The use of OPTIMAL Instructions and Feedback in Physical Education Settings

Abstract

In physical education (PE), the use of instruction and feedback are central to children's motor skill learning. Recently, it has been identified that instruction and feedback which promote OPTIMAL theory motor learning factors (e.g., an external focus of attention, enhanced expectancies and autonomy support) can enhance children's motor learning. However, it is unclear how PE teachers use OPTIMAL instructional approaches and therefore, was examined in the present study. Verbal statements (n = 5765) from seven PE teachers (Mean age: 39.29 ± 7.19yrs) over 10 PE lessons were collected and thematically analysed. Results indicate that PE teachers use more externally focused (25%) vs internally focused (10%) instructional behaviours. Moreover, PE teachers used instructional approaches that enhanced (35%) as compared to diminished expectancies (8%) in addition to statements which supported (35%) rather than thwarted (23%) autonomy. Overall, PE teachers appear to use instructional behaviours which support OPTIMAL motor learning however, more efforts are needed to improve the provision of optimised instructional behaviours. Additionally, the findings indicate that OPTIMAL instructions and feedback are rarely delivered in isolation and may be influenced by the contextual factors of PE and sometimes conflict in their delivery (i.e., externally focused and autonomy thwarting).

Key words: External Focus, Enhanced Expectancies, Autonomy Support, Observation

1. Introduction

Verbal instructional behaviours have been identified to be a critical component to affect the learning and performance of motor skills (Rink, 2013; Schmidt & Lee 2019; Metzler, 2017). Given the importance of verbal instruction and feedback, research has been concerned with understanding how practitioners (e.g., sports coaches, rehabilitation therapists and physical education teachers) apply these verbal behaviours in practice (Halperin et al., 2016; Ford et al., 2010; Becker & Wrisberg, 2008). For example, research has shown that in both youth amateur volleyball (Isabel et al., 2008) and elite collegiate basketball settings (Becker & Wrisberg, 2008), verbal instructional behaviours where the most prevalent coaching behaviours used to influence learning and performance (35.94% and 48% respectively). Additionally, in youth soccer settings Ford et al., (2010) reported that verbal instruction was the most frequently used coaching behaviour (30% of all behaviours observed) whereas Partington and Button (2013) highlighted that instruction and feedback accounted for 53.42% of all coaching behaviours. Despite the importance of verbal instructional behaviours, research has identified that the quality of feedback and instruction may prevent optimal learning and performance and that practitioners may not be applying best scientific practice (e.g., Porter et al., 2010; Powell et al., 2021; Van der Graff et al., 2018; Halperin et al., 2016; Kal et al., 2018; Durham et al., 2009; Johnson et al., 2013). Additionally, there is a lack of research investigating the verbal instructional approaches of physical education teachers despite physical education being a critical environment to develop children's motor skills to provide them with "*the motivation, confidence, physical competence, knowledge and understanding to value and engage in physical activity for life*" (Whitehead, 2019. P.25). Understanding how PE teachers use verbal instructional approaches, and the quality of instruction and feedback is critical to inform best practice to enhance children's motor skill learning.

Wulf and Lewthwaite (2016) have proposed that instruction and feedback which promotes an external focus of attention, enhances expectations for success and supports a learner's autonomy are key attentional and motivational variables which can independently and interactively optimise motor learning (referred to as OPTIMAL theory) (see also An et al., 2021). While others have challenged the tenets of OPTIMAL theory (McKay et al., 2022; McKay, et al., 2023; St-Germain, et al., 2022), the importance of attention and motivation for skill learning cannot be understated, particularly for a child's holistic development (Whitehead, 2019). Therefore, we opted to use the "framework" of OPTIMAL theory as a basis for the coding procedures within our research. For example, an external focus (i.e., a focus on intended movement outcomes or effects) have consistently been shown to enhance motor performance and learning, as compared to an internal focus, by promoting more effective goal-action coupling through reducing conscious motor control. Additionally, expectations for success have been enhanced when instruction and feedback highlight good performances (e.g., positive feedback), promote positive social comparison, enhance conceptions of ability, lower perceptions of task difficulty and promote positive peer modelling (Bacelar et al., 2022). Moreover, instructions and feedback which allow learners to make task-relevant and task-irrelevant choices, which are delivered using supportive rather than controlling language and provide a meaningful rationales have demonstrated to have a positive effect on motor performance, learning and motivation (Su & Reeve, 2011; Hooyman et al., 2014; Ikudome et al., 2019). Despite this, few studies have explored how these OPTIMAL factors have been used in instructional approaches in applied settings, and those that have, typically address an external focus of attention.

For example, Porter et al. (2010) reported that elite track and field coaches were reported to use more internally (i.e., a focus on body movements) vs externally focused (i.e., a focus on the intended movement effect) instruction (84.6% vs 15.4% respectively).

