education sciences

MDPI

*Article*

# Making Learning Happen in Teaching Games for Understanding with Cognitive Load Theory

**Stephen Harvey [1,*] and Edward Cope [2]**

[1] Department of Recreation, Sport Pedagogy, and Consumer Sciences, Ohio University, 100 East Union St., Athens, OH 45701, USA
[2] School of Sport, Exercise, and Health Sciences, Loughborough University, Mathhew Arnold Building, MAR.1.01, Epinal Way, Loughborough LE11 3TU, UK; e.cope@lboro.ac.uk
* Correspondence: harveys3@ohio.edu

**Abstract:** Game-Based Approaches (GBAs) to teaching and learning in physical education and sport pedagogy, such as Teaching Games for Understanding (TGfU), were initially developed in response to secondary school physical education (PE) students' difficulties in applying this technique within context. The early noughties experienced a significant body of work highlighting the benefits of adopting GBAs such as TGfU across physical education and sport pedagogy contexts. A theme residing in much of this work was understanding TGfU through the lens of social constructivism to the point whereby it seemed this was the only lens through which to consider how learning might happen through TGfU and/or related approaches. However, the exclusive alignment between TGfU and social constructivism is not heavily research-informed and/or evidence-supported, and it seems timely to question if other learning theories from cognitive science might help researchers and practitioners understand the benefits of applying a TGfU approach in teaching and coaching. We specifically approach this topic by appreciating Cognitive Load Theory (CLT) and how pedagogical concepts associated with CLT might help develop a new understanding of how TGfU could support learning.

**Keywords:** learning; pedagogy; physical education; sports coaching



Academic Editor: Thomas M. Leeder

Received: 31 March 2025
Revised: 16 May 2025
Accepted: 16 May 2025
Published: 21 May 2025

**Citation:** Harvey, S., & Cope, E. (2025). Making Learning Happen in Teaching Games for Understanding with Cognitive Load Theory. *Education Sciences*, *15*(5), 631. https://doi.org/10.3390/educsci15050631



## 1. Introduction

The current paper explores how Cognitive Load Theory (CLT; Sweller, 1998) and its associated pedagogical concepts can offer a complementary theoretical framework for understanding how Game-Based Approaches (GBAs), such as the Teaching Games for Understanding (TGfU) approach, can impact student/athlete learning. Social constructivism has been the main learning theory used to explain learning in TGfU (Kirk & MacDonald, 1998; Kirk & MacPhail, 2002; Light & Fawns, 2003; Light, 2008; Wang & Ha, 2012). However, its dominance may have inadvertently narrowed rather than broadened the ways the field of sport pedagogy could conceive how teaching and learning happens in TGfU. In this paper, we argue that CLT may provide a complementary theoretical perspective by discussing the relationship between the pedagogical concepts associated with CLT and the pedagogical principles underpinning TGfU (sampling, modification representation, modification exaggeration, and tactical complexity; Thorpe et al., 1986).

TGfU was originally developed as a practitioner-informed response to the observation that students often lacked motivation and a deep understanding of games within PE (Bunker & Thorpe, 1982). Seminal writings on TGfU were focused on presenting practical ideas for the implementation of its approach in sports such as tennis (Thorpe, 1983), cricket

(Bunker, 1983), and netball (Booth, 1993). It was only later and alongside sport pedagogy becoming an increasingly bona fide academic subject area that theoretical frameworks housed in teaching and learning were used to explain the benefits of TGfU and approaches based on similar pedagogical sentiments (i.e., Sport Education, Cooperative Learning; see Dyson et al., 2004).

The idea that learning to play a game occurs through active engagement in the game itself led many academics to understand learning in TGfU through a social constructivist theoretical lens (Kirk & MacDonald, 1998; Light & Fawns, 2003; Light, 2008). This association occurred when there was a broader academic shift towards constructivism in sport pedagogy contexts. Following Kirk and MacDonald's (1998) pioneering work, the following three decades have seen TGfU symbolized and referred to as a social constructivist approach to teaching and coaching (Light & Fawns, 2003; Rovegno et al., 2001; Wang & Ha, 2012; Wright et al., 2009). This strong association, while influential, carries the potential to limit the understanding of how teachers and coaches can effectively support the development of skillful gameplay through TGfU.

Consequently, this conceptual paper specifically draws upon CLT as an alternative framework to suggest how learning happens in TGfU, and by doing so, attempts to help teachers and coaches develop other ways of teaching and learning within TGfU. Rather than adhering to a singular theory, this encourages a pluralistic view of learning (Ranganathan & Driska, 2023), one that integrates insights from both social constructivism and findings from cognitive science research (Cope & Cushion, 2020; Collins et al., 2024; Harvey et al., 2018). Through this lens, practitioners can optimize their teaching and learning strategies to support learning in TGfU better, providing a more flexible but evidence-supported approach to TGfU preparation and implementation.

To structure our argument, we begin by outlining the historical development of TGfU and examining how it became theoretically aligned with social constructivism and is discussed as a constructivist teaching approach. In this section, we critically assess these developments and discuss the limitations of viewing TGfU solely through a social constructivist lens. Following this, we outline CLT and its core pedagogical concepts to view TGfU through a different, albeit complementary perspective. Using practical examples, we explore how the science of teaching and learning can enhance our understanding of the learning process through TGfU. Finally, we discuss the implications of this complementary perspective for teaching and coaching practice, offering recommendations for how CLT-informed strategies can be integrated into TGfU-focused teaching/coaching sessions to optimize the achievement of learning outcomes.

