instruments that included flute, clarinet, saxophone, woodwind, trumpet, French horn, euphonium,	School	External focus instruction: Think about the sound of your playing Internal focus instruction: Think about your fingers/hands, the ones that are moving Control instruction: Play as accurately as	No significant differences in evenness were found between conditions at acquisition and retention, nor within instrument

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
				valved brass group, and trombones.		possible and like you heard in the recording.	groups from acquisition to retention. More woodwind and valve brass students tended to play most evenly in the internal focus condition. Majority of trombone students tended to play most evenly in the external focus condition.
2017	Teixeira Da Silva et al.	To investigate the influence of attentional focus instructions on the learning of a balance task, and the learners' motivation and subjective learning experience.	9 - 10 years old Typically developing N = 38 (all female)	Performing a ballet pirouette which consists of a complete rotation of the body around the longitudinal axis on one foot. The goal of the task was to rotate as far as possible.	Dance school	External focus instruction: participants were asked to focus on a spotting point on the wall in front of them for as long as possible (no verbatim report). Internal focus instruction: participants were asked to focus on the initial position of their head relative to the wall in front of them and on keeping it in that position for as long as possible (no verbatim report).	External, relative to internal, focus instructions enhanced the students' learning of the pirouette, their perceived competence, and satisfaction with their performance.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2019	Tse	To examine whether an external focus of attention benefits the motor learning of children with autism spectrum disorder.	9 – 12 years old Children with autism N = 65 (48 male, 17 female)	Throwing beanbags to hit the center of a vertical target board.	Laboratory	External focus instructions: ● Look at the target attentively for a few seconds. ● While throwing the beanbag, concentrate on its flight directly toward the target. Internal focus instructions: ● Before throwing, concentrate on your arm position. Also, pay attention to your elbow movement. ● Bring your hand backward until the beanbag touch your ear. At the end of the throw, your elbow is fully straightened. Control: no instruction.	Internal focus led to a more robust motor performance compared to external focus and control in both retention and transfer tests.
2017	Tse & van Ginneken	To investigate whether conscious control propensity moderates the role of attentional focus in motor skill acquisition of children.	8 - 12 years old Typically developing N = 60 (36 male, 24 female)	Darts throwing towards a static target	School	External focus instructions: ● Hold the dart with your hand. Roll the dart and concentrate on its weight and position. ● Pay attention that the dart is parallel to the ground. ● Bring the dart to eye level and feel the dart directly in front of you. ● Look at the target center carefully for few seconds. ● Bring the dart toward your ear and throw the dart.	Children with a high conscious control propensity performed better with the internal focus instruction. Children with a low conscious control propensity performed better

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
						● While throwing the dart, concentrate on its flight directly toward the target. ● After every 10 trials: Focus on the dart (how it feels, its weight and position) and look at the target. Internal focus instructions: ● On your hand that holds the dart, place your thumb next to your middle finger and index finger. ● Flex your elbow until your hand reaches your eye height. ● Before throwing, concentrate on your finger motion and the correct position. ● Pay attention to your grasp and to the flexing and extending of your elbow. ● Bring your hand backward, approximately to your ear, and while throwing extend all of your fingers together so that, at the end of the throw, your hand is directed forward and your elbow is fully straightened. ● After every 10 trials: Focus on how your arm and hand (elbow, wrist, and fingers) feel before and during the throw.	with the external focus instruction.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
2018	van Abswoude et al.	To examine the benefits of internal and external focus instructions on golf putting performance in children; to determine the influence of working memory capacity, disposition for conscious control, and task-specific focus preference on learning.	8 - 12 years old Typically developing N = 25 (13 male, 12 female)	Golf putting task	School	Within-subjects design where children performed the task with both the internal and external focus instructions (counter-balanced order). Instructions were given both verbally and visually by showing the children what a pendulum is and how it works Internal focus instruction: Move your arms like a pendulum External focus instruction: Move the golf club like a pendulum	There was no difference in the improvements in golf putting between external and internal focus instructions. Better performance was found when the task-specific focus preference was matched with the focus of instruction.
2018	van Cappellen – van Maldegem et al.	To examine the effect of feedback with an internal or external focus of attention on motor learning of children with probable Developmental Coordination Disorder.	4 - 12 years old Probably Developmental Coordination Disorder N = 26 (23 males, 3 females)	Throwing task including a preliminary swing (i.e., slinger ball) towards a target on the floor	Physiotherapy clinic	General instructions: In this exercise you are going to aim this 'slingerball' at the target. You can swing the ball around a few times before you let it go. External focus feedback: ● Make sure the ribbon is slacker/tighter when you swing it. ● Make sure the ball is lower/higher when you let it go.	There was no difference in improvements in throwing accuracy between external and internal focus feedback. Visuospatial working memory

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
						● Make sure the ball turns slower/faster before you let it go. ● Make sure the ball is lower/higher when you let it go. ● Make sure you let it go sooner/later. Internal focus feedback: ● Make sure your arm is stretched less/more when you swing the ball. ● Make sure your arm is lower/higher when you release it. ● Make sure your arm turns slower/faster before you let go. ● Make sure your arm is lower/higher when you release it. ● Make sure you let go sooner/later.	capacity enhanced learning, especially for those receiving external focus feedback.
2010	Wulf, Chiviacowsky, et al.	To the hypothesis that feedback inducing an external focus of attention enhances motor learning if it is provided frequently rather than less frequently	10 - 12 years old Typically developing N = 48 (18 male, 30 female)	Throwing a soccer ball towards a target on the ground	School	● Feedback was given after every trial (100%) or every third trial (33%) External focus feedback: ● The sneakers should point at the target; keep them apart ● Produce a "C" at the beginning of the throw ● The grip should look like a "W" on the back of the ball ● The ball should be behind you at the beginning of the throw ● Propel the ball forward and release it in front of you, aiming at the target	External focus feedback with higher frequency was most effective in improving movement form.

Publication Year	Author	Purpose	Learner characteristics	Task	Environment	Instructions/Feedback (verbatim)	Main findings
						● The ball should not spin during flight ● Ball should be released just in front of you ● The sneakers should remain on the ground Internal focus feedback: ● The feet, hips, knees, and shoulders should be facing the target, feet should be shoulder-width apart ● The back should be arched at the beginning of the throw ● The grip should look like a "W" with the thumbs together on the back of the ball ● The ball should start behind the head at the beginning of the throw ● The arms should go over the head during the throw and finish by being aimed at the target ● There should be no spin on the ball during flight ● The ball should be released just in front of the head ● The feet should remain on the ground	

3.4.1 Learner

While we were willing to accept studies in which participants were aged 3-17 years old, the actual age of participants in the reviewed studies ranged from 4-15 years old. Most studies (n = 20) involved children in middle childhood (i.e., 6-11 years). One study each involved young teens (i.e., 12-15 years) and children in early childhood (i.e., 4-5 years). Five studies involved a combination of children in early and middle childhood, and three studies used a combination of participants from middle childhood and young teens (n = 3).

Most studies involved typically developing children (n = 23). The few studies that involved clinical populations consisted of those with intellectual disability (ID; n = 2), developmental coordination disorder (DCD; n = 2), attention deficit-hyperactive disorder (ADHD; n = 2), and autism spectrum disorder (ASD; n = 1).

3.4.2 Task

The most frequently trained task in the reviewed studies was the fundamental movement skill of throwing (n = 10), including two studies that specified the task to include a preliminary swing before throwing (i.e., referred to as slinger ball). Three other fundamental movement skills were targeted in other studies: kicking (n = 1), jumping (n = 1) and balancing (n = 1). Sport-related tasks were trained in many studies, including basketball skills (n = 3), golf putting (n = 2), soccer (n = 2), darts (n = 2), tennis (n = 1), and volleyball passing (n = 1). Other tasks were functional, such as using a Pedalo (n = 2), which is for training coordination and balance. Other functional/game tasks included using a shuffle board (n = 1), playing band instruments (n = 1), pirouettes (n = 1), yoga (n = 1), and a fine motor tracking task (n = 1).

Most studies (n = 23) examined FOA only for instructions. A few studies included both instructions and feedback (n = 3) or only feedback (n = 4). Most studies reported

verbatim instructions and feedback (n = 25), and they can be found in the supplementary table (see appendix).

3.4.3 Environment

Most studies were conducted in school settings (n = 20), followed by research laboratories (n = 9). Even when seven studies involved populations with developmental conditions, only one was conducted in a clinical setting and delivered by physiotherapists.

Table 3.2

Summary of the number of studies that focused on different subgroups of learners, tasks, and environment settings

Learner	Task	Environment
Age	Fundamental movement skills	Field-based (school): n = 20
Early childhood: n = 1	Throwing: n = 10	Research laboratory: n = 9
Middle childhood: n = 20	Kicking: n = 1	Clinic (physiotherapy): n = 1
Teens: n = 1	Balancing: n = 1	
Combination: n = 8	Jumping: n=1	
Development	Sport-related tasks	
Typically, developed: n = 23	Basketball: n = 3	
Intellectual disability (ID): n = 2	Golf putting: n = 2	
Developmental coordination disorder (DCD): n = 2	Soccer: n = 2	
	Darts: n = 2	
Attention deficit-hyperactivity disorder (ADHD): n = 2	Tennis: n = 1	
	Volleyball: n = 1	
Autism spectrum disorder (ASD): n = 1		
	Functional tasks	
	Pedalo: n = 2	
	Shuffle board: n = 1	
	Band instrument: n = 1	
	Pirouette: n = 1	
	Yoga: n = 1	
	Tracking: n = 1	

3.4.4 Study Designs and Outcomes

The study designs for which the outcomes were measured varied across these reviewed studies. Among the experimental studies, the most frequent design measured outcomes during the learning phase, at retention, and with a transfer task (n = 9). An almost equal number of studies measured outcomes at pretest, during the learning phase, and at retention (n = 7). Four studies used a simpler design consisting of outcomes at pretest and retention. On the other hand, some other studies adopted the most complex design consisting of outcomes at pretest, during the learning phase, at retention, and with transfer tasks (n = 3). A few studies looked at only the learning and retention phases (n = 2) or the learning and transfer phases (n = 2). One study each measured outcomes at pretest, retention, and transfer, only at the learning phase, or only at retention.

Table 3.3 summarises the differential outcomes between external and internal FOA relative to the learner-task-environment framework. Most studies (n = 18) showed that external FOA instructions and feedback were more advantageous than internal FOA. Among these studies, 15 involved typically developing children whose ages ranged from early childhood to adolescence. Two studies involved children with ADHD, and one study involved children with ID. Most of the tasks where external FOA led to greater improvements in performance (n = 13) involved object manipulation (e.g., ball, stick). Three other studies showed benefits for complex tasks (i.e., pedaling, ballet pirouette), while one study each showed benefits to a locomotion (i.e., jumping) and balancing task (i.e., jumping). Evidence supporting the advantages of external FOA was generated by 12 (out of 20) school-based studies and six (out of nine) laboratory-based studies.

Table 3.3

The advantageous effects of external and internal focus instructions/feedback with reference to the learner, task, and environment

Author/Year	Learner	Task	Environment	Advantageous effect		
				External	Internal	None
Agar et al. 2016	Typically developing children; 5-12 years old	Shooting task using a shuffleboard, stick and pucks	Laboratory			+
Asadi et al. 2021	Typically developing children; 7-10 years old	Overarm tossing task using a ball toward a target on the wall	Laboratory	+		
Bahmani et al. 2021	Typically developing children; 9-11 years old	Overarm tossing task using a ball toward a target on the wall	Laboratory	+		
Brocken et al. 2016	Typically developing children; 8-12 years old	Golf putting task	Laboratory	+		
Chiviacowsky et al. 2013	Children with ID; 10-14 years old	Throwing task using a beanbag toward a vertical target	School	+		
Chow et al. 2014	Typically developing children; 9-10 years old	Long jumping task on a standing board	School	+		
Emanuel et al. 2008	Typically developing children; 8-9 years old	Darts throwing task	Laboratory			+
Flôres et al. 2016	Typically developing children; 6-10 years old	Pedaling task	School	+		
Flôres et al. 2015	Typically developing children; 6-10 years old	Pedaling task	School	+		

Author/Year	Learner	Task	Environment	Advantageous effect		
				External	Internal	None
Ghorbani et al. 2020	Children with ADHD; 7-11 years old	Yoga posing task	School	+		
Gredin & Williams 2016	Typically developing children; 9-10 years old	Kicking task using a stationary ball toward a target on the floor	School		+	
Hadler et al. 2014	Typically developing children; 10-12 years old	Forehand tennis striking task	Laboratory	+		
Jarus et al. 2015	Typically developing children; 9-12 years old	Computer tracking task	Laboratory	+		
	Children with DCD; 9-12 years old					+
Kok et al. 2021	Children with ID; 9-13 years old	Balancing task using a slackline	School			+
Krajenbrink et al. 2018	Typically developing children; 8-12 years old	Throwing task using a slinger toward a horizontal target	School			+
Lola et al. 2022	Typically developing children; 9-10 years old	Volleyball passing task	School	+		
Lola et al. 2021	Typically developing children; 5-6 years old	Throwing task using a beanbag toward a horizontal target	School	+		
Miçooğulları et al. 2012	Typically developing children; 12-15 years old	Soccer head kicking task	School	+		
Perreault & French 2016	Typically developing children; 9-11 years old	Basketball free throwing task	School			+

Author/Year	Learner	Task	Environment	Advantageous effect		
				External	Internal	None
Perreault & French 2015	Typically developing children; 9-11 years old	Basketball free throwing task	School	+		
Petranek et al. 2019	Typically developing children; 6-7 years old	Overhand throwing task using a foamball toward a vertical target	School		+	
Saemi et al. 2013	Children with ADHD; 8-11 years old	Throwing task using a ball toward a horizontal target	School	+		
Schwab et al. 2019	Adolescents; age not specified	Soccer free kicking task	Laboratory	+		
Stambaugh 2019	Typically developing children; 12 years old	Playing a variety of band instruments	School			+
Texeira-da Silva et al. 2017	Typically developing children; 9-10 years old	Performing a ballet pirouette	Dance school	+		
Tse 2019	Children with autism; 9-12 years old	Throwing task using a beanbag toward a vertical target	Laboratory		+	
Tse & van Ginneken 2017	Typically developing children; 8-12 years old	Darts throwing task	School			+
van Abswoude et al. 2018	Typically developing children; 8-12 years old	Golf putting task	School			+
van Cappellen-van Maldegem et al. 2018	Children with DCD; 4-12 years old	Throwing task using a slinger toward a horizontal target	Physiotherapy clinic			+
Wulf et al. 2010	Typically developing children; 10-12 years old	Throwing task using a ball toward a horizontal target	School	+		

A substantial number of studies (n = 10) found no significant differences in the outcomes between external and internal FOA instructions and feedback. Seven of these studies involved typically developing children, while one study involved children with ID. Two studies were of children with DCD, one of which found concurrently no difference between external and internal FOA for children and advantages associated with external FOA only for typically developing children (Jarus et al., 2015). Nearly all studies involved object manipulation tasks (n = 8), while one study involved a balancing task (i.e., slackline) and another involved playing a variety of instruments. Six studies were school-based, three were laboratory-based, and one study was in a physiotherapy clinic.

Three studies showed that internal FOA instructions were more advantageous – two of these were with typically developing children and one was with children with ASD. These studies showed greater improvements in the performance of tasks that involved object manipulation. The studies of typically developing children were conducted in schools, while the study of children with ASD was conducted in the laboratory.

The common limitations cited by the studies suggest the need to address ecological validity. Several laboratory-based studies acknowledged that the findings from a controlled environment and protocol may have limited transferability to the real world. On the other hand, some school-based studies were noted to have relatively short learning phases, which may not reflect the length of time that children might need to acquire complex motor skills. Other studies also acknowledged the lack of an effective manipulation check, through which it can be verified whether the children in fact followed the specified instructions or feedback that directed their focus.

3.5 Discussion

This review was guided by the learner-task-environment framework for motor learning (Gordon & Magill, 2016), in which we aimed to map the conditions in which FOA instructions and feedback have been examined in research with children. Particularly, we focused on children's developmental characteristics, the nature of movement tasks that were learned, and the settings in which motor skill acquisition took place. Prior reviews of evidence related to FOA strategies in children have focused on quantifying the effectiveness and the relative advantages associated with the type of instructional focus, highlighting an external FOA specifically (Simpson et al., 2021; van der Veer et al., 2022). In the studies we reviewed, most showed that an external FOA may be advantageous for children, including those with ADHD. Nevertheless, there were a substantial number of studies that showed no differences between the effects of external and internal FOA strategies, and this group included children with DCD. Studies that showed equivocal results suggested that individual differences must be considered in children's learning, meaning that future investigators should account for individual learning trajectories (Perreault & French, 2016; van Cappellen – van Maldegem et al., 2018). This suggestion is highlighted by the apparent different responses among children with ADHD and DCD, perhaps indicating the importance of the learner's distinct characteristics as matched with the learning conditions.

In general, our findings concurred with those of previous reviews that provided support for the use of external FOA instructions and feedback for children (van der Veer et al., 2022; Simpson et al., 2021). However, the details we provided using the learner-task-environment framework elicited further considerations, as follows below.

3.5.1 Learner

In terms of the learner, studies of FOA strategies with children appear to have predominantly focused on typically developing children in middle childhood (i.e., 6-11 years

of age). In this period, children master fundamental movement skills and develop concrete operational thinking (i.e., reasoning and problem solving) (DelGiudice, 2018) enabling research on movement skill acquisition. For instance, newly developed problem-solving abilities allow middle childhood learners to process instructions and feedback in relation to motor skills. In contrast, very few studies have examined children in early childhood, a crucial stage when fundamental movement skills first emerge (Donnelly et al., 2017). Fundamental movement skills consist of locomotor, object control, and balance skills (Goodway et al., 2021), the development of which is often targeted in early childhood education and care settings. Teachers may be able to promote these skills better by utilising appropriate FOA instructions and feedback. However, there is limited research in early childhood, with only one study focusing on object control skill of throwing (Lola et al., 2022). While these authors' findings showed that external FOA instructions and feedback were more beneficial, there is a pressing need for more research in this age group.

While the overwhelming majority of available evidence has been drawn from samples of typically developing children, effective motor learning strategies are especially important to address in children with neurodevelopmental disorders (NDDs). According to the Diagnostic and Statistical Manual of Psychiatric Disorders (DSM-5; American Psychiatric Association, 2022), NDDs include ID, ADHD, communication disorders, ASD, specific learning disorders, and motor disorders that may include DCD. Many children with NDDs are known to have motor issues and therefore constitute groups of children who need to be supported by effective motor learning strategies. For instance, in the physiotherapy of children with NDDs, the use of instructions and feedback is especially crucial due to potential physical constraints and sensory impairments that may affect the processing of movement-related information (Gordon & Magill, 2016). However, very few studies have applied FOA

strategies for children with NDDs, and this should be a direction for future investigators to take.

The advantages associated with external FOA instructions and feedback were found to be evident in children with ADHD, but only in two studies (Ghorbani et al., 2020; Saemi et al., 2013). External FOA instructions encourage learners to direct attention toward the task's goal. This approach has been advantageous for children with ADHD, who contend with heightened distractibility. The external FOA enables them to visualise and work toward achieving a tangible endpoint. In children with DCD, two studies showed no differences in the effects of external and internal focus instructions (Jarus et al., 2015; van Cappellen – van Maldegem et al., 2018). As discussed earlier, children with DCD tend to have difficulty learning from their mistakes and persist with incorrect movement patterns (Biotteau et al., 2020). Thus, they might be better attuned to identifying and correcting erroneous movements when they focus internally and monitor their own performances. In other research, however, "quiet eye" has been found to effectively improve visuomotor task performance in children with DCD by facilitating their ability to focus, anticipate, and track the target object (Miles et al., 2015). These quiet eye mechanisms appear to be aligned with an external focus (i.e., focusing on the target object). Thus, future researchers should examine the contexts in which FOA instructions and feedback are delivered (i.e., in addition to quiet eye) to identify the ways in which children with DCD process and execute movement skills.

Two further studies involved children with ID, but only one of these studies found external FOA to be advantageous (Chiviacowsky et al., 2013), while the other found no differences in learning effects (Kok et al., 2021). An external focus is assumed to be associated with reduced attentional demands (Wulf, McNevin, et al., 2001), perhaps making this strategy advantageous for children with ID who have cognitive limitations. Kok and

colleagues (2021) offered the nuanced suggestion that the choice of instructions for these children should be dependent on those cognitive resources.

Finally, one study showed that internal FOA instructions were better suited for children with ASD, and the authors proposed that this was due to these children being more attuned to relying on proprioception (Tse, 2019). This explanation was drawn, in part, from previous research that showed that children with ASD tend to rely on proprioception rather than vision when learning a movement skill (Marko et al., 2015). However, this single study of FOA in children with ASD, limited to those with high-functioning ASD who were aged 9-12 years, is too limited in scope for drawing definitive inferences about children with ASD generally. Clearly, there is a need for further research of this kind for children with NDDs and particularly for those with ASD.

3.5.2 Task

The most commonly targeted tasks in these reviewed studies were fundamental movement skills, which are considered to form the foundations of more complex tasks (Donnelly et al., 2017). Crucially, fundamental movement skills enable exploration of the environment and interaction with peers, which are important contributors to cognitive and socioemotional development (Cameron et al., 2016; Veldman et al., 2019). Many of the reviewed studies targeted isolated object control skills in particular; however, in the real world, physical play and other activities require that children use a coordinated combination of fundamental movement skills. Indeed, many authors of studies we reviewed acknowledged that the ecological validity of movement tasks and training conditions should be enhanced in future research (e.g., Bahmani et al., 2021; Ghorbani et al., 2020). It has also been emphasised in recent research that fundamental movement skills should not be viewed as discrete isolated tasks (Ng & Button, 2023). While the importance of fundamental movement skills is well established, future research regarding attentional focus instructions and feedback

with children should consider play- or game-based contexts rather than studying movement skills in isolation.

Many studies we reviewed involved sport-related and functional tasks that are more complex than fundamental movement skills and more consistent with actual contexts of children's play. For instance, tasks related to basketball, golf, and soccer were trained, and it appears that an external FOA was more advantageous in these studies (e.g., Brocken et al., 2016; Gredin & Williams, 2016; Perreault & French, 2015). However, as most studies have focused on only specific tasks (e.g., throwing, putting), future research on attentional focus instruction might train a combination of sport-related and functional tasks.

3.5.3 Environment

A large portion of the studies we reviewed were conducted in laboratory settings, aligning with the trend of motor learning research (Kleynen et al., 2015). Interestingly, most of these laboratory studies showed advantages with an external FOA. Possibly, the controlled settings helped elicit these findings, in which case these data should be interpreted cautiously, given the limited ecological validity of laboratory conditions. Compared to studies of adults, field-based settings in schools have made better progress with children. Studies conducted in schools offer potential for knowledge translation in physical education and sports coaching contexts. As most of these reviewed studies reported the actual instructions used in school settings, teachers and coaches may refer to them when considering how to structure and deliver the instructions and feedback for their own contexts.

Considering the importance of effective motor learning strategies for children with NDDs, future investigators should further explore clinical settings. We reviewed only one study in a physiotherapy clinic setting. In physiotherapy for children with NDDs, instructions and feedback are especially crucial due to potential physical constraints and/or sensory impairments that might affect these children's processing of movement-related information

(Gordon & Magill, 2016). There is potential for integrating FOA instructions and feedback systematically in paediatric physiotherapy practice, but there is simply insufficient research at this time to inform practice in these clinical settings or for different diagnostic groups.

3.5.4 Limitations of this Review

We followed the established protocols for scoping reviews, but by excluding non-English papers, we might have missed some evidence. We summarised the findings in terms of the advantages associated with external and internal focus but given the nature of a scoping review (Munn et al., 2018), we did not conduct a quality assessment of the reviewed studies; hence, we do not offer insights into the quality and strength of available evidence. This limitation should be considered when considering the synthesised evidence in this review. Additionally, in considering learner-task-environment factors, we examined only a few limited descriptors in each category (e.g., children's developmental characteristics, fundamental movement skills and sports-related tasks, and laboratory, school-based, and clinical settings). There may be other relevant descriptors in each category that would be valuable for future researchers to examine.

3.6 Conclusion

In this scoping review, we determined the extent of research conducted to date on the use of FOA strategies to facilitate children's learning of movement tasks. While more studies have shown the advantages of an external FOA in these motor learning applications, some studies we reviewed showed no differences between an external and internal focus, highlighting the need to consider children's individual differences. Regarding tasks, FOA strategies are evidently useful for tasks that range from isolated fundamental movement skills to functional and sport-related tasks, and further work could explore combinations of these

skills. Most studies were situated in school-based, or laboratory settings and limited work had examined FOA strategies among children with NDDs.