Similarly, in an elite youth baseball setting, van de Graff et al. (2018) found that 69% of coaching instruction was internally focused, however, both Porter et al. (2010) and van de Graff et al., (2018) used questionnaires to examine the athlete's perception of instructional content which may be hindered by retrospective bias. Nevertheless, Powell et al. (2021) used real-time observation of the instructional approaches of elite para-swimming coaches and revealed a greater use for internally focused instruction compared to externally focused instruction during practice. In rehabilitation settings, practitioners have been reported to use more internally focused instruction early in the re-learning process with a later transition to externally focused cues, presumably to correct movement errors and "*tune the patient in*" for a functional task focus later on (Kal et al., 2013; Durham et al., 2009). Taken together, these findings indicate that practitioners may not be applying best scientific practice with regards to instructional behaviours given the overwhelming evidence highlighting the benefits of an external vs internal focus of attention (Chua et al., 2021).

With regards to motivational instructional behaviours, Mason et al. (2020) revealed that elite Australian rules coaches used feedback statements that where more negative (20%) than positive (13%) and were more controlling than autonomy supportive. Additionally, Halperin et al. (2016) reported that in-between rounds of competitive bouts, elite boxing coaches used feedback statements that were generally internally focused (15%) (vs 6% externally focused), positive (29%) vs negative (12%) and delivered in an autonomy controlling manner (53%) vs a supportive manner (5.8%). These findings suggest that elite coaches use instructional approaches which can lower expectations for success, undermine perceptions of autonomy and hinder motor performance. Nevertheless, Mason et al. (2020) and Halperin et al. (2016) reported that more positive (i.e., to enhance expectancies) and autonomy supportive feedback statements which can improve motor performance (Wulf & Lewthwaite, 2016), were provided more often for winning as compared to losing bouts/quarters. Whilst no causal relationship can be inferred, it is interesting to note this performance-feedback relationship and highlight that the feedback provision may be influenced by the environmental setting (e.g., winning vs losing).

Given that positive feedback can influence perceptions of competence (i.e., enhance expectancies), and in turn affecting intentions to participate in sport and physical education (Mouratidis et al., 2008), more efforts are needed to observe the current instructional behaviours of physical education teachers. Finally, only Halperin et al. (2016) have examined the use of OPTIMAL instructional language but did not address the implications of coaches providing successive or additive factors which can optimise (i.e., external focus, enhanced expectancies & autonomy support; An et al., 2021) or detriment motor performance (i.e., negative feedback, controlling language, internal focus). For example, Abdollahipour et al. (2017) found that autonomy support offset the negative effects of an internal focus but improved motor performance to a greater extent when paired with an external focus. Moreover, given that practitioners appear to use approaches which are not always aligned with the scientific research (i.e., external focus and internal focus feedback; external focus and negative feedback; Johnson et al., 2013; Kal et al., 2018), insight into the potential presentation of such conditions to improve children's motor learning in PE settings would inform this line of inquiry.

In summary, the importance of instruction and feedback for the learning of motor skills in physical education is critical (Rink, 2013; Schmidt & Lee 2019; Metzler, 2017). Moreover, the motivational and attentional content embedded within instruction and feedback can influence social-cognitive-affective-motor development and requires further examination in the PE setting (Corbett et al., 2023; Simpson et al, 2020). Whilst the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016) has been highlighted as a key framework to underpin instructional content, research exploring OPTIMAL instructional behaviours in applied settings (i.e., PE) is lacking. Therefore, the current study used real-time observation to explore the instructional behaviours of PE teachers undertaking their normal teaching activity, in relation to the implementation of OPTIMAL theory (i.e., external focus, enhanced expectancies and autonomy support).

2. Methods

2.1 Participants

Seven PE teachers (4 males, 3 females; Mean age: 39.29 ± 7.19yrs; teaching experience: 16.25 ± 7.91yrs) were recruited from high schools in northwest England. Teachers were recruited based on the criteria that they specialised in teaching PE. Overall, instructional behaviours were recorded from ten PE lessons, totalling 8:05 hours of recorded data. Specifically, three PE teachers were recorded over two lessons (i.e., same class, different tasks) and four teachers were recorded over one lesson. For contextual relevance, lesson details are provided in table 1.

Participants were provided a verbal description of the study and observation techniques to be used, however, participants where naïve to the true purpose of the study to minimise observer effects and preserve ecological validity (van der Graaff et al., 2018). Written informed consent and gatekeeper consent was obtained prior to the study. Ethical approval was granted by the departmental ethics committee (SPA-REC-2019-008R1).

[Table 1 near here]

2.2 Study design

An observational single group design described the frequencies of verbal instructional behaviours of PE teachers in relation to attentional focus, expectancies and autonomy (Kal et al., 2018; Halperin et al., 2016; Wulf & Lewthwaite, 2016). Verbal behaviours were recorded with a digital voice recorder (Olympus WS-853) and a tie clip microphone secured to the lapel of the shirt worn. A categoric system was derived from the SOPROX system of observation for proxemic communication (Castaner et al., 2013) to determine the target for instruction and feedback (i.e., whole class, small group, individual).