## 2. Historical Development of GBAs and TGfU

GBAs, such as TGfU, were initially developed in response to secondary school PE students' difficulties in applying sports techniques within the context of their use. TGfU was designed by a Loughborough games team (led initially by the practical ideas from Thorpe and Bunker, and the later theoretical developments by Almond (2015a; also reported in Harvey et al., 2018) to counter the dominant traditional teaching approach at the time characterized by the isolation of techniques from the circumstances under which these techniques were required in the game. A typical traditional PE teaching lesson format included an introductory activity, a skill/drill practice phase focused on developing and improving technique or aspects of technique, followed by a game (Blomqvist et al., 2001). This skills-first session structure, therefore, emphasized the "how" before the "why" and received criticism from the Loughborough games team for failing to provide students the necessary opportunities to learn technical and tactical strategies through the game. It was the idea of learning through the game that presented the greatest departure of TGfU away

from common teaching and coaching practice, with its emphasis on supporting students' understanding of what, when, where, how, and why to apply technique within games.

TGfU was outlined as a six-step process with the learner at the center. The process began the lesson with an initial game form that met the developmental needs of the learner, which first aimed to help develop their game appreciation before teachers/coaches moved onto focusing on tactical awareness via questioning; developing 'what to do' via decision making before focusing on the skill execution of 'how to do it'; and finally finishing the process with (hopefully) improvements in game performance. Overall, TGfU was suggested to flip the previously referred to skills-first teaching/coaching approach to one that was skills-second, where skills were only focused on after the learner developed an understanding of 'why' those skills may be needed within the game context, through the initial game play, game appreciation, tactical awareness, and decision-making stages of the TGfU model. Knowing this could likely lead to increases in a learner's motivation to commit to the skill learning process and consequently lead to improvements in overall game performance.

This six-step process was supported by four pedagogical principles: sampling, modification representation, modification exaggeration, and tactical complexity. These principles took advantage of the various categories of games (invasion, net–wall), with some more complex than others, so teachers (and coaches) could structure learning across different types of games and take advantage of knowledge transfer within and between categories of games, develop curricula by increasing tactical complexity year-on-year, and scale games (through modification representation) to the needs of the learner (e.g., play 3 vs. 3 soccer with younger players instead of 11 vs. 11). Teachers and coaches could also shape, focus, and enhance play (Launder & Piltz, 2013) by using modification exaggeration to highlight key tactical ideas within the various game forms by designing, modifying, and/or conditioning/constraining game-focused activities, by, for example, changing the size and shape of the playing area (long thin badminton court opposed to the regular width), how players score goals/points (to a goal/multiple goals, target player(s), or line in soccer), altering player numbers (1 vs. 2 singles in badminton, or 4 vs. 2 game in soccer), etc.

The practitioner-developed writings of Bunker and Thorpe, and later Almond, were in essence the early etchings of a grounded theory of learning to teach and coach games based on these authors' experiences and expertise of being games teachers. These ideas were integrated into an action research project in Coventry, where teachers collaborated with the Loughborough games team to test, modify, and refine the initial ideas of the TGfU model.

Len Almond, building on his foundational work on TGfU as a member of the Loughborough games team, later presented pedagogical ideas for TGfU at two AIESEP (the International Organization for Physical Education in Higher Education) conference presentations in Madrid (Almond, 2015b) and Laramie (Almond, 2016) and shared additional thoughts on these ideas through personal communications with the first author of this paper. These four pedagogical ideas were shaping a games curriculum, developing a pedagogy for teaching games lessons, a pedagogy of engagement within TGfU, and developing game sense. Each of these ideas built upon the pedagogical principles of TGfU.

Shaping a game curriculum was based on the pedagogical principle of sampling, and the notion of how learners would progress through learning about different game types (invasion, net–wall, striking, target) as well as the different game types (i.e., invasion) and individual games themselves. The pedagogical idea of the curriculum is also closely linked to the principle of tactical complexity, where tactical problems are dealt with in simpler ways at the beginning of a curriculum (i.e., small game forms in terms of player numbers, smaller spaces, etc., and with reduced technical demands) and are expanded upon in terms of their complexity throughout the curriculum. For example, Almond linked to the work

of Bruner and his notions of the spiral curriculum, where games and sports would be revisited (and/or interleaved) throughout the curriculum (Kang, 2016; Wahlheim et al., 2014). The best ideas of this development in various games are exemplified in the work of S. A. Mitchell et al. (2021) in their Tactical Games Approach.

Related to the above idea of curriculum, Almond also noted the need to develop a pedagogy of games teaching. This pedagogical idea builds on TGfU's modification strategies of representation, exaggeration, and tactical complexity that serve as scaffolding tools to optimize intrinsic load (Wood et al., 1976). In developing his ideas for a pedagogy of games teaching, Almond also drew on the work of Launder and Piltz (2013) in their *Play Practice* text.

The third area of a pedagogy of engagement within TGfU is how teachers and coaches engage learners in the content to be learned and how they engage players through their use of pedagogical skills and techniques in teacher/coach–player interactions. This includes the use of guided learning and structured questioning (e.g., McNeill et al., 2008) to engage and draw out player thinking focused on the tactical problems being worked on and developed via the sampling of the curriculum, its progression in terms of tactical complexity, and the use of game modifications to shape, focus, and enhance player learning in individual sessions.

The final pedagogical idea, the development of game sense, the ultimate outcome of TGfU, is connected to the notion of intelligent performance. While it may be a utopian vision for teachers and coaches to develop the perfect game sense for all their learners, learners can develop the appropriate if-then-do conditional knowledge required for 'intelligent performance' (Kirk, 1983) through a carefully sequenced curriculum of tactical problems and game experiences, informed by sampling and facilitated by appropriate game modifications and engagement.