3.7 Relevance to Thesis

Chapters 2 and 3 together address the gap in synthesised knowledge by mapping the evidence related to motor learning strategies and their key elements, as framed by Kleynen et al. (2020). Although both reviews initially aimed to focus on children with neurodevelopmental disorders (NDDs), the scope of Chapter 3 was broadened to include typically developing children owing to the limited number of studies specifically involving those with NDDs. The combined findings highlight that the application of FOA strategies for instructions and feedback in clinical settings, particularly for children with NDDs, requires further research. Before any clinical trials or interventions can be designed, it is important to gain an understanding of context-specific practice (Johnson et al., 2013). Chapter 4, therefore, presents an exploratory study into the use of FOA by physiotherapists practicing in the Philippines, a setting chosen due to its unique healthcare context, resource constraints, and underrepresentation in the existing FOA literature. The studies presented in the succeeding chapters contribute to bridging the gap between research evidence and professional practice.

Chapter 4: Survey Study[3]

Physiotherapists' Use of Attentional Focus Instructions and Feedback in the Philippines: A Survey Study

4.1 Commentary

This chapter presents an exploratory cross-sectional study examining the preferences and practices of physiotherapists in the Philippines regarding the use of focus of attention (FOA) strategies, specifically external and internal focus, when delivering verbal instructions and feedback in clinical settings. Although there has been considerable evidence supporting the benefits of using external FOA in motor learning, most existing research originates from high-resource, Western contexts. There is a significant gap in the understanding of how these strategies are being used in diverse, lower-resource environments or in countries that have different cultural practices compared to the Western countries. Given the unique healthcare context and professional landscape in the Philippines, a country situated in Southeast Asia, this study addresses an important knowledge gap by exploring local physiotherapists' FOA preferences, the relationships of these preferences with professional characteristics and the considerations the physiotherapists have that influence their delivery of instructions and feedback to their clients. This study highlights the disconnect between available evidence and clinical practice, given that about half of the participants were unfamiliar with the concept of FOA. Furthermore, this study underscores the need for targeted knowledge translation tailored to context-specific realities.

[3] This chapter is based on a manuscript that has been published: Eguia, K. F., Ng, S. S., & Wong, T. W. L. (2025). Physiotherapists' Use of Attentional Focus Instructions and Feedback in the Philippines: A Survey Study. *Physiotherapy Research International*, 30(2), e70035.

As the third chapter in this thesis, this study builds on the foundational work about motor learning and FOA strategies covered in the earlier chapters. This empirical study shows that despite the possible differences in culture and physiotherapy practices, the need to disseminate information about FOA strategies in physiotherapy also exists not only in Western countries but also in Southeast Asian countries like the Philippines. This chapter offers insights into the real-world context that can help bridge the gap between research and everyday clinical practice. This understanding is important for developing FOA-based interventions that are culturally and practically appropriate for paediatric physiotherapy in diverse settings.

4.2 Introduction

Motor learning principles form an important framework that supports physiotherapy practice. However, there continues to be limited evidence on how physiotherapists implement motor learning strategies and elements in clinical practice. Key elements of motor learning include instructions and feedback (Kleynen et al., 2020), which are often delivered verbally as collections of words that describe how a skill is to be performed (Magill & Anderson, 2021). There has been growing evidence of the importance of directing learners' FOA when delivering instructions and feedback for learning movement skills (see Neumann, 2019; Wulf, 2013). As such, it has been recommended that such knowledge about FOA be translated into physiotherapy practice to enhance treatment outcomes (Hunt et al., 2017).

4.2.1 Physiotherapy Practice and Focus of Attention

Research exploring the delivery of physiotherapy instructions and feedback in relation to FOA has increased in recent years (e.g., Hussien, Gignac, et al., 2023; Kal et al., 2018). Earlier observational studies of physiotherapists' preferences for FOA were based on one pair of physiotherapist and client with stroke (Durham et al., 2009), followed by observations of

the practices of eight physiotherapists (Johnson et al., 2013) in the United Kingdom. These studies indicated that physiotherapists' instructions tended to direct their clients' FOA internally (i.e., focus on the movement process of their body parts) more frequently than they did externally (i.e., focus on the effects of the movement). For example, for ball kicking, an external focus instruction would be *"Kick the ball into the goal"*, which directs the athlete's attention toward the desired outcome of the action. In contrast, an internal focus instruction might be *"Start your kick by bringing your foot back and then striking the ball with the front of your foot"*, which emphasises the mechanics of the movement. A more recent study in the Netherlands observed physiotherapy sessions of clients with stroke and reported a similar tendency by physiotherapists to adopt an internal FOA when giving feedback but a tendency for external FOA when providing instructions (Kal et al., 2018). This study involving Dutch practitioners suggested that physiotherapists' use of internal and external FOA should be examined separately for instructions and feedback. We note, however, that these observational studies focused on physiotherapy for stroke patients, involved small sample sizes, and represented European contexts.

In Canada, an observational study revealed a similar preference among physiotherapists working with clients with musculoskeletal injuries for internal FOA when providing instructions and feedback (Zachariah, 2013). Additionally, this study noted that there was a difference between how the therapists believed they applied FOA in practice and what was observed, with therapists overestimating their use of externally focused statements. Given that previous studies were limited by small sample sizes and clinical settings (i.e., mostly involving stroke), Hussien and Ste-Marie (2023) surveyed a larger sample of Canadian physiotherapists. Their findings also revealed that physiotherapists tended to adopt internal FOA in their practice. In contrast to the study of Kal et al. (2018), internal FOA was consistently preferred across both instructions and feedback.

According to the Constrained Action Hypothesis, an external FOA promotes automatic control of movement, whereas an internal FOA leads to heightened consciousness, which can disrupt automatic movement control (McNevin et al., 2003; Wulf et al., 2000, 2002). Law and Wong (2021) reported neurological evidence (i.e., electroencephalogram) of heightened conscious movement planning associated with internal FOA. Thus, external FOA may be advantageous, as evident in studies where learners perform sports-related tasks such as basketball shooting (Zachry et al., 2005) and jumping (Wulf, Dufek, et al., 2010) and in rehabilitation contexts such as balance training (Chiviacowsky et al., 2009; Jackson & Holmes, 2011). Wulf and Lewthwaite (2016) further suggested that using external FOA directs the learner's attention to an actual goal (i.e., the outcome), which enhances the learner's sense of satisfaction and perceived competence.

Thus far, studies of physiotherapists' practices suggest that evidence of the benefits of external FOA does not translate successfully into practice in Europe and Canada. Nevertheless, the majority of physiotherapists are familiar with the concept of FOA in motor learning (Atun-Einy & Kafri, 2019; Hussien & Ste-Marie, 2023; Kal et al., 2018). We note that these findings are context-specific because practice environments vary across territories. No research has explored physiotherapists' use of FOA in Asian regions where patients currently do not have direct access to physiotherapy. In the Philippines, in addition to a lack of direct access, physiotherapy services are funded by out-of-pocket expenses or compulsory/voluntary insurance (World Confederation for Physical Therapy, 2019). Given the low ratio of practicing physiotherapists to the population size, research that supports efficient and effective practice is crucial. Context-specific evidence is needed to form the basis of knowledge translation in the Philippine practice environment. Moreover, physiotherapists' use of FOA for instructions and feedback has been characterised mostly through observational studies in stroke rehabilitation, and only one study has addressed

general physiotherapy practice (Hussien & Ste-Marie, 2023). A broader understanding of the use of FOA in delivering instructions and feedback across physiotherapy practice areas is needed.

4.2.2 Current Study

While there is increasing evidence that externally focused instructions and feedback are beneficial to clients, physiotherapists have been shown to have a predilection for using internal FOA. Our current knowledge of physiotherapists' practices in relation to FOA has been largely drawn from observational studies, with most studies focused on stroke rehabilitation. There is a knowledge gap concerning context-specific physiotherapy practices in relation to FOA. The use of FOA strategies may vary across regions due to differences in physiotherapy education, cultural norms, and clinical traditions. For example, Hunt and colleagues (2017) reported that physiotherapists tend to use internally focused instructions over 90% of the time, possibly because of traditional views emphasised in their curricula. This study, therefore, contributes to addressing this gap by determining the preference of physiotherapists for external or internal FOA when delivering instructions and feedback across a range of practice areas (i.e., not only stroke rehabilitation) and in the Philippine context. The Philippines is a developing country that is facing a shortage of as many as 190,000 healthcare workers, including physiotherapists (Mangaluz, 2024), and provides an important setting for this research topic. Understanding the use of FOA strategies can reveal directions for supporting more efficient practices, which is crucial in low-resource settings such as the Philippines.

We explored physiotherapists' preferences across practice areas (e.g., paediatric, neurologic). With a cross-sectional survey design (Portney, 2020), physiotherapists self-reported their preference for using external or internal FOA when delivering instructions and feedback. Based on previous studies, we hypothesised that (i) physiotherapists will have a

greater preference for internal rather than external FOA and that (ii) the majority of physiotherapists will be aware of the concept of FOA. In addition, we examined whether physiotherapists' preferences for internal or external FOA are associated with their professional and individual characteristics. Finally, we explored physiotherapists' considerations when delivering instructions and feedback.

4.3 Methods

We utilised a cross-sectional survey design (Portney, 2020), with the survey administered online using Qualtrics. All procedures were reviewed and approved by the research ethics committee of the university (Ref. No.: HSEARS20231219002).

4.3.1 Participants

The study is situated in the Philippines, and the participants included physiotherapists who were (1) registered according to the licensure requirements and (2) currently practising in the country. According to the annual membership census from the World Physiotherapy (World Physiotherapy, 2023), there are 16,605 physiotherapists in the Philippines. The sample size calculation (Qualtrics, 2023) indicated that a sample of 163 participants was needed to achieve an 80% confidence level and a 5% margin of error. Data were gathered from January to February 2024. A total of 223 respondents consented to participate in the study and completed the online survey. Data from those who responded to the questions on their preferences for external and internal FOA (n = 182) were analysed. In comparison, the survey study of Hussien & Ste. Marie (2023) involved 121 Canadian physiotherapists.

4.3.2 Procedures

The participants were recruited through notices posted on the social media pages of the local physiotherapy professional association, local physiotherapy academic journal, and specialist physiotherapy groups (e.g., paediatric special interest group). Invitations to

participate in the study were also emailed to clinics, centres, and hospitals providing physiotherapy services whose contact details were publicly available. Potential participants were invited to complete an online questionnaire hosted by Qualtrics.

The survey consists of three parts. The first part collected descriptive information from the physiotherapists (i.e., age, sex, years of experience, qualifications, practice area).

The second part of the survey asked about the participants' preferences for using internal or external FOA based on clinical scenarios. We adopted items from two previous studies where pairs of externally and internally focused statements were presented, and the participants selected the option that they generally preferred to use (Hussien & Ste-Marie, 2023; Kal et al., 2018). For example, instructions related to the transfer of weight during gait were presented as "feel the ground rolling" (external) or "transfer your weight from your heel to your toes" (internal). Like in the study of Kal et al. (2018), internally focused choices were given a score of 0, and externally focused choices were given a score of 1. Seven pairs of instructions and three pairs of feedback statements were presented. The participants also indicated their familiarity with FOA in relation to the provision of instruction and feedback as a dichotomous response (i.e., yes/no).

The third part of the survey was developed by the researchers and explored participants' conscious planning when delivering instructions and feedback through a five-point Likert-type scale, where higher scores indicated a greater frequency of conscious planning (i.e., 1 – never, 5 – all the time). Open-ended questions prompted the participants to specify the reasons/factors that influence their planning and variation of instructions and feedback. Finally, a dichotomous question was used to determine whether participants delivered instructions and feedback differently between patients and caregivers. Open-ended questions prompted the participants to specify their considerations when varying their instructions between caregivers and patients.

The items adopted from previous studies went through face validation (Hussien & Ste-Marie, 2023) and pilot testing procedures (Kal et al., 2018). We further assessed content validity of our complete survey on the basis of expert review and a pilot test (McGartland Rubio, 2005). Two researchers with expertise in motor learning and physiotherapy reviewed the survey questions to evaluate the suitability of the questions for the research purpose. This was followed by a pilot test involving three local physiotherapists who answered the survey and additional questions to ascertain the relevance, formatting, readability, clarity, and appropriateness of the survey given its purpose (P. Ranganathan et al., 2024). The first and second parts of the survey were adopted as originally designed, and minor revisions were made to improve the clarity of the open-ended questions in the third part of the survey. The survey was administered in English, considering that this is an official language in the Philippines and is the medium of instruction for university degree programmes in the country (Bolton & Botha, 2020).

4.3.3 Data Analysis

Data from dichotomous and scale-response items were analysed quantitatively using descriptive and inferential statistics. The relative focus score was calculated from the second part of the questionnaire, where scores below the midpoint reflected a preference for internal FOA and those above the midpoint reflected a preference for external FOA (Kal et al., 2018). Based on the seven instruction statements, scores <3.5 reflected a preference for internal FOA; scores >3.5 reflected a preference for external FOA. Based on the three feedback statements, scores <1.5 reflected a preference for internal FOA, whereas scores >1.5 reflected a preference for external FOA. Considering the combined instruction and feedback statements, scores <5.0 reflected a preference for internal FOA, and scores >5.0 reflected a preference for external FOA.

We performed Chi-square tests to test the hypotheses that (i) participants prefer internal rather than external FOA and that (ii) the majority of the participants are familiar with the concept of FOA in relation to instructions and feedback. Cohen's w and φ were calculated to determine the effect size with benchmarks of 0.10, 0.30 and 0.50 for small, medium, and large effect sizes respectively (Cohen, 1988). Associations between relative focus scores and participants' characteristics were examined using Pearson's product moment correlation coefficient or Spearman's rank correlation coefficient (i.e., when parametric assumptions are violated). Comparisons between groups (i.e., practice area, specialisation group, familiar/not familiar) were performed using the Mann–Whitney U test. For the quantitative analyses, alpha was set at $p<0.05$.

We performed content analysis of the responses to the open-ended questions. We adopted a realist framework that assumed that language captures participants' experiences (Terry et al., 2017). Using an inductive approach (i.e., bottom-up), we defined coding units (i.e., words, phrases, etc.) and developed a coding scheme based on recurring themes (Berthet et al., 2023). Trustworthiness was established by having two researchers read the open-ended responses and perform the coding independently. Inconsistencies in the coding of the two researchers were resolved through discussion and consensus among the research team. Code frequencies were calculated to identify frequently reported considerations by physiotherapists when planning the delivery of instructions and feedback.

4.4 Results

The findings are based on the responses of 182 physiotherapists with years of experience ranging from one month to 30 years (mean 5.68 years S.D. 6.85). The majority were female (66%), had completed a bachelor's degree (85%), did not consider themselves specialised in a specific practice area (52%), practised in the northern region, which includes

the capital of the country (76%), and were affiliated with private healthcare providers (82%). The participants' characteristics, along with their practice and specialisation areas, are summarised in Table 4.1.

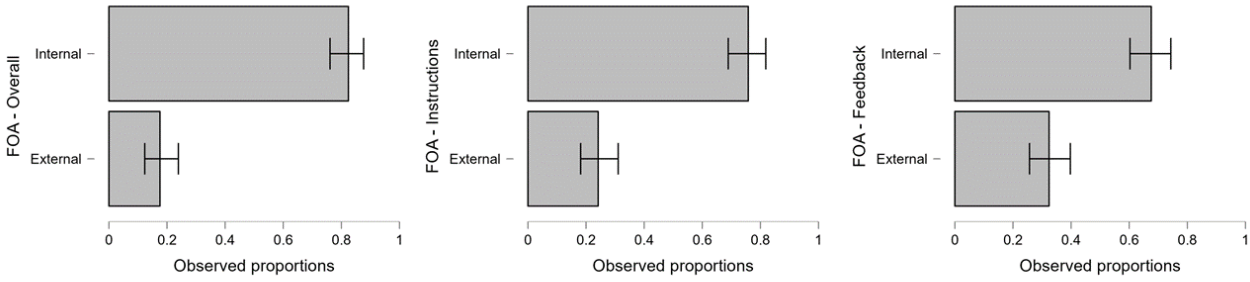
Table 4.1

Characteristics of the participants (N = 182)

Characteristic	Category	Frequency	Percentage
Sex	Female	120	65.9
	Male	56	30.8
	Prefer not to say	6	3.3
Education	Bachelor's Degree	155	85.2
	Postgraduate	27	14.8
Practice Area	Musculoskeletal/Orthopaedics	135	74.2
	Neurologic	117	64.3
	Pain management	109	59.9
	Geriatrics	94	51.6
	Sports/Exercise	76	41.8
	Paediatrics	70	38.5
	Occupational Health/Ergonomics	29	15.9
	Cardio	21	11.5
	Palliative care	15	8.2
	Mental Health	9	4.9
	Women's Health/Men's Health	4	2.2
Considers oneself as specialist	Yes	85	46.7
	No	97	53.3
Specialisation Areas (n = 85)	Musculoskeletal/Orthopaedics	36	42.3
	Neurologic	36	42.3
	Pain management	33	38.8
	Paediatrics	24	28.2
	Sports Exercise	23	27.0
	Geriatrics	21	24.7
	Occupational Health/Ergonomics	11	12.9
	Cardio physiotherapy	5	5.9
	Palliative care	4	4.7
	Mental Health	2	2.3
	Women's Health/Men's Health	2	2.3
Geographic region of practice	National capital region	72	40.0
	Northern region	65	36.1
	Middle and Southern regions	45	23.9
Practice setting	Private healthcare provider	112	81.8
	Publicly funded health services	25	18.2

4.4.1 Relative Focus

The overall relative focus scores (mean relative focus score = 4.00 S.D. 1.79; <5.00) show that the participants tended to prefer internal rather than external FOA. The preference for internal FOA was evident across instructions (mean relative focus score = 2.77 S.D. = 1.32; <3.50) and feedback (mean relative focus score = 1.23 S.D. = 0.86; <1.50). Chi-square tests supported the hypothesis that more participants prefer internal rather than external FOA overall ($\chi 2 = 76.50$, df = 1, $p < 0.001$, w = 0.65) indicating a large effect, with instructions ($\chi 2 = 48.55$, df = 1, $p < 0.001$, w = 0.52) indicating a large effect, and with feedback ($\chi 2 = 22.51$, df = 1, $p < 0.001$, w = 0.35) indicating a medium effect (Cohen, 1988). These findings are illustrated in Figure 4.1.



	Overall	Instructions	Feedback
Internal FOA	150	138	123
External FOA	32	44	59

Figure 4.1. Distribution of participants who preferred internal and external FOA overall, with instructions, and with feedback (n = 182).

4.4.2 Familiarity with Focus of Attention and Conscious Planning

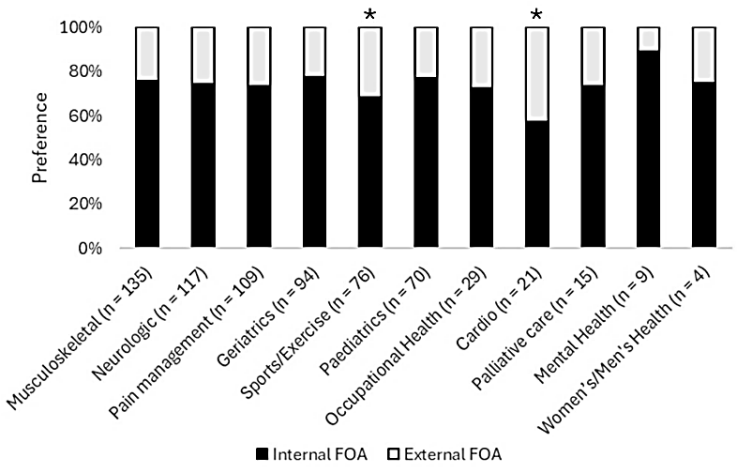
Only slightly more than half of the participants (52.20%) reported familiarity with the concept of FOA in relation to providing instructions and feedback to their clients. The proportion of participants who were or were not familiar with attentional focus did not significantly differ ($\chi 2 = 0.35$, df = 1, $p = 0.55$). The participants gained knowledge about

FOA through their undergraduate studies (36.3%), professional networks (19.2%), continuing professional development activities (18.7%), social media (7.7%), and postgraduate studies (4.4%).

Scores from the 5-point Likert-type scales show that the participants tended to consciously plan how they would deliver instructions and feedback prior to their sessions (mean score = 4.12 S.D. 0.95) and consciously choose internal or external FOA (mean score = 4.08 S.D. 0.87).

4.4.3 Factors Related to Relative Focus

The participants' relative focus was not related to any of their professional characteristics, including educational background, years of experience, being specialised or not, geographic region of practice, nature of the affiliated healthcare provider, or familiarity with attentional focus. The participants generally preferred internal over external FOA across all practice areas, but the distributions of preferences for instructions were significantly different among those who practised in cardio-physiotherapy ($\chi 2 = 4.52$, $df = 1$, $p = 0.03$, $\varphi = 0.16$) and sports/exercise ($\chi 2 = 3.90$, $df = 1$, $p = 0.04$, $\varphi = 0.15$) than among those who did not practice in these areas, with small effect sizes. As shown in Figure 4.2, there tends to be a greater percentage of those preferring external FOA in cardio-physiotherapy and sports/exercise compared to other areas. There was a weak but significant association between the tendency to consciously plan the delivery of instructions and feedback, with relative focus scores indicating an overall preference for internal focus ($r = -0.15$, $p = 0.04$).



*Note: *statistically significant difference in distribution, $p < 0.05$.*

Figure 4.2. Distribution of participants' preferences for internal and external FOA when delivering instructions across practice areas.

4.4.4 Considerations when planning the delivery of Instructions and Feedback

Among the respondents, 145 provided responses to the open-ended questions. The coded responses revealed a range of factors that the physiotherapists considered when planning how to deliver instructions and feedback. More participants (55.9%) reported considering the cognitive ability of the patient. The other factors include the age of the patient, type of learning, and language complexity (see Table 4.2).

Table 4.2

Factors that the participants considered when planning the delivery of instructions and feedback.

	Valid responses (N)	Percentage	Counts
Cognitive ability of patient	145	57.2	83
Age of patient	145	27.6	40
Type of learning (visual/verbal)	145	20.7	30
Language complexity	145	15.2	22
Level of impairment of the patient	145	13.8	20
Type of exercise/activity being conducted	145	13.8	20
Goals for the session	145	11.0	16

	Valid responses (N)	Percentage	Counts
Attitude and personality of the patient	145	10.4	15
Language preference of the patient	145	9.0	13
Phase of rehabilitation of the patient	145	4.8	7
Whether the patient is a new referral or regular patient	145	4.1	6
Novelty of the task	145	3.5	5
Safety considerations	145	2.8	4

Most of the participants (78.0%) noted that they delivered instructions and feedback differently between patients and caregivers. Among the 110 respondents who provided answers to the open-ended question, the considerations that were frequently reported included the cognitive abilities of the patient (60.7%) and the caregiver (49.5%) and the purpose or function of the physiotherapists' instructions/feedback (32.7%). The other considerations included the age of the patient, level of involvement of the caregiver, and age of the caregiver (see Table 4.3).

Table 4.3

Factors that the participants considered when varying the instructions and feedback between patients and caregivers

	Valid responses (N)	Percentage	Counts
Cognitive ability of patient	110	60.4	67
Cognitive ability of caregiver	110	47.8	53
Function of the instruction and feedback	110	32.4	36
Age of patient	110	21.8	24
Level of involvement of the caregiver	110	18.0	20
Age of caregiver	110	9.9	11

4.5 Discussion

We aimed to examine physiotherapists' self-reported preferences for using external or internal FOA when delivering instructions and feedback. Our results support our first hypothesis that physiotherapists tend to prefer using internal rather than external FOA, with medium to large effect sizes. This finding is consistent with previous studies involving smaller samples with observational designs in the UK and in the Netherlands (Johnson et al., 2013; Kal et al., 2018) and a similarly large sample with a survey design in Canada (Hussien & Ste-Marie, 2023). Preference for internal FOA was consistent for instructions and feedback, similar to Canadian physiotherapists (Hussien & Ste Marie, 2023). Our findings contribute to understanding physiotherapists' use of FOA for instruction and feedback from the context of a developing country in Asia. Physiotherapists have been described to be more attuned to instruct patients on "how to" move (Johnson et al., 2013), possibly explaining this preference for internal FOA, which appears consistent, including for those practicing in low-resource settings such as the Philippines.

One potential factor that may influence the use of FOA is the existing educational practices within physiotherapy training programs (Hussien et al., 2023). Many physiotherapy programmes emphasise teaching students about the mechanics of movement, focusing on how to instruct patients on the internal processes of their bodies. This approach aligns with traditional educational models that prioritise detailed anatomical and physiological knowledge, which may inadvertently lead to a preference for internal FOA. Research indicates that educational curricula often prioritise internal cues, as they are easier to teach and assess in a structured learning environment (Atun-Einy & Kafri, 2019). Educational experiences play a vital role in the practice patterns of physiotherapists. If training programs predominantly emphasise internal FOA strategies, practitioners may develop a habitual preference for these methods because of comfort and familiarity (Hunt et al., 2017).