2.3 Data analysis

Following extensive discussions, it was agreed that instructional statements would be analysed using a 6-stage thematic analysis process (Braun & Clarke, 2006; Braun et al., 2016) including: 1) data familiarization, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) producing the report. Data analysis primarily adopted a deductive reasoning approach where the analytic process was informed by previous coding matrix's and underpinned by the OPTIMAL theory (Halperin et al., 2016; Kal et al., 2018; Wulf & Lewthwaite, 2016). Nevertheless, an inductive "data driven" approach was also used, particularly concerning *"other"* statements where PE teachers may have used "OPTIMAL" language without context to skill acquisition (e.g., acknowledging a learner's feelings [autonomy support] after an injury). Stage one and two of the thematic analysis involved immersion in, and familiarisation with the transcribed data, identifying meaningful ideas and concepts related to OPTIMAL theory and motor learning. These codes were initially tagged as short phrases to reflect their content and later clustered into higher order patterns informed by the theoretical framework (e.g., "positive feedback" later grouped into enhanced expectancies) (stages 3-5). Following the coding procedure, a second researcher independently coded 25% of statements to determine interrater reliability using Cohen's Kappa (McHugh, 2012), where an acceptable level of agreement was set at k >.60 (Moderate agreement). For all categories (e.g., external focus) there was strong to perfect agreement (k >.80).

Firstly, the intended target of instruction and feedback was determined and coded as either "*whole class*" (directed to all students in the class); *"small groups"* (directed towards a group of students); and *"individual"* (directed at a single student) (Castaner et al., 2013). Next, each statement was coded as, "*instruction"* (i.e., information about a desired action or execution in a future/upcoming practice attempt, including organisation of the task); "*feedback*" (i.e., information pertaining to a previously executed movement) or "*other*" (e.g., general talk not relevant to the task/lesson – i.e., "*the football was good last night, wasn't it?*") (Kal et al., 2018; Johnson et al., 2013). Instruction, feedback, and target of communication was operationalised through researcher observations. That is, the lead researcher observed lessons in-situ and synchronised a stopwatch to the start of the recording to note content (e.g., instruction) and target (e.g., small group). Where in-situ observation was not possible due to covid-19 (4 lessons), the lead researcher determined instruction, feedback and target group based on the contextual information, tone and loudness of spoken communication. For example, if participants split students into groups for skill practice, it was determined that instruction would be directed towards small groups or individuals for the upcoming passage of recording (based on previous in-situ observations). An increase of volume of communication typically signified an end to a task and progression on the next and it was inferred that communication target was to the whole class (based on previous in-situ observations). Similarly, contextual information was used to determine instruction and feedback. Here movement information during the task after an initial instruction was classified as feedback (Kal et al., 2018; Johnson et al., 2013). Each statement was coded once per OPTIMAL category: attentional focus, autonomy, and expectations (Halperin et al., 2016). Each OPTIMAL category included a "neutral" option where the statement could not be classified into or was irrelevant to a specific category. For example, the statement "*Better good, good well done"* could be considered as enhanced expectancies but neutral in the attentional focus and autonomy categories. As there were occasions where a statement could be coded to more than one category (e.g., attentional focus and autonomy), each statement was coded three times (Halperin et al., 2016): once in the attentional focus category (external focus [EF], internal focus [IF], mixed focus or neutral); once in the autonomy category (supportive [AS], controlling [AC], or neutral); and once in the expectations category (enhanced [EE], diminished [dim-ex], or neutral). The definitions of each OPTIMAL category are described next.

Statements which directed attention to the intended movement effect or outcome (e.g., "*dribbling around trying to keep the ball nice and low*" *[sic]*) were coded as EF (Wulf, 2013). In contrast, statements which directed attention to the self, body parts or muscle groups were coded as IF (e.g., "*elbows out, extend your arms*"*)* (Wulf, 2013). Additionally, statements which conveyed EF and IF information in the same statement were coded as a mixed focus of attention (Kal et al., 2018; Johnson et al., 2013).

Moreover, statements which offered opportunities for choice (task relevant and irrelevant), used supportive instructional language and provided meaningful rationales, were coded as AS (Su & Reeve, 2011; Wulf & Lewthwaite, 2016; Halperin et al., 2016). To capture the various approaches to supporting autonomy, each AS statement was coded into these sub-categories. Supportive instructional language was defined as instruction or feedback that was delivered through an autonomy supportive or suggestive manner (Su & Reeve, 2011; Hooyman et al., 2014; Halperin et al., 2016) (e.g., *"Try and keep the ball bouncing")*. Additionally, instructional behaviours where coded as meaningful rationale if reasons for decisions in the learning environment were used, which also included consideration of a learner's feelings or perspectives (Su & Reeve, 2011). Finally, choice was defined as instructional language which allowed control over elements of practice. These were further coded into task relevant (e.g., choice over practice partner, skill challenge level) (e.g., "*You choose. You choose your challenge, ok? You can pick your challenge. And, how do you know, if you've never tried it." [sic]*), or task irrelevant (e.g., choice of equipment colour choices). Conversely, instructional behaviours which demanded students to perform an action/skill/task in a particular way (controlling language) (e.g., *"Make sure for your chest pass, you get behind the ball. Your elbows don't need to be stuck out. Not completely stuck out, but you don't want them out here" [sic]*) prevented opportunity for choice (task relevant and irrelevant) through identifying a specific course of action within the learning environment, or, did not provide an explanatory rationale for decisions, were coded as controlling (AC) and later coded into their specific sub-categories (Haerens et al., 2015).