In parallel to these pedagogical refinements, the initial ideas of TGfU have morphed into several different paths up the same mountain (S. Mitchell, 2005), with additional forms of TGfU being applied to meet contextual and cultural demands across the globe. For example, game sense was developed in Australia as Rod Thorpe shared his ideas on TGfU with coaches in Australia. Steve Mitchell, a former Loughborough University student, took the ideas of TGfU to the U.S. and collaborated with Judy Oslin and Linda Griffin to develop the Tactical Games Approach (TGA). Mitchell and colleagues simplified the six-step TGfU model to a three-step game–skill–game approach, so it was more manageable for U.S. physical educators. They also developed units of work within specific games across the categories of games, which unpacked ideas on tactical complexity through the various attacking and defending tactical problems in games. These developments reflect the use of the umbrella term of GBAs, with various GBAs sharing common features related to those initially espoused with the development of TGFU. However, alongside the practical developments in various "versions" of GBAs, theoretical developments in how learning is understood to occur within GBAs, such as TGfU, have occurred, which will be outlined in the next section of this paper.

## 3. Limitations of Social Constructivism in TGfU

TGfU was initially developed to address and solve practical problems faced by teachers (and coaches). Early publications (e.g., Almond, 1983; Booth, 1993; Bunker, 1983; Jackson et al., 1982; Thorpe & Bunker, 1982; Thorpe, 1983) primarily focused on demonstrating ways to present the alternative lesson structure and activities to be used within this structure. Consequently, the early publications from TGfU authors (such as those from the Loughborough games team cited above) did not share an underpinning theoretical basis for their ideas. However, according to one game team member, Len Almond, TGfU arguably

had a theoretical basis at its inception, even though this was not explicitly stated at the outset (see Harvey et al., 2018 for a more detailed review). While Pigott (1982) presented some of the "psychological basis" underpinning TGfU, including links to motor learning (i.e., through schema development), it was not until the late 1990s and early 2000s that we saw an increased emphasis on publications seeking to build the theoretical basis for TGfU (Harvey et al., 2018). Thus, the early noughties experienced a significant body of academic works published positioning TGfU within a social constructivist learning paradigm (Light & Fawns, 2003), especially using situated learning theory (i.e., Dyson et al., 2004; Kirk & MacDonald, 1998; Kirk & MacPhail, 2002; Wang & Ha, 2012). This work additionally highlighted the benefits of adopting TGfU across physical education and sport pedagogy contexts through this social constructivist lens.

The initial premise for aligning TGfU with social constructivism was based upon the interest in students' knowledge and how this was constructed (Rovegno & Dolly, 2006), especially since a key element of TGfU was the development of "understanding" (Harvey et al., 2018) and, in turn, "intelligent performance" (Kirk, 1983, p. 43). In addition, there was a focus in TGfU on the interaction between decision-making and skill execution and the acknowledgment by researchers and practitioners of their interdependency (Kirk & MacPhail, 2002). Thus, the development from constructivism to social constructivism was largely based on the notion of the dialogical aspects of learning in GBAs such as TGfU, where there was an interaction between what Light and Fawns (2003) called speech and action. In other words, periods of gameplay and/or game-related practice were interspersed with periods of questioning that were intended to increase students' tactical awareness and build their decision-making (know what to do or select an appropriate response), so that they can then execute this response and, in turn, improve game performance (Harvey et al., 2016; Harvey & Light, 2015; McNeill et al., 2008). Light and Fawns (2003) further highlighted the need for the teacher/coach to position themselves in the role of facilitator, whereby they guided students through cycles of play–reflect–play, adjusting the challenge level of game-like scenarios and tasks to the needs of the students/players and engaging students in reflection via asking open-ended and probing questions. Richard Light (see, for example, Light & Fawns, 2003; Light, 2008) was a major proponent of GBAs such as TGfU, challenging notions of Cartesian dualism where learning was seen as an internal cognitive process and not one where the mind and body acted as one (monism). Light and colleagues argued that learning in GBAs such as TGfU occurred through experience, emphasizing cycles of action and interaction with the environment, particularly through problem-solving and reflection within the game context. They contended that cognition is embodied, meaning that knowledge is developed through engagement, movement, and social interaction, including both playing and reflecting on play, and, thus, a social constructivist view of learning through the mind and body acting as one became the main means to explain learning in GBAs such as TGfU.

Situated learning theory was another theory introduced into the physical education literature and then aligned to TGfU that rejected the notion of dualism. Situated learning occurs through legitimate peripheral participation in a community of practice (i.e., learning is developed through engagement in specific social contexts) and was first introduced concerning TGfU by Kirk and MacDonald (1998). These authors argued that teachers and coaches could use TGfU to move away from "technicist" and/or "performative" physical education aligned with direct teaching approaches and rote learning to one that was more student-centered, holistic, and focused on learning through social processes such as interaction and discussion, whereby students learned to move from peripheral to full participation in a community of practice. The authors argued that situating learning within more game-like scenarios and providing students with opportunities for interaction,

discussion, and dialogue with others (mutual engagement; Wang & Ha, 2012) enabled students to see the connections and interdependence of decision-making and skill execution to allow them to make better sense of the game (shared repertoire; Wang & Ha, 2012) and thus develop their overall game understanding (joint enterprise; Wang & Ha, 2012), as well as to move from peripheral to full participation in the community of practice through this "apprenticeship" process.

A theme residing in much of this work was understanding TGfU through the lens of social constructivism (i.e., Light, 2008; Light & Fawns, 2003; Wang & Ha, 2012) to the point whereby it seemed this was the primary lens by which to consider how learning might happen through TGfU and/or related approaches. However, it could be argued that the alignment between TGfU and social constructivism was merely a conceptualization of TGfU rather than anything built on empirical evidence. For example, although the point about learning being situated is an important one to make, this is not the same as constructivism nor necessarily related to constructivism, as it has been written and claimed.