Many physiotherapists may not be adequately exposed to motor learning research that investigates the use of FOA, as highlighted by Atun-Einy and Kafri (2019). Considering that nearly half of our participants reported being unfamiliar with the concept of FOA, a gap in knowledge could be a relevant explanation for our participants' overall preference for internal FOA. Based on the findings of earlier studies (Atun-Einy & Kafri, 2019, Hussien & Ste-Marie, 2023, Kal et al., 2018), we hypothesised that the majority of our participants would be familiar with the concept of FOA. This hypothesis was not supported by our findings, as there was no difference in the proportion of those familiar with FOA concepts and those unfamiliar with their use in providing instructions and feedback. Our participants' familiarity with the concept of FOA is relatively low compared with studies in other places, e.g., approximately 71% in Canada (Hussien & Ste-Marie, 2023), 79% in Israel (Atun-Einy & Kafri, 2019), and 100% in the Netherlands (Kal et al., 2018). This suggests a need to strengthen practitioners' knowledge and understanding of FOA concepts and principles because such knowledge may contribute to better delivery of instructions and feedback, leading to better treatment outcomes (Hunt et al., 2017). While we found that physiotherapists in the Philippines prefer internal FOA, evidence supporting the benefits of external FOA for clinical populations seeking rehabilitation has been growing (e.g., balance disorders, Richer et al., 2020; musculoskeletal impairments, Piccoli et al., 2018). Thus, there appears to be a gap between evidence and professional practice that needs bridging. We note, however, that such a gap is similarly apparent in relatively high-income countries such as Canada and the UK.

In contrast, Dutch physiotherapists who were observed during the treatment of clients with stroke tended to utilise internal FOA only when providing feedback (Kal et al., 2018). They generally preferred using external FOA for instructions and reported a preference for external FOA in daily practice. Kal and colleagues (2018) suggested that this preference for

external FOA might be due to participants being highly experienced and updated through continuing education on motor learning, along with the trend toward task-based training in Dutch physiotherapy practice. We therefore expected that educational attainment, years of experience, and being specialised might be associated with our participants' preference for external or internal FOA. However, our findings show that internal FOA was generally preferred regardless of education and experience. This consistent preference for internal FOA further highlights the knowledge gap among physiotherapists in the Philippines.

There is likely variable coverage of FOA strategies within the educational curricula of physiotherapy training in the Philippines. As seen in our findings, from just over half of the participants who reported familiarity with the concept of FOA, only 36.3% acquired this knowledge from their undergraduate studies (i.e., less than 20% of the respondents). Furthermore, the limited number of participants who gained knowledge on FOA and motor learning through continuing professional activities suggests limited exposure to updated research on the benefits of external FOA, which may hinder the adoption of more effective strategies.

We anticipated that preferences for internal or external FOA might vary among practitioners in different practice areas, particularly those in neurological and developmental (i.e., paediatric, geriatric) fields. This expectation is based on the understanding that neurologic and developmental paediatrics emphasise cognitive and communication concerns during physiotherapy sessions (Kleynen et al., 2015). However, our findings indicate that the majority of practitioners across all areas preferred internal FOA. We suggest that time constraints in clinical settings could possibly lead physiotherapists to favour internal FOA, as it can be perceived as easier and quicker to implement during patient interactions. This tendency is potentially compounded by the expectation for immediate results from patients, reinforcing the use of internal cues that provide straightforward guidance on movement

mechanics. Patients' expectations may be especially influential in the context of physiotherapy services being funded by out-of-pocket expenses such as those in the Philippines (World Confederation for Physical Therapy, 2019). Familiarity with traditional practices may also be a factor, as many practitioners tend to feel more secure using traditional methods learned during their education (Hicks, 1997) rather than exploring relatively new approaches that require additional cognitive effort or adjustment.

Interestingly, while the majority of cardio-physiotherapy and sport/exercise practitioners also preferred internal FOA, the proportions differed from those of nonpractitioners in these areas. With the focus on exercise in these two practice areas, it is possible that relatively more practitioners have accessed motor learning evidence on FOA drawn from research focused on sports and exercise performance. There is a relatively large evidence base supporting the use of FOA in sports, as evident in recent systematic reviews and meta-analyses (e.g., sprint performance (Li et al., 2022) and racket sports (Starzak et al., 2024)). It is also possible that external FOA aligns with physiotherapists' strategies to support patients in learning the appropriate exercise intensity and exertion levels, such as in the case of monitoring step counts in the pedometer (Butler et al., 2009) or checking heart rates on a monitor.

4.5.1 The need for Knowledge Translation

Atun-Einy and Kafri (2019) suggested that knowledge translation efforts should aim beyond enhancing awareness because even when physiotherapists are aware of FOA concepts, they may not consider whether internal or external FOA is the better option. Our participants, however, reported that they tended to consciously plan instructions and feedback and that this conscious planning was associated with a preference for internal FOA. This suggests that our participants may currently lack updated information about FOA but would

potentially consider whether internal or external FOA is the appropriate option in their specific contexts.

In practice, physiotherapists consider factors such as physiological processes, recovery, and patient prognosis (Kleim & Jones, 2008; Krakauer, 2020) when designing motor learning interventions. Findings from our qualitative data revealed that physiotherapists' primary considerations when delivering instructions and feedback were related to patients' cognitive ability, age, impairment, and responses to verbal or visual stimuli. The physiotherapists also varied the instructions and feedback between patients and caregivers while considering the cognitive ability and age of recipients. In the local culture in the Philippines, family members assume caregiving roles that are crucial to patients' functional activities and health care (Abalos et al., 2018; Zaldarriaga et al., 2024). Our qualitative findings suggest an important cultural context in which physiotherapists consider caregivers as active recipients of instructions and feedback that are adapted according to their ability to process information (i.e., cognitive).

Kal et al. (2018) noted that despite Dutch physiotherapists' consideration of patients' cognitive abilities, this factor did not influence their preference for internal or external FOA when observed in practice. Our current findings similarly showed that even when our participants actively considered the cognitive abilities of both patients and caregivers, they still generally preferred internal FOA when delivering instructions and feedback. Synthesising our findings from the quantitative and qualitative data, the physiotherapists' preference for internal FOA likely stems from a limited awareness or understanding of the benefits of external FOA, as suggested by previous studies (Zachariah, 2013; Hussien & Ste-Marie, 2023). While local physiotherapists tend to consciously plan their instructions and provide feedback to both patients and caregivers, targeted educational interventions and knowledge translation efforts are needed to enable evidence-based practice.

4.5.2 Strengths and Limitations

Most studies that have explored the use of internal and external FOA by physiotherapists have utilised observational designs, small sample sizes, and focused on stroke rehabilitation. In addition to the study of Hussien and Ste Marie (2023), the current study is the only research thus far that provides information drawn from a relatively large sample size representing a broader physiotherapy practice background. We also present new knowledge related to physiotherapy practices in a developing and low-resource country in Asia, where effectiveness and efficiency are crucial (World Confederation for Physical Therapy, 2019). Thus, the present study provides much-needed baseline information upon which we can build future efforts to bridge the gap between research and professional practice.

We acknowledge the inherent temporal limitation in cross-sectional studies such that we are unable to discount any variation over time, which can be assessed only through a longitudinal design. Moreover, knowledge from self-reports may also be limited by the possibility that what participants report may differ from their actual practices (Neil-Sztramko et al., 2017; Zachariah, 2013). This limitation is particularly relevant in our study, as participants may have been aware of the studies reporting the advantages of using external FOA in practice and could have over-reported their use of it owing to social desirability bias or a tendency to align with what is perceived as the desirable practice (Kuncel & Tellegen, 2009). Such biases can compromise the validity of self-reported data. While our questionnaire was based on previous studies and we tested the content validity, we did not perform further tests of validity and reliability. To address these limitations, future studies could employ observational methods to directly assess physiotherapists' use of FOA strategies during practice. Additionally, incorporating patient-reported outcomes could

provide valuable insights into the effectiveness and application of these strategies in real-world settings.

With convenience sampling, we cannot discount the possibility that our participants were those who were more inherently interested in research and in topics related to motor learning practices. Moreover, we did not gather information on the participants' practice settings (e.g., tertiary, primary healthcare) besides the private/publicly funded settings and thus cannot account for potential related variations. Finally, we note that the survey was delivered online. Although internet-enabled research has become widespread during the pandemic (De Man et al., 2021), our findings may not be representative of physiotherapists, who do not spend significant amounts of time online. Nevertheless, we note that the Philippines is considered a high user of the internet, with individuals spending an average of 10 hours online daily (Statista Research Department, 2023) which supports the plausibility that online recruitment enabled broad reach within the target professional population. Future studies could enhance representativeness by using probability-based sampling frames (e.g., through professional registries), stratifying recruitment by region and practice setting, and combining online with offline recruitment strategies.

4.6 Implications for Physiotherapy Practice

Through a survey design, we found that physiotherapists in the Philippines tended to use internal FOA to deliver instructions and feedback regardless of their educational and professional background. Only approximately half of the respondents reported familiarity with the principles and evidence related to FOA, which is relatively low compared to physiotherapists in other places (i.e., the Netherlands, Canada). Our respondents tended to consciously consider the cognitive abilities not only of their patients but also of the caregivers

when delivering instructions and feedback. These findings provide a characterisation of practice patterns in relation to knowledge from motor learning research in the local context.

To help bridge the gap between research and physiotherapy practice, we propose several actionable recommendations. First, targeted continuing professional development programs that translate research knowledge about FOA strategies are essential. Kafri and colleagues (2023) reported benefits from an intervention program for physiotherapists to apply motor learning knowledge to their practice, which included a didactic course and a structured guide to clinical thinking. Similarly, programs focused on FOA could include workshops and hands-on training sessions designed to equip physiotherapists with the ability to apply knowledge in various clinical scenarios. Mentorship programs that pair less experienced physiotherapists with experts may also facilitate the adoption of these strategies, with consideration for the needs and prevailing local practice environment (Gagliardi et al., 2015). Regular dissemination of research findings through newsletters and online platforms will further support ongoing education and awareness. From a long-term perspective, integrating principles of FOA strategies into physiotherapy educational curricula will enhance the preparedness of future practitioners. Finally, FOA strategies can be evaluated through systematic approaches that collect patient-reported outcomes, which could improve the quality and effectiveness of physiotherapy practice (Anderson et al., 2024). Future research could examine this topic with a particular focus on the prevailing sociocultural context in the Philippines.

Given the growing body of evidence highlighting the benefits of external FOA in facilitating motor learning, it is concerning that only half of our respondents reported familiarity with its principles and evidence and that the majority preferred to adopt internal FOA when delivering instructions and feedback. This highlights an urgent need to address the gap between research and clinical practice through knowledge translation initiatives. Such

initiatives can empower physiotherapists to adopt strategies that are evidenced to enhance patients' movement performance, ultimately leading to improved treatment outcomes. Moreover, given the ongoing shortage of healthcare workers, including physiotherapists, in the Philippines, it is essential to optimise efficiency, such as by enhancing therapy outcomes through the effective use of FOA strategies in motor learning.

4.7 Relevance to Thesis

This chapter extends the work of the previous chapters by providing context-specific insight into the current practices of physiotherapists in the Philippines regarding the use of FOA strategies. Through a cross-sectional survey, this study addresses the marked lack of regionally relevant research by examining not only the general preferences for internal or external FOA in clinical instruction and feedback but also the factors influencing these decisions including professional background, familiarity with FOA, and specific patient considerations.

The findings reveal that physiotherapists in the Philippines predominantly use internal FOA to deliver both instructions and feedback, regardless of their educational or professional background. Almost half of the respondents were unfamiliar with the concept of FOA as applied to instruction and feedback delivery. These results highlight a clear gap between current motor learning research and clinical practice, underscoring the need for targeted knowledge translation efforts to promote the adoption of evidence-based FOA strategies.

While we intended to explore the use of FOA in telehealth practice, the proportion of respondents who were engaging in telehealth turned out to be small. On the basis of our limited data, we found that those who currently deliver physiotherapy via telehealth also prefer an internal FOA for both instructions and feedback. We also found that those who practice in paediatrics and therefore are likely to provide services for children with NDDs

prefer internal over external FOA. To gain a better understanding of how FOA may be deployed in telehealth contexts for children with NDDs, we adopted an observational study design in the next study which is presented in Chapter 5.

Chapter 5: Observational Study[4]

The use of focus of attention for instructions and feedback during telehealth physiotherapy: An observational study

5.1 Commentary

This chapter presents an observational study designed to explore how focus of attention (FOA) strategies are employed by paediatric physiotherapists during telehealth sessions for children with neurodevelopmental disorders (NDDs) in the Philippines. Investigating FOA in telehealth is important, as FOA has been shown to significantly influence motor learning outcomes, and understanding its use in virtual care is crucial, while telehealth has become an increasingly common mode of service delivery for accessibility reasons. Previous research has relied primarily on self-reported data from physiotherapists, and this chapter aims to build on those findings by using direct observation to capture actual clinical practices in a real-world virtual care setting. The use of telehealth in paediatric physiotherapy presents unique opportunities and challenges, especially in a lower-resource Southeast Asian context, particularly in the Philippines, where accessibility and equity are ongoing concerns in relation to health services such as physiotherapy. This study aims to bridge the gap between existing motor learning evidence and its practical application in telehealth, exploring how FOA strategies are utilised through remote interventions. By focusing on this emerging mode of care, this chapter addresses an important knowledge gap,

[4] This chapter is based on a manuscript that has been submitted for publication: Eguia, K.F., Ng, S.S.M., Capio, C.M., Wong, T.W.L. (under review). The use of focus of attention for instructions and feedback during telehealth physiotherapy: an observational study. *Physiotherapy Theory & Practice*.

facilitating the development of more tailored knowledge translation efforts that reflect the realities of telehealth service delivery in the Philippine healthcare environment.

5.2 Introduction

Telehealth has emerged as a viable mode for delivering physiotherapy through digital platforms, which have been suggested to increase accessibility and offer flexibility while maintaining comparable outcomes to those of in-person therapy sessions (Davies & Lawford, 2024; Zischke et al., 2021). In paediatric physiotherapy, telehealth came to fore during the COVID-19 pandemic as a means to ensure the continuity of care for children with disabilities (Chivate et al., 2022). The continuing development of technology and evidence from the pandemic period suggest that telehealth represents an effective alternative service delivery mode for children (Hall et al., 2021). Telehealth in physiotherapy has become an important alternative to in-person care because of its benefits in improving accessibility, reducing costs, and offering flexible care options (Kumar et al., 2022; White et al., 2025). Research shows that telehealth-delivered physiotherapy can achieve outcomes comparable to those of in-person treatment, making it a viable option for rehabilitation (Hinman et al., 2024; Kumar et al., 2022). These benefits are especially critical in areas with limited healthcare infrastructure or travel barriers, such as the geographically isolated regions of the Philippines with poor physical accessibility (Collado, 2024).

In the paediatric physiotherapy context, telehealth relies heavily on active caregiver involvement, effective therapist-family communication, and adaptation of interventions to the home environment (Fishman & Elkins, 2022). In the Philippines, a study during the pandemic also revealed that physiotherapists reported a heightened reliance on verbal instructions and feedback during telehealth for children with neurodevelopmental disorders (NDDs), which

presented a challenge to practitioners (Eguia & Capio, 2022). This study aims to establish knowledge that will contribute to addressing this challenge through motor learning strategies.

5.2.1 Focus of attention for instructions and feedback

Movement-related instructions and feedback that are delivered through demonstrations, tactile cures, or verbal instructions constitute a critical component of physiotherapy practice (Palisano et al., 2018). Instructions are guidelines or directions provided to learners to help them understand and focus on the components of a motor task before performing it, whereas feedback is information given to learners about their performance during or after the movement (Palisano et al., 2018; Schmidt & Lee, 2020). Instructions and feedback are also considered key elements of motor learning (Kleynen et al., 2020) and are especially crucial for children with NDDs because of the potential physical constraints, sensory impairments and cognitive challenges that may affect how they process movement-related information (Gordon & Magill, 2016). NDDs include conditions such as cerebral palsy (CP), developmental coordination disorder (DCD), autism, intellectual disability (ID), dyslexia, and attention deficit-hyperactivity disorder (ADHD) (American Psychiatric Association, 2022).

A growing body of research has shown that instructions and feedback that direct the learner's focus of attention (FOA) to the effect or outcome of the movement (i.e., external) are more advantageous than those that direct the FOA to the learner's own body (i.e., internal) (Neumann, 2019; Wulf, 2013). McNevin and colleagues (2003) proposed that externally focused instructions (e.g., "kick the ball to the target") promote automatic control of movement, whereas internally focused instructions (e.g., "lock your ankle as your forefoot hits the ball") lead to heightened consciousness, which can disrupt automatic movement control. Moreover, external FOA instructions direct attention to an actual goal (i.e., the

outcome), which influences the learners' sense of satisfaction and competence associated with their ability to achieve those goals (Wulf & Lewthwaite, 2016).

The proposed mechanisms support the potential utility of integrating FOA strategies in paediatric physiotherapy, especially for children with NDDs, who often experience difficulties sustaining attention and maintaining motivation (American Psychiatric Association, 2022; Ghanizadeh, 2011; Koegel et al., 2010; Novak et al., 2013). A review of studies involving children revealed that external FOA tends to be more advantageous than internal FOA (Eguia et al., 2023). This finding suggests that translating this knowledge about FOA strategies to paediatric physiotherapy practice could potentially contribute to improving the treatment outcomes of children with NDDs (Hunt et al., 2017). For telehealth practice, such knowledge could be critical, given the challenges associated with a heightened emphasis on verbal instructions and feedback (Eguia & Capio, 2022).

5.2.2 Physiotherapists' practice in relation to FOA

To develop suitable knowledge translation efforts, we need to understand local contexts by understanding how practitioners utilise FOA strategies along with the factors that are associated with their practice (Hussien, Gignac, et al., 2023). Observations and self-reports of physiotherapists in Europe and Canada show a relative preference for internal FOA when delivering instructions and feedback (Hussien, Gignac, et al., 2023; Johnson et al., 2013; Kal et al., 2018; Zachariah, 2013).

In the Philippines, physiotherapists also self-reported a preference for internal FOA when delivering instructions and feedback (Eguia, Ng, & Wong, 2025). The physiotherapists' educational and professional background did not influence their relative FOA preference. Those who currently deliver physiotherapy via telehealth platforms also tend to use internal rather than external FOA. With only approximately half of the respondents familiar with the concept of FOA strategies, it appears that there is a need for knowledge translation efforts in

the Philippine context. However, relatively few respondents were engaged in telehealth practice, thus limiting a context-specific understanding of the use of FOA strategies.

5.2.3 Current study

While previous studies of physiotherapists' use of FOA relied on self-reports (e.g., Eguia et al., 2025; Hussien et al., 2023), direct observation of physiotherapists' clinical sessions could capture authentic and real-world descriptions of practice because it reveals actual behaviours (Fix et al., 2022; Fritz & Overmeer, 2023). Building on the existing knowledge of the Philippine context that has been drawn from physiotherapists' self-reports (Eguia, Ng, & Wong, 2025), the current study aims to examine paediatric physiotherapists' practices in relation to FOA strategies when delivering instructions and feedback during telehealth using an observational design. The relative FOA preference adopted by physiotherapists during telehealth is determined through structured observation informed by previous studies of physiotherapy practice (Johnson et al. 2013; Johnson et al. 2023; Kal et al. 2018; van der Veer et al. 2023). Based on previous studies (Hussien & Ste-Marie, 2023; Johnson et al., 2013; Zachariah, 2013), we expect that physiotherapists will display a relative preference for internal or external FOA when giving instructions and feedback. While it has been shown that physiotherapists' background is not associated with their relative preference for FOA strategies, we explore whether patients' background contributes to such relative FOA preferences. The current study focuses on the Philippines, where telehealth could address equity and accessibility issues in paediatric physiotherapy services (Eguia & Capio, 2022).

5.3 Methods

We adopted an exploratory observational design, which involves systematically collecting data by observing participants in their natural clinical settings without

manipulating variables or intervening in usual care processes. This approach is deemed suitable for identifying context-dependent behaviours and generating meaningful information that represents practice during patient care (Fix et al., 2022). All procedures were reviewed and approved by the research ethics committee of the university (Ref. No. HSEARS20230206004).

5.3.1 Participants

This observational study is situated in the Philippines, and participants were recruited from two specialised paediatric therapy centres in the capital of Metro Manila. The participants included paediatric physiotherapists (n = 6) who met the following inclusion criteria: (i) delivers paediatric physiotherapy via telehealth, (ii) had at least two years of experience in paediatric practice, and (iii) has a caseload consisting of mainly children with NDDs. Each physiotherapist purposively selected two children from their caseload (n = 12) who met the following criteria: (i) aged 3 to 18 years, (ii) diagnosed with an NDD, (iii) currently undergoing telehealth physiotherapy at least once weekly, and (iv) has a physiotherapy treatment plan that includes learning movement tasks. The sample sizes were set considering that this study is descriptive and exploratory in nature, focusing on collecting detailed information about real-life situations rather than making broad generalisations. Such studies usually use small, carefully chosen samples to gather detailed, context-specific information (Aggarwal & Ranganathan, 2019; Tay & Tinmouth, 2007). Research that aims to scale up programs suggests that in designs similar to those used in the current study, findings often reach a plateau with as few as five participants and can be sufficient to capture meaningful patterns and behaviours (Boring, 2006). For example, an observational study that assessed physiotherapists' delivery of rehabilitation for Achilles tendinopathy involved two physiotherapists and five patients from each of them (Phillips et al., 2025). The

characteristics of the physiotherapists and the children in the current study are summarised in Table 5.1.

Table 5.1

Characteristics of the observed physiotherapists and their corresponding patients

Physiotherapist	Sex	Years of experience	Patient	Age/Sex	Diagnosis
P01	Female	14	C01	10 years, Male	DS
			C02	19 years, Male	DS, ASD
P02	Female	8	C03	12 years, Female	CP, ADHD, ASD
			C04	12 years, Male	DS, ASD
P03	Male	3	C05	4 years, Male	ASD
			C06	9 years, Female	DS
P04	Male	10	C07	9 years, Male	ASD
			C08	5 years, Female	ASD
P05	Female	2	C09	19 years, Male	DS, ASD
			C10	17 years, Female	CP
P06	Female	6	C11	15 years, Male	Developmental Delay
			C12	3 years, Male	DS

5.3.2 Procedures

To obtain a representative picture of telehealth sessions in paediatric physiotherapy practice, our study protocol involved recording three telehealth sessions for each patient using a videoconference system (Zoom). A minimum of three sessions per child help ensure that both routine care and spontaneous, ad hoc practice adjustments are captured. For

instance, a longitudinal observation of paediatric physiotherapy in Norway revealed that the majority of children would have attended at least three sessions (Evensen et al., 2021). Thus, employing three recorded sessions per patient reflects clinical realities and enhances data representativeness. The three sessions for each patient were completed within a 4- to 6-week period and scheduled based on the availability of physiotherapists, patients, and their caregivers, accommodating their routine schedules to minimise disruption and reflect real-world clinical practice.

Physiotherapists had full control of the content and duration of the session to ensure that routine procedures and genuine clinical interactions were captured. The researcher set up the recording but left it once the session commenced to mitigate observer bias (Johnson et al., 2023), allowing therapists and patients to interact naturally without feeling observed. Following the first recorded session, physiotherapists completed the clinician rating forms of the Developmental Profile, 4th edition (DP-4, Alpern 2020) to assess each patient's physical and cognitive development. The DP-4 is a standardised assessment designed for individuals from birth to 21 years and 11 months that evaluates five development domains: physical, adaptive behaviour, social-emotional, cognitive, and communication. It may be administered using parent/caregiver interviews, teacher checklists, or clinician ratings, which are the forms used in this study. DP-4 has been shown to have good to excellent internal consistency; moderate to high test-retest and intertester reliability; and established content, construct, and convergent validity (Alpern, 2020; Ozonoff et al., 2024).

5.3.3 Data processing and analysis

All statements during the recorded sessions were transcribed verbatim, and the duration of the session was recorded. At the very beginning of the analysis, two researchers (KE, CC) jointly coded one complete telehealth session to establish a shared understanding of the coding categories and to reach consensus on how to apply them in ambiguous cases.