Next, instructional behaviours which framed performance in a positive or negative manner was coded as EE and dim-ex respectively (Wulf & Lewthwaite, 2016; Halperin et al., 2016). More specifically, sub-categories for enhanced expectancies included: positive social comparative feedback (i.e., positive feedback in relation the learner's peer's performance); enhanced conceptions of ability (i.e., through framing tasks as achievable with practice/effort); positive peer modelling (i.e., when a learner was used to model good performances) and reducing perceptions of task difficulty (i.e., when the task is simplified to enhance success rate) (Bacelar et al., 2022) . Moreover, positive feedback was coded as instruction or feedback that positively framed previous performance. This included task-specific feedback (e.g., "*good chest pass*"*)* and non-specific feedback (e.g., "*good job, well done"*). In contrast, negative feedback (i.e., instruction or feedback that negatively framed performance that was both task-specific and non-specific); negative social comparative feedback (i.e., negative feedback in relation to the learner's peer's performances); diminished conceptions of ability (i.e., through framing task failure as a lack of ability or talent); negative peer modelling (i.e., when a learner was used to model poor performances); increasing perceptions of task difficulty (i.e., when the task is simplified to enhance success rate).

The relative frequency (%) of verbal statements for each lesson was calculated by statement type (i.e., instruction, feedback or other), main-factor (i.e., attentional focus, expectations, or autonomy), category-factor (i.e., EF/IF/Mixed/Neutral; EE/dim-ex /Neutral; AS/AC/Neutral); sub-factor (e.g., positive feedback, negative modelling etc.) and audience (i.e., whole class, small group or individual) and averaged across all lessons.

3. Results

A total of 5765 instructional statements were analysed, examples of instructional statements are provided in tables 2-4.

[Tables 2-4 near here]

Overall, instructional behaviour appeared to support rather than thwart OPTIMAL factors (OPTIMAL- 33%; non-optimal - 18%; neutral – 49%). Irrespective of audience (e.g., whole class) and statement type (e.g., feedback), within the attention focus category, 25% of statements promoted an EF, 20% promoted an IF and 10% induced a mixed focus (figure 1a). Moreover, in the expectations category, 35% of statements were coded as EE, and 8% as dim-ex (figure 1b). Finally, 35% of statements where coded as AS and 23% as AC (figure 1c). Additionally, table 5 highlights the breakdown relative distribution of statements into sub-categories for EE, dim-ex, AS and AC.

[Figure 1 near here]

[Table 5 near here]

For instruction type, 17% of all statements were coded as *instruction* (980), 39% as *feedback* (2248) and 44% (2537) as *other*. For audience, instruction and feedback collectively, were primarily directed at *individuals* (45%) followed by *whole class* (32%) and *small groups* (22%). Further analysis revealed that instructions were mainly delivered to the whole class (72%) as compared to small groups (15%) and individuals (13%) whereas feedback was predominantly directed towards individuals (57%) as compared to the whole class (21%) and to small groups (22%). An overview of statement distributions for audience and statement type relative to sub-category are displayed in table 6.

[Table 6 near here]

In addition to analysing each category independently, the relative frequency of statements which combined two or more factors are reported. For example, where an EF instruction is provided with AS language. Hence, 15% of all EF statements also supported learner autonomy and vice versa (i.e., 15% AS statements promoted an EF). A breakdown of paired factor statements is presented in table 7. Moreover, only 15 statements combined all three OPTIMAL factors (i.e., EF, EE, and AS). For example, participant one in their Basketball lesson provided the feedback "*Nice Lucas (EE). Try (AS) and get a bit more of a loop on the ball (EF). Nice (EE)"* thereby impacting all 3 OPTIMAL factors. Additionally, in a netball passing lesson, participant seven provided the feedback "*Grace that was good, you stepped into the ball (EE) gives you more power, now try (AS) and pass [the]ball a little higher (EF)"*. In contrast, only 8 statements combined "non-OPTIMAL" factors (i.e., IF, dim-ex and AC). For example, "*Ok, no not like that Poppy, that's wrong (dim-ex). You have got to (AC) keep your feet still (IF)"* (participant 2 – netball passing)*;* and *"No, watch this. Your elbows are not flexed (IF), you need (AC) to sink through your knees (IF). Your technique is wrong, no control (dim-ex) (sic)"* (participant 4 – volleyball set shot).

[Table 7 near here]

4. Discussion

This study examined the instructional approaches of PE teachers in relation to optimal theory using real-time observation. Overall, teachers generally used instructional approaches which satisfy OPTIMAL learning conditions (Wulf & Lewthwaite, 2016). This contrasted with previous research showing a prominent use of IF and AC instructional behaviours in coaching and rehabilitation settings (Powell et al., 2021; Johnson et al., 2013; Durham et al., 2008; Halperin et al., 2016).