The shift to social constructivism led to some interpretations that the teacher/coach's role was "hands-off" (Cushion, 2013), and for TGfU to work, the coach needed to step back and simply guide student learning within games and tasks. However, as pointed out by researchers (e.g., Cushion, 2013; Harvey et al., 2018), this reflected a naive conception of learning within TGfU. More recent critiques of the teacher/coach's role within TGfU suggest that theory should not define method (Cope & Cushion, 2020). In other words, teacher/coach behaviors used by a teacher/coach using TGfU do not need to be aligned with simply one theoretical lens (Collins et al., 2024; Ranganathan & Driska, 2023). For example, a coach may tell a player what to do and how to do it, even though they have set up a tactical problem in practice for their players to solve. Thus, there is a need for GBA researchers and teachers/coaches using GBAs to recognize pluralism (Ranganathan & Driska, 2023) and the need to guide their teaching using an alternative theory and one that may be more flexible and based on "what works" in the real world (Collins et al., 2024). Teachers and coaches therefore need to use a variety of methods (Collins et al., 2024), especially those optimal methods grounded in teaching and learning research from cognitive science such as strongly guided as opposed to weakly guided instruction (Alfieri et al., 2011; Kirschner et al., 2006; Mayer, 2004).

Consequently, while the alignment of TGfU with social constructivism has provided some valuable insights, a nuanced understanding of learning in GBAs such as TGfU may benefit from considering other theoretical approaches that offer a complementary lens, such as CLT, particularly concerning cognitive processes and associated instructional strategies.

## 4. Cognitive Load Theory (CLT) and Its Pedagogical Concepts

### *4.1. What Is CLT?*

Decades of research investigating how learners, across a range of educational contexts, learn new information resulted in the development of CLT (Chandler & Sweller, 1991). At its simplest, CLT is concerned with the idea that if a learning activity is too easy for the learner, the level of challenge needs to be increased, and equally, if the activity is too hard, it needs to be made easier for the same reason: to make the level of challenge more appropriate.

Ultimately, any pedagogic activity should be concerned with managing a learner's cognitive load to enable efficient and effective learning (R. C. Clark et al., 2011; Paas & van Merrienboer, 2020). There are three types of cognitive load teachers and coaches need to be aware of, which are (1) intrinsic, (2) extraneous, and (3) germane (Kalyuga, 2011). Intrinsic load refers to the inherent complexity of the material being learned, with the complexity determined by what the learner knows and can do. Extraneous load is the

irrelevant cognitive load imposed by the instructional environment, including the manner and structure of instruction (i.e., confusing instructions, non-relevant practice conditions), distractions (i.e., background noise, other groups being coached, etc.), and organization of learning. In essence, extraneous load is caused by how the teacher or coach designs the learning environment and the behaviors they use within this environment. Finally, germane load is the relevant cognitive load, as determined by how teachers or coaches use evidence-informed learning strategies (i.e., scaffolding) to support efficient and effective learning. We contend that the three types of cognitive load and associated concepts and ideas offer a useful means by which to further consider and understand how the pedagogical principles of TGfU at the different stages of the TGfU can support learners' learning. This is depicted in Table 1 below, where we make explicit links between the six stages of TGfU, with its pedagogical principles and their relationship to CLT load features, CLT concepts, and the pedagogical strategy that supports athlete learning.

**Table 1.** Prospective alignment between teaching games for understanding model stages, pedagogical principles, and Cognitive Load Theory features and concepts.

| TGfU Stage | TGfU Pedagogical Principle Example | Related CLT Load Feature | Related CLT Concept | Pedagogical Strategy to Make Learning Happen |
|---|---|---|---|---|
| Initial Game Form | Representation Tactical Complexity | Intrinsic Load | Scaffolding | Use of small-sided games (e.g., 2 vs. 2) or overload and underload practices (e.g., 3 vs. 1) to reduce tactical complexity. Learners focus their attention on the most salient information within the learning environment. |
| Game Appreciation | Sampling | Intrinsic Load Germane Load | Retrieval Practice, Interleaving Schema Acquisition | Use of similar tactical problems across games and categories of games (e.g., use of space in attack in invasion, net/wall, and striking/fielding games). Learners make connections between tactical problems that exist across similar game categories. |
| Tactical Awareness | Exaggeration | Extraneous Load Germane Load | Split Attention Effect Schema Acquisition | Modify games using space/area, how you score, player numbers, etc. (e.g., shallow and wide field to emphasize width and switch play, long narrow court in net/wall games to emphasize how to attack space in front and behind the opponent). Learners create meaning from different aspects of gameplay based on what is already known about how to be successful in these situations. |
| Decision Making | Tactical Complexity | Intrinsic and Germane Load | Expertise Reversal Effect | Scaffold player decisions with structured guided questioning around tactical concepts; fade cues/prompts as you observe learning happening; move to more open-ended and player-led debates and action planning so learners take ownership of solving tactical problems independent of the teacher or coach. |
| Skill Execution | Representation | Extraneous Load Intrinsic Load | Worked Examples, Guidance Fading, and Scaffolding | Demonstrate appropriate ways to solve tactical problems (e.g., different ways to attack space in front and behind the opponent); use cues/prompts to draw learners' attention to; reduce support as learners become more proficient and demonstrate greater success in skill execution. |

**Table 1.** *Cont.*

| TGfU Stage | TGfU Pedagogical Principle Example | Related CLT Load Feature | Related CLT Concept | Pedagogical Strategy to Make Learning Happen |
|---|---|---|---|---|
| Game Performance | Tactical Complexity | Germane & Intrinsic Load | Retrieval Practice, Interleaving | Use spaced retrieval of tactical problems and ideas; vary game conditions (e.g., playing a player down) or specific situations (e.g., 2–1 down with 10 min to go). Learners apply previous knowledge by recognizing solutions to tactical problems from previous matchplay situations. |
| All stages | All stages | All | Spacing, Interleaving, Scaffolding | Plan curriculum and session sequences to revisit tactical problems and specific game situations with increasing tactical complexity within and between game categories and specific games. This is best achieved through interleaving the tactical problems to ensure long-term learning over shorter-term performance. |

Note: The examples presented in the above table illustrate suggested ways that CLT features and concepts may align with TGfU stages and pedagogical principles. They are not intended to represent an exhaustive or definitive mapping. We acknowledge and actively welcome alternative interpretations and applications as future research and discussion continue to expand our knowledge and understanding.