Following the procedures described by Johnson et al. (2013), primary coding and categorisation of all data were conducted by the primary researcher (KE). When uncertainty arose about how to categorise a particular statement, the primary coder consulted the second researcher (CC), and disagreements were resolved through discussion. A structured categorisation system similar to that used in studies of stroke patients by Johnson et al. (2013, 2023) and Kal et al. (2018) was initially established. In this system, statements are categorised as either (i) instructions, i.e., describing a movement task or guiding task execution; (ii) feedback, i.e., information about previous execution of a movement task; or (iii) other or general chatter, i.e., general conversation or statements not related to a movement task.

In the next step, statements categorised as instruction or feedback were further categorised on the basis of focus: (i) internal or (ii) external. Drawing from a recent study involving children with DCD by van der Veer et al. (2023), two additional focus categories were added: (iii) a strategy that focused on the task requirements (e.g., the sequence of steps) and (iv) reinforcement aimed at encouraging the child to perform the task (e.g., "Well done!", "Good job!"). The categorisation system is illustrated in Figure 5.1.

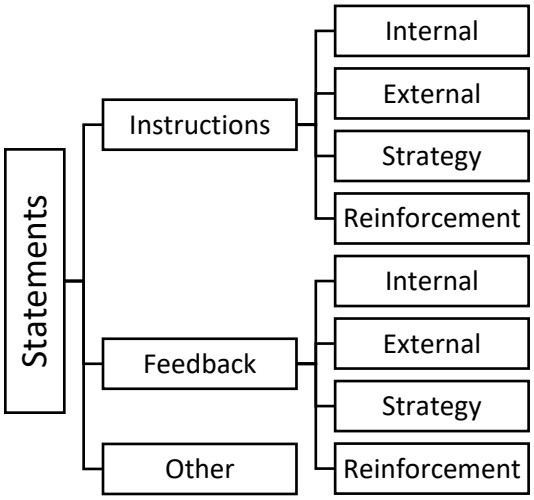


Figure 5.1. Categorisation system of statements (Johnson et al., 2013; Kal et al., 2018; van der Veer et al., 2023).

In addition to the categorisation system described above, the statements were also categorised according to the modality used for delivery: (i) verbal, (ii) visual, or (iii) mixed (van der Veer et al., 2023). Our pilot study also suggested that in the telehealth context, the statements may be categorised according to the recipients: (i) patient or (ii) caregiver (Eguia et al., 2024). This was particularly relevant because a designated caregiver was typically directly involved in each physiotherapy session conducted on telehealth. Table 5.2 summarises the variables that were recorded in each observed session.

Table 5.2

Variables recorded from the observations

Variable	Description
General characteristics of the session	• Duration • Number of statements • Frequency of statements per unit time
Nature of statements (% distribution)	• Percentage of statements – instructions • Percentage of statements – feedback • Percentage of statements – other
Focus of instructions (% distribution) Focus of feedback (% distribution)	• Internal • External • Strategy • Reinforcement
Modality of statements	• Verbal • Visual • Mixed
Audience	• Patient • Caregiver

The distribution of statements according to each categorisation group was calculated via frequency tables. To estimate the physiotherapists' preference for internal or external FOA, the relative focus score was calculated for the overall statements and separately for instructions and feedback. The following formula was used (Kal et al., 2018):

A score of 0% means that the physiotherapist used exclusively external FOA; a score of 100% means that exclusively internal FOA was used. Thus, a score <50% represented a tendency for external FOA, and a score >50% represented a tendency to prefer internal FOA. The DP-4 scores and ages of the children were normally distributed according to the Shapiro–Wilk test (all $p > 0.05$). Paired samples t tests were used to compare the distribution of instructions and feedback according to focus between those directed to the child and those directed to the caregiver. Pearson's product moment correlation coefficient was used to assess the associations of the children's age and DP-4 scores with the physical (maximum score: 41) and cognitive (maximum score: 31) subscales, with the physiotherapists' relative focus scores. For the statistical analyses, the alpha level was set at $p < 0.05$.

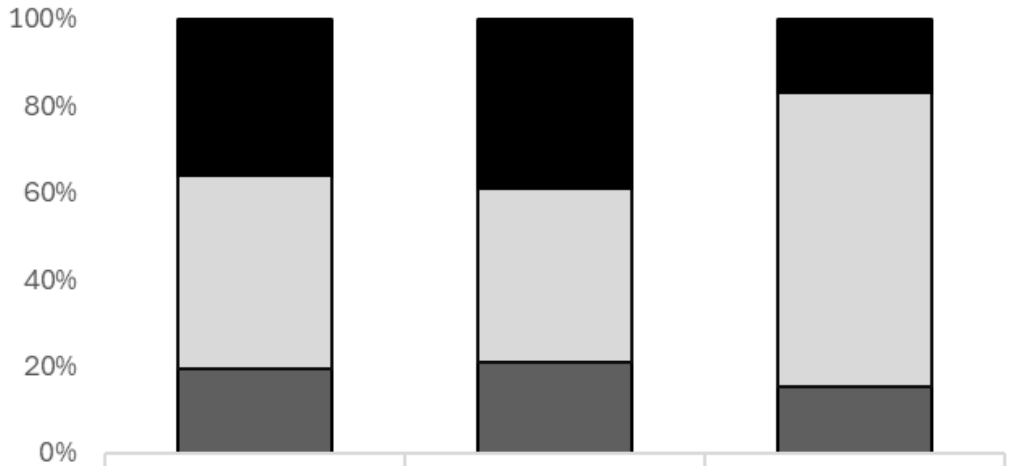
5.4 Results

A total of 36 telehealth physiotherapy sessions were recorded (i.e., 12 children x 3 sessions each). The mean duration of the observed sessions was 48.08 (SD 6.31) minutes. There was a mean of 159.69 (SD 62.20) transcribed statements, and the mean frequency was 3.28 (SD 1.01) statements per minute. The statements consisted of 44.52% (SD 10.31) instructions, 49.18% (SD 9.64) feedback, and 6.30% (SD 4.19) general chatter.

The dominant modality for delivering the statements was verbal (95.34% SD 2.41), with mixed verbal and visual modalities accounting for the remaining statements. The majority of the statements were directed towards the child (84.94%, SD 12.01), whereas the remaining statements were directed towards the caregiver (15.06%, SD 12.01).

Excluding general chatter, the majority of the statements focused on strategy (e.g., turn and squat), comprising 44.51% (SD 9.12), and reinforcements (e.g., good job), comprising 35.98% (SD 7.61). FOA was utilised in 19.50% (SD 5.74) of the statements. As

shown in Figure 5.2, FOA was utilised similarly for statements addressed to the child and to the caregiver ($t(32) = 1.39$, $p = 0.17$). The strategy statements were directed more toward the caregiver ($t(32) = -6.51$, $p < 0.001$), whereas the reinforcement statements were directed more toward the child ($t(32) = 9.78$, $p < 0.001$).

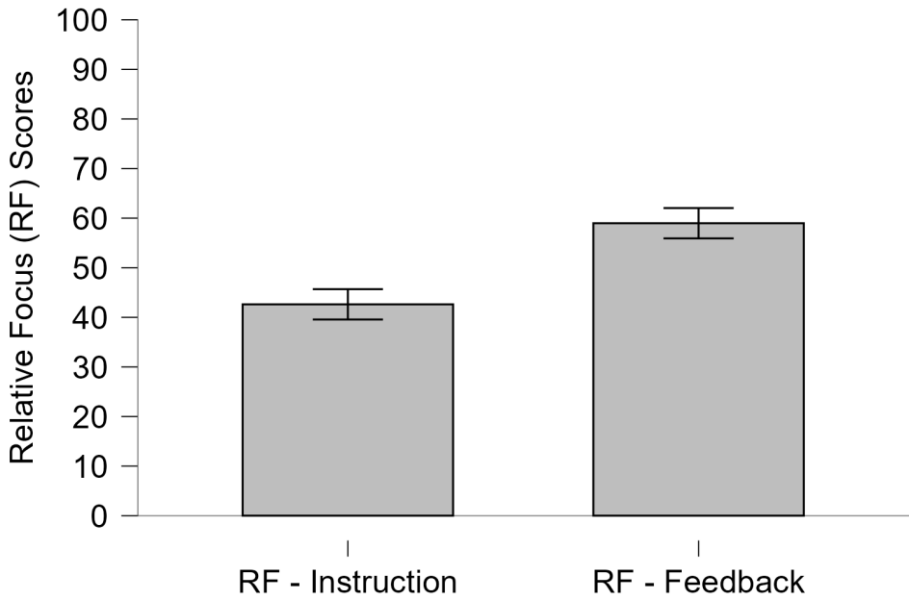


	Overall	Child	Caregiver
Reinforcement	35.98	38.90	16.80
Strategy	44.51	40.29	68.00
FOA	19.50	20.81	15.20

Figure 5.2 Comparison of the distribution of statements' focus for those directed to the child and to the caregiver.

5.4.1 Relative focus

The physiotherapists' mean relative focus scores overall were 49.05% (SD 21.80), 42.62% (SD 25.03) for instructions, and 58.98% (SD 23.80) for feedback. This means that overall, the use of internal and external FOA was evenly distributed. However, there is a trend toward a preference for external FOA for instructions and internal FOA for feedback. Figure 5.3 illustrates the mean relative focus scores for instructions and feedback.



Note: A score <50% represents a tendency for external FOA, and a score >50% represents a preference for internal FOA.

Figure 5.3 Mean (SE) relative focus scores for instructions and feedback across the observed sessions.

The children's average age was 11.83 (S.D. 6.39) years. The average DP-4 score was 24.17 (S.D. 4.81) for physical development and 24.24 (S.D. 8.85) for cognitive development. As shown in Table 3, the physiotherapists' overall relative focus scores were significantly associated with the patients' age, physical development score, and cognitive development score, where there was a greater tendency for internal FOA when the patients were older and had higher physical and cognitive development levels. The physiotherapists' relative focus scores for instructions also tended towards internal FOA when the patients had higher physical and cognitive development levels. The physiotherapists' relative focus scores for feedback tended towards internal FOA for older patients.

Table 5.3

Correlations between patient characteristics and physiotherapists' relative focus scores

Variable		1	2	3	4	5	6
1. Age	Pearson's *r*	--					
	p	--					
2. Physical development	Pearson's *r*	0.395	--				
	p	0.017*	--				
3. Cognitive development	Pearson's *r*	0.399	0.889	--			
	p	0.016*	<0.001***	--			
4. Relative focus (overall)	Pearson's *r*	0.396	0.552	0.552	--		
	p	0.017*	<0.001***	<0.001***	--		
5. Relative focus (instruction)	Pearson's *r*	0.310	0.534	0.484	0.925	--	
	p	0.066	<0.001***	0.003**	<.001***	--	
6. Relative focus (feedback)	Pearson's *r*	0.328	0.251	0.277	0.656	0.436	--
	p	0.049*	0.139	0.102	<.001***	0.008*	--

*Note: *p < 0.05; **p < 0.01; ***p < 0.001*

5.5 Discussion

We aimed to examine paediatric physiotherapists' practices when delivering instructions and feedback during telehealth via an observational design. We sought to understand how practitioners utilise FOA strategies in their local contexts, along with the factors that are associated with their practice, to develop appropriate knowledge translation plans (Hussien, Gignac, et al., 2023).

The findings from observations of actual practice confirm earlier findings that physiotherapists self-reported a heightened reliance on delivering instructions and feedback verbally during telehealth (Eguia & Capio, 2022). All instructions or feedback were delivered with verbal input.

We determined that instructions and feedback during telehealth paediatric physiotherapy may be categorised according to the recipient, i.e., the child or caregiver. Caregivers are typically actively involved in paediatric physiotherapy by delivering home

exercise programmes and acting as motivators during in-person sessions (Baker et al., 2012; Thomas et al., 2022). When the sessions are held on a telehealth platform, caregivers' roles are expanded, and they carry out the activities as guided by the physiotherapist (Tkach & Earwood, 2024). This is apparent in our findings, which show that physiotherapists' instructions and feedback are also directed to caregivers. The majority of statements directed at caregivers focus on strategies (e.g., the sequence of steps) since the caregivers are expected to facilitate completion of the task requirement. Fewer statements that focus on motivational reinforcement, which is typically delivered through the feedback provided by physiotherapists, were directed to caregivers. Since such statements were intended to encourage the child to complete the task, they were directed mostly to the child. These aspects of instructions and feedback were not relevant considerations in previous observational studies of in-person physiotherapy of adult patients (Johnson et al., 2013; Kal et al., 2018) and reflect nuanced aspects of paediatric telehealth practice. Our findings suggest that efforts to strengthen the instructions and feedback by paediatric physiotherapists for telehealth practice should consider the ways in which they can be delivered not only for children but also for caregivers. Instructions and feedback that utilised internal or external FOA comprised a relatively minor portion of the recorded statements, both for children and caregivers. This finding shows that there is a need to strengthen physiotherapists' knowledge of FOA strategies to facilitate greater use.

It appears that external FOA tends to be adopted by paediatric physiotherapists when they provide instructions. In contrast, an internal FOA is adopted when giving feedback. These findings are consistent with those of Kal and colleagues (2018), who reported that Dutch physiotherapists working with patients with stroke similarly tended to adopt external FOA for instructions and internal FOA for feedback. In contrast, the self-reported preferences of physiotherapists in the Philippines lean towards internal FOA for both instructions and

feedback (Eguia et al., 2025), similar to the Canadian physiotherapists who were surveyed by Hussien and Ste Marie (2023). This discrepancy between observed practices and self-reported preferences suggests a possible gap in physiotherapists' knowledge or awareness of their actual use of FOA. Previous research has shown that self-reports tend to differ from what participants actually do when they are observed (Neil-Sztramko et al., 2017; Zachariah, 2013). Our current findings suggest that even when physiotherapists do not appear to use evidence that favours external FOA on the basis of their self-reports (Eguia et al., 2025), they may actually be using external FOA in practice, particularly for giving instructions. The variation in our observed FOA preference between instructions and feedback, as well as between different recipients such as caregivers and children, underscores the importance of tailored knowledge translation strategies. Knowledge translation efforts should take an approach that builds on enhancing physiotherapists' understanding and application of FOA, taking into account the clinical context and individual considerations to promote the most suitable use of either internal or external FOA.

We found that physiotherapists tend to prefer internal FOA when children are older and have better physical and cognitive development levels, suggesting that they have the cognitive capacity to process internal FOA instructions and feedback. Working memory capacity and information-processing efficiency increase across childhood, enabling older children to hold and manipulate greater amounts of information than younger children (Cowan, 2022). It has been suggested that external FOA is more implicit than explicit (van Abswoude et al., 2021) and therefore is relatively less reliant on cognitive resources (Steenbergen et al., 2010). Therefore, from a theoretical perspective, external FOA would be more suitable for children with less mature development and working memory capacity which might explain the observation that physiotherapists tend to use external FOA for children with less mature development. In a qualitative study of physiotherapists' use of

motor learning for children with developmental disorders, age and cognition were among the child's characteristics that Dutch physiotherapists considered (van der Veer et al., 2022). In our current study, it is possible that the tendency towards internal FOA for children with more mature development stems from the physiotherapists' expectations that the opportunity to learn through cognitive processes should be utilised. Brocken et al. (2016), however showed that external FOA was advantageous for children and this was not associated with age nor verbal working memory capacity. In contrast, van Abswoude et al. (2018) found that children benefit from both internal and external FOA instructions in the short term but also not affected by working memory capacity. As such, while the theoretical expectation is that external FOA may be deployed with limited cognitive capacities, limited support comes from the available empirical evidence. While the overall evidence in children tends to favour external FOA (Wulf & Lewthwaite, 2016), one aspect to consider for future knowledge translation is whether there are benefits to adopting an external FOA for both instructions and feedback even when patients have the cognitive capacity to process internal FOA statements. While the survey study in this dissertation revealed that the professional backgrounds of physiotherapists in the Philippines do not influence their relative FOA preference, the backgrounds of their patients do. Further research can explore these considerations, such as qualitative studies that would allow physiotherapists to explain their considerations when using internal or external FOA when delivering instructions and feedback.

5.5.1 Strengths and limitations

This is the first observational study of physiotherapists' use of FOA for delivering instructions and feedback in a paediatric telehealth context. By drawing from the methods of previous studies, we were able to identify physiotherapists' relative FOA preferences on the basis of actual practice. By conducting multiple observations for each child, we were able to account for variations in paediatric sessions that tend to occur due to the child's disposition

(e.g., mood, tantrums). Although we observed a greater number of sessions than those reported in previous studies (e.g., 8 sessions (Johnson et al., 2013); 26 sessions (Kal et al., 2018)), our findings are still based on a relatively small sample of physiotherapists and children, which limits generalisability. In addition, the sample's composition limits generalisability across NDD groups. Most participants had Down syndrome and/or autism spectrum disorder, reflecting the local caseload. Thus, the observed FOA patterns likely apply mainly to these groups, and FOA use may vary with each condition's unique needs. Future research can consider larger and more diverse samples, with multiple similar sessions per child, to enable stronger conclusions about patterns of FOA use across NDD profiles.

5.6 Conclusion

On the basis of observations of actual telehealth practice, we found that paediatric physiotherapists in the Philippines tend to adopt external FOA when delivering instructions and internal FOA when giving feedback. The relative FOA preferences are associated with the age, physical development, and cognitive development of the patients. While evidence supports the benefits of external FOA, the findings of the current study inform future targeted knowledge translation efforts by emphasising that FOA use is context dependent, specifically within telehealth settings. These efforts should guide therapists on how and when to appropriately apply external or internal FOA based on patient characteristics and therapy goals, thereby helping to bridge the gap between research and clinical practice. Given the constraints and heightened reliance on verbal instructions in telehealth, this study provides important baseline information to support the ongoing development and improvement of effective paediatric physiotherapy telehealth delivery.

5.7 Relevance to Thesis

This chapter advances the findings of previous studies by moving beyond self-reported data to directly observe how paediatric physiotherapists in the Philippines use FOA strategies during telehealth sessions with children with NDDs. It addresses a key gap by providing real-world, context-specific insight into clinical practices within telehealth, which is an expanding but still underexplored mode of service delivery both in the region and other parts of the world.

By distinguishing the roles of children and caregivers as separate recipients of instructions and feedback, the chapter highlights important clinical details specific to paediatric telehealth. Caregivers' involvement in facilitating therapy tasks and the different FOA strategies used for children and caregivers demonstrate thoughtful clinical decision-making. Additionally, variation in FOA preferences based on patient developmental factors, such as age, physical ability, and cognitive capacity, provides a deeper understanding of how therapists adapt motor learning principles to meet individual needs.

These findings enrich the thesis by bridging gaps between theory, self-reports, and actual practice, thereby informing targeted knowledge translation efforts for paediatric physiotherapy in the Philippine context. With these new insights in mind, the next chapter focuses on knowledge translation strategies to support physiotherapists in effectively integrating evidence-based FOA practices into their clinical work. Together, these chapters guide efforts towards improved therapeutic outcomes and more equitable care for children with NDDs in the Philippine healthcare system.

Chapter 6: Knowledge Translation[5]

The use of focus of attention in paediatric physical therapy: translating motor learning knowledge to practice

6.1 Commentary

This chapter presents a mixed-methods study evaluating the impact of an online knowledge translation (KT) activity designed to increase Philippine physiotherapists' awareness, knowledge, self-efficacy, and application of focus of attention (FOA) strategies in paediatric physiotherapy, specifically for children with NDDs. While motor learning principles, including the strategic use of FOA, are well supported by research, their integration in clinical practice remains inconsistent, especially in lower-resource and culturally diverse settings such as the Philippines. This study addresses the critical gap in translating evidence-based motor learning strategies into paediatric physiotherapy using an online KT intervention tailored to the local context, guided by the Knowledge-to-Action (KTA) framework. The findings demonstrate significant improvements in therapists' understanding of and confidence in the use of FOA strategies, a measurable shift toward a preference for external focus, and real-world clinical adoption of these concepts. Importantly, this study reveals the organisational and individual factors influencing implementation and highlights emerging opportunities, such as telehealth, for FOA integration. This work shows that an online KT activity, designed based on context-specific and evidence-based knowledge, could contribute to enhanced utilisation of motor learning principles in paediatric

[5] This chapter is based on a manuscript that will be resubmitted for publication: Eguia, K.F., Ng, S.S.M., Capio, C.M., Wong, T.W.L. (in preparation). The use of focus of attention in paediatric physical therapy: translating motor learning knowledge to practice. *Advances in Health Science Education.*

physiotherapy. To facilitate adoption, future efforts should address identified barriers while building on facilitators. Additionally, this work emphasises the need for ongoing, context-sensitive educational initiatives and system-level support to narrow the gap between knowledge and practice, ultimately aiming to optimise therapy outcomes for children with NDDs in resource-constrained environments.

6.2 Introduction

The facilitation of learning and/or re-learning skills is fundamental to physiotherapy practice, with practitioners continuously looking for more effective and efficient methods to promote motor skill acquisition. Despite motor learning strategies being widely acknowledged as integral to physiotherapy, evidence suggests that their application in clinical settings remains limited (Kafri & Atun-Einy, 2019). Previous investigations have explored the factors contributing to this underutilisation. For example, physiotherapists have been reported to have moderate self-efficacy for implementing motor learning principles, with a lack of knowledge and time being major barriers to implementation (Atun-Einy & Kafri, 2019). Levac and colleagues (2016) suggested that it can be challenging for therapists to identify relevant motor learning strategies for use due to their abundance and the lack of consensus on terminology. A Delphi study reached a consensus on the definitions of implicit and explicit motor learning and identified seven primary strategies within this context but did not reach a consensus on whether these strategies promote implicit or explicit learning (Kleynen et al., 2014). Additionally, limited educational resources and time constraints contribute to the underuse of motor learning strategies by physiotherapists (Rothuizen et al., 2024). In the present study, we implemented a KT activity to facilitate the utilisation of motor learning knowledge in physiotherapy practice, with particular emphasis on the knowledge and evidence related to the use of FOA when delivering instructions and feedback.

6.2.1 Focus of attention (FOA)

Providing instructions and feedback, key elements in motor learning, is a critical component of physiotherapy practice. Instructions are statements communicated to the patient about a specific desired action or the method for performing a skill, whereas feedback consists of statements that provide information on previously observed movements with the goal of guiding or adjusting future attempts (Johnson et al., 2013). These elements are especially important in paediatrics, where children with neurodevelopmental disorders (NDDs) may face physical, sensory, and cognitive challenges that affect how they process movement-related information (Gordon & Magill, 2016). Instructions and feedback can be framed to guide the patient's FOA either internally or externally. Internal FOA directs attention to the body's own movements or mechanics (Wulf, 2013), such as the placement of the feet. In contrast, external FOA directs one's attention to information in the environment that relates to the movement, such as markers on the floor. For example, an internal FOA instruction for a child who is practicing throwing a ball could be "focus on bending your wrist as you release the ball". An external FOA instruction, on the other hand, could be "try to hit the blue target on the wall with your ball".

There has been growing evidence that external FOA instructions are advantageous because they promote automatic control of movement, whereas internal FOA leads to deliberate conscious control of movement (McNevin et al., 2003; Wulf, McNevin, et al., 2001). Wulf and Lewthwaite (Wulf & Lewthwaite, 2016) also suggested that external FOA instructions direct attention to an actual goal (i.e., the outcome or result), which contributes to goal-action coupling. A comprehensive 15-year review revealed benefits of using external FOA for movement effectiveness and efficiency (Wulf, 2013). Further reviews that examined the use of FOA among children revealed that the use of external FOA tends to be beneficial for children, including those with NDDs (Eguia et al., 2023; Simpson et al., 2021). Despite

growing evidence suggesting the benefits of using FOA strategies in physiotherapy, this knowledge seems to have limited reach in practice, which KT could help address.

6.3 Knowledge Translation (KT)

KT consists of the synthesis, exchange, and application of research findings to ensure that evidence reaches and is understood by diverse audiences, including clinicians (Khalil, 2016; Straus et al., 2011). It could involve strategies that range from developing conceptual frameworks to training activities (e.g., workshops, courses) and audits (Jamtvedt et al., 2006; Menon et al., 2009; Scott et al., 2012).

Specific to motor learning research, KT efforts have focused on the development of conceptual frameworks (e.g., (Kleynen et al., 2020; Winstein et al., 2014) and instruments that aim to understand physiotherapists' knowledge and understanding of motor learning principles (Levac et al., 2011; Ryan et al., 2020). One study implemented and evaluated a KT activity that included a didactic course to build Israeli physiotherapists' capacity to integrate general motor learning knowledge into their practice (Kafri et al., 2023). They reported that the intervention enhanced physiotherapists' self-efficacy and self-reported use of motor learning principles in their general practice.

One other study applied a systematic approach to translate FOA knowledge to Canadian physiotherapy practice (Hussien, Khodko, et al., 2023).Based on the input of practitioners, the intervention combined a virtual workshop with asynchronously accessible online modules. They reported that the intervention enhanced physiotherapists' self-reported knowledge, skills, attitudes, and self-efficacy through the application of FOA knowledge in practice. The participants also reported greater use of external FOA and perceived enhanced client outcomes.