To understand why certain instructional behaviours emerged, consideration of the contextual setting is required. PE addresses children's holistic development targeting their physical, social, cognitive, and emotional development (Rudd et al., 2021; Lubans et al., 2010; Whitehead, 2019; Bailey et al., 2009). Therefore, opportunities to improve a learner's motivation (i.e., through EE and AS) may be more apparent in PE compared to a setting like boxing, where coaches may feel obliged to provide more explicit internally focused and controlling feedback to positively influence performance or to protect their athlete (Halperin et al., 2016). Whilst motivational approaches in elite sport are still critical for long term engagement (Trbojevic & Petrovic, 2021), PE is a compulsory subject in the UK, which may undermine intrinsic motivation and often includes learners with differing levels of motivation (Ntoumanis et al., 2004). For example, unlike voluntary sports settings, learners who are amotivated are still required to participate in PE, which can negatively impact intention and engagement in longer term physical activity (Stodden et al., 2008; Lubans et al., 2010). Therefore, PE teachers may adopt more motivational instructional approaches to increase engagement in PE and physical activity, and to develop young people's cognitive, social, affective and motor skills (Ladwig et al., 2018; Beni et al., 2017; Teixeira et al., 2012; Jaakkola et al., 2013). Future research should use follow-up interviews to understand the rationale behind these instructional approaches.

In contrast to studies in baseball, swimming, track and field, and stroke rehabilitation settings (van der Graff et al., 2018; Powell et al., 2021; Porter et al., 2010; Durham et al., 2009; Johnson et al., 2013; Kal et al., 2018), PE teachers used more externally vs internally focused instructional behaviours. In the present study, the focus on object manipulation skills may have better facilitated the emergence of externally focused information. The presence of clear environmental goals (i.e., a target to aim for) and implements (i.e., a basketball) in the present study likely increased the probability that teachers used an EF. Indeed, baseball coaches provided more EF cues (31%) compared to track and field coaches (17%) (van der Graff et al., 2018; Porter et al., 2010). Additionally, there was a higher frequency of whole class EF compared to IF instructions, suggesting that EF instructions may be a time-efficient approach to deliver movement information, as compared to potentially more time-consuming internally focused prescriptive instructions (i.e., allowing more on-task skill practice). In contrast, there was an even distribution of externally and internally focused individual feedback, suggesting that teachers adapt the content of feedback based on the intended recipient (i.e., whole class vs individual).

The equal use of internally and externally focused individual feedback could be explained by the nature of motor skill learning in PE and the corrective nature of feedback. Where whole-class EF instruction provides a general overview of the intended outcome or effect of a skill, individualised feedback aims to correct movement errors towards an “ideal” norm (Rink, 2013; Rudd et al., 2021; Durham et al., 2009). Indeed, the greater number of feedback statements suggests that teachers attempt to impose direct control over children’s movement skill execution and potentially undermine autonomy. Additionally, the corrective nature of feedback lends itself to IF content, although less frequent externally focused feedback is more effective in supporting motor learning (Wulf et al., 2010). Yet, the equal frequency of individualised EF and IF feedback suggests that attentional focus feedback may be dependent on the learners needs (Simpson et al., 2020). For example, for lower ability learners, IF feedback which explicitly states how to achieve successful motor actions may enhance perceptions of success (Petranek et al., 2019), intrinsic motivation, and task engagement (Lohse et al., 2016). In the present study, ability level of the classes was predetermined by the class teachers, which potentially explains why the frequencies of IF and EF instructional behaviours were observed. Such is the developmental nature of PE, considerations for use of an IF are needed, particularly as it relates to a learner's intrinsic motivation. Nevertheless, future research should examine PE teachers' justifications for such instructional approaches.

Beyond attentional focus, PE teachers used instructional behaviours that can increase intrinsic motivation by enhancing expectancies (Halperin et al., 2016; Kal et al., 2018). Specifically, like past studies (Corbett et al., 2024), positive expectancy information was predominantly delivered on an individual basis and via positive feedback. Likewise, elite youth soccer coaches used more positive feedback (4.9%) compared to negative feedback (2.6%), as they indicated the importance of positive feedback in re-motivating players - particularly after negative feedback (Partington & Cushion, 2013). Future research is required to investigate if teachers adopt a similar rationale for their feedback. In this study, positive feedback - both non-specific (42%) (e.g., "*well done"*) and skill-specific (37%) (e.g., "*yes! That's a great dig shot"*) - was the most common approach to enhance expectancies in this study and may be a method for teachers to quickly relay positive competence-based information (Zeman et al., 2006; Hagger et al., 2006; Mouratidis et al., 2008). A recent meta-analysis revealed that corrective feedback which guides learners towards information necessary to improve is the most effective for learning (Wisniewski et al., 2020) (e.g., *keep your arms up, buddy. And as your knees straighten, your elbows* [are] *gonna stay,* [you're] *going to push the ball up in the air" (sic)*). In contrast, Wisniewski et al. (2020) found that simple forms of reinforcement and praise had small effect sizes, but can influence participants' motivation, motor performance and learning (Wulf & Lewthwaite, 2016). However, we cannot determine the motor or motivational outcomes of positive feedback in this study and future research should explore the impacts of instructor feedback in ecologically valid settings.