### *4.2. Understanding Learning in TGfU Through CLT*

In a CLT-informed learning environment, situated and active learning are as important as has been suggested in constructivist-informed learning environments. van Merrienboer and Kirschner (2007) stated that critical to any effective learning environment is the placing of learners in the context or situation to which the learning is to be applied. On the point of engaging learners in active learning, Mayer (2009) claims that for anyone to learn anything, the learning experience must always be an active process, but differentiation is required between being cognitively active and behaviorally active. Mayer (2009) writes that being cognitively active is about engaging learners in hard, effortful thinking, whereas behaviorally active is the involvement in the doing part of learning. This is why we provide examples in Table 1, which retain a game-like component and encourage as much tactical complexity within a practice activity relative to the age and stage of the learner. This is then combined with teacher or coach questioning strategies that support learners in being behaviorally active (Harvey et al., 2016; Harvey & Light, 2015; McNeill et al., 2008).

We also wish to challenge the idea that CLT is a purely information-processing view of the world. We agree with what Light and other colleagues have suggested previously, and what we referred to earlier in the paper regarding learning as both an individual and social process. Respecting the view that learning is situated and active, van Merrienboer and Sweller (2005) stress that CLT helps educators understand how they can seek to manage the complexity presented through games by using instructional methods that reduce the extraneous load on learners, as we provide additional examples for in Table 1.

The four pedagogical principles of TGfU can serve to manage a learner's intrinsic load, prevent unnecessary extraneous load, and enhance schema development via germane load (see Table 1). For example, the principles of sampling and modification representation can be applied by changing the task, so players initially pass with their hands instead of their feet. This sits with Almond's pedagogy of teaching games, and specifically 'shaping play', as through reducing the task complexity, players develop game appreciation of where to be positioned in relation to the opposition and their teammates. Both principles of modification, representation, and exaggeration could occur through changing a 5 vs. 5 game to two lots of 3 vs. 2 overload practices. Similar decision-making opportunities are afforded to the players, but given that fewer players are on the pitch, there is generally less

information for players to pay attention to and thus fewer possible decision-making options for players. Exaggeration of the 5 vs. 5 practice helps 'focus play', which reduces extraneous load by directing players' attention to key tactical aspects (e.g., distance between players). Focusing play through exaggeration could occur through changing the pitch dimensions and/or putting restrictions on the areas of the pitch players are allowed to move into. The pitch area might be made bigger to allow more time and space, and restricting player movement could help manage player decision-making. Finally, the fourth principle, tactical complexity, could be managed through sacrificing certain rules, such as offside or the goalkeeper being allowed to pick the ball up from a pass back or reductions in numbers and pitch size, as discussed. Managing the tasks' tactical complexity 'enhances play', thus increasing germane load, as such learning instances require players to apply tactical solutions and problem-solving under progressively more complex conditions relative to what is appropriate for any one player or group of players. Over time and exposure to these sorts of learning environments and tasks, there is an expertise reversal effect (which we discuss in more detail below) as learners internalize tactical schemas, which reduces cognitive effort in decision making (see Table 1). In turn, this enables learners to develop adaptable, transferable game intelligence in more complex conditions and with less support from the teacher/coach.

Understanding the need to reduce extraneous load can provide teachers and coaches working within a TGfU approach with a better appreciation that not all tasks (and learners) will have the same cognitive demands, and some games or game-related tasks may be too complex for some learners in their current presented form. For example, in a 5 vs. 5 soccer practice with no conditions, some players may be unduly overwhelmed with the volume of available information present within the learning environment. Such information could include the proximity of the opposition, the positioning of teammates, receiving and controlling the ball, moving the body in relation to moving the ball, and deciding the best decision if the ball is under control, all happening at the same time. For more experienced game players, such an environment might be a more ideal learning setting to support their skill development (the ability to apply the right movement, technique, and decision at the same time), and so the possibility for teachers and coaches to set problems to be solved becomes available to prevent the expertise reversal effect, which we discuss in more detail below. However, for other players, they will need teacher or coach support to manage the copious demands placed on their intrinsic load if they are to develop their game sense and game intelligence, as referenced by Almond. We contend that designing games through cognitive load management helps shift coaches' thinking more critically towards the quality of practice, rather than simply type.

In sum, TGfU's pedagogical principles alongside Almond's pedagogy of games concepts are a combination of scaffolding strategies, which, interpreted through CLT, serve to support players' schema construction and suitably manage players' germane load (van Nooijen et al., 2024). In the motor skill acquisition literature, the challenge point framework (CPF) has been a concept developed to help think about how to design practice activities that are positioned at the right level of challenge depending on the learner characteristics (Guadagnoli & Lee, 2004; Hodges & Lohse, 2022). The CPF explains how the difficulty of the task (referred to as the functional difficulty) needs to be considered alongside the learner's skill level (referred to as the nominal task difficulty). If the task is beyond what the learner is capable of, then the task difficulty needs to be reduced; equally, if it is too easy, the task difficulty needs to increase. The role of the teacher or coach when shaping a curriculum of games should reduce intrinsic load by ensuring learners encounter games in an appropriate sequence and minimize extraneous load by structuring tasks logically and progressively. Reducing intrinsic load and minimizing extraneous load has been found to

increase learner engagement and motivation for learning (Evans et al., 2024). While the CPF has not explicitly been understood through a CLT perspective, its central ideas are closely associated and help teachers and coaches think more effectively about their practice design within a TGfU approach.