6.3.1 Current Study

There continues to be limited work on the systematic translation of FOA knowledge to physiotherapy practice, especially in non-Western contexts. The KTA framework (Graham et al., 2006) is a well-established and widely utilised model that guides the systematic implementation of evidence-based healthcare interventions. It comprises two interconnected and iterative phases: (i) knowledge creation and (ii) action cycle. The knowledge creation phase involves generating, appraising, and synthesising research evidence, which forms the basis for developing tools to facilitate KT. This foundational knowledge is critical for ensuring that recommendations are evidence-based and relevant. The action cycle focuses on the dynamic process of applying this knowledge in specific clinical or community settings by tailoring it to local contextual factors. This includes identifying barriers and facilitators that may influence the implementation process, adapting interventions to meet the needs of the target users or environment, and implementing strategies to promote uptake (Manns, 2021). Studies have demonstrated how using the KTA framework can facilitate the embedding of evidence-based stroke rehabilitation practices into clinical settings (Janzen et al., 2016) and identify gaps and barriers to standardised assessment tools in physiotherapy, leading to tailored interventions that enhance practice (Sibley & Salbach, 2015b).

This current study is contextualised to paediatric physiotherapists in the Philippines and was guided by the KTA framework. The knowledge creation component draws on existing evidence demonstrating the benefits of external FOA for movement skill performance across populations (Wulf, 2013), including children with NDDs (Eguia et al., 2023; Simpson et al., 2021). The reviews presented in Chapters 2 and 3 of this dissertation contribute to the evidence. Knowledge of how physiotherapists in the Philippines utilise FOA when delivering instructions and feedback in general and in telehealth practices has been established in prior studies presented in Chapters 4 and 5 of this dissertation. A survey of

Filipino physiotherapists revealed a predominant use of internal FOA during instruction and feedback, regardless of educational or professional background, whereas only half reported familiarity with FOA concepts, highlighting the need for KT activities (Eguia, Ng, & Wong, 2025). An observational study in paediatric telehealth further showed that local physiotherapists prefer external FOA for instruction but internal FOA for feedback. Although participants prefer external FOA for telehealth instructions, its use is only just above 50%, leaving room to increase its application (Eguia et al., 2024).

In the context of the Philippines, telehealth presents a useful platform for addressing critical equity and accessibility issues in therapy services, and it has been shown to empower parents of children with NDDs through their active involvement in therapy (Eguia & Capio, 2022). Informed by the knowledge that had been previously generated, we commenced the action cycle by designing a KT activity consisting of an online workshop with synchronous and asynchronous components. The research question focuses on the effects of the KT activity on physiotherapists' relative focus, knowledge, self-efficacy, and use of FOA strategies in the delivery of instructions and feedback for children with NDDs. While previous studies have assessed the quantitative outcomes of KT on the basis of physiotherapists' self-reports of knowledge and self-efficacy (Hussien, Khodko, et al., 2023; Kafri et al., 2023), we adopted a mixed-methods approach to conduct a more comprehensive evaluation. Mixed methods research integrates quantitative and qualitative approaches within a single study, offering a comprehensive understanding of the subject at hand (Rana & Chimoriya, 2025; Tariq & Woodman, 2013). This methodology allows researchers to capitalise on the strengths of both approaches, gathering broader quantitative data alongside deep qualitative insights (Shorten & Smith, 2017). In this study, alongside the quantitative measurement of KT outcomes, we gathered qualitative data to (i) gain an in-depth understanding of how the KT activity impacts clinical practice in real-world settings and (ii)

explicitly identify facilitators of and barriers to the use of FOA strategies, including those unique to the telehealth context.

6.4 Methods

Physiotherapists participated in an online workshop with synchronous and asynchronous components. A sequential mixed-methods design (Creswell & Plano Clark, 2018) was adopted to evaluate the effects of the KT activity on the uptake of FOA evidence to paediatric physiotherapy practice. The initial quantitative phase assessed the impact of the KT activity on physiotherapists' FOA preference, awareness, knowledge, self-efficacy, and implementation of FOA. The subsequent qualitative phase gathered insights into how the KT activity influenced clinical behaviour and identified contextual facilitators and barriers to applying FOA strategies, including challenges specific to telehealth delivery. All procedures were reviewed and approved by the university research ethics committee (HSEARS20240603001).

6.4.1 Participants

The participants consisted of physiotherapists (n = 127) who met the following criteria: (i) registered physiotherapist in the Philippines, (ii) had at least two years of experience in paediatric practice, and (iii) have a caseload that includes children with NDDs. All physiotherapy degree programs leading to registration in the Philippines use English as the medium of instruction; hence, all physiotherapists can read and understand the English language for professional purposes. Participants were recruited through purposive convenience sampling to ensure the selection of participants who met the inclusion criteria while maintaining practical feasibility. Based on the most recent country profile from the World Physiotherapy (World Physiotherapy, 2025), there are 17,556 physiotherapists in the Philippines. The number of practising paediatric physiotherapists in the Philippines is not

known but based on available international paediatric specialisation rates (approximately 7.11%; (American Physical Therapy Association, 2023), a paediatric physiotherapy population of about 1,248 in the Philippines is suggested. Post hoc calculations revealed a <5% margin of error at the 95% confidence level for survey responses with 127 participants.

6.4.2 Procedures

Invitations to participate in a KT activity were publicised through multiple channels, including social media pages of the national physiotherapy professional association, a local physiotherapy academic journal, and specialist groups (i.e., the paediatric special interest group). Further invitations were emailed to clinics, centres, and hospitals providing paediatric physiotherapy services whose contact details were publicly available. Potential participants were invited to register for the activity and answer a preactivity questionnaire on Qualtrics. The preactivity questionnaire consisted of three parts. The first part focused on professional background (i.e., educational attainment, years of paediatric practice, and engagement in telehealth practices). The second part consisted of questions adopted from previous research that assessed the participants' preferences for using internal or external FOA on the basis of instructions and feedback statements presented in clinical scenarios (Eguia, Ng, & Wong, 2025). The third part included questions from previous research on participants' awareness, self-efficacy, implementation, and knowledge of FOA in relation to their practice (Hussien, Khodko, et al., 2023; Kafri et al., 2023).

The KT activity consisted of a two-hour synchronous webinar delivered by a researcher physiotherapist specialised in paediatrics (>10 years of clinical practice) and motor learning (>15 years of active research). Based on previous evidence related to the translation of FOA knowledge (Hussien, Khodko, et al., 2023) and recent evidence syntheses including those presented in Chapters 2 and 3 of this dissertation (Eguia et al., 2023; Eguia, Ng, & Wong, 2025), the webinar covered the following components: (i) definitions of FOA

concepts, (ii) summary of evidence in relation to children, including those with NDDs, (iii) examples of external and internal FOA for the delivery of instructions and feedback, and (iv) active discussion of external and internal FOA for specific case scenarios. The webinar delivery also incorporated principles from social cognitive theory, which emphasises learning through observation; the importance of self-efficacy; the dynamic interaction between personal, behavioural, and environmental factors (Bandura, 1986); and adult learning theory, which highlights adults' need for relevant, practical, and self-directed learning based on prior experience, promoting active engagement and reflection (Lippitt et al., 1984). Supplementary learning materials (i.e., webinar slides, evidence synthesis papers, case scenarios) were made available online for asynchronous access. A dedicated email address was also provided for participants to send questions, share experiences, and request feedback from the workshop facilitator. Those who attended the webinar and received the asynchronous learning materials were invited to complete a postactivity questionnaire on Qualtrics within 72 hours after the webinar.

The postactivity questionnaire reassessed the participants' FOA preferences using clinical scenarios, which is the same instrument used in the survey study reported in Chapter 4 of this dissertation (Eguia, Ng, & Wong, 2025). The questionnaire also assessed the participants' awareness, self-efficacy, implementation, and knowledge of FOA in relation to practice (Hussien, Khodko, et al., 2023; Kafri et al., 2023). In addition, participants rated their satisfaction with and perceived relevance of the webinar to their practice.

The participants who reported that they deliver telehealth sessions to children with NDDs (n = 38) were invited to participate in individual interviews. Six participants consented to join the individual interviews, which were conducted three to four weeks post-webinar and lasted for 30 to 40 minutes each. A small sample size is appropriate for qualitative interview studies aiming to gain an in-depth understanding of specific situations rather than to

generalise findings (Crouch & McKenzie, 2006). Research suggests that five to nine cases are sufficient for code identification (Hennink & Kaiser, 2022; D. S. Young & Casey, 2019). Open-ended questions and probes were developed from previous research (Kafri et al., 2023) to explore the participants' (i) perceptions and clinical practices following the KT activity and (ii) considerations and factors (i.e., facilitators, barriers) that influence their preferences for and use of external or internal FOA in practice. All the interviews were audio-recorded and transcribed verbatim.

6.4.3 Data analysis

Quantitative analysis was performed using descriptive statistics for data from dichotomous questions and inferential statistics for data from scale-response items. For the inferential statistics, alpha was set at $p < 0.05$.

The first part of the questionnaire collected demographic and professional information from participants, and descriptive statistics were used to summarise the variables including educational attainment, years of paediatric practice, and involvement in telehealth services.

From the second part of the questionnaire, relative focus scores were calculated to categorise participants' FOA preference as internal (i.e., scores below the midpoint) or external (i.e., scores above the midpoint) (Kal et al., 2018). Based on the three statements each for instructions and feedback, scores ≤1.5 reflected a preference for internal FOA; scores > 1.5 reflected a preference for external FOA. The overall FOA preference, which is based on combined instruction and feedback statements, was determined by a threshold of ≤3.0 for internal FOA and > 3.0 for external FOA. Owing to the data not being normally distributed, the Wilcoxon signed-rank test was used to examine the pre- to postactivity changes in relative focus scores, assessing whether there were statistically significant differences in the median FOA preference scores following the KT activity. A chi-square test was performed to assess the hypothesis that the distribution of participants who preferred

internal or external FOA would change following KT activity. Cohen's φ was calculated for effect size, with small/medium/large benchmarks of 0.10, 0.30, and 0.50 respectively (Cohen, 1988).

From the third part of the questionnaire, scale–response scores were calculated for webinar satisfaction and relevance, as well as for participants' awareness, self-efficacy, and implementation of FOA. Dichotomous items (correct/incorrect) were scored to calculate knowledge scores. To test the hypothesis that participants would display improvements in awareness, self-efficacy, implementation, and knowledge related to FOA following KT activity, Wilcoxon signed-rank tests were conducted due to non-normal data distributions with rank biserial correlations to calculate effect size (Kerby, 2014). To ensure that years of clinical experience and educational background did not influence the observed changes, change scores were computed for all variables. Spearman's rho correlations were then used to assess the relationships between years of experience and these change scores, whereas Mann–Whitney U tests were used to compare change scores across educational background groups.

Thematic analysis was performed on the qualitative data generated from the interviews. A realist framework was adopted, which assumes that participants' language reflects their actual experiences (Terry et al., 2017). A pragmatic framework was also considered, where the analysis is positioned in the context of each physiotherapist's experience (Yardley & Bishop, 2017) of the KT activity and their recent clinical practice. Using an inductive approach (i.e., bottom-up), we defined coding units (i.e., words, phrases, etc.) and developed a coding scheme based on recurring themes (Berthet et al., 2023). We then performed a deductive approach (top-down) based on the coding scheme that was developed in the inductive phase. Trustworthiness was established by having two researchers (first and third authors in the manuscript under review) read the interview transcripts and perform the coding independently. Differences in coding were resolved through discussion

and consensus among the research team. Saturation was reached after the fifth interview was coded. The two researchers who performed the coding are also paediatric physiotherapists; hence, qualitative analysis is subject to the researchers' personal reflexivity (Olmos-Vega et al., 2023).

6.5 Results

6.5.1 Sample characteristics

The participants' years of experience ranged from one month to 26 years (mean 5.01 years S.D. 5.51). The majority had completed a bachelor's degree (82%), while approximately one-third engaged in telehealth practices. The participants' education and practice backgrounds are summarised in Table 6.1. Among the 127 participants who met the criteria, 123 completed both the preactivity and postactivity questionnaires; their responses were analysed quantitatively in the subsequent sections.

Table 6.1

Characteristics of the participants (N = 127)

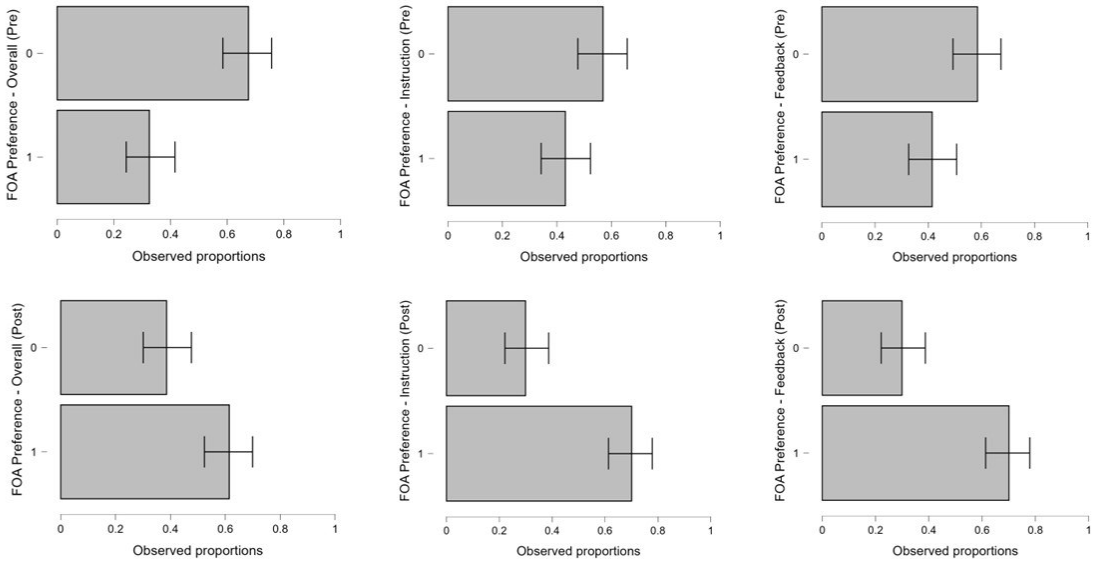
Characteristic	Category	Frequency	Percentage
Education	Bachelor's Degree	104	81.9
	Postgraduate	23	18.1
Telehealth practice	Delivers telehealth	38	29.9
	Does not deliver telehealth	89	70.1

6.5.2 Quantitative findings

6.5.2.1 Relative focus

Wilcoxon signed-rank tests indicated a statistically significant increase in overall relative focus scores ($W = 1015.00$, $p < 0.001$, $r = -0.63$) from preactivity (mean relative focus score = 2.87 S.D. 1.65; <3.00) to postactivity (mean relative focus score = 3.95 S.D.

1.81; >3.00). As evident in Figure 6.1, there was also a shift in preference where a greater proportion of the participants preferred internal FOA preactivity but preferred external FOA postactivity. The findings support the hypothesis that participants' overall preference for FOA will change following the KT activity ($\chi 2 = 10.77$, df = 1, $p = 0.001$, $\varphi = 0.30$) showing medium effect size.



	Overall		Instructions		Feedback	
	Pre	Post	Pre	Post	Pre	Post
Internal FOA (0)	83	49	70	38	72	38
External FOA (1)	40	78	53	89	51	89

Figure 6.1. Distribution of participants who preferred internal (0) or external (1) FOA overall, for instructions, and for feedback before (pre) and after (post) the knowledge translation activity (n = 123)

Table 6.2 summarises the mean relative focus scores, Wilcoxon signed-rank test statistics, and p values across categories. Wilcoxon signed-rank tests revealed statistically significant increases in relative focus scores for both feedback ($W = 716.00$, $p < 0.001$, $r = -0.61$) and instructions ($W = 827.00$, $p < 0.001$, $r = -0.54$). The preference for internal FOA pre-activity was evident across instructions (mean relative focus score = 1.47 S.D. = 0.93;

<1.50) and feedback (mean relative focus score = 1.39 S.D. = 1.05; <1.50). The preference for external FOA post-activity was evident across instructions (mean relative focus score = 1.96 S.D. = 0.92; >1.50) and feedback (mean relative focus score = 1.98 S.D. = 1.09; >1.50). However, the change in the distribution of participants' preferences for internal or external FOA was statistically significant only for feedback ($\chi 2 = 11.08$, df = 1, $p < 0.001$, $\varphi = 0.30$) showing medium effect size, but not for instructions ($\chi 2 = 1.98$, df = 1, $p = 0.16$).

Table 6.2

Mean relative focus scores pre- and post-KT activity with Wilcoxon signed-rank test results

Condition	Mean Relative Focus Score Pre-KT Activity (SD)	Mean Relative Focus Score Post- KT Activity (SD)	Maximum Possible Score	Wilcoxon Signed-Rank Test W, p value
Overall	2.87 (1.65) (Internal)	3.95 (1.81) (External)	6.00	1015.00, < 0.001
Instructions	1.47 (0.93) (Internal)	1.96 (0.92) (External)	3.00	827.00, < 0.001
Feedback	1.39 (1.05) (Internal)	1.98 (1.09) (External)	3.00	716.00, < 0.001

Notes: Scores below the midpoint indicate internal FOA preference, whereas scores above the midpoint indicate external FOA preference. FOA preference labels (internal/external) are included inside parentheses for clarity. Means and standard deviations are presented for descriptive purposes, whereas Wilcoxon signed-rank tests were performed due to the nonnormal distribution of the data.

6.5.2.2 Awareness and Knowledge of FOA

On a five-point scale, participants' awareness of FOA concepts was relatively high pre-activity (mean 3.66, S.D. 1.12) and increased significantly post-activity (mean 3.91, S.D. 1.07; W = 964.00, p = 0.019, r = -0.31) showing a medium effect size. The change in level of awareness before and after the activity was not associated with the participants' years of experience ($r_s(121) = 0.015$, p = 0.87), and there was no difference in change scores between

those with a bachelor's degree and those with postgraduate studies (U = 887.00, z = –0.42, p = 0.668).

The participants' knowledge of FOA assessed on a 3-point scale also improved significantly from pre-activity (mean 1.41, S.D. 0.87) to post-activity (mean 2.15, S.D. 0.86; W = 542.00, p < 0.001, r = -0.72) showing a large effect size. Similar to the participants' level of awareness, the change in knowledge before and after the activity was not associated with their years of experience ($r_s(121) = -0.01$, p = 0.83), nor was there a difference in change scores between those with a bachelor's degree and those with postgraduate studies (U = 1022.50, z = 0.56, p = 0.56).

6.5.2.3 Self-efficacy and Implementation of FOA

On a five-point scale, participants' self-efficacy or confidence in their ability to understand and verbally communicate the distinction between internal and external FOA improved significantly from pre-activity (mean 2.65, S.D. 1.02) to post-activity (mean 3.80, S.D. 0.94; W = 315.00, p < 0.001, r = -0.86) showing a large effect size. The change in the level of self-efficacy before and after the activity was not associated with the participants' years of experience ($r_s(121) = 0.027$, p = 0.77), nor did it differ between those with a bachelor's degree and those with postgraduate studies (U = 1125.00, z = 1.29, p = 0.19).

The reported implementation of FOA in practice, measured on a 15-point scale, increased from pre-activity (mean 9.81, S.D. 2.55) to post-activity planned implementation (mean 13.24, S.D. 1.98; W = 284.00, p < 0.001, r = -0.91) showing a large effect size. The 15-point scale represents the sum of the responses to three implementation-related questions, each rated on a 5-point Likert-type scale. As with other variables, changes in implementation were not associated with years of experience ($r_s(121) = .060$, p = 0.51), and there was no difference between educational groups (U = 757.00, z = -1.35, p = 0.18).

6.5.2.4 Satisfaction with and relevance of knowledge translation activity

On a 10-point scale, the participants reported high levels of satisfaction with the webinar (mean 9.58 S.D. 0.76) and perceived the content to be highly relevant to their clinical practice (mean 9.65 S.D. 0.81).

6.5.3 Qualitative findings

To enrich our understanding of the impact of knowledge translation (KT), we conducted qualitative interviews with a purposive subsample of participants (n = 6). These interviews aimed to explore in depth the participants' experiences, perceived changes in knowledge and practice, and factors influencing the use of FOA strategies. The subgroup of participants who participated in individual interviews had years of experience ranging from one year to 15 years. They are all currently engaged in paediatric physiotherapy for children with NDDs, including through a telehealth platform. Their clinical context comprises public and private tertiary hospital settings, private developmental clinics, private home care, private school settings, and nongovernment organisation-funded community-based rehabilitation. The characteristics of this interview subgroup are summarised in Table 6.3.

Table 6.3

Characteristics of the interview participants (n = 6)

Participant Code	Sex	Professional Background			
		Education	Years of Experience	Current Practice	Previous Practice
01	Female	BSc	5 years	Public hospital with adult neurologic and paediatric developmental cases	Private clinic with paediatric developmental cases
02	Male	BSc	3 years	Private hospital with paediatric, geriatric, neurological cases	None
03	Male	BSc, MSc	15 years	Private home care practice with paediatric, geriatric, neurological cases; University lecturer	Public hospital with inpatient and outpatient adult and paediatric cases

04	Male	BSc	1 year	School setting with paediatric developmental cases	None
05	Male	BSc	8 years	Community-based rehabilitation for paediatric developmental cases, mainly via telehealth	Private clinic for paediatric developmental cases; University lecturer
06	Female	BSc, DPT	11 years	Private clinic for paediatric developmental cases	None

6.5.3.1 Impact of the knowledge translation activity on the participants' understanding and practices related to FOA

To gain an in-depth understanding of the impact of KT activity on physiotherapists' knowledge and practice, we asked the participants what new knowledge they gained from the webinar or what changed in their practice. Four themes were identified in the participants' discussions: (i) understanding the concept of FOA, (ii) the suitability of internal or external FOA for a variety of clinical contexts, (iii) how to utilise FOA in planning and designing instructions and feedback, and (iv) increased use of external FOA. The codes, themes, and sample quotes for each code are summarised in the supplementary file.

The first theme was about an increased depth of understanding of FOA that was described by all participants. There was some prior knowledge of FOA, which was enhanced by the webinar, as Participant 04 explained: "*Theoretically, we learned that in university, but when the theories were explained, my understanding deepened*." There appears to be some shift from what participants learned previously in their education. For example, Participant 03 mentioned that "*We were trained on kinematic concepts, and I was not aware that focusing on internal or external cues matter.*" The second theme was about participants' appreciation of how FOA may be suitable across various patient populations, including those cases they previously encountered. While all the participants practiced in paediatrics, they also identified the suitability of FOA for other conditions, such as how Participant 05 explicitly

identified "*If I imagine in an adult setting, I can also use it. I see the application in musculoskeletal or neurological conditions.*"

In addition to the conceptual understanding, the participants appeared to have learned applied aspects that changed their practice. The third theme relates to how the participants described planning and designing instructions and feedback using FOA post-webinar. Participant 01 mentioned, "*I now try to simplify my instructions and actively use cues. In my daily practice, I actively think about FOA now.*" The fourth theme is consistent with the findings from the quantitative questionnaires that suggest a shift to greater use of external FOA. Each participant described actual instructions or feedback in which they shifted from using an internal FOA to an external FOA. For example, Participant 02 explained that "*Instead of saying 'bend your knees,' I said 'sit down slowly into the chair'—the instruction was more digestible.*"

6.5.3.2 Considerations and factors that influence the use of FOA in practice

To explicitly identify the facilitators of and barriers to using FOA in practice, we asked the participants about the factors that they considered when using external or internal FOA, including those that made applying the strategy difficult or easy. We identified four themes that represent the factors that the participants considered in relation to the use of FOA in their practice: (i) patient-related factors, (ii) clinic- and organisation-related factors, (iii) physical environment-related factors, and (iv) therapist-related factors (see the supplementary file for coding details).

Patient-related factors were discussed by all participants and referred to patient characteristics, including diagnosis, age, cognitive ability, and therapy goals. The participants referred to information from the webinar about the evidence supporting the suitability of external or internal FOA for specific conditions. For example, Participant 06 mentioned that "*I learned that, aside from children with autism, other neurodevelopmental disorders seem to*

benefit from external FOA." In general, internal FOA is thought to be suitable for patients who have greater receptive verbal ability (i.e., who are able to understand instructions and feedback) and those who can plan their movement. This is illustrated by Participant 01 who said that "*The verbal ability of paediatric patients affects whether I will use internal or external FOA. If it's difficult for them to understand, I will use external FOA.*" In terms of therapy goals, the participants tended to adopt internal FOA when focusing on safety-related concerns to encourage patients to pay closer attention to their movements and external FOA when the focus is on task-specific performance guiding towards effects of movement, such as reaching for an object to allow the spine to straighten naturally when trying to improve a patient's posture.