In addition to positive feedback, expectations were enhanced by PE teachers reducing perceptions of task difficulty, enhancing conceptions of ability, positive peer modelling, and positive social comparative feedback. As our coding themes were informed by previous research (Bacelar et al., 2020), the findings highlight differences between experimental manipulations and real-world approaches. For example, participant one indicated that the basketball passing drill was too difficult and the task was to be made easier (i.e., "*push the cone out, make it bigger, we'll make it easier, more space"*). This statement was coded as reducing task difficulty; however, it is unclear how it enhances expectancies. For some learner's the task becoming easier may increase self-efficacy (Chiviacowsky & Hater, 2015), but for others tit may not provide an appropriate level of challenge and limit expectancies (Wulf & Lewthwaite, 2016; Hodges & Lohse, 2022). Additionally, positive peer modelling was coded as such, due to attempts from the teacher to demonstrate good performances to the class. Whilst this approach may be effective in providing learners with skill-related information (Asadi et al., 2021; Ste-Marie et al., 2012; Ste-Marie et al., 2020), it may expose the model to unwanted social attention, a focus on their motor competence, and a self-focus which hinders performance (Cimpian et al., 2007; Jourden et al., 1991; Mckay et al., 2015).

These findings highlight that the PE setting may influence teachers' instructional behaviours. Nonetheless, further research is required to understand their intentions. Additionally, observational research should help inform experimental conditions in studies, so that findings can highlight best practice principles for skill acquisition.

Along with enhancing expectations, PE teachers supported learner autonomy through supportive language, and providing choice (task relevant and incidental) and a meaningful rationale. Supportive language was the most common approach (e.g., "*Try and get the height, imagine there is a defender in the way. You might want to try and get a bit more of a loop on it, nice."* – basketball javelin pass). This aligns with studies showing that flexible and non-evaluative comments (e.g., "you may…") increase perceptions of autonomy, self-efficacy, positive affect, motor learning and engagement in physical activity (Hooyman et al., 2014; De Meyer et al., 2016; Reeve & Jang, 2006). These findings contrasted with studies of elite boxing and Australian rules football coaches who used more controlling language during competition (Halperin at al. ,2016; Mason et al., 2020). Perhaps the developmental nature of PE (Whitehead, 2019) may afford opportunities for more autonomy supportive behaviours to emerge. Nevertheless, Sarrazin et al. (2006) highlighted that PE teachers used more controlling behaviours with students who had a lower motivation to engage in PE. As such, future studies should investigate if teacher's perceptions of student's influence their instructional behaviours.

Our findings showed that PE teachers offered learners task relevant choices (e.g., choice of task difficulty and dribbling technique to be used) and irrelevant choices (e.g., choice of basketball to use) which where both cognitive, procedural, and organisational in nature (Perencevich et al., 2004; Agbuga et al., 2016). Such findings align with Xiang et al. (2017), who reported that 90% of PE teachers provide students with choices as they believe that choice during practice is effective for learning. However, recent research has highlighted that self-controlled learning (i.e., a learner having the opportunity for choice) has a negligible effect on motor learning (St Germain et al., 2022). Nevertheless, the opportunity for choice can improve perceptions of autonomy and competence, and therefore positively influence motor learning through indirect motivational pathways (Aniszewski et al., 2019; White et al., 2021; Xiang et al., 2017; Lemos et al., 2017; Hooyman et al., 2014; Kaefer & Chiviacowsky, 2021; Wulf & Lewthwaite, 2016). Overall, disseminating knowledge on the benefits of choice and autonomy support is critical as teacher's instructional efficacy influences their teaching behaviours (Pajares, 1992). This is particularly important as choices may not always be beneficial if they lack clarity or offer too many choices, which could lead to sub-optimal decisions (Ziv et al., 2020; Ziv & Lidor, 2021).

Despite the use of OPTIMAL instructional behaviours, PE teachers were ineffective in combining EF, EE and AS. Moreover, our findings suggest that teachers combine OPTIMAL and "non-optimal" factors in a single instruction (e.g., feedback that promotes IF using autonomy supportive language) and switch between approaches (e.g., EF instruction and IF feedback). Given the large amounts of students in PE lessons, it can be expected that such instructional behaviours would emerge. Whether these approaches are intentional or shaped by training, experience or for ease of communication remains speculative and requires further investigation. However, the intended target of instructions and feedback appear to drive the combinations of motivational and attentional content of instructions. For example, EF instructions appear to be delivered to the whole class and EE feedback to the individual. The benefits of combined or successive implementation of OPTIMAL factors have been established (An et al., 2020), yet the effects of combined or successive OPTIMAL and so-called "non-optimal" factors (e.g., IF, diminished expectancies and controlling instructions) are relatively unknown. For example, Makaruk et al. (2019) found that an EF/AS combination and EF-alone improved football shooting performance compared to an IF/AS combination, which suggests that "non-optimal" factor can undermine the effects of an OPTIMAL factor. In contrast, Abdollahipour et al. (2017) found that choice improved children's bowling performance when paired with EF and IF instructions, with greatest benefit in the EF condition. This suggests that AS can offset the detrimental effects of an IF and optimise performance when paired with an EF. Given that PE teachers use "theoretically inconsistent" instructional behaviours (i.e., EF but controlling instructions) future research is required to understand how such approaches impact motor learning.