In addition to thinking about how TGfU's pedagogical principles relate to the different types of cognitive load, there is also a need to consider how teaching and coaching behaviors can be understood through CLT ideas. Teachers and coaches' use of behaviors such as specific and corrective feedback, demonstrations, and instruction can help support the development of learners' game intelligence, but the use of such behaviors needs to align with learners' needs. A central CLT concept is the expertise reversal effect, which is where teachers or coaches provide strong support and guidance for learners who have already developed effective and efficient problem-solving capabilities (Myhill & Warren, 2005; van Nooijen et al., 2024). This idea is referred to as the expertise reversal effect because coach instruction and guidance are redundant, and instead, teachers and coaches should be seeking to help players better connect and strengthen prior learning (see Table 1). In such instances, teachers and coaches should adopt a problem-setting stance using open-ended questioning strategies, such as the debate of ideas and the reflective toss (Harvey et al., 2016; Harvey & Light, 2015), which support learners to activate prior knowledge to solve the problem the coach and game are posing. Indeed, Rosenshine's ten principles of instruction (Rosenshine, 2012), which were derived from decades of cognitive science research, identified questioning as being critical to checking for understanding and helping learners strengthen existing knowledge and understanding of what was being learned. Activation of prior learning, however, can only occur once time has elapsed between initial learning exposure and some forgetting of that learning. Once such a time has elapsed, spaced retrieval practice is possible, which is a process of engaging players in hard and effortful thinking back to prior learning, such as revisiting tactical concepts across sessions to reinforce long-term understanding (Ben-David & Roll, 2023; Kang, 2016; Wahlheim et al., 2014). Almond saw questioning as serving the purpose of drawing out ideas learners had and stretching learners' thinking beyond its current state. Understanding the purpose of questioning in this way links back to managing the extraneous load placed on players, as questioning strategies can be dialed up or down as appropriate to the level of challenge required (Cope et al., 2016), as seen in the examples in Table 1.

If the level of challenge remains too high for the learner despite the changing of practice conditions using TGfU's pedagogical principles, asking learners to come up with answers for something they know little about seems a futile teaching and coaching strategy (McLaren et al., 2014). Under circumstances where the learner is struggling with the task difficulty, which, in turn, is placing undue pressure on their intrinsic load, stronger teacher or coach support is required, which would typically come through increased specific and correct feedback, demonstrations, and cues and prompts to help with player problem-solving (R. E. Clark et al., 2012; Sweller, 2023). Within the TGfU and broader GBA literature, the role of teacher or coach behavior beyond questioning has received limited attention (Cushion, 2013). Through the lens of CLT, in situations where learners are finding the task too difficult within modified games, teachers or coaches providing clear and specific feedback, providing a reference point for what the practice attempt could look like through modeling, and providing instructional cues to help learners recognize important environmental information are all pedagogical strategies that could support learners in developing a better level of game understanding (Kalyuga et al., 2012; Sweller, 2023). However, these behaviors can just as easily overburden a learner's cognitive load if the information provided to the learner is not high-quality and does not support their learning. This often plays out through teachers or coaches using high and contradictory

amounts of feedback and instruction to the point that learners are left more confused than before receiving teacher or coach intervention. Too much information from the teacher or coach, alongside language that learners do not understand, generates a high extraneous load and should be avoided under all circumstances. What is important here is that the pedagogical strategies are employed in line with the cognitive load capacity of the learner (see Table 1). For some learners, this will entail more deductive teaching and coaching strategies, such as showing how to solve a problem alongside verbal instructions to help learners become aware of the most salient information to pay attention to. However, and contrary to some views, inductive teaching and coaching strategies, such as problem-based learning and forms of discovery learning, are compatible with CLT, as highlighted by Gorbunova et al. (2023), so long as the learner has the required prerequisite knowledge to solve the required problem. The links between teacher and coach behavior in the context of a TGfU approach have been given limited attention within the TGfU literature. We contend that using the principles of CLT helps teachers and coaches better recognize when and how teacher and coach behavior are used to support player decision-making, a central goal of TGfU and one of the main departures away from traditional teaching and coaching practice that had an almost exclusively technique-first focus.

## 5. Conclusions

In this paper, we explored CLT as an alternative theoretical framework for better understanding how learning happens in GBAs such as TGfU. We provided a detailed mapping of TGfU stages and pedagogical principles aligned with CLT features, related concepts, and adaptable pedagogical strategies. This alignment is intended to support teachers and coaches in designing and implementing TGfU sessions based on learners' cognitive needs and developmental stages.

We hope our proposed suggestions help teachers and coaches design TGfU experiences that integrate the structure and strongly guided instruction emphasized in CLT (Mayer, 2004) while maintaining the learner autonomy central to constructivist approaches. This balance, between cognitive efficiency and learner discovery, can progressively guide learners toward a deeper understanding of games, in line with the foundational intent of GBAs such as TGfU.

We reiterate the importance of considering alternative frameworks like CLT to analyze and enhance the pedagogical effectiveness and impact of GBAs, such as TGfU. Additional pedagogical empirical research that explores how learning happens in GBAs, such as TGfU, through the lens of cognitive science is needed to expand evidence-supported insights into teachers' and coaches' use of GBAs. This might include how teachers and coaches optimize, reduce, or manage intrinsic, extraneous, and germane load, respectively, at different stages of the TGfU model using its four pedagogical principles alongside specific CLT-informed pedagogical strategies. Such work should prioritize methodologically sound studies that track learning over a sufficient time to examine the specific effects of CLT-aligned interventions in ecologically valid, authentic learning contexts.