The physical environment-related factors were also widely discussed by all the participants. This theme refers to the availability of objects and materials that physiotherapists can refer to in their instructions. This factor tends to be a facilitator in school settings where the physiotherapist may perceive an abundance of objects that the patients can manipulate, such as Participant 04 who states that "*I can maximise the environment in the school, where there are many manipulatives I can truly use*." In telehealth settings, this factor is variable and highly dependent on the equipment available at the patient's home, which can sometimes pose a barrier to physiotherapists' use of external FOA.

Organisation-related factors refer to the expectations and routines that dominate the various practice settings of the participants, which appear to present barriers to the active adoption of FOA strategies. For those working in hospital settings, applying FOA strategies requires planning, the time for which may be difficult to allocate given the heavy caseload. Furthermore, there are treatment protocols adopted across practice settings, including hospitals and private clinics, that must be adapted for physiotherapists to integrate FOA strategies in their practice. For example, Participant 03 described the public hospital context

such that "*There needs to be adjustment when practising in a public hospital setting because planning for FOA may not take that long time, but the overall efficiency may be encroached.*" Aside from logistical challenges, participants also identified resistance and a lack of familiarity with FOA concepts among peers and within the organisational culture as potential barriers. Participant 03 specifically mentioned that *"few will be familiar with the concepts,"* which could influence their decision to adopt FOA. In paediatric telehealth contexts, however, the participants viewed the expectations in this setting as matched to using external FOA. Specifically, external FOA are deemed useful when giving instructions to parents or caregivers, facilitating clearer communication and understanding. Participant 05 mentioned, *"It involves parent coaching; external FOA makes them get the concept of the activity easily."*

Therapist-related factors refer to the training and experiences of physiotherapists, which they perceive to influence how they utilise FOA strategies in their practice. This theme includes references to the curriculum of physiotherapists, which is perceived by participants to set them up towards using internal FOA. For example, Participant 03 mentioned that *"If I trace the curriculum, we were trained to use more internal FOA. However, maybe the teachers need to explicitly state that there is also another option to work on external FOA?"* Hence, the participants tend to have a greater tendency to use internal FOA in their practice prior to the webinar. Notably, conscious adaptation among physiotherapists is needed if they were to adopt internal FOA, as evident in Participant 06, *"I guess it would need some planning because it's more natural for me to resort to internal FOA feedback."*

6.5.3.3 FOA strategies for telehealth practices

We also asked them how FOA strategies could be useful in telehealth practice. We identified three themes that reflect how the participants thought FOA strategies can aid in the

delivery of telehealth physiotherapy for children with NDDs: (i) adapting to the client context, (ii) enhancing instructions and feedback, and (iii) enhancing therapy outcomes.

The participants described telehealth as challenging in relation to their lack of familiarity with the patients' home environments and the variability thereof. Given that therapists cannot rely on standardised clinic equipment and therefore need to use household items as therapeutic tools or cues, they described FOA strategies as adaptable tools to accommodate the specific circumstances, resources, and routines unique to each client's setting. This adaptation involved modifying instructions and feedback to fit not only the physical environment but also the availability and involvement of family members or caregivers who played a role in therapy delivery. For example, Participant 03 explained, *"Regardless of internal or external FOA, I have options when giving instructions. But external FOA makes me focus on the options for cues in the home that are more relatable to the patient."*

Given that verbal instructions and feedback are critically important in telehealth, the participants described how applying FOA strategies immediately enhanced the clarity and effectiveness of their instructions and feedback. Several participants reported that FOA strategies enabled them to be more creative and precise in guiding movements, especially when instructing remotely and relying solely on verbal cues. Participant 01 shared that *"Instead of saying, 'Straighten your back,' I think of something he can reach for — so that his back straightens or extends naturally. That's what I do now, and it works!"* The participants also demonstrated consciousness of FOA knowledge being useful for planning instructions, as Participant 03 noted that *"The knowledge of the focus of attention actually helps when I run out of ways of giving instructions, and the patient still does not understand how to do it."* Participants further reported that the impact of FOA knowledge on enhancing instructions

and feedback extended not only to paediatric clients but also to geriatric patients during telehealth sessions.

The participants were also cognisant of how using FOA strategies generated evident improved outcomes for their patients on telehealth. These outcomes were generally related to effective movement performance, either independently by the patient or as facilitated by the parent or caregiver. For example, Participant 04 shared that *"With an obstacle course, I instructed the mom to reduce the proprioceptive input of knee compression. Instead, I instructed her to say, 'Step on the ledge, heavy foot on the chair,' and the child did the movements right away."*

6.6 Discussion

We aimed to assess the impact of a KT activity on physiotherapists' knowledge and use of FOA strategies in paediatric practice and to explore in depth perceived changes in actual practice and the factors related to FOA strategies. Guided by the KTA framework (Graham et al., 2006), we utilised knowledge that had been created in previous studies and examined the outcomes of KT activity along with the facilitators and barriers to the uptake of FOA in clinical practice.

The participants were highly satisfied with the webinar and strongly perceived the content to be relevant to their practice. Such satisfaction is important because physiotherapists who are satisfied with KT activities are more likely to engage actively, retain information, and apply evidence-based strategies in their daily practice, leading to improved confidence in implementing clinical approaches that help narrow the gap between research and practice (Babatunde et al., 2017; Kafri et al., 2023). Studies have also shown that KT training can increase participants' self-efficacy, understanding, and confidence in using KT practices, with positive outcomes being sustained for up to 24 months post-training (J. S.

Park et al., 2018). Long-term studies of KT programs have further demonstrated that therapists tend to sustain improvements in self-efficacy and self-reported changes in practice when interventions are perceived as relevant and valuable (Tilson et al., 2016). Consistent with these findings, our study revealed significant increases not only in physiotherapists' self-efficacy in the use of FOA strategies in clinical practice but also in their knowledge of FOA concepts and self-reported implementation following the webinar with large effect sizes. These improvements parallel the results from Hussien and colleagues' (2023) KT study involving Canadian physiotherapists, suggesting that well-structured educational interventions can strengthen therapists' confidence, understanding, and clinical behaviours related to FOA.

Our sequential mixed-methods design allowed us to further identify the ways in which the participants' knowledge and implementation increased. In addition to gaining a better understanding of FOA concepts, the participants gained appreciation of the suitability of internal or external FOA and how to design instructions and feedback better. The observed significant increase in awareness of FOA concepts highlights the effectiveness of KT activity in deepening participants' understanding, even among those with prior foundational knowledge. This suggests that targeted KT initiatives can move beyond raising mere awareness to fostering a deeper understanding and applied comprehension that supports better clinical decision-making (Biard et al., 2024; Légaré et al., 2016).

6.6.1 Barriers to implementing FOA strategies in practice

Although our qualitative data showed that participants are now actively implementing FOA strategies in their practice and that the quantitative data reflected their increased intention to do so following the webinar, it is important to recognise that various barriers remain. Research indicates that contextual factors can hinder consistent knowledge translation (Oborn, 2012), and identifying barriers is a key step in addressing issues related to

evidence utilisation in clinical settings (Sadeghi-Bazargani et al., 2014). In the present study, participants identified organisational obstacles such as time constraints and the existence of more traditional established protocols in hospital and clinic settings, which can restrict opportunities for integrating new approaches such as FOA strategies. Similarly, prior investigations have reported that insufficient time and a lack of managerial support are significant barriers to integrating research findings into rehabilitation practices (Montpetit-Tourangeau et al., 2020; Patel et al., 2017; Regalado et al., 2023). Environmental factors were especially relevant in telehealth contexts, where the limited availability of objects to serve as external cues was seen as a challenge. In another telehealth study, Eguia and Capio (2022) reported that therapists experienced difficulties delivering instructions and engaging children without enough physical cues. These challenges could be mitigated by ensuring access to appropriate objects that could function as external cues. The study also noted that parents identified limited material resources at home as a factor that makes teletherapy challenging. Additionally, prior studies (Elor et al., 2022) emphasised the environment as an important consideration for physiotherapists in planning telerehabilitation sessions.

In addition to organisation- and environment-related factors, the participants also identified therapist-related barriers. These barriers were linked to educational training, with many participants perceiving their physiotherapy curricula to have emphasised internal FOA, thereby influencing their habitual clinical practices. Studies have shown that curriculum orientation influences therapists' clinical reasoning abilities and approaches (Elvén et al., 2019). Our survey study reported in Chapter 4 revealed that many physiotherapists in the Philippines were unfamiliar with the FOA concept, and among those who were unfamiliar with it, only a minority had learned about it during their undergraduate studies (Eguia, Ng, & Wong, 2025). This highlights the need to better integrate motor learning principles into physiotherapy curricula. In low-resource environments such as those in low-middle income

countries (LMICs), the organisation- and environment-related factors that influence implementation of motor learning evidence should be considered in curricular design. Similarly, in Canada, there is a call to explore the integration of motor learning strategies into physiotherapy education because although current instruction may provide adequate motor learning content, there are insufficient opportunities to optimally apply motor learning principles in practice (Bramley et al., 2018). The findings from this research should then be disseminated to the governing bodies that set and operationalise standards and guidelines for physiotherapy education in the Philippines – i.e., the Commission on Higher Education and the Professional Regulatory Board of Physical Therapy.

Similar organisational and individual challenges related to balance and gait assessment in physiotherapy have been documented in KT research. Our findings reinforce the need for more comprehensive integration of motor learning principles—including FOA strategies—into the physiotherapy curriculum and clinical training programs. Continued professional education programs also represent crucial avenues for disseminating current motor learning evidence to practicing therapists (Bramley et al., 2018) and encouraging the incorporation of such evidence into clinical protocols.

6.6.2 Shift in FOA preference

Organisational and individual barriers to KT are reflected in the clinical behaviours and FOA preferences of therapists. Two empirical studies in this dissertation showed that physiotherapists in the Philippines have an overall preference for internal FOA (Eguia et al., 2025; Eguia et al., 2024). In the present study, the participants similarly preferred internal FOA prior to the KT activity. We subsequently found a shift in relative focus after the KT activity, where the participants displayed an overall preference for external FOA. It appears that when research knowledge about FOA was presented in the context of local paediatric practice, physiotherapists could be encouraged to adopt external FOA in their instructions

and feedback. This highlights that the gap between motor learning evidence and physiotherapy practice could be bridged even through an online learning platform. Levac and colleagues (2016) noted that online KT resources could reach large numbers of practitioners but need to be tailored to the users and the online format, as we did in this study.

Following the observed shift in therapists' FOA preferences after the KT activity, it is important to consider how these motor learning strategies may be applied in specific clinical contexts, such as telehealth delivery for paediatric patients. While telehealth has been shown to have benefits for children with NDDs receiving physiotherapy in the Philippines, it also comes with challenges associated with increased reliance on verbal instructions and feedback (Eguia & Capio, 2022). Our qualitative exploration suggests that the participants viewed FOA strategies as means to mitigate difficulties with instructions and feedback during telehealth, helping therapists design clearer, more effective instructions and feedback tailored for telehealth, ultimately contributing to better patient outcomes. Fishman and Elkins (2022) described a framework for the effective delivery of telehealth paediatric physiotherapy, which included having a "therapist telehealth toolbox" comprising treatment management tools and therapist–caregiver collaboration tools. Our qualitative findings suggest that FOA strategies contribute to these toolboxes, where instructions and feedback could be better designed to improve both parents' collaboration with the therapist and children's movement skills.

6.6.3 Strengths and limitations

The KTA framework and the mixed-methods design offer strengths that facilitate the systematic implementation and evaluation of an activity to translate FOA knowledge to physiotherapy practice. Nevertheless, some limitations should be considered when interpreting our findings. The synchronous component of the KT program was relatively brief, and no follow-up was conducted to monitor engagement with the asynchronous components. It is possible that some changes would be different if the asynchronous

component was followed up, e.g., self-reported implementation could have resulted in significant improvements. The post-activity self-reports were recorded within 72 hours after the webinar; hence, they do not represent any long-term outcomes. The interviews were conducted after at least two weeks of clinical practice and provided actual practice scenarios but still represented short-term changes in practice. Similarly, Hussien, Khodko and colleagues (2023) were limited to a short-term evaluation of KT outcomes following a similar workshop-based intervention. Kafri and colleagues (2023), however showed that long-term outcomes at one year post-training were evident following a KT programme of longer duration (i.e., 20 hours didactics). It is therefore recommended that further work be done to build on the current findings, with consideration for a longer KT activity and long-term follow-up of outcomes, including clinical practice. Finally, our findings from the qualitative component of the evaluation that suggest FOA strategies contribute to physiotherapists' "toolbox" may be verified in future studies that would objectively measure patient-level outcomes.

Because self-reported data are subject to potential response bias, the reported implementation may be overestimated. In considering the change in FOA preference, we should consider that preferences represent a general disposition of physiotherapists and that changes may vary when patient-specific factors are considered. For instance, we found in Chapter 5 that FOA preference is associated with the patient's cognitive and physical development. Hence, changes in FOA preference following a KT activity might vary when assessed in the context of specific patients.

Finally, given the context-specific nature of the KT activity and its participant sample, the generalisability of the findings to other clinical environments may be limited. Future research should therefore evaluate the impact of KT activities across diverse clinical and

cultural contexts, recognising that cultural practices, health systems, and clinician-patient dynamics influence both barriers to and facilitators of KT.

6.7 Conclusion

This study represents a context-specific and systematic effort at translating motor learning knowledge to paediatric physiotherapy practice. We found that an online KT programme consisting of synchronous and asynchronous components effectively enhanced physiotherapists' knowledge and self-efficacy in relation to FOA strategies in paediatric practice. The program also facilitated a significant shift in the participants' relative preference to external FOA for instructions and feedback. Importantly, the qualitative findings provide a picture of actual changes in practice following the KT program highlighting a nuanced approach to adopting internal or external FOA. While organisational and individual barriers to adopting FOA strategies were identified, the study highlights the considerable potential for enhancing telehealth practices through the integration of FOA knowledge. Furthermore, this study opens avenues for future research to quantify the direct effects of FOA strategies on patient outcomes in telehealth settings, potentially leading to standardised best practices that improve functional gains for children with NDDs.

Chapter 7: General Discussion

It has been estimated that it takes about 17 years for research evidence to be integrated into routine clinical and public health practices (Rubin, 2023). This research-to-practice lag means that opportunities to optimise patient outcomes and use resources efficiently are missed. In physiotherapy, such research-to-practice lags behind motor learning research (Kafri & Atun-Einy, 2019). The ultimate aim of this dissertation is to contribute to addressing this lag by facilitating knowledge translation so that motor learning evidence on focus of attention (FOA) may be suitably deployed when delivering instructions and feedback to children with neurodevelopmental disorders (NDDs) in settings that match their needs and enhance service accessibility. The studies that were sequentially presented in chapters 2 to 6 represent a stepwise approach to achieve the overall aim of this dissertation.

Throughout the five studies that comprise this dissertation, theoretical models and frameworks were used to guide the research design and interpretation of the findings. With the overall aim of facilitating knowledge translation, the Knowledge-to-Action (KTA) framework (Graham & Tetroe, 2010; Manns, 2021), following its two distinct processes, was utilised. First, for the knowledge creation phase, the two systematic scoping reviews synthesised knowledge on the use of motor learning strategies for children with NDDs with a specific focus on FOA. To operationalise this knowledge within the Philippine context, we moved into the action phase and conducted a survey of physiotherapists to examine their preferences and practices regarding the use of FOA strategies when delivering verbal instructions and feedback in clinical settings. We determined that a gap exists between available research and physiotherapists' self-reported practices, and that physiotherapists' relative preference for internal or external focus was not related to their professional characteristics or educational backgrounds. Additionally, the survey study revealed

physiotherapists' considerations that influence their delivery of instructions and feedback to clients. Further extending this action phase, we determined whether the survey results align with physiotherapists' actual use of FOA strategies in telehealth through structured observations of telehealth physiotherapy sessions for children with NDDs. Altogether, the four studies enabled a closer look at the local context, and the comprehensive findings from all phases informed the development of the knowledge translation intervention that was evaluated in the final study.

7.1 State of evidence: motor learning strategies and FOA in children

The first objective of this dissertation was to synthesise the current evidence related to motor learning and FOA among children, which was addressed in Chapters 2 and 3. Guided by the motor learning framework for neurorehabilitation (Kleynen et al., 2020), the evidence synthesis focused on motor learning strategies and determined that research involving children with NDDs have so far focused on cerebral palsy (CP), with randomised controlled trials (RCTs) of clinical interventions to improve upper limb function, balance, and locomotion. Evidence supports the use of dual-task strategies and observational learning for children with CP. While studies that apply motor learning strategies for children with intellectual disability (ID), autism spectrum disorders (ASD) and developmental coordination disorder (DCD) are growing, further research is needed to generate robust evidence. With evidence having been generated by researchers, the involvement of clinical practitioners is needed to generate context-specific knowledge that would facilitate successful uptake of evidence in actual practice (Rafferty et al., 2023).

A further evidence synthesis focused on the motor learning elements of instructions and feedback (Kleynen et al., 2020). Guided by the learner-task-environment framework (Gordon & Magill, 2016), the state of evidence related to the use of internal or external FOA

when delivering instructions and feedback for children learning movement tasks was determined. Learners' individual differences are important considerations because even when the majority of the studies suggest that external FOA is advantageous for children, studies that involved children with NDDs have shown inconsistent results. FOA strategies may be useful for training fundamental movement skills, as well as functional and sport-related tasks. The current evidence has been largely drawn from school and laboratory environments, such that the application of FOA strategies for children with NDDs in clinical settings warrants careful consideration of context-specific practice (Johnson et al., 2013). Figure 7.1 summarises the motor learning strategies that have been most commonly applied to different populations of children with NDD. The size of the circles represents the volume of studies that involved each NDD group.

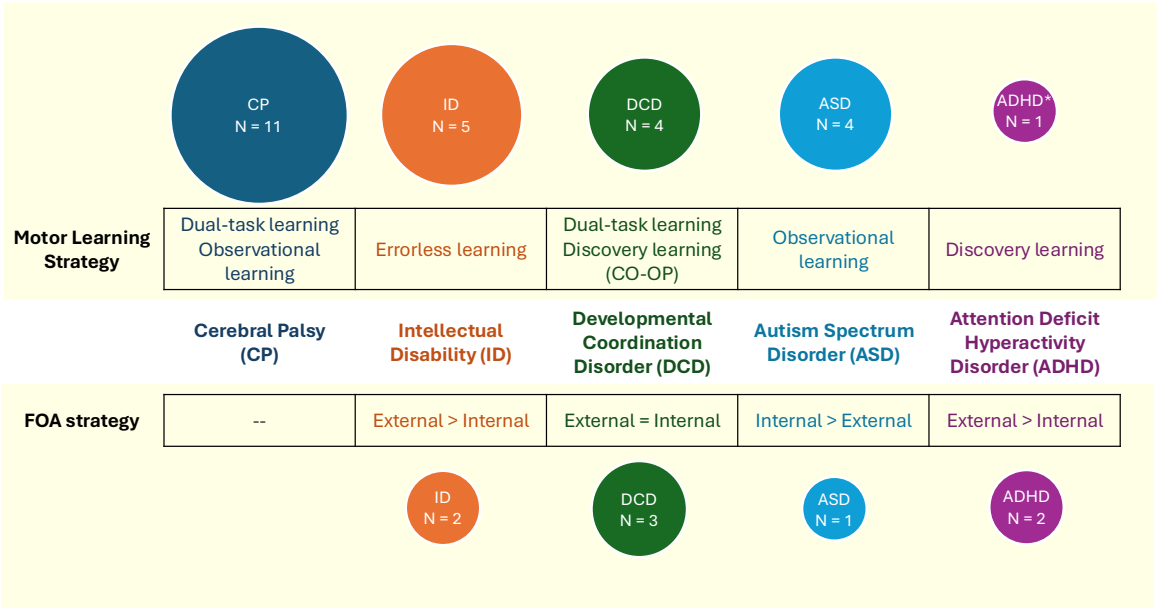


Figure 7.1. Evidence-supported motor learning strategies and FOA strategies for NDD groups.

The evidence synthesised in this dissertation emphasises that the individual characteristics of each patient, alongside their diagnoses, are crucial factors to consider when selecting the appropriate motor learning strategy. Each diagnosis comes with a set of considerations, but each individual also has different presentations that need to be considered.

For children with CP, although the reviewed studies generally support the use of dual-task strategies, it is important to consider the learner's unique characteristics and the complexity of the tasks involved. Dual-task practice in motor learning involves performing a primary motor task alongside a secondary cognitive task (Surkar et al., 2025). For this population, the challenge level of seemingly automatic motor tasks, such as walking, can differ depending on factors such as muscle tone (e.g., spasticity) or the type of impairment (e.g., diplegia, hemiplegia) (Majnemer et al., 2010). Adding a concurrent cognitive or motor task may increase difficulty to a level that impairs overall performance (Roostaei et al., 2021). For example, van Abswoude et al. (2015) found that maintaining stability in an aiming task reduced performance on a simultaneous counting task, likely due to the reduced working memory capacity common in children with CP (van Rooijen et al., 2012, 2014). Moreover, the same study highlighted that the amount of learning was related to initial motor proficiency, the number of errors made during practice, and the type of working memory measured. The authors suggest that to effectively design error-minimising or error-strewn practice protocols, task difficulty should be carefully adjusted to match the individual capacities of each participant. There has been no study that examined the use of FOA among children with CP.

For children with ID, the severity of cognitive impairments must be considered when motor learning strategies are selected. Research has shown that greater severity of ID is linked to increased difficulties with manual dexterity and balance (Vuijk et al., 2010). Among the motor learning strategies available, errorless motor learning has been proposed as a

suitable strategy for children with ID (Eguia, Ng, Capio, et al., 2025) because the relative lack of reliance on cognitive resources associated with this approach accommodates the cognitive impairments of children with ID (Capio et al., 2013). Errorless learning is defined as a practice paradigm that supports modification of the environment to minimise the number of errors that learners commit, resulting in motor learning that is largely implicit requiring low awareness of declarative knowledge (Capio et al., 2012). Additionally, age is an important factor to consider in this population when tailoring activities, as it has been shown be associated with children's motor performance (Capio et al., 2013). Supporting the tailored approach, a study by Capio and Eguia (2021) found that an object control skills training program incorporating individualisation, i.e., task difficulty, progressed individually, and the adaptation of assistance was provided, e.g., hand-over-hand support, based on the individual needs of the participants, was beneficial for children with ID.

In terms of utilising FOA, we found two studies that involved children with ID. One study found external FOA to be advantageous (Chiviacowsky et al., 2013), while the other found no differences in learning effects between external and internal FOA (Kok et al., 2021). An external focus is assumed to be associated with reduced attentional demands (Wulf, Shea, et al., 2001), potentially making this strategy advantageous for children with ID who have cognitive limitations. The lack of difference between internal and external FOA in the study by Kok et al. (2021) may be explained by the set of instructions in both conditions, which was highly complex and could be difficult for children with ID to comprehend. The specific external and internal focus instructions used in the study are summarised in Table 7.1. The difficulty associated with such complex instructions illustrates the importance of tailoring instructions and feedback to the cognitive capacities of individuals.

Table 7.1

Internal and external FOA instructions used in the study by Kok et al. (2021)

External Focus Instructions	Internal Focus Instructions
Focus on the red circle	Direct your eyes towards the end of the line
Pretend as if you are a big tree, which branches are waving in the wind	Keep your upper body in an erect position and move your hands above your shoulders
Direct the tip of your shoe towards the red circle	Place your feet straight on the line
Pretend as if you are sitting on a high chair	Bend your knees slightly

For children with DCD, the nature and severity of motor impairments should be carefully considered when selecting motor learning strategies. Children with DCD typically exhibit difficulties with coordinated motor actions, resulting in slow, clumsy, or inaccurate movements that impact daily activities such as handwriting and participation in physical education (Biotteau et al., 2020; Zwicker et al., 2013). Because motor deficits in DCD are not attributable primarily to intellectual disability (American Psychiatric Association, 2022), motor learning strategies that engage cognitive resources, such as dual-task training and discovery learning, may be appropriate. Dual-task approaches that incorporate a secondary task designed to reinforce primary motor skills have shown promise in improving motor performance in children with DCD (Inacio et al., 2023; Jahanbakhsh et al., 2020). Additionally, discovery learning, which involves learners actively exploring and experimenting with movement patterns to find effective ways to perform skills with no instructions from another person (Kleynen et al., 2014), through the Cognitive Orientation to Daily Occupational Performance (CO-OP) benefits children with DCD by helping them acquire complex motor sequences, which are especially challenging for this group (Izadi-Najafabadi, Rinat, et al., 2022). CO-OP is a child-centred, performance-based approach that helps individuals acquire motor skills by guiding them to develop their own strategies

through goal setting, planning, doing, and checking, rather than direct instruction (Polatajko & Mandich, 2004). Studies have shown that CO-OP improves motor performance, cognitive flexibility, and task-specific skills (Yasunaga et al., 2023) and enhances functioning across impairment, activity, and participation levels (Thornton et al., 2016). This approach actively involves children in choosing functional goals, tailoring task difficulty, and using guided discovery to develop personalised strategies (Miller et al., 2001), underscoring the importance of considering individual differences in rehabilitation.