The present study has limitations that should be considered. First, the impact of instructional behaviours on learners are speculative and theoretical, as no performance or motivational measures were collected. Nevertheless, the present study was the first to examine instructional behaviours in PE settings in relation to OPTIMAL theory. Second, due to the timing of observations, all schools were focusing on invasion/object manipulation sports (e.g., football, and basketball). Therefore, it is possible that in sports like gymnastics and dance, different instructional behaviours may emerge. Third, there were challenges in the operationalisation of OPTIMAL factors in the coding framework and process, due to the complexity of real-world instructional behaviours. For example, whilst lowering perceptions of task difficulty may enhance expectations for one learner, this may not provide sufficient challenge for another and may lower the expectancy effect (Wulf & Lewthwaite, 2016). Future experimental studies that include ecologically valid instructional behaviours may help to enhance the applicability of research in this domain. Finally, most lessons observed adopted a teacher-centred approach, which may have influenced their instructional behaviour. Future research may consider post-observation interviews to better understand why certain instructional approaches were used by teachers (Powell et al., 2021).

5. Conclusion

PE teachers appear to engage in instructional behaviours that facilitate OPTIMAL learning conditions. In contrast to rehabilitation or competitive performance settings, the developmental nature of PE may better support positive instructional behaviours. However, efforts are needed to further promote best-practice instructional behaviours, given that teachers use some instructional approaches which may not be conducive for optimal motor learning. Finally, more research is needed to understand how theoretically conflicting instructional approaches impact children's motor learning in PE.

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Table 1. Overview of observed PE lessons

Age range - years (school year group)	Ability	Class Gender	Task	Children's previous exposure to task in PE
12-13 (8)	Mixed	M	Basketball (Passing)	1
12-13 (8)	Mixed	M	Volleyball (Setting)	1
11-12 (7)	Mixed	F	Netball (Passing)	3
11-12 (7)	Mixed	F	Football (Dribbling)	3
11-12 (7)	Low/mixed	M	Basketball (Dribbling and Lay-ups)	2

11-12 (7)	Mixed	M	Volleyball (Setting)	2
11-12 (7)	Mixed	M	Basketball (Dribbling)	1
12-13 (8)	Mixed	M	Handball (Restarts)	4
13-14 (9)	Mixed	F	Netball (Passing and Footwork)	4
13-14 (9)	Mixed	F	Netball (Passing and Footwork)	4

Notes: M = Male; F = Female.

Table 2. Examples of attentional focus instructional behaviours used by PE teachers.

EF	IF	Mixed
"Dribbling around trying to keep the ball nice and low, off you go" (sic)	*"Good try and keep your feet still"*	*"And 3. 3 sit down, try keep your hand on top of the ball and can you bounce it through your legs. Keep the ball bouncing at all times".*
"Guys imagine there is a defender in the way and he's a giant, it's got to go over his head, way over his head"	*"So, if you want like real power, aim it down a little bit and extend your arms out" (sic)*	*"So, you still need the short sharp passes, but don't move your feet when you've got the ball"*
"Sometimes it's best if you carry the ball ok, and dribble it up the pitch, and keep it with you until a passing opportunity appears".	*"Remember squat into it lads, remember bend your legs, legs Ryan legs, legs" (sic)*	"*They go from bent arms to straight arms, and they push that ball away"*
"You only have to dribble to that line alright? and then go back to that white line alright?"	*"Well, where should your elbows be for Both? Show me".*	*"They're trying to keep the ball between the feet" (sic)* *"They're using the insides of the feet to channel it [the ball] to keep it under control*" *(sic)*
"*You've just got to get the bounce lower*"	*"OK, would you say his elbows are flexed. So, he needs to sink through your knees. That's it, that's it" (sic)*	*"Who managed the minimum to catch the ball in the base of your fingers" (sic)*
"So how long can you keep the ball off the floor? Just using set shot"	*"Push through your fingers on release"*	*"Keep your arms up, buddy. And as your knees straighten, your elbows gonna stay, going to push the ball up in the air" (sic)*

Notes: EF = external focus of attention (i.e., a focus on the intended movement effect or outcome); IF = internal focus of attention (i.e., a focus on the self, body parts or muscle groups); mixed = mixed focus of attention (i.e., conveyed both EF and IF information).

Table 3. Examples of instructional behaviours used to manipulate expectations by PE teachers.