**Author Contributions:** Conceptualization, S.H. and E.C.; writing—original draft preparation, S.H. and E.C.; writing—review and editing, S.H. and E.C.; visualization, S.H. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** No new data were created or analyzed in this study. Data sharing is not applicable to this article.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| GBAs | Game-Based Approaches |
| TGfU | Teaching Games for Understanding |
| CLT | Cognitive Load Theory |
| CPF | Challenge Point Framework |

## References

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, *103*(1), 1–18. [CrossRef]

Almond, L. (1983). Games making. *Bulletin of Physical Education*, *19*(1), 32–35.

Almond, L. (2015a). Rethinking teaching games for understanding. *Agora for Physical Education and Sport*, *17*(1), 15–25.

Almond, L. (2015b, July 8–11). *Developing a games education for players* [Conference presentation]. AIESEP (International Organization for Physical Education in Higher Education) Conference, Madrid, Spain.

Almond, L. (2016, June 8–12). *Revisiting teaching games for understanding* [Conference presentation]. AIESEP (International Organization for Physical Education in Higher Education) Conference, Laramie, WY, USA.

Ben-David, J., & Roll, I. (2023). Desirable difficulties? The effects of spaced and interleaved practice in an educational game. In *International conference on artificial intelligence in education* (pp. 136–141). Springer Nature. [CrossRef]

Blomqvist, M., Luhtanen, P., & Laakso, L. (2001). Comparison of two types of instruction in badminton. *European Journal of Physical Education*, *6*(2), 139–155. [CrossRef]

Booth, K. (1993). An introduction to netball—An alternative approach. *Bulletin of Physical Education*, *19*(1), 27–31.

Bunker, D. J. (1983). Taking an understanding approach to the teaching of cricket—An example of a fielding game. *Bulletin of Physical Education*, *19*(1), 20–26.

Bunker, D. J., & Thorpe, R. D. (1982). A model for the teaching of games in the secondary school. *Bulletin of Physical Education*, *18*(1), 5–8.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, *8*(4), 293–332. [CrossRef]

Clark, R. C., Nguyen, F., & Sweller, J. (2011). *Efficiency in learning: Evidence-based guidelines to manage cognitive load*. John Wiley & Sons, Inc.

Clark, R. E., Kirschner, P. A., & Sweller, J. (2012). Putting students on the path to learning. *American Educator*, *36*(1), 6–11.

Collins, D., Carson, H. J., Rylander, P., & Bobrownicki, R. (2024). Ecological dynamics as an accurate and parsimonious contributor to applied practice: A critical appraisal. *Sports Medicine*, *55*, 799–810. [CrossRef]

Cope, E., & Cushion, C. (2020). A move towards reconceptualising direct instruction in sport coaching pedagogy. *Impact Journal*, *10*. Available online: https://my.chartered.college/impact_article/a-move-towards-reconceptualising-direct-instruction-in-sport-coaching-pedagogy/ (accessed on 20 March 2025).

Cope, E., Partington, M., Cushion, C. J., & Harvey, S. (2016). An investigation of professional top-level youth football coaches' questioning practice. *Qualitative Research in Sport, Exercise and Health*, *8*(4), 380–393. [CrossRef]

Cushion, C. J. (2013). Applying game centered approaches in coaching: A critical analysis of the 'dilemmas of practice' impacting change. *Sports Coaching Review*, *2*(1), 61–76. [CrossRef]

Dyson, B., Griffin, L. L., & Hastie, P. A. (2004). Sport education, tactical games, and cooperative learning: Theoretical and pedagogical considerations. *Quest*, *56*(2), 226–240. [CrossRef]

Evans, P., Vansteenkiste, M., Parker, P., Kingsford-Smith, A., & Zhou, S. (2024). Cognitive load theory and its relationships with motivation: A self-determination theory perspective. *Educational Psychology Review*, *36*(1), 7. [CrossRef]

Gorbunova, A., van Merrienboer, J. J. G., & Costley, J. (2023). Are inductive teaching methods compatible with cognitive load theory? *Educational Psychology Review*, *35*(4), 111. [CrossRef]

Guadagnoli, M. A., & Lee, T. D. (2004). Challenge point: A framework for conceptualizing the effects of various practice conditions in motor learning. *Journal of Motor Behavior*, *36*(2), 212–224. [CrossRef] [PubMed]

Harvey, S., Cope, E., & Jones, R. (2016). Developing questioning in game-centered approaches. *Journal of Physical Education, Recreation & Dance*, *87*(3), 28–35. [CrossRef]

Harvey, S., & Light, R. L. (2015). Questioning for learning in game-based approaches to teaching and coaching. *Asia-Pacific Journal of Health, Sport and Physical Education*, *6*(2), 175–190. [CrossRef]

Harvey, S., Pill, S., & Almond, L. (2018). Old wine in new bottles: A response to claims that teaching games for understanding was not developed as a theoretically based pedagogical framework. *Physical Education and Sport Pedagogy*, *23*(2), 166–180. [CrossRef]

Hodges, N. J., & Lohse, K. R. (2022). An extended challenge-based framework for practice design in sports coaching. *Journal of Sports Sciences*, *40*(7), 754–768. [CrossRef]

Jackson, S., Jones, D., & Williamson, T. (1982). It's a different ball game. *Bulletin of Physical Education*, *18*(1), 17–22.