Regarding FOA in children with DCD, two studies found no difference between the effects of external and internal FOA instructions on motor learning outcomes (Jarus et al., 2015; van Cappellen – van Maldegem et al., 2018). In the study that trained computer tracking task, the effects of FOA on motor learning were not significant, although visual analysis illustrated that external FOA was slightly more beneficial for children with DCD during skills acquisition. The authors proposed that the absence of differences between external and internal FOA may be due to delayed motor learning or challenges in understanding and applying focus instructions during the transfer and retention phases. They suggest that children with DCD may require clear, specific guidance on how to control their movements to achieve a certain skill level over time. Given that children with DCD often struggle to learn from their mistakes and tend to persist with incorrect movement patterns (Biotteau et al., 2020), they might be better attuned to identifying and correcting erroneous movements when they focus internally and monitor their own performance (Eguia et al., 2023). Research suggests that children with DCD can and do self-monitor their performance and this ability can be improved by discovery learning strategies such as CO-OP (Hyland & Polatajko, 2012). Another consideration for this population is their visuospatial working memory capacity. A study by van Cappellen–van Maldegem et al. (2018) found that children receiving external FOA instructions improved more when they had stronger visuospatial

working memory; however, there was no impact of visuospatial working memory capacity on motor learning when children received internal FOA instructions. These findings suggest that visuospatial working memory may be a critical factor to consider when designing effective motor learning strategies for children with DCD.

For children with ASD, the presence and extent of motor deficits and ASD severity should be considered when selecting motor learning strategies. Although ASD is primarily defined by social communication impairments and repetitive behaviours, research increasingly shows that motor impairments are pervasive in this population and affect daily functioning (Bhat et al., 2022; da Silva et al., 2025). To date, motor learning research for children with ASD has focused on observational learning and visual analogy approaches. Observational learning, which involves learning by observing a movement (Kleynen et al., 2014) using video or live demonstrations has been shown to support motor skill acquisition (Heidari et al., 2021; Saber Sotoodeh & Taheri-Torbati, 2021; Taheri-Torbati & Sotoodeh, 2019). Compared with explicit teaching alone, visual analogy learning, a method where complex motor tasks are simplified into a single, easily understood visual metaphor or image that represents the movement (Kleynen et al., 2014), has demonstrated improved retention and transfer of acquired skills (Tse & Masters, 2019). However, both video-based and visual analogy strategies rely heavily on visual input, which may be particularly challenging for children with ASD who often have impaired visuospatial processing (Nejati et al., 2021). This challenge is partly supported by findings from a study where a point-light display in which irrelevant visual information was removed to highlight core movement patterns proved more advantageous than standard video observation (Saber Sotoodeh & Taheri-Torbati, 2021). Despite these findings, reviews have noted significant variability in reporting ASD severity, making it difficult to determine how severity impacts motor learning success (Holloway et al., 2023) and factors such as age, cognitive abilities, and preferred learning

styles influence how children with ASD respond to motor learning interventions, highlighting the importance of tailoring approaches to individual differences (Zheng, 2024). Only one study thus far has examined FOA among children with ASD (Tse, 2019), which showed internal FOA to be more suitable for this population. While it was argued that children with ASD tend to rely on proprioception rather than vision when learning movements (Marko et al., 2015), thus aligning with internal FOA, there is simply insufficient evidence at this point to inform the use of FOA for children with ASD.

For children with ADHD, motor skill deficits and delayed motor development are common (Rosa Neto et al., 2015) and should be carefully considered when selecting motor learning strategies. The prevalence of motor problems in children with ADHD is estimated to be 30-50% (Goulardins et al., 2017). Our evidence synthesis shows that no study had examined motor learning strategies specifically among children with ADHD. Instead, ADHD was considered only as a comorbidity in children with DCD. There is a strong link between ADHD and DCD, although the exact nature of this relationship remains unclear (Goulardins et al., 2017). In one study of children with both DCD and ADHD, discovery learning through CO-OP was found to improve their movement quality and self-perceived motor performance. A core characteristic of ADHD is inattention, which involves difficulty maintaining focus on tasks, frequently losing track of instructions, and becoming easily distracted, despite understanding the instructions given (American Psychiatric Association, 2022). Since CO-OP involves patients in setting personal goals that they consider important, this approach may be effective by fostering intrinsic motivation, highlighting the importance of autonomy and choice in motivating behaviours (Deci & Ryan, 2013). The opportunity for children to choose and prioritise their own tasks can enhance their internal drive to engage and persist in the task at hand. In terms of FOA, two studies have shown that external FOA may be more advantageous for children with ADHD (Ghorbani et al., 2020; Saemi et al., 2013). It was

proposed that external FOA likely reduced the attentional demands of the movement task, which accommodated the deficits in attention that were commonly observed in children with ADHD. The relative advantage observed with external FOA and the importance of autonomy for children with ADHD also align with the OPTIMAL theory of motor learning which states that intrinsic motivation and external FOA optimally enhance motor learning and performance by strengthening the coupling of goals to actions (Wulf & Lewthwaite, 2016).

Overall, this dissertation determined the state of evidence related to motor learning strategies and external/internal FOA for children with NDDs, contributing to the process of translating motor learning knowledge to physiotherapy practice (Khatri et al., 2025; Scott et al., 2012). While the evidence that external FOA is advantageous among typically developing children is generally consistent (Simpson et al., 2021; van der Veer et al., 2022), the relatively scarce research that had focused specifically on children with NDDs suggests that translation of research knowledge to clinical practice needs a contextualised approach at this stage.

7.2 Context for applying FOA evidence in the Philippine practice

The second and third objectives of this dissertation were to describe physiotherapists' use of FOA in the Philippine practice context, and to focus on paediatric physiotherapists' delivery of instructions and feedback to children with NDDs using a telehealth platform.

With only half of the respondent physiotherapists in the Philippines reporting familiarity with the concept of FOA, we found an urgent need for knowledge translation activities. This finding is consistent with previous research that had shown clear and convergent evidence of physiotherapists' insufficient familiarity with motor learning strategies (Levac et al., 2016; Ryan et al., 2020). Moreover, the self-reports of our respondent physiotherapists showed that they tend to prefer internal FOA when delivering instructions

and feedback, including in telehealth platforms, regardless of their educational and professional backgrounds. While the evidence synthesised in this dissertation do not specifically favour external FOA for children with NDDs, a contextualised approach that considers the learners' characteristics and the environment for practice is warranted. Thus, such an overall preference for internal FOA by the physiotherapists in our survey suggests that opportunities for children to benefit from external FOA may be missed. The survey also revealed that physiotherapists consider the cognitive abilities not only of their patients but also of their caregivers when delivering instructions and feedback, which contributes to our knowledge of practice patterns in relation to the translation of motor learning research to local practice.

Because self-reports may vary significantly from actual practice when it comes to the use of FOA by physiotherapists (Zachariah, 2013), our subsequent study used structured observation to verify local physiotherapists' relative preference for external and internal FOA. Focusing on paediatric physiotherapists conducting telehealth sessions, we found that they tend to adopt external FOA for instructions and internal FOA for feedback. This finding offers a more refined understanding of physiotherapists' relative FOA preference compared to self-reported preference revealed by the survey study. Moreover, while the survey study showed no relationship between self-reported FOA preference and the physiotherapists' background, the observational study revealed that the age, physical development, and cognitive development of patients are associated with the observed FOA preference. Specifically, physiotherapists appear to prefer using internal FOA with older children who demonstrate more advanced physical and cognitive development, implying that these children have the mental capacity to effectively understand and apply internal FOA instructions and feedback. Research suggests that external FOA is generally more implicit than explicit because it directs attention to the effects of movements on the environment rather than to

body movements, which reduces conscious control and cognitive effort (Steenbergen et al., 2010; van Abswoude et al., 2021). Maxwell and Masters (2002) explain this by proposing that an external focus involves minimal explicit processing and lowers working memory load, whereas an internal focus increases cognitive demands, making external FOA inherently more automatic and efficient for motor learning. Therefore, external FOA might be more appropriate for children who have less developed cognitive skills and physical maturity. Although there is strong evidence favouring external FOA for children (Wulf & Lewthwaite, 2016), it remains important to consider whether consistently using external FOA for both instructions and feedback is beneficial, even when children have the cognitive ability to handle internal FOA. It is possible that physiotherapists choose internal FOA for older or more developed children to leverage their capacity for learning through conscious cognitive processing.

The findings of the survey and observational studies in this dissertation highlight the importance of a multi-method approach in understanding local practice contexts. The combination of survey and observation methods clarifies ambiguities and allows triangulation, which provides a more robust and accurate assessment of practice patterns (O'Donovan et al., 2020). Further initiatives, beyond this dissertation, that aim to understand physiotherapy practice may consider a similar multi-method approach.

It was discussed in the previous chapters that the ongoing shortage of healthcare workers, including physiotherapists, in the Philippines demands strategies to optimise efficiency, and the effective use of external and internal FOA for instructions and feedback could contribute to improved outcomes (Hunt et al., 2017). The context in which FOA might be used in paediatric physiotherapy practice in the Philippines has been clarified by the findings of the survey and observational studies, paving the way for a knowledge translation intervention following the KTA framework (Manns, 2021).

7.3 Translating Focus of Attention (FOA) knowledge to physiotherapy

The final objective of this dissertation was to evaluate the effects of a knowledge translation intervention on paediatric physiotherapists' use of FOA in clinical practice, including the telehealth platform. The first four studies in this dissertation critically informed the design, delivery, and evaluation of the knowledge translation intervention. We highlight, however, that this final study also drew from previous work on knowledge translation of motor learning and FOA knowledge (Hussien, Khodko, et al., 2023; Kafri et al., 2023). The knowledge translation intervention in this research was delivered online because digital platforms have been shown to facilitate accessibility and wide reach for professional development (Stavermann, 2025), especially for healthcare professionals in developing countries (Wewer Albrechtsen et al., 2017), such as physiotherapists in the Philippines. The online knowledge translation intervention in this research consisted primarily of a synchronous component and a supporting asynchronous component (Hussien, Khodko, et al., 2023) and was found to effectively enhance physiotherapists' self-reported knowledge and self-efficacy in relation to FOA strategies in paediatric practice. The participants' relative FOA preference for instructions and feedback was also found to shift significantly towards external FOA. Considering the findings from the previous two studies, this shift shows that the online knowledge translation activity has the potential to nudge practitioners towards applying the knowledge about FOA to their practice despite having been trained to be more inclined to use internal FOA.

The findings from the qualitative component of the evaluation provide an in-depth understanding of the impact of the knowledge translation intervention on the participants' practice. As the participants described an enhanced understanding of when and how to utilise internal or external FOA given the variety of clinical scenarios, we can determine the underlying processes that enabled the apparent shift in relative preference towards external

FOA. It appears that physiotherapists can be more attuned to applying motor learning evidence (related to external FOA in this case) when knowledge translation is not limited to disseminating theoretical concepts but rather encompasses applied components that address questions of *"how"* and *"when"* to apply evidence. Furthermore, the interviews generated four themes representing factors participants considered in relation to their FOA use in practice: (i) patient-related factors, (ii) clinic and organisation-related factors, (iii) physical environment-related factors, and (iv) therapist-related factors. Consistent with the observation and survey studies, patient-related factors such as diagnosis, age, and cognitive ability were important considerations that were mentioned in the interviews. Further work, however, is needed to sustain and widen the benefits demonstrated in the knowledge translation intervention in this dissertation. It has been shown that large-scale implementation of knowledge translation requires collaborative engagement, funding, and organisation commitment of supporting agencies (Young et al., 2023). While our knowledge translation intervention is evidently effective, we will need to seek resources to roll it out and assess broader impact especially with consideration for long-term effects and verifying patient-level outcomes.

The role of organisational systems was also highlighted in the barriers to adopting FOA strategies in practice that were identified in the qualitative component of the evaluation of the knowledge translation intervention. Combined with the findings from the survey and observational studies of the local practice context, we identified the factors that are associated with physiotherapists' use of external or internal FOA in clinical practice. Figure 7.2 illustrates these factors, building on the motor learning framework for neurorehabilitation (Kleynen et al., 2020). In this enhanced framework, we demonstrate that physiotherapists may focus on the motor learning elements of instruction and feedback and consider whether they will use more external or more internal FOA depending on factors that are related to

individuals (i.e., patients, caregivers, physiotherapists) or systems (i.e., organisation, physical environment). The reviews in this dissertation also emphasised the importance of accounting for individual differences when deciding the most appropriate combination of motor learning and FOA strategies, recognising that each diagnosis comes with a unique set of abilities. Moreover, beyond diagnostic categories, each individual presents unique characteristics that must be considered. Encouragingly, evidence from our survey study, observational study, and knowledge translation interviews show that physiotherapist participants actively integrate these individual considerations into their clinical decision-making.

As shown by the convergent findings of the survey, observational study, and knowledge translation intervention, physiotherapists' preference for FOA is not a dichotomous concept but rather a relative indicator based on a range of scores. Similarly, Kal et al. assessed relative preference based on a range of scores and applied cut-off points. Hence, the enhanced framework reflects this relative preference (i.e., more external, more internal), where physiotherapists may adopt external or internal FOA across a continuum depending on the relevant individual and systems factors in their local context. Rather than simply opting for external or internal FOA all the time, physiotherapists' relative preference may be considered dynamic over a continuum. Through this framework, this dissertation contributes to our theoretical understanding of how motor learning evidence can be deployed in physiotherapy practice. The individual and systems factors identified in this enhanced framework can directly influence how researchers and practitioners alike would design future initiatives that can enhance the delivery of motor learning elements in rehabilitation, directly contributing to mitigating the research-to-practice lag in physiotherapy.

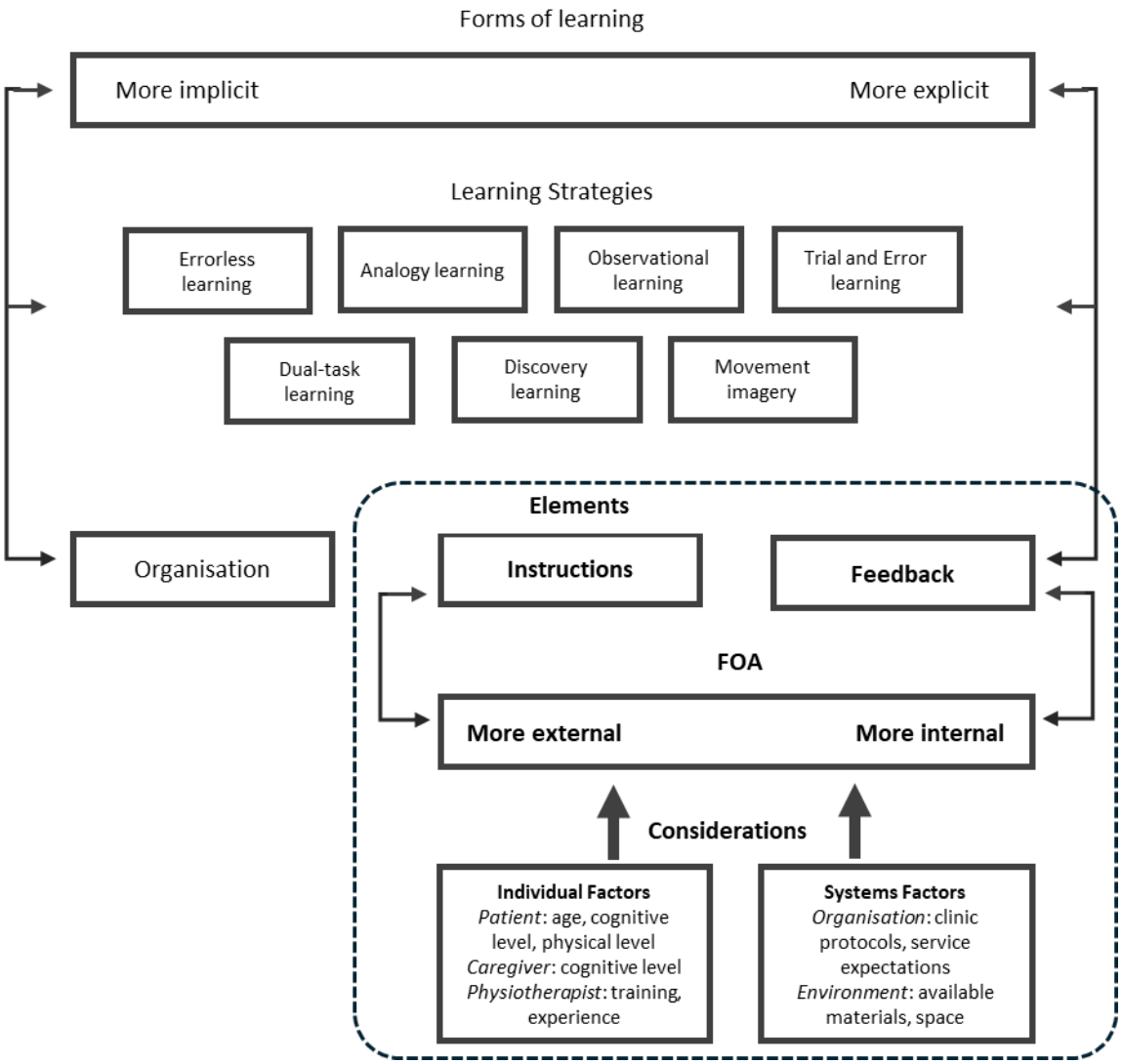


Figure 7.2. Enhanced motor learning framework for rehabilitation (adapted and modified from Kleynen et al., 2020) focusing on the motor elements of instruction and feedback.

7.4 Use of FOA strategies in paediatric physiotherapy

Based on the findings of this dissertation, we introduce two novel aspects that contribute to our understanding of the use of external and internal FOA in paediatric physiotherapy: one relates to the recipients of instructions and feedback, while the other relates to telehealth.

Prior to this dissertation, observational studies that explored physiotherapists' use of FOA have examined the use of instructions and feedback for patients (Johnson et al., 2013;

Kal et al., 2018). To our knowledge, this project represents the first study specifically investigating FOA in paediatric physiotherapy. In our observational study, we distinguished children and caregivers as separate recipients of physiotherapists' instructions and feedback, highlighting an important detail specific to paediatric practice. A family-centred approach is strongly recommended for paediatric physiotherapy, in which caregivers play an important role across goal setting and programme implementation (Baker et al., 2012; Pritchard-Wiart et al., 2019). Such approach recognises family members as active partners in therapy, enhancing both clinical outcomes and caregiver satisfaction (Barnes et al., 2024). Our observational study highlights caregivers' involvement in facilitating children's performance of tasks during physiotherapy, and the variation in FOA strategies used for children and caregivers demonstrates an aspect of FOA-related clinical decision-making that is unique to paediatric practice. This is further highlighted by our findings from the qualitative evaluation of the knowledge translation intervention, where the participants described external FOA as a suitable strategy when giving coaching instructions for parents or caregivers. As such, future investigations of FOA strategies in paediatric physiotherapy should consider the design of instructions and feedback for caregivers by drawing from the methods and findings of this dissertation.

Research has shown that telehealth is a promising avenue for promoting family inclusion in paediatric physiotherapy (Camden & Silva, 2021). In a study of teletherapy for children with neurodevelopmental disorders in the Philippines, parents reported that telehealth helped them gain a better understanding of their child's needs, which in turn improved their ability to manage their child's behaviours (Eguia & Capio, 2022). Telehealth has the potential to enhance the equity, accessibility, cost-effectiveness, and family-centeredness of healthcare services for children with disabilities (Camden & Silva, 2021; Eddison et al., 2022; Smith & Innes, 2025), and this dissertation is the first to explore the use

of FOA strategies in paediatric physiotherapy delivered via telehealth. The observational study confirmed that physiotherapists relied heavily on verbal instructions and feedback during telehealth sessions. Instructions were largely focused on the requirements and specifications of the task to perform while most feedback was aimed to motivate task completion. Similarly, the reliance on verbal modality had been reported by physiotherapists when telehealth was deployed during the pandemic, which was perceived as a challenge to practice (Eguia & Capio, 2022). While participants in the knowledge translation activity also acknowledged the challenge posed by relying on verbal modality during telehealth, they also described how FOA strategies immediately enhanced the clarity and effectiveness of their instructions and feedback. The participants further reported that knowledge of external and internal FOA enhanced their adaptive responses to the variation in patients' home environments. The findings of this dissertation suggest that motor learning knowledge, such as those related to FOA, are potentially critical for facilitating the delivery of telehealth paediatric physiotherapy.

7.5 Future directions for research and implications for practice and education

This dissertation represents the first research programme that focused on translating FOA knowledge to paediatric physiotherapy practice. The convergent findings from three empirical studies inform the enhanced motor learning framework discussed in the preceding section. Follow-up research is needed to further examine the individual and system factors that are proposed to influence the physiotherapists' relative preference for external or internal FOA. The protocol used in the observational study in this dissertation may be adopted to investigate in-person paediatric physiotherapy sessions and explore potential variations or similarities in modality, recipients, and focus of instructions and feedback when compared to telehealth sessions. A hybrid care model consisting of in-person and telehealth sessions has

been increasingly recommended as it has been shown to be effective, efficient, and associated with high patient and provider satisfaction (Galin, 2024; Smith & Innes, 2025). They also offer the dual benefits of accessibility and outcome quality, acting as a means to achieving equity, which is especially critical in developing countries. As such, studies are needed to compare the in-person context to our findings in the telehealth context to inform future work that can explore hybrid models of care.

Implementation trials that deploy FOA strategies in clinical contexts may also be used for a robust examination of patient outcomes following the use of external or internal FOA. While the current evidence supports the superiority of external FOA in general, our syntheses of evidence suggest that this is not as clear-cut in children with NDDs. Randomised controlled trials may test interventions that are informed by our proposed enhanced motor learning framework, measure patient outcomes, and quantify the influence of individual and systems factors. Given the difficulty in recruiting clinical samples especially children with NDDs (MacNeil et al., 2024; Mire et al., 2024), such trials may take a longer duration to form large samples that will generate sufficient power. Furthermore, future studies may also adopt an effectiveness-implementation hybrid design that takes a dual focus in assessing clinical effectiveness and evaluating implementation strategies (Curran et al., 2012). Such studies can support the process of embedding FOA strategies in physiotherapy practice.

To enhance paediatric physiotherapy practice, further knowledge translation activities are recommended. Paediatric physiotherapists who deliver services via telehealth need a "therapist telehealth toolbox" comprising treatment management tools and therapist-caregiver collaboration tools (Fishman & Elkins, 2022). One of the implications for practice that may be gathered from this dissertation is that knowledge of "when" and "how" to use external and internal FOA contributes to this toolbox. As a treatment management tool, FOA strategies could enhance the effectiveness of instructions and feedback in motivating children to

perform movement tasks successfully. As a therapist-caregiver collaboration tool, external FOA strategies could facilitate clarity for caregivers who facilitate the movement activities in their home environments. As evident in the last study in this dissertation, learning about FOA strategies would be beneficial for paediatric physiotherapists delivering services in-person and in telehealth settings.

The empirical studies in this dissertation focused on the Philippines, which consists of more than 7,600 islands and where patients are in geographically remote regions. Access to services through telehealth is a potential game changer that can improve patients' quality of life (Fabian et al., 2024; Macariola et al., 2021). While the findings provide valuable insights for telehealth paediatric physiotherapy practice in the Philippines, other countries with similar geographic challenges and healthcare access issues may also benefit from the results, provided they first establish information about physiotherapy practices and FOA use within their own contexts before developing tailored knowledge translation activities.

Telehealth for paediatric physiotherapy is likely to evolve as digital technologies develop (Simons et al., 2022). Future work could consider the ways that motor learning knowledge could be integrated with immersive digital platforms. For instance, augmented or virtual reality programmes could be designed with prompts for internal or external FOA and the effects of engagement, clarity of goals, and movement outcomes for children and their caregivers could be examined. Emerging work on AI-driven virtual assistants and decision-support tools suggests that future systems could deliver real-time, individualised external FOA cues and feedback within home and telehealth environments (Olawade et al., 2025).

The knowledge generated from this work directly informs paediatric physiotherapy practice in the Philippines. Knowledge translation interventions in motor learning may be further developed and deployed across a larger group of paediatric physiotherapists, including those working in school-based programmes, in-person hospital and clinic settings (both

public and private), and telehealth. A collaboration with the paediatric special interest group of the national physiotherapy association (i.e., Philippine Physical Therapy Association) can support the uptake of the evidence from this dissertation for continuing professional development programmes.