EE	dim-ex
"That's better. Last time you up were at head height. (sic)	*"Josh,* Josh, *too hard you are not looking where you're throwing it"*
"Keep going Ben, unlucky".	*"Harry don't punch it like that"*
"Nice and accurate josh well done"	*"Oh, come on, mark,* mark, *mark. Don't let them pass it around"* (sic)
"Nice dribbling"	*"Look up girls don't just kick it. Look at what you're doing".*
"Well controlled. That was a good use of another part of your foot, well done"	*"Paddy, is that as good as you can go son? It's not, it's not as good as you can go"* (sic)
"Now those People who did that really, really well. Which was the majority"	*"Ok whilst the foot movement might be important. The hand movement certainly isn't because it's not relevant. Playing in the wrong sport. For those people who are dribbling the volleyball that is not allowed in the games is not a skill and technique"* (sic)
"OK. this time when you get to the turn. If you didn't master that, I'd like you to do that again. If you did master that, I'd like you to now turn by taking the ball between your legs. OK"	*"Too slow, too slow. Defenders have got back. You've got the quick. It's high intensity. Your speed determines this move. If you dordell and get to here like this and receive the pass, that would just be a possession game then. All right. High intensity, let's go"* (sic)

Notes: EE = enhanced expectancies (i.e., statements which framed perfromance as positive); dim-ex = diminished expectancies (i.e., statements which framed perfromance as negative).

Table 4. Examples of instructional behaviours to impact autonomy used by PE teachers.

AS	AC
"Try and keep the ball bouncing".	*"Right because you are that far back now look you are gonna have to step into it with your foot. So, if you step out, better but if you get it to pop up a little bit in front of him"* (sic)
"Figure of 8 through your legs, try and keep your feet still, planted on the ground"	*"So, you still the short sharp passes, but don't move your feet when you've got the ball. OK"* (sic)
"Extending your arms and fingertips, it's called a set because just like in football, if you were setting someone for a shot, you gonna say set set, it's the same in volleyball, you are meant to be setting somebody up so they can come in and do a better shot maybe a spike although a bit hard in these nets" (sic)	*"What I need you to do, what we need you to do is to get that ball"*. *"So, you get into propulsion here. All right. And the force of both arms behind the ball"*
"Anyone else volunteer first before who's not been one before. Who's never been a leader?" (sic)	*"I'm going to put into groups will tell you leaders you're doing to warm up. All right. I want you organised. I want to see a pulse raiser. I want to see dynamic and static stretches. And then I will take charge of skills practise"* (sic)
"You choose. You choose your challenge, ok? You can pick your challenge. And, how do you know, if you've never tried it."	*"I don't want you covering or being clever. All right"*
"OK. How was that girls? We're quite, quite squashed together". (sic) *What can we do? Absolutely, spread out. How do we spread out in a game of netball? Well, running into space. Keep moving"*	*"Make sure for your chest pass you get behind the ball"*. *"Your elbows don't need to be stuck out. Not completely stuck out, but you don't want them out here"*.

"Wonderful. Are we ready, gentlemen? Two guys here. *Are you ready? Choose one ball. Put the other one away"*.	*"So, you need to keep the ball here and your body needs to be first with your body and your arms needs to be put underneath the ball from there to get the height. If you bring it down to there, how do you get the rest of your body underneath it? Physically impossible, basically. All right. So, focus on releasing the ball above your head height"*

Notes: AS = autonomy supportive (i.e., opportunities for choice, supportive instructional language and meaningful rationales); AC = Autonomy controlling (i.e., prevented choice, controlling language, no meaningful rationales).

Table 5. Relative distribution (%) of instructional behaviours by sub-category.

Main Category	Subcategory	Relative distribution
Enhanced expectancies	Positive feedback	79.26% (non-task specific- 42.12%; Task specific – 37.14%)
	Enhanced conceptions of ability	16.22%
	Lower perceptions of task difficulty	2.87%
	Positive peer modelling	1.03%
	Positive social comparative feedback	0.62%
Diminished expectancies	Negative feedback	71.67% (non-task specific – 57.34%; Task specific – 14.33%)
	Negative social comparative feedback	10.56%
	Negative modelling	2.78%
	Increased perceptions of task difficulty	7.22%
	Diminished conceptions of ability	7.78%
Autonomy support	Choice	25.28% (Task relevant choice – 43.75%; Task irrelevant choice – 56.25%)
	Meaning rationale	36.08%
	Supportive instructional language	38.64%
Controlling	No choice	18.61%
	Controlling language	67.26%
	No rationale	14.13%

Table 6. Relative distribution (%) of instructional behaviours by audience.

	Attentional focus				**Expectancies**			**Autonomy**		
	EF	IF	Mixed	Neutral	EE	DimEx	Neutral	AS	AC	Neutral
Whole class	15%	11%	7%	67%	18%	6%	76%	25%	13%	62%
Small group	11%	4%	4%	80%	23%	6%	71%	18%	16%	67%
Individual	8%	9%	2%	81%	37%	7%	56%	15%	11%	74%

Notes: EF = external focus of attention; IF = Internal focus of attention; mixed = mixed focus of attention; EE = enhanced expectancies; dim-ex = diminished expectancies; AS = autonomy support; AC = autonomy controlling.

Table 7. Relative frequency (%) of statements coded into two categories.

	AS	**AC**
EF	15%	14%
IF	10%	14%
Mixed	9%	11%

	EE	**Dim-ex**
EF	7%	9%
IF	6%	6%
Mixed	4%	5%

	EE	**Dim-ex**
AS	9%	12%
AC	7%	12%

Notes: EF = external focus of attention; IF = Internal focus of attention; mixed = mixed focus of attention; EE = enhanced expectancies; dim-ex = diminished expectancies; AS = autonomy support; AC = autonomy controlling.