Kalyuga, S. (2011). Cognitive load theory. How many types of load does it really need? *Educational Psychology Review*, *23*(1), 1–19. [CrossRef]

Kalyuga, S., Rikers, R., & Paas, F. (2012). Educational implications of expertise reversal effects in learning and performance of complex cognitive and sensorimotor skills. *Educational Psychology Review*, *24*(2), 313–337. [CrossRef]

Kang, S. H. K. (2016). Spaced repetition promotes efficient and effective learning: Policy implications for instruction. *Policy Insights from the Behavioral and Brain Sciences*, *3*(1), 12–19. [CrossRef]

Kirk, D. (1983). Theoretical guidelines for 'teaching for understanding'. *Bulletin of Physical Education*, *19*(1), 12–19.

Kirk, D., & MacDonald, D. (1998). Situated learning in physical education. *Journal of Teaching in Physical Education*, *17*(3), 376–387. [CrossRef]

Kirk, D., & MacPhail, A. (2002). Teaching games for understanding and situated learning: Rethinking the Bunker-Thorpe model. *Journal of Teaching in Physical Education*, *21*(2), 177–192. [CrossRef]

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86. [CrossRef]

Launder, A. G., & Piltz, W. (2013). *Play practice: Engaging and developing skilled players from beginner to elite* (2nd ed.). Human Kinetics.

Light, R. (2008). Complex learning theory—Its epistemology and its assumptions about learning: Implications for physical education. *Journal of Teaching in Physical Education*, *27*(1), 21–37. [CrossRef]

Light, R., & Fawns, R. (2003). Knowing the game: Integrating speech and action in games teaching through TGfU. *Quest*, *55*(2), 161–176. [CrossRef]

Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist*, *59*(1), 14–19. [CrossRef] [PubMed]

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

McLaren, I. P. L., Forrest, C. L. D., McLaren, R. P., Jones, F. W., Aitken, M. R. F., & Mackintosh, N. J. (2014). Associations and propositions: The case for a dual-process account of learning in humans. *Neurobiology of Learning and Memory*, *108*, 185–195. [CrossRef]

McNeill, M. C., Fry, J. M., Wright, S. C., Tan, C. W. K., & Rossi, T. (2008). Structuring time and questioning to achieve tactical awareness in games lessons. *Physical Education & Sport Pedagogy*, *13*(3), 231–249. [CrossRef]

Mitchell, S. (2005, December 14–17). *Different paths up the same mountain: Global perspectives on TGfU* [Conference presentation]. The 3rd Teaching Games for Understanding International Conference, Hong Kong, China.

Mitchell, S. A., Oslin, J. L., & Griffin, L. L. (2021). *Teaching sport concepts and skills: A tactical games approach* (4th ed.). Human Kinetics.

Myhill, D., & Warren, P. (2005). Scaffolds or straitjackets? Critical moments in classroom discourse. *Educational Review*, *57*(1), 55–69. [CrossRef]

Paas, F., & van Merrienboer, J. J. (2020). Cognitive-load theory: Methods to manage working memory load in the learning of complex tasks. *Current Directions in Psychological Science*, *29*(4), 394–398. [CrossRef]

Pigott, B. (1982). A psychological basis for new trends in games teaching. *Bulletin of Physical Education*, *18*(1), 17–22.

Ranganathan, R., & Driska, A. (2023). Is premature theorizing hurting skill acquisition research? *Frontiers in Sports and Active Living*, *5*, 1185734. [CrossRef]

Rosenshine, B. (2012). Principles of instruction: Research-based strategies that all teachers should know. *American Educator*, *36*(1), 12–19.

Rovegno, I., & Dolly, J. P. (2006). Constructivist perspectives on learning. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *Handbook of physical education* (pp. 242–261). SAGE Publications.

Rovegno, I., Nevett, M., Brock, S., & Babiarz, M. (2001). Chapter 7: Teaching and learning basic invasion-game tactics in 4th grade: A descriptive study from situated and constraints theoretical perspectives. *Journal of Teaching in Physical Education*, *20*(4), 370–388. [CrossRef]

Sweller, J. (1998). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*, 257–285. [CrossRef]

Sweller, J. (2023). The development of cognitive load theory: Replication crises and incorporation of other theories can lead to theory expansion. *Educational Psychology Review*, *35*(4), 95. [CrossRef]

Thorpe, R. D. (1983). An 'understanding approach' to the teaching of tennis. *Bulletin of Physical Education*, *19*(1), 12–19.

Thorpe, R. D., & Bunker, D. J. (1982). From theory to practice: Two examples of an 'understanding approach' to the teaching of games. *Bulletin of Physical Education*, *18*(1), 9–16.

Thorpe, R. D., Bunker, D. J., & Almond, L. (1986). Sport pedagogy. In *Olympic scientific congress*. Human Kinetics.

van Merrienboer, J. J. G., & Kirschner, P. A. (2007). *Ten steps to complex learning: A systematic approach to four-component instructional design*. Routledge.

van Merrienboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review*, *17*(2), 147–177. [CrossRef]

van Nooijen, C. C., de Koning, B. B., Bramer, W. M., Isahakyan, A., Asoodar, M., Kok, E., van Merrienboer, J. J. G., & Paas, F. (2024). A cognitive load theory approach to understanding expert scaffolding of visual problem-solving tasks: A scoping review. *Educational Psychology Review*, *36*(1), 12. [CrossRef]

Wahlheim, C. N., Maddox, G. B., & Jacoby, L. L. (2014). The role of reminding in the effects of spaced repetitions on cued recall: Sufficient but not necessary. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(1), 94–105. [CrossRef]

Wang, L., & Ha, A. (2012). Mentoring in TGfU teaching: Collaborative reflective practices. *European Physical Education Review*, *18*(1), 50–61. [CrossRef]

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Child Psychology & Psychiatry & Allied Disciplines*, *17*(2), 89–100. [CrossRef]

Wright, S., McNeill, M., & Fry, J. M. (2009). The tactical approach to teaching games from teaching, learning, and mentoring perspectives. *Sport, Education, & Society*, *14*(2), 223–244.