While this dissertation did not specifically seek to examine the physiotherapy curricula in the Philippines in relation to FOA knowledge and practice of clinicians, some of the findings could inform future curriculum development in the field. Specifically, findings from the survey and interviews suggest that motor learning principles such as FOA are not uniformly addressed in undergraduate education, and that clinicians report their training to have set them up towards the use of internal FOA when giving instructions. Future physiotherapy curricular development could explicitly include motor learning and FOA as core learning content, with structured teaching and assessment that train students to evaluate internal or external FOA in relation to patient-, organisation-, and environment-related contexts.

7.6 Limitations

Due to the time limitations of this doctoral study, establishing causal evidence for the impact of the knowledge translation intervention is beyond the research scope. Nevertheless, the current findings set the stage for future, more rigorous investigations as outlined in the recommendations in the preceding chapters and the future directions proposed in this final chapter. This dissertation is focused on paediatric physiotherapy practice, and this is consistent across the evidence synthesis and empirical studies that were conducted. As such, the applicability of the enhanced motor learning framework developed here may be limited and should not be assumed to generalise readily to other physiotherapy domains (e.g. gerontology, sports physiotherapy) without further investigation. Additionally, the complex

interplay of individual and system-level factors identified in this framework suggests that further research is necessary to explore and adapt frameworks that support the effective integration of FOA strategies and motor learning principles across diverse physiotherapy contexts. Addressing these gaps will be crucial to advancing holistic, evidence-informed rehabilitation practices beyond the paediatric setting.

7.7 Conclusions

This dissertation makes substantive contributions to narrowing the research-to-practice lag observed in motor learning research and its application in paediatric physiotherapy practice, particularly in using FOA strategies for children with NDDs within the Philippine context. Through a systematic and multi-phase approach grounded in the KTA framework, this dissertation synthesised existing evidence, investigated local physiotherapy practices, and developed an effective knowledge translation activity to bring information to physiotherapists, who in reality often do not have enough time to synthesise and scrutinise the available evidence themselves. Bringing together the studies in this dissertation, it is highlighted that while external FOA is generally known to facilitate motor learning effectively, its implementation for children with NDDS must be carefully tailored to individual learner characteristics and contextual factors within clinical environments. The survey and pre-knowledge translation intervention findings revealed a prevailing preference for internal FOA among physiotherapists in the Philippines, highlighting the critical need for context-specific knowledge translation efforts. Although the observational study found no significant difference in overall preference between internal and external FOA and showed that paediatric physiotherapists preferred external FOA during telehealth sessions, the overall preference trend still leans towards internal FOA, and the external FOA use was just a little over 50%, indicating room for further increase to optimise practice. Furthermore, this work

identified and highlighted the dynamic factors influencing FOA use, including patient profiles and caregiver involvement, which includes a pivotal role as co-recipients of instructions in paediatric care, organisational variables and the modality of service delivery.

The inclusion of telehealth as a focus of investigation in this project highlights its important role not only in expanding access to paediatric physiotherapy services for children living in geographically remote or underserved areas but also for those who, despite having the resources to attend clinics, choose telehealth as a preferable option due to practical barriers such as the challenging traffic conditions in the urban areas in the Philippines. Importantly, this research demonstrates that providing therapists with knowledge of FOA can help partially address the challenge of heavy reliance on verbal communication in telehealth by enabling clearer and more effective instructions and feedback during sessions.

The knowledge translation intervention, delivered via an accessible online platform, enhanced physiotherapists' knowledge and self-efficacy and was associated with a reported shift in their intention to incorporate more evidence-based external FOA strategies contextualised to their clinical practice in the immediate term. This work also offers a theoretical contribution via an enhanced motor learning framework that reconceptualises FOA preference as a dynamic continuum influenced by multiple individual factors, such as patient, caregiver, and therapist characteristics, as well as system-level determinants, including organisational and environmental contexts. This enhanced framework offers a practical and context-sensitive guide to inform clinical decision-making and future research. In summary, this research not only advances theoretical understanding but also provides actionable strategies to reduce the research-to-practice lag and promote the integration of FOA strategies in diverse clinical contexts. While beyond the scope of the empirical evidence generated by this thesis, reducing the gap between research and practice could ultimately contribute to improved patient outcomes (Rubin, 2023). Continued efforts to scale up

knowledge translation initiatives followed by evaluation of rehabilitation outcomes among children with NDDs are essential. Future work that will develop hybrid models of care that combine telehealth and in-person services alongside knowledge translation could sustain and broaden the changes in practice of physiotherapists who continue to deliver services to the children who need them.

Appendices

Appendix A: Questionnaire from Chapter 4

Attentional Strategies and Motor Learning in PT - general survey

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Start of Block: Part I. Introduction

Q1 Thank you for agreeing to participate in this project. This project will examine and explore physical therapists' use of instructions and feedback in their clinical practice. This study could facilitate an understanding of how physical therapists utilise motor learning strategies in their practice.

Q2 Are you a registered physical therapist in the Philippines?

- ○ Yes (1)
- ○ No (2)

Q3 In which year were you registered as a physical therapist with the Professional Regulations Commission (PRC)?

_____

End of Block: Part I. Introduction

Start of Block: Part II. Background

Q4 Please indicate your sex:

- ○ Male (1)
- ○ Female (2)
- ○ Prefer not to say (3)

Q5 What is/are your educational qualification(s):
Check all that apply

- ☐ Bachelor's degree (1)
- ☐ Postgraduate certificate (2)
- ☐ Postgraduate diploma (3)
- ☐ Master's degree (4)
- ☐ Doctorate degree (5)
- ☐ Others (6) _____

Q6 How long have you been practicing your profession (in months and/or years):
e.g., 2 years and 1 month

_____

Q7 What is/are the current and relevant practice area(s) for you:
Check all that apply

- ☐ Pediatrics/Developmental (1)
- ☐ Geriatrics/Gerontology (2)
- ☐ Women's/Men's/Pelvic health (3)
- ☐ Manual/Musculoskeletal (4)
- ☐ Neurologic (5)
- ☐ Cardiorespiratory (6)
- ☐ Sport/Exercise (7)
- ☐ Occupational Health/Ergonomics (8)
- ☐ Pain management (9)
- ☐ Palliative (10)
- ☐ Mental health (11)
- ☐ Others (12) _____

Q8 Would you consider yourself specialised in particular practice area?

- ○ Yes (1)
- ○ No (2)

Q9 If yes, which particular practice area(s)?
Check all that apply

- ☐ Pediatrics/Developmental (1)
- ☐ Geriatrics/Gerontology (2)
- ☐ Women's/Men's/Pelvic health (3)
- ☐ Manual/Musculoskeletal (4)
- ☐ Neurologic (5)
- ☐ Cardiorespiratory (6)
- ☐ Sport/Exercise (7)
- ☐ Occupational Health/Ergonomics (8)
- ☐ Pain management (9)
- ☐ Palliative (10)
- ☐ Mental health (11)
- ☐ Others (12) _____

End of Block: Part II. Background

Start of Block: Part III. Platform of Practice

Q10 This section will explore more information related to your current practice platforms.

Q11 In which forms do you currently deliver physical therapy services?
Check all that apply

- ☐ In-person (1)
- ☐ Telehealth (2)

Q12 On average, how many **in-person** therapy sessions are you currently delivering per week?
_____

Q13 On average, how many **telehealth** sessions are you currently delivering per week?
_____

Q14 Which platforms/apps do you use to deliver telehealth?
Check all that apply

- ☐ Zoom (1)
- ☐ Skype (2)
- ☐ Facetime (3)
- ☐ Facebook (4)
- ☐ Microsoft Teams (5)
- ☐ Viber (6)
- ☐ Google Duo/Meet (7)
- ☐ Others (8) _____

End of Block: Part III. Platform of Practice

Start of Block: Part IV.

Q15 For the following series of questions, please respond with which feedback you are likely to implement in interactions with your client.
Note, **feedback** here is described as **information you give your client after they have completed a movement.** There are no wrong or right answers.

Q15.1. Your client is performing a tandem stance balance exercise in a comfortable pair of shoes and you notice the back foot is not positioned directly behind the front foot. Which feedback statement would you provide?

- ○ "Focus on keeping your feet touching and in a straight line" (4)
- ○ "Focus on keeping your shoes touching and in a straight line" (5)
- ○ No preference (6)

Q15.2. Your client is performing a circular shoulder pendulum exercise, with a small dumbbell in their hand, and you notice they are swinging their arm in a straight line. What feedback statement would you provide?

- ○ "Swing your arm in a circle" (4)
- ○ "Swing the dumbell in a circle" (5)
- ○ No preference (6)

Q15.3. Your client is performing a functional reaching task consisting of bringing a glass they are holding to rest on a table top, and you notice their movements are jerky. What feedback statement would you provide?

- ○ "Focus on keeping the glass moving smoothly through space" (4)
- ○ "Focus on keeping your hand moving smoothly through space" (5)
- ○ No preference (6)

Q16 For the following series of questions, please respond with which instruction you are likely to implement in interactions with your client.
Note, **instruction** here is described as i**nformation you give your client before they begin a movement.** There are no wrong or right answers.

Q16.1. You are instructing your client on how to perform a squat and you have placed markers on the floor to indicate where they should place their heels. What instruction statement would you provide?

- "Make sure to keep your heels on the markers" (4)
- "Make sure to keep your shoe heels on the markers" (5)
- No preference (6)

Q16.2. You are instructing your client to perform a pelvic squeeze with a ball between their knees. What instruction statement would you provide?

- "Squeeze the ball" (4)
- "Squeeze your knees together" (5)
- No preference (6)

Q16.3. You are instructing your client on how to perform the heel-toe motion required for stepping while wearing shoes. What instruction statement would you provide?

- "Have the heel of your foot make first contact and then move through to the toes" (4)
- "Have the heel of your shoe make first contact and then move through to the front of your shoe" (5)
- No preference (6)

Q17 Instruction: Below are four sets of statements that patients may hear when retraining gait (or training movement skills). One statement is internally referenced, and one statement is externally referenced.

External statements refer to the outcome or goal of the movement, while **internal statements** refer to the body and movement execution itself.

Please indicate for each gait parameter which statement or instruction you would generally prefer to use in practice during gait training. **There are no wrong or right answers.**

Q17.1 Gait Parameter: Step length

- ○ Try to step over the cones (1)
- ○ Try to extend your leg more when taking a step (2)
- ○ No preference (3)

Q17.2 Gait Parameter: Foot clearance

- ○ Try not to shuffle during walking (1)
- ○ Try to lift your knee properly during walking (2)
- ○ No preference (3)

Q17.3 Gait Parameter: Weight bearing transport

- ○ Feel the ground “rolling through” (1)
- ○ Transfer your weight from your heel to your toes (2)
- ○ No preference (3)

Q17.4 Gait Parameter: Step width

- ○ Try to walk between the lines (1)
- ○ Try to walk with your feet in front of each other (2)
- ○ No preference (3)

Q18 In daily practice...

	Never 1	2	3	4	Always 5
Do you consciously plan how to deliver the instructions and feedback to your clients? ()					
Do you make conscious choices in your use of internal and external focus of attention when giving instructions and feedback? ()					

Q19 In daily practice...

	Never 1	2	3	4	Always 5
If you do telehealth, do you deliver instructions and feedback differently between in-person and telehealth formats? ()					

Q20 Could you specify any reasons/factors that you consider **when planning how to deliver** instructions and feedback to your patient? (e.g., in terms of patient characteristics - please specificy specific characteristics if possible, session goals, type of exercise, rehabilitation phase, personal preference, other considerations)

_____

Q21 Could you specify your reasons/factors for **varying your instructions/feedback for in-person and telehealth** formats?

_____

Q22 Do you deliver instructions and feedback differently between patients and caregivers?

- ○ Yes (1)
- ○ No (2)

Q23 If YES, can you specify the factors/considerations for you to vary the instructions and feedback between patients and caregivers?

_____

Q24 Before answering this survey, were you familiar with the distinction between internal and external focus of attention.

- ○ Yes (1)
- ○ No (2)

Q25 If YES, where did you gain your familiarity of internal/external focus of attention in physical therapy instructions and feedback?
Check all that apply

- ☐ Undergraduate degree courses (including internship) (1)
- ☐ Postgraduate degree courses (2)
- ☐ Continuing professional education (3)
- ☐ Professional networks (i.e., colleagues) (4)
- ☐ Information shared on social media (5)
- ☐ Others (6)

End of Block: Part IV.

Appendix B: Questionnaire from Chapter 6

Introduction

Q1 **Directing Attention, Enhancing Movement: Using Attentional Focus in Physical Therapy**
Thank you for joining our webinar. We hope the insights on "focus of attention" (FOA) will benefit Filipino physical therapists, especially those working with children with neurodevelopmental disorders (NDDs). Please take 5-7 minutes to complete this questionnaire. Some questions repeat those from before the webinar to help us evaluate its impact and improve future sessions.

Q2 Please indicate the primary category you belong to:

- ☐ Physical therapist (including student) (1)
- ☐ Others (please indicate details in the box - e.g., physician, parent) (6)

_____

Q3 If you are a physical therapist, please indicate your highest qualification:

- ○ Undergraduate student or intern (7)
- ○ Bachelor's degree (1)
- ○ Postgraduate certificate/diploma (2)
- ○ Master's degree (4)
- ○ Doctorate degree (5)
- ○ Others (6) _____

Q4 Are you *currently* working with children with neurodevelopmental disorders (e.g. Cerebral Palsy, Down Syndrome, Autism, etc)?

- ○ Yes (1)
- ○ No (2)

Q5 How long have you been working with children (in months and/or years)? *e.g., 2 years and 1 month*

_____

Q6 Have you delivered/are you delivering physical therapy sessions via telehealth?

- ○ Yes (1)
- ○ No (2)

Q7 For the following questions, please respond regarding your **satisfaction** with and **perceived relevance** of the webinar you just attended. Please respond on a scale from strongly disagree to strongly agree.

Q7.1 **"I found the content easy to understand and follow."**

- ○ Strongly agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly disagree (1)

Q7.2 **"My learning was enhanced by the speaker's knowledge and experience."**

- ○ Strongly agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly disagree (1)

Q7.3 **"The content was relevant to my practice."**

- ○ Strongly agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly disagree (1)

Q7.4 **"Applying what I learned today will positively impact my clients."**

- ○ Strongly agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly disagree (1)

Q8 **The next set of questions will be about the topic discussed in the webinar. Please take your time to answer each question carefully.**

Q8.1 Awareness How aware are you that instructions and feedback statements can be used to direct individuals' focus of attention? *Note: **Focus of attention** refers to how instructions and feedback direct an individual's attention during a task.*

- ○ Not at all aware (1)
- ○ Slightly aware (6)
- ○ Somewhat aware (7)
- ○ Moderately aware (8)
- ○ Extremely aware (9)

Q8.2 Self-Efficacy How confident are you that you can explain to someone else the difference between giving instructions using "external focus of attention" compared to an "internal focus of attention".

- ○ Not at all confident (1)
- ○ Slightly confident (6)
- ○ Somewhat confident (7)
- ○ Moderately confident (8)
- ○ Extremely confident (9)

Q9 **Post-webinar Knowledge Assessment**

Q9.1 Attentional focus, as defined by Wulf and colleagues (1998), is described as:

- ○ Where an individual focuses their eyes during a movement task (1)
- ○ Where an individual assigns their mental focus during a movement task (2)
- ○ Whether an individual is focused on, or away, from somatic sensations (3)
- ○ I don't know (4)

Q9.2 Which of the following represents an ***internal*** focus of attention statement that a physiotherapist could provide to a client who performed an improper squat?

- ○ Make sure your hips are pushed back when you squat down (1)
- ○ Slow down the movement as you move the weight up (2)
- ○ When you lower, pretend like you are going to be sitting on a low chair (5)
- ○ I don't know (4)

Q9.3 Which of the following represents an ***external*** focus of attention feedback statement that a physiotherapist could provide to a client struggling to maintain their balance while performing a static lunge with one foot on a BOSU ball:

- ○ Try to center your foot on the BOSU ball (1)
- ○ Try to reduce the movement of the BOSU ball (2)
- ○ Try placing your hands on your hips when balancing on the BOSU ball (5)
- ○ I don't know (4)

Q10 For the following series of questions, please respond with which ***feedback*** you are likely to implement in interactions with your client. Note, **feedback** here is described as information you give your client **after they have completed a movement.** There are no wrong or right answers.

Q10.1 Your client is performing a tandem stance balance exercise in a comfortable pair of shoes and you notice the back foot is not positioned directly behind the front foot. Which feedback statement would you provide?

- ○ "Focus on keeping your feet touching and in a straight line" (4)
- ○ "Focus on keeping your shoes touching and in a straight line" (5)

Q10.2 Your client is performing a circular shoulder pendulum exercise, with a small dumbbell in their hand, and you notice they are swinging their arm in a straight line. What feedback statement would you provide?

- ○ "Swing your arm in a circle" (4)
- ○ "Swing the dumbell in a circle" (5)

Q10.3 Your client is performing a functional reaching task consisting of bringing a glass they are holding to rest on a table top, and you notice their movements are jerky. What feedback statement would you provide?

- ○ "Focus on keeping the glass moving smoothly through space" (4)
- ○ "Focus on keeping your hand moving smoothly through space" (5)

Q11 For the following series of questions, please respond with which ***instruction*** you are likely to implement in interactions with your client. Note, **instruction** here is described as information you give your client **before they begin a movement.** There are no wrong or right answers.

Q11.1 You are instructing your client on how to perform a squat and you have placed markers on the floor to indicate where they should place their heels. What instruction statement would you provide?

- ○ "Make sure to keep your heels on the markers" (4)
- ○ "Make sure to keep your shoe heels on the markers" (5)

Q11.2 You are instructing your client to perform a pelvic squeeze with a ball between their knees. What instruction statement would you provide?

- ○ "Squeeze the ball" (4)
- ○ "Squeeze your knees together" (5)

Q11.3 You are instructing your client on how to perform the heel-toe motion required for stepping while wearing shoes. What instruction statement would you provide?

- ○ "Have the heel of your foot make first contact and then move through to the toes" (4)
- ○ "Have the heel of your shoe make first contact and then move through to the front of your shoe" (5)

Q12 **Now let us know about your future PT sessions.**

Q12.1 In your future physical therapy sessions, to what degree would you use "focus of attention" when giving instructions?

- ○ Very little (1)
- ○ A little (6)
- ○ To some degree (7)
- ○ A lot (8)
- ○ Very much (9)

Q12.2 In your future physical therapy sessions, to what degree would you use "focus of attention" when giving feedback?

- ○ Very little (1)
- ○ A little (6)
- ○ To some degree (7)
- ○ A lot (8)
- ○ Very much (9)

Q12.3 In your future physical therapy sessions, how much would you plan to choose between internal or external "focus of attention" for instructions and feedback?

- ○ Very little (1)
- ○ A little (6)
- ○ To some degree (7)
- ○ A lot (8)
- ○ Very much (9)

Q13 Interview Would you be willing to participate in a 20–30 minute follow-up interview 3-4 weeks after the webinar to discuss your use of Focus of Attention (FOA) principles in practice?

- ○ YES (1)
- ○ NO (2)

Appendix C: Themes, Codes and Sample Quotes from Chapter 6

Impact of the knowledge translation activity on the participants' understanding and practices related to FOA

Theme	Code	Sample Quote
Understanding the concept of FOA	Theory underpinning FOA	"I understood the motor learning theories, especially the Optimal Theory, and I realised I could actually use this knowledge in my day-to-day practice."
	Differentiating external and internal focus instructions/feedback	"I am clearer with the idea of external focus—for example, instead of saying 'bend your knees,' I could say 'sit down slowly into the chair."
	Change from prior knowledge	"Most of us were trained to focus on kinematic concepts, focus on giving internal feedback that focused on the body parts. So I was not very aware that those cues matter and may affect if we try to focus on the external environment."
Suitability of internal or external FOA for a variety of clinical contexts	Paediatric conditions	"What really stuck with me was that aside from children with autism, external focus of attention tends to be more effective for kids."
	Musculoskeletal conditions	"I'd say the athletes are suitable to internal focus like my sporty MSK patients."
	Geriatric conditions	"The use of FOA is suitable in my current practice. Most of the patients I see now are geriatric."
	Neurologic conditions	"For neuro cases, in my experience, external focus of attention is more effective."
How to utilise FOA in planning and designing instructions and feedback	Using the environment as external focus	"That you can use the environment. It's a good reminder and I'm doing the right thing for the kids, that I'm using external factors, their environment to help them cope with task demands."
	Adaptive strategies through FOA	"I learned that if I put foot markers, and then use cones, the child can perform the task of lifting his feet from the floor, using instructions that tell him to try avoiding hitting the cones."
Increased use of external FOA	Change in instructions	"So instead of saying, *'Straighten your back, straighten your back,'* I now think of something he can reach for — so that his back straightens or extends naturally."
	Change in feedback	"Now, in my daily practice, I actively use tools that help me use external focus - like coloured tapes that can give the child feedback that he's doing the task correctly."

Considerations and factors that influence the use of FOA in practice

Theme	Code	Sample Quote
Patient-related	Diagnosis	"For stroke patients who are able to communicate, I can ask if they understood the instructions, or if they have questions, or need clarification."
	Age and development level	"In paediatric patients, I think their verbal ability affects whether I use internal or external focus."
	Therapy goals	"For patients who are really early in the rehab process, I'd start with internal FOA because my goal is for them to understand their body parts first."
Clinic and organisation-related	Practice setting protocols	"It's a little bit constrained for me to plan my instructions and feedback given the limitation that PT sessions are only 30 minutes long or even less and we have protocols."
	Organisational culture	"I think there needs to be adjustment when practicing in a public hospital setting. Even if we know the principle to integrate it readily into practice, sometimes the way we do things have become tacit."
	Peers	"I shared my learning among my peers back in the hospital, some said '*Okay, we can try that*' but very few are familiar with the concepts, so it will be hard to change."
	Service delivery expectations	"In paediatric settings, we tend to assume that parents' level of comprehension is sufficient when we teach handling techniques. We also need to teach them how to monitor, how to position themselves, so we should be thinking of those things with our instructions."
Physical environment-related	Availability of materials	"Actually, I think I can use external focus because in my current setting (school) there's a lot of manipulatives I can really use."
	Technology factors	"After I give my instructions, it is hard to check if the patient is doing it correctly because I couldn't see their full body (during telehealth)."
Therapist-related factors	Physiotherapy curriculum	"Most of us were trained to focus on kinematic concepts, focus on giving internal feedback that focused on the body parts. If we look at the curriculum, this is what we were trained to do – to use more internal focus."
	Access to continuing education	"I think learning from webinars like this is very beneficial (for physiotherapists) because I think it's something new that we can explore – which works better for different cases."
	Experience and exposure	"For me, it's not impossible to apply it (using FOA), but it will take more planning and practice for me to consistently be conscious of which focus I will use."

FOA strategies for telehealth practice

Theme	Code	Sample Quote
Adaptation to the clients' contexts	Adapt to home environments	"I think giving that external focus can provide more relatable cues for the patient because we refer to things that they are familiar with in their home environment."
	Adapt to limited equipment	"At home, I saw that they had toy cones. So instead of focusing internally on the to lift his feet from the floor during exercise, I used those cones at home and asked my patient to try avoiding to hit the cones."
	Adapt to home routines	"It's hard for patients to digest the proper execution of movements. Focus instructions can make it be very practical, something that's very tangible that they can see, or that they can relate to with their tasks at home."
Enhancing instructions and feedback	Conscious planning	"I try to apply FOA to accommodate individual differences or impairments. I think there are ways like even using sound. For example, I can tell the child, *'raise your hand to the side where the sound is coming from'*. The principle remains the same, which I think I can keep using to plan instructions."
	Creativity	"Considering the focus of attention could actually be beneficial because sometimes we run out of ways of giving alternative instructions and they still don't understand how to do it on telehealth. Now, I feel like I can think of more alternatives."
	Enhanced understanding	"Using external focus of attention makes things simpler. You're not too technical but I think my patients understood the task better."
Enhancing therapy outcomes	Patients' movement performance	"For the exercise, I was telling my patient to *'bend your knees'* but he was not really responding. When I said *'sit down slowly into the chair'*, the instruction was more digestible. Then we could do the sit-stand exercise."
	Caregivers' facilitation of tasks	"My patient is 7 years old, cerebral palsy with dystonia. During the session, I noticed the child was overstimulated by the parent's constant instructions on reaching - *'do this,' 'do that'*. So I asked her to shift from body-based cues to something visible instead – *'shoot the ring'*. The child did it! And the mom noticeably became more relaxed"